Hazardous waste infrastructure needs and capacity assessment

Final report

prepared for

Department of the Environment

July 2015

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Final report: P530
July 2015

Blue Environment prints on 100% recycled content paper

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Abbreviations & glossary

The Act	*Hazardous Waste (Regulation of Exports and Imports) Act 1989*
AFFF	Aqueous film forming foams
ANZSIC	Australia and New Zealand Standard Industry Codes
Basel Convention	*The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal*. The Convention puts an onus on exporting countries to ensure that hazardous wastes are managed in an environmentally sound manner in the country of import.
CAGR	Compound annual growth rate.
CPT	Chemical or physical treatment (facility)
Controlled Waste	Waste that falls under the control of the Controlled Waste National Environment Protection Measure. Generally equivalent to hazardous waste, although definitional differences of the latter exist across jurisdictions
Controlled Waste NEPM	National Environment Protection (Movement of Controlled Waste between States and Territories) Measure.
DoE	The Australian Government Department of the Environment
EPS	Expanded polystyrene
Hazardous waste	A hazardous waste, as defined in the Australian Government's *National Waste Policy: Less waste, more resources* (2009), is a substance or object that exhibits hazardous characteristics, is no longer fit for its intended use and requires disposal. According to the Act, hazardous waste means: (a) waste prescribed by the regulations, where the waste has any of the characteristics mentioned in Annex III to the Basel Convention; or (b) wastes covered by paragraph 1(a) of Article 1 of the Basel Convention; or (c) household waste; or (d) residues arising from the incineration of household waste; but does not include wastes covered by paragraph 4 of Article 1 of the Basel Convention.
Interstate data	Data collected about hazardous waste generated in one jurisdiction and treated in another, through cross-border transport under the Controlled Waste NEPM
Intrastate data	Data collected about hazardous waste generated, transported and treated within the one jurisdiction
kt	Kilotonnes (thousands of tonnes)
LPCL	Low POP concentration limit
Mt	Megatonnes (millions of tonnes)
NEPM	*National Environment Protection (Movement of Controlled Waste between States and Territories) Measure 1998*
PCB	Polychlorinated biphenyl
PFOS	Perfluorooctane sulfonate
POP	Persistent organic pollutant
POP-BDE	Persistent organic pollutants - bromodiphenyl ethers (various forms)
Potential infrastructure capacity	Refers to the maximum capacity that the current infrastructure set and those facilities that are under development could process on an annual basis. For some sites, an EPA licence or planning permit amendments may be required to process the potential tonnage. The maximum capacity at current operating infrastructure has been combined with the capacity of planned infrastructure, that industry identified during consultation, to protect the commercial information regarding planned site developments. Industry stated that planned infrastructure information is particularly sensitive and must be protected.

Waste groups	The classification system adopted for generating the projections of waste arisings (closely follows the NEPM categories.
Infrastructure groups	The Rawtec (2014) database provided information on infrastructure 'treatment activities' and on the types of waste received by NEPM 15 codes and for a few sites by NEPM 75 codes. This information was combined with industry survey responses to produce a set of hazardous waste infrastructure groups that could be used to compare waste group arisings and fate to the current and potential infrastructure capacity.
Tracking system	Jurisdiction-based hazardous waste tracking systems, which are in place in New South Wales, Queensland, South Australia, Western Australia and Victoria. These tracking systems can be either online, paper-based, or a combination of both these mechanisms.
Tracked data	Hazardous waste collected under the arrangements of a tracking system
Treatment	Treatment of waste is the removal, reduction or immobilisation of a hazardous characteristic to enable the waste to be reused, recycled, sent to an Energy from Waste facility or disposed.
Waste	(For data collation purposes) is 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	Hazardous waste is said to 'arise' when it causes demand for processing, storage, treatment or disposal infrastructure.
Waste Code	Three-digit code typically used by jurisdictions to describe NEPM-listed wastes. These are also referred to as 'NEPM codes' although it is noted that the actual codes do not appear in the NEPM itself.
Waste fate	Refers to the destination of the waste within the set of defined end points. It includes reuse, treatment, recycling, energy recovery, and disposal. Waste transfer and storage should not generally considered as a waste fate. The term fate does not infer that the waste material is destroyed or lost.
WEEE	Waste electrical and electronic equipment

Acknowledgements

This project could not have been completed without the valuable input of government and industry stakeholders. The project team would like to thanks all of those who have taken the time to respond to our requests for input.

Federal and state government stakeholders we need to thank:
Andrew McNee, Andrew Morgan, David Powers, Des Clayton, Dr Paul Starr, Dr Sara Broomhall, Emma Young, Glenn Ellis, Greg Thomas, Jaimie Clarke, John Horan, John Vanzo, Kate Hamer, Kylie Hughes, Laurence Knight, Lee Eeles, Louise Sindall, Mark Bannister, Paul Bainton, Paul Kesby, Reuben Gregor, Sally Thomas, Scott McKenzie, Scott Mears, Steven Sergi, Tim Eaton, Tony Hodgson.

Industry and local government stakeholders we need to thank:

ABM Envirosafe Treatment Plant	Clive lynn
Ace Waste	John Homewood, Kevin Maddick
Auscol	Ryan Knight
Australian Refined Alloys	Todd Vains
Bowser Landfill	Courtney
Bradbury Industrial Services Pty Ltd	John Hewitson
Castlemaine Landfill	Dallas Giles
CMA Ecocycle	Nick Dodd
Coast and Valley Oil	
Cootamundra Soil Recycling Facility	Maxine Imrie
Dooen Landfill	Mario Malibiran
Drums Go Round	Mike Ritchie
Eaglehawk Eco Centre	Gary Leech
Gannawarra Shire Council Landfill	Adam Cooper
Geocycle	Ross Nicholls
Hanson's Wollert Landfill	Harry Taylor
Hi-Quality	Lance Ingrams
J.J.Richards	Kurt Whalan
Jackson Street Waste Management Centre	Shafiq Mohamed
Koonwarra Landfill	Peter Roberts
Mildura Landfill	Sarah O'connor
MRI (Australia)	Will LeMessurier
National Resource Recovery	Tim
NYRSTAR	Bertus DeVilliers
Onslow Refuse Disposal Site	Andrew Johnson
Regain	Bernie Cooper
Renex	Peter Mirkov
Sims E-Recycling	Troy Ruediger
SITA	Mark Globan
Solveco	Geoff
Solvents Australia	Colin
State Waste Services	Chris
Stawell and Ararat Regional Landfill	Jordan
SteriHealth	Pablo Perez-Reigosa
Swan Hill Landfill	Jordan
Toxfree	Adam Greenwood, Karl Baltpurvins
Transpacific	Paul Vujic
Veolia	Matt Stanelos, Max Spedding
VIP Steel Packaging	Helen Szabo
Weston Aluminium	Ian Burns, Garbis Simonian
Windell Refuse Site	Mel Rowe
Wren Oil	Peter

Executive summary

Introduction

Following a commitment in the *National Waste Policy: Less Waste, More Resources*, in June 2014 the Australian Government Department of the Environment (DoE) commissioned this project to assess Australia's current and future hazardous waste infrastructure capacity and needs.

The project had three parts:

1. Prepare projections of hazardous waste arisings and fates over the coming 20 years.
2. Consult with industry to estimate Australia's current hazardous waste infrastructure capacity, its distribution and expected future.
3. Combine the results of the first two parts to identify the extent to which current infrastructure meets future needs, considering the nature and locations of particular infrastructure.

Each part of the project is discussed below.

Limitations and uncertainty

This assessment of projected hazardous waste infrastructure need vs. capacity is affected by the following:

1. the levels of uncertainty in the projected arisings of hazardous wastes
2. the levels of uncertainty in assuming how much of each waste's arisings will be managed by what infrastructure (the assumed fate)
3. the limitations and levels of uncertainty of 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.

Projections of hazardous waste infrastructure needs

Hazardous waste is taken to correspond with the wastes that the states and territories (the jurisdictions) regulate as requiring particularly high levels of management and control. An important aspect of the context for this project is the potential for 'new' hazardous waste streams to arise due mainly to changes under the Stockholm Convention on Persistent Organic Pollutants.

Twenty-nine waste groups were defined for use in the projections. These closely corresponded with the *National Environment Protection (Movement of Controlled Waste between States and Territories) Measure 1998* (the NEPM). Some categories were disaggregated where a component waste was of particular interest to DoE. 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.

Table S1: 'Waste groups' and wastes of particular interest

	Waste group	Closest NEPM category	The component of particular interest
1	Plating & heat treatment	A	
2	Acids	B	
3	Alkalis	C	
4	Mercury & compounds	D120	Mercury wastes
5	Lead & compounds	D220	Lead wastes and waste lead acid batteries
6	Non-toxic salts	D300	Coal seam gas wastes
7	Other inorganic chemicals	Other D	Spent potlining wastes from Aluminium industry.
8	Reactive chemicals	E	
9	Paints, resins, inks, organic sludges	F	
10	Organic solvents	G	
11	Pesticides	H	
12	Oils	J	Waste oil and oil/water mixtures
13	Animal effluent and residues (+ food processing waste)	K100	Large tonnage low hazard organic waste
14	Grease trap waste	K110	Large tonnage low hazard organic waste
15	Tannery & wool scouring wastes	K140 & 190	Large tonnage low hazard organic waste
16	PFOS	M160a	Perfluorooctanesulfonic acid (PFOS) including potential PFOS contaminated biosolids
17	POP-BDEs	M160b	Polybrominated diphenyl ethers (PBDEs) including potential PBDEs contaminated biosolids
18	HBCD	M160c	Hexabromocyclododecane (HBCD) including potential HBCD contaminated biosolids
19	HCB	M160d	Orica stockpile of Hexachlorobenzene
20	Other organic chemicals	Other M	
21	Contaminated soils	N120	Contaminated soils
22	Contaminated biosolids	N205a	Contaminated biosolids potential inorganics contamination. Potential POP contam. see M160a-c
23	Other industrial treatment residues	N205b	
24	Asbestos	N220	Waste asbestos
25	Other soil/sludges	Other N	
26	Clinical & pharmaceutical	R	
27	Tyres	T140	Tyres
28	Other miscellaneous	Other T	
29	Lithium-ion batteries[1]	n/a	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 Qld, NSW, SA, Vic and 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. These systems were established to ensure that hazardous waste is appropriately managed. Data from these systems was collected, collated and analysed, together with other jurisdictional waste data.

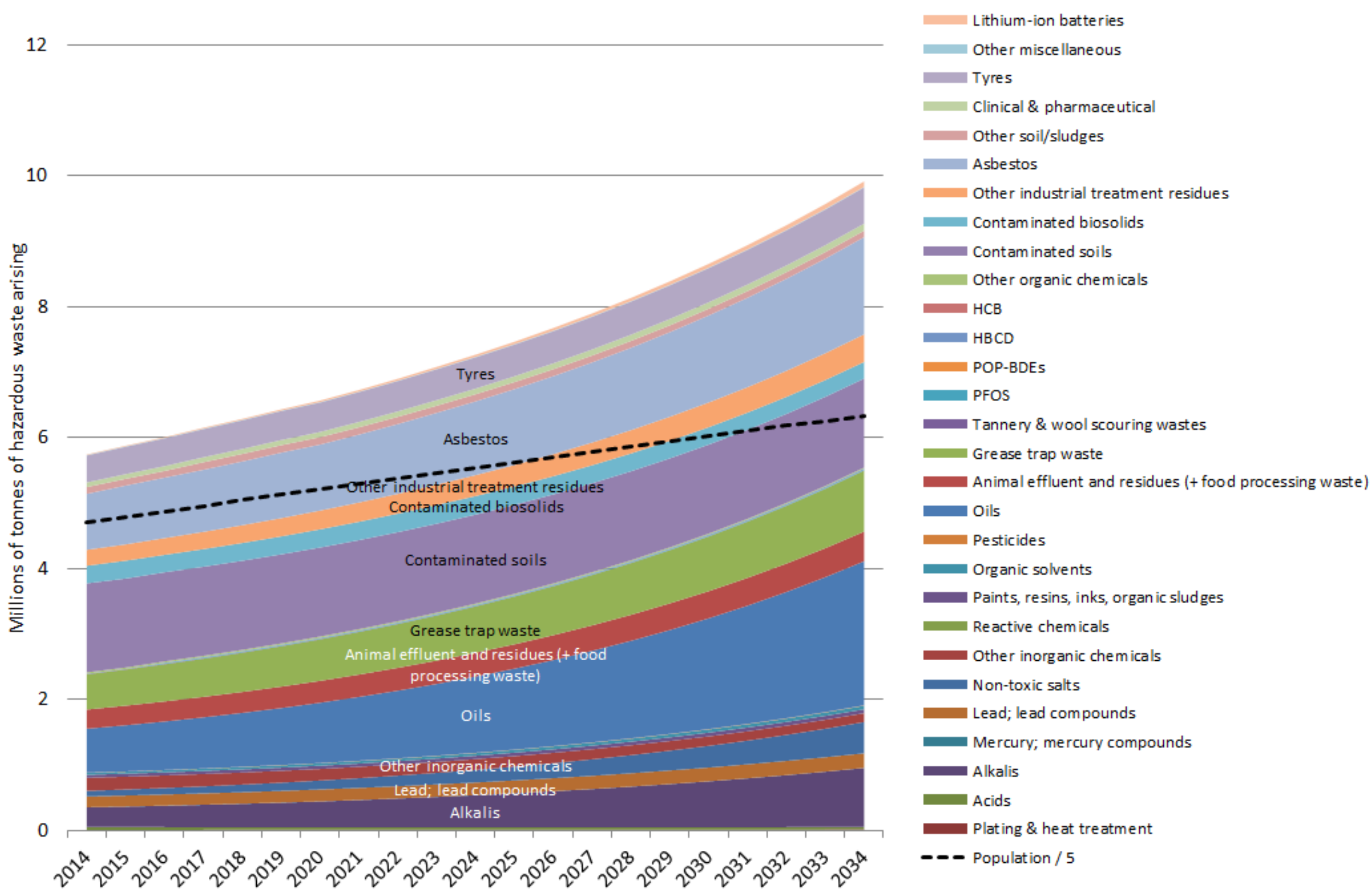
A baseline tonnage figure was established for each of 29 waste groups in each jurisdiction, typically based on the most recent datum available. Three scenarios (best, high and low estimates) of future quantities of each waste group until 2034 were developed based on considerations that varied with the waste group. Providing three scenarios reflects the highly uncertain nature of projecting future quantities of hazardous

[1] Lithium-ion batteries are not currently regulated as hazardous waste. This may change in future due mainly to issues of flammability.

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.

The projected waste arisings for each waste group under the best estimate scenario are shown in Figure S1. Under this scenario, the quantity of hazardous waste rises from about 5.7 million tonnes (Mt) in 2013-14 to 9.9 Mt in 2033-34. This represents an average growth rate of 2.8% per year. The top six groups – alkalis, oils, grease trap waste, contaminated soils, asbestos and tyres – represent about three-quarters of the hazardous waste volumes at both the start and end of the projection period. Some waste groups are projected to grow strongly over this period, including: lithium-ion batteries (average growth rate 12% per year); non-toxic salts (9.0%); oils (6.1%); and alkalis (5.7%). In addition, the combined M160 'new Stockholm wastes' (PFOS, POP-BDEs, HBCD and HCB) grow from 3,800 t in 2013-14 to 28,000 t in 2033-34, following Australia's assumed ratification of the new wastes in 2016-17. Seven groups decline, including: tannery and wool scouring wastes (average decline of 4.1% per year); other organic chemicals (2%); and acids (0.9%).

Figure S1: Best estimate of national projections for all hazardous waste to 2034

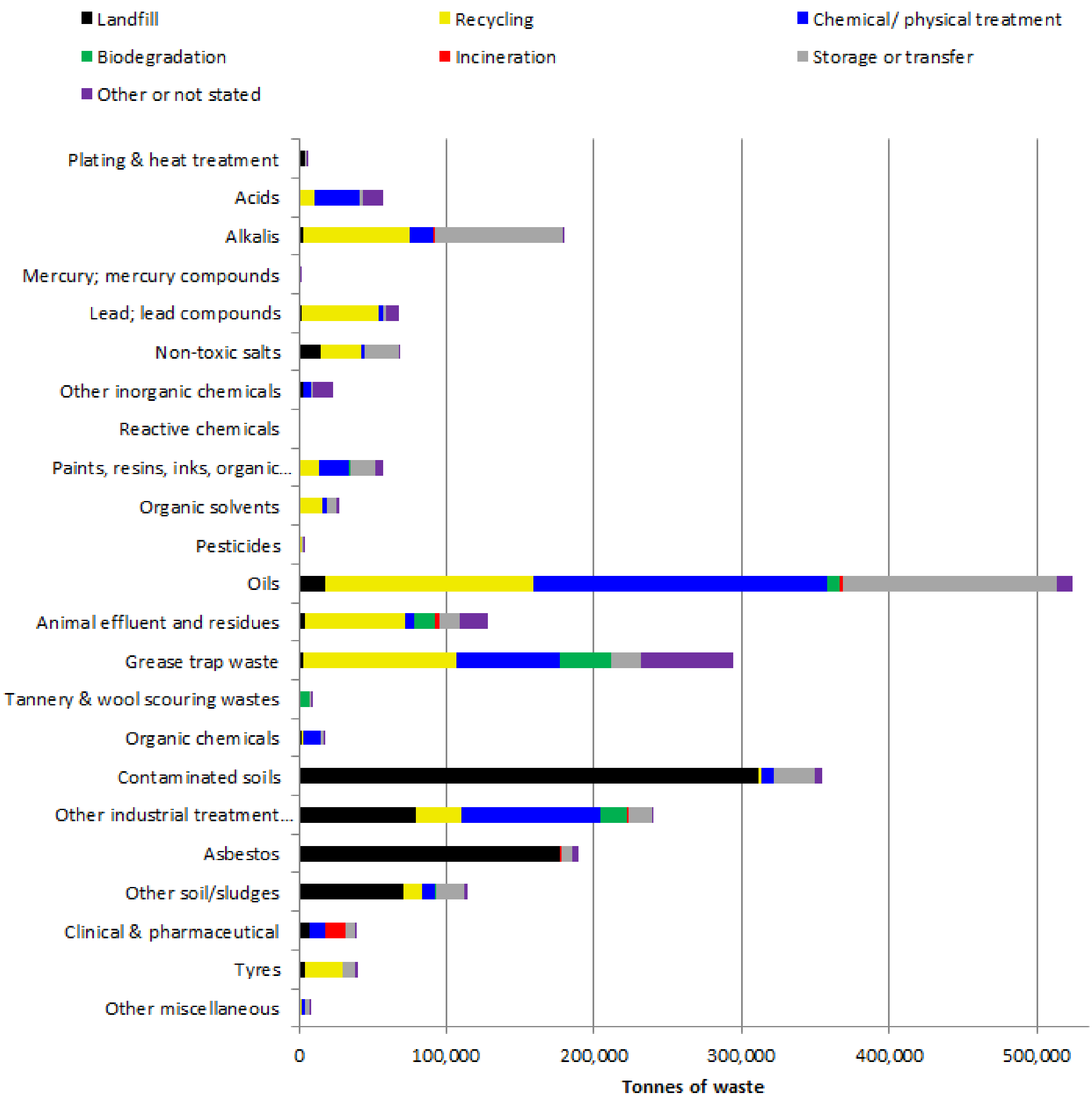


Section 2.6 provides an account for each waste group of industry sources, considerations and factors applied in developing the projections, the arithmetical methods used, and a figure showing the projected quantities in the best, high and low estimate scenarios.

The fate of hazardous wastes

Data on the fate (i.e. how the waste is managed) of hazardous waste in 2012-13 was compiled from NSW, Qld and Vic tracking system data. This provided a basis for estimating the fate proportions for SA, WA, NT, ACT, and Tas, from which fate data was not available. The overall tonnage data by fate is presented in Figure S2. See Section 2.7 for detailed analysis of available fate data.

Figure S2: The fate of tracked hazardous waste in NSW, Qld and Vic, 2012-13



Hazardous waste infrastructure assessment

The starting point of the hazardous infrastructure assessment was an infrastructure database produced for DoE by Rawtec (2014). Companies included on that list (and others identified during the project) were asked a series of questions designed to understand the type, scale and potential capacity of their infrastructure. In total, 126 companies were contacted in relation to 241 sites. A site response rate of 64% was achieved.

Similarly, infrastructure was allocated into one of 17 'infrastructure groups' based on the main wastes received and the primary function[2]. Infrastructure group examples include 'Oil re-refining', 'POP thermal destruction', 'Clinical waste treatment' and 'Clinical waste thermal destruction'. See Table S2 below for a description of the infrastructure groups.

Table S2: Infrastructure groups description and coverage

Infrastructure group	Description
Recovery: recycling and energy recovery (ER)	
Hazwaste packaging fac.	Facilities that recycle industrial packing that contains residual hazardous wastes. Containers are typically refurbished and reused or materials are recycled.
E-waste fac.	Major e-waste physical/chemical and manual disassembly processing facilities. Facilities receive inorganic hazardous wastes, such as copper, cobalt, and lead.
Oil re-refining fac.	Facilities that re-refine (recycle) waste oil. Facilities that dewatering and filter waste oil (only) are not included in this group as the primary function is assumed to be transfer waste oil onto oil re-refining facilities.
Lead fac.	Facilities that recycle lead. Typically the lead is from used lead acid batteries.
Mercury fac.	Facilities that recycle mercury. Used fluorescent light fittings are usually a key waste.
Solvents/paints fac.	Facilities that recycle paints, resins, inks, organic sludges and/or organic solvents.
Solvents/paints fac. (ER)	Facilities that recover solvents, paints, organics solvents for the purposes of energy recovery. The energy recovery may occur off-site from the facility.
Spent potlining fac.	Facilities that recycle spent potlining waste from the aluminium industry.
Organics fac. (NEPM code K wastes)	Facilities that recycle a range of low hazard organic wastes such as grease trap waste, cooking oil, animal effluents, etc. **Coverage limitation**: "*Grease trap was captured where the … facility also treated other hazardous wastes. Grease trap to composting facilities was not included*" Rawtec (2014).
Treatment (T)	
Chemical and physical treatment (CPT) plant	Sophisticated and significant capital expenditure facilities that provide a range of chemical and physical treatments to a broad range of waste groups. This is a large and critical infrastructure group. Often licensed to receive almost all NEPM 15 waste codes. Rawtec (2014) lists most CPT sites as receiving codes B, C, D, E, F, G, H, J, K, L, M, N, R, and T. Processes can include all chemical treatments (e.g. oxidation, reduction, precipitation, neutralisation, etc.) and physical treatments (e.g. sedimentation, filtration, adsorption, immobilisation, etc.)
Clinical waste fac. (T)	Facilities that treat clinical waste typically using an autoclave.
Soils treatment fac.	Facilities that treat contaminated soils. Treatment processes include biodegradation and thermal destruction of contaminants.
Disposal: landfill, thermal destruction (TD)	
Hazwaste landfill disposal fac.	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 disposal fac. (NEPM codes N, T only)	Landfill facilities that are generally only licensed to dispose low level contaminated soils, asbestos, and tyres (NEPM 15 codes N and T). These landfills also generally dispose of non-hazardous wastes which are typically the majority of the tonnages disposed at the site.

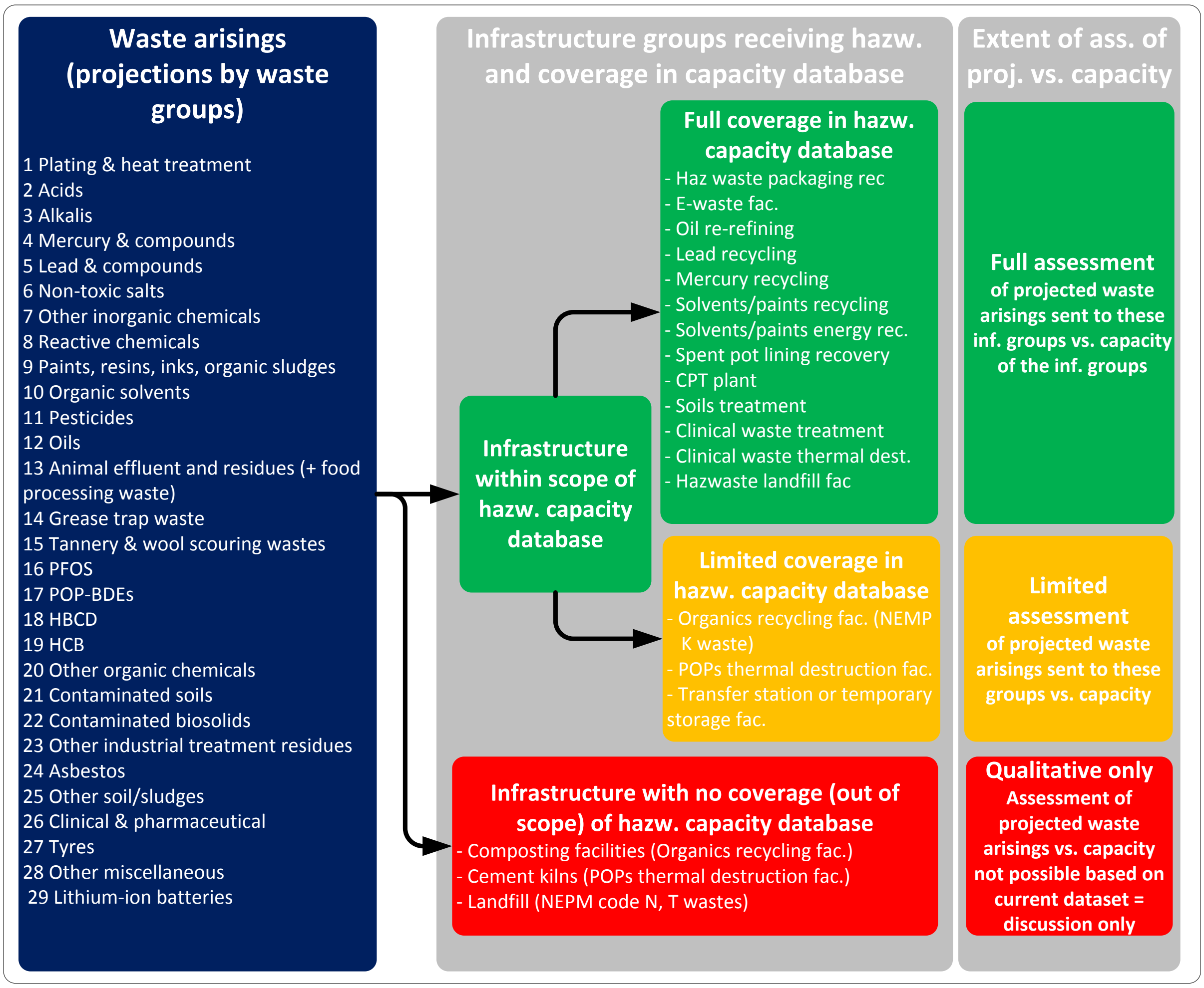
[2] The 'primary function' of the infrastructure refers to the waste fates that the infrastructure provides (e.g. recycling, treatment).

	Rawtec (2014 p.7) states that the database does not include "*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*". This group is not covered by the infrastructure database or capacity assessment.
POPs fac (TD).	Facilities that are able to destroy persistent organic compounds (POPs) by thermal destruction. **Coverage limitation**: "*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*" Rawtec (2014).
Clinical waste fac. (TD)	Facilities that dispose of medical waste by thermal destruction.
Transfer station or temporary storage fac.	Facilities for the transfer or temporary storage of hazardous wastes. Some of these facilities receive a wide range of wastes, others only specific wastes. **Coverage limitation**: "*some intermediate storage facilities are included in this dataset. … other facilities which deal with hazardous wastes … are not included in the dataset, such as smaller storage facilities and transfer stations*" Rawtec (2014).

Note: shaded grey infrastructure groups have coverage limitations as noted.

The scope and coverage of the infrastructure database constrains the assessment of infrastructure capacity against projected arisings. Some hazardous wastes are managed in facilities that are not included in the infrastructure database, while others are sent to infrastructure with limited coverage in the database. This 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 S3 illustrates which infrastructure groups are out of the capacity assessment scope or have limited coverage.

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



The capacity of each infrastructure groups 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 provides 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. The difference between overall arisings (5.7 Mt) and overall capacity (3.0 Mt) is mainly attributable to the limits on the scope of the infrastructure database.

Table S3: National capacity estimate of hazardous waste infrastructure

Hazardous waste infrastructure group	No. sites	Est. currently received (kt/yr)[3]	Est. potential capacity (kt/yr)[4]	Uncertainty of capacity assessment
Recovery: recycling and energy recovery (ER)				
Hazwaste packaging fac.	31	22	55	Moderate
E-waste fac.	12	64	161	Moderate
Oil re-refining fac.	13	363	694	Moderate
Lead fac.	4	106	188	Low
Mercury fac.	2			Low
Solvents/paints fac.	5	10	16	High
Solvents/paints fac. (ER)	1			Low
Spent potlining fac.	5			Low
Organics fac.	12	205	273	Very high
Treatment				
CPT plant	49	1,159	1,559	Moderate
Clinical waste fac. (T)	10	26	26	High
Soils treatment fac.	4	74	185	Moderate
Disposal: landfill, thermal destruction (TD)				
Hazwaste landfill fac.	7	208	274	High
Landfill fac. (NEPM code N, T)	27	433	761	Na
POPs fac. (TD)	1			Very high
Clinical waste fac. (TD)	6	17	30	Low
Transfer station or temporary storage fac.	43	232	335	Very high
Total	**232**	**3,052**	**4,780**	

Notes: shaded grey infrastructure groups have coverage limitations. Landfill fac. (NEPM codes N, T only) inf. group is outside of the capacity assessment scope.

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 a detailed discussion of these steps):

1. The fate of 2012-13 waste arisings were expressed in proportions (percentages) and adjusted to remove anomalies.
2. For each waste group, the fate proportions were allocated to an infrastructure group. Table S4 illustrates these allocations and includes the estimated 'national average' proportions of each waste group sent to each infrastructure group. The table also shows the extent to which waste arisings can be compared to infrastructure capacity (taking into account the limitations of the infrastructure database). The 2015 estimated arisings are also included in the waste groups to illustrate the tonnage significance of the waste groups that are sent to infrastructure with limited or no coverage in the capacity database.

[3] Estimate based on a three year average of wastes received at the site.

[4] Refers to the maximum capacity that the current infrastructure set and those facilities that are under development could process on an annual basis.

Table S4: Waste groups allocation to infrastructure groups, national average fate proportions, and 2015 best estimate arisings

	A Plating & heat treat. 2015 aris. 6Kt	B Acids 2015 aris. 42kt	C Alkalis 2015 aris. 313kt	D120 Mercury 2015 aris. 1.5kt	D220 Lead 2015 aris. 168kt	D300 Non-toxic salts 2015 aris. 92kt	Other D Inorganic chems. 2015 aris. 196kt	E Reactive chems. 2015 aris. 0.1kt	F Paints, resins, inks 2015 aris. 47kt	G Organic solvents 2015 aris. 32kt	H Pesticides 2015 aris 4kt	J Oils 2015 aris. 704kt	K100 Animal eff. +food.. 2015 aris. 300kt	K110 Grease trap 2015 aris. 552kt	K140, 190 Tannery... 2015 aris. 7kt	M160s PFOS, BDEs, HBCD, HCB. 2015 aris PFOS 3kt, BDEs, HBCD,..	Other M Organic chems. 2015 aris 21 kt	N120 Contam. Soils 2015 aris. 1360kt	N205a Contam. Biosolids 2015 aris. 272kt	N205b Ind. treat res... 2015 aris. 232kt	N220 Asbestos 2015 aris. 899kt	Other N soil/sludge 2015 aris. 103kt	R Clinical & pharma. 2015 aris. 73kt	T140 Tyres 2015 aris. 417kt	Other T Miscellaneous 2015 aris. 7kt	Lithium-ion batts. 2015 aris. 10kt
Hazw. Packg. Recycling fac.																						11%				
E-waste recycling fac.							7%																			100%
Oil re-refining fac.												66%														
Lead recycling fac.					88%																					
Mercury recycling fac.				15%																						
Solv/paints rec. fac.									25%	61%																
Spent pot lining recycling fac.							(6)																			
Solv/paints energy recovery fac.									1%	1%	73%		3%												1%	
CPT fac.	6%	94%	49%	22%	4%	44%	56%	39%	40%	12%	11%		6%	30%			82%			52%		8%			51%	
Clinical waste treatment fac.																							30%			
Soils treatment fac.																		3%								
Clinical waste TD fac.																							34%			
Hazards waste landfill fac.	80%	2%	2%	17%	4%	22%	29%	2%	2%		5%	4%	4%	1%	3%		10%			33%		63%	17%		7%	
Organics recycling fac.													62%	45%	6%											
POPs TD fac.																100%										
Transfer or temp storage fac.	14%	4%	49%	45%	4%	34%	7%	59%	32%	26%	11%	28%	13%	8%	1%		8%	8%		7%	4%	18%	19%		38%	
Landfill fac. (NEPM code N, T)																		89%	100%		96%			(7)		
Extent of ass. of proj. arisings vs. inf. capacity	Full (1)	Full (1)	Full (1)	Full (1)	Full (1)	Full (1)	Full (1)	Full (1)	Full (1)	Full (1)	Full (1)	Full (1)	Limited (2)	Limited (2)	Limited (2)	Limited (3)	Full (1)	Limited (2)	Qualitative (5)	Full (1)	Qualitative (4)	Full (1)	Full (1)	Qualitative (4)	Limited (2)	Full (1)

Notes:

1: Full assessment, however, limited assessment of transfer infrastructure capacity.
2: Limited due large tonnages sent to inf. out of hazw. inf. dataset coverage.
3: Limited assessment for 'new hazwastes' due to large tonnages assumed sent to inf. out of hazwaste inf. dataset coverage in future.
4: Qualitative assessment only due to the waste arisings all being sent to an inf. group that is out of the inf. dataset scope.
5: Qualitative assessment only due to the future waste arisings all being sent to an inf. group that is out of the inf. dataset scope.
6: Spent pot lining wastes have historically not been transported to off-site SPL recycling facilities and hence have not been significant in tracking system fate data. Under waste projections SPL waste tonnages arisings are assumed to be 100% sent to SPL recycling facilities
7.Tyres were excluded from fate allocation because (a) the proportion for which data is available is very low; (b) the proportion going to hazardous waste infrastructure is very low

(Dashed box) 'New hazardous waste' (i.e. have not been managed as hazardous waste in the past).

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 2012-13 (i.e. the recovery rate of each waste group remains constant over the projection 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 59 to Table 66).

Table S5: National assessment of projected arisings vs. infrastructure capacity

Infrastructure group	Uncertainty of cap. ass.	Estimate year that arisings exceed capacity Best	High	Low
Recovery: recycling and energy recovery (ER)				
Hazwaste packaging fac.	Moderate	>2034	>2034	>2034
E-waste fac.	Moderate	>2034	2034	>2034
Oil re-refining fac.	Moderate	2023	2020	>2034
Lead fac.	Low	2031	2022	>2034
Mercury fac.	Low	>2034	>2034	>2034
Solvents/paints fac.	High	2015	2015	2015
Solvents/paints fac. (ER)	Low	>2034	2030	>2034
Spent potlining fac.	Low	>2034	>2034	>2034
Organics fac.	Very high	2015	2015	2015
Treatment				
CPT plant	Moderate	>2034	2030	>2034
Clinical waste fac. (T)	High	2026	2020	>2034
Soils treatment fac.	Moderate	>2034	>2034	>2034
Disposal: landfill, thermal destruction (TD)				
Hazwaste landfill fac.	High	2015	2015	2015
Landfill fac. (NEPM code N, T)	Na	2015	2015	2015
POPs fac. (TD)	Very high	2015	2015	2015
Clinical waste fac. (TD)	Low	2024	2019	>2034
Transfer station or temporary storage fac.	Very high	2015	2015	2015

Notes: shaded grey infrastructure groups have coverage limitations. Landfill fac. (NEPM codes N, T only) inf. group is outside of the capacity assessment scope, see discussion in Section 3.2.

Conclusions and recommendations

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 difficult to characterise, changeable 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, which are given below, should be taken as indicative. The various dimensions of the uncertainty included in the assessment are discussed in detail in Section 4.

Recommendation 1: DoE should work with the jurisdictions to improve hazardous waste tracking system data so that fate is consistently recorded and categorised.

Hazwaste packaging recycling facilities

The national assessment indicates that under all scenarios over the next 20 years the potential capacity of Australia's current and planned hazardous waste packaging recycling infrastructure will be able to recycle waste arisings. The infrastructure capacity assessment for this group has moderate uncertainty due to a low response rate during consultation and the infrastructure group being highly diffuse increasing the probability of capacity not being included in the capacity database.

A shortfall in current capacity to recycle hazardous waste packaging is apparent in Qld. Contaminated containers are voluminous and cannot be cost-effectively transported. Some survey respondents commented on a broader need for improved recovery options for small hazardous waste packaging and small packages of waste hazardous goods, however, planned infrastructure included in the potential capacity should provide the capacity and coverage required.

E-waste major physical/chemical & disassembly facilities

The national assessment indicates that under the best and low scenarios over the next 20 years the potential capacity of Australia's current hazardous e-waste (major physical/chemical and manual disassembly processing) infrastructure will be able to recycle waste arisings. Capacity could become constrained by 2034 if e-waste arisings grow very strongly.

It must be noted that estimates assume no change to the current estimated proportions of fate of e-waste, which is mostly landfill. Changes to product stewardship agreements or landfill bans on e-waste would significantly change these estimates. The infrastructure capacity assessment for this group has moderate uncertainty due moderate response rate during consultation and the infrastructure group capacity having some overlap with other functions (such as PCB oil decontamination) resulting in a likely overestimate of the infrastructure group capacity.

A shortfall in current capacity to apparent in NT and WA. e-waste in these jurisdictions is likely sent interstate or is sent to landfill.

Lithium-ion batteries infrastructure

The potential arisings of lithium-ion batteries, which are not currently regulated as hazardous wastes, are assessed is this report due their potential to have a significant impact on hazardous and non-hazardous waste infrastructure. Waste lithium-ion batteries are projected to increase at an average growth rate of 12% 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).

Whilst this assessment does not indicate a shortfall in the overall e-waste processing capacity in Australia, at the time of writing there are no e-waste facilities with lithium-ion recycling capacity. All lithium-ion batteries that are recovered are 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 2: The potential hazards posed by lithium-ion batteries, and the best means of managing these hazards, needs further assessment. Following the assessment of hazard, assessment of the collection and processing infrastructure needs for lithium-ion batteries in Australia should be completed.

Oil re-refining facilities

At a national level, based on projected increases in waste oil arisings in Qld and WA (from the mining industry), the best estimate scenario projects that waste oil re-refining capacity in Australia could be exceeded in 2023 or by 2020 under the high scenario. Changes in the rates of growth of the mining industry in Qld and WA could have a significant impact on this assessment. Under a low arisings scenario (which includes Qld and WA arisings increasing at national rate of economic growth) waste oil re-refining capacity in Australia is likely to be sufficient beyond 2034.

The infrastructure capacity assessment for this group has moderate uncertainty due to the group's capacity having some overlap with the transfer station or temporary storage infrastructure group resulting in a potential overestimate of the infrastructure group capacity.

Offsetting the potential overestimation of this group's capacity is the allocating of all NEPM J codes recycling tonnages to this group. Some of the J code 'recycling' tonnage is likely to be *J120 Waste oil/water, hydrocarbons/water mixtures or emulsions* that is taken to facilities that are filtering and dewatering only (not re-refining) resulting in an overestimate of the arisings of oils being sent to re-refining. In addition some waste oils 'recycling' may actually be sent for energy recovery which, again, would result in an overestimate of waste oil re-refining demand.

No re-refining capacity was identified in the ACT or NT, from which waste oils are likely transported interstate. Qld oil re-refining capacity could be currently constrained locally. However, almost all of the transfer station and temporary storage capacity in Qld is for waste oil prior to transport to re-refining or some alternative in Qld or interstate, suggesting that Qld should be able to manage waste oil arisings. WA's oil re-refining capacity could be constrained by 2027 or 2024 if mining sector grows very strongly. Vic, NSW, SA, Tas oil re-refining capacity should be sufficient.

The Product Stewardship for Oil Program was introduced by the Australian Government in 2001. It provides a financial incentive (of 50 cents/litre) for industry to re-refine waste oil for sale. There appears to be some uncertainty as to what activities and materials are eligible, and it is possible that some subsidies are being expended on mixtures of oil and water and potentially storage and transfer activities.

Recommendation 3: DoE should assess waste oil infrastructure to clarify which sites are providing re-refining of oils for sale that qualify them for the product stewardship payment.

Lead recycling facilities

At a national level, based on the best estimate projection of arisings increasing at the rate of population growth the current and planned lead recycling infrastructure could be exceeded by 2031. Based on the high estimate projection of arisings increasing strongly at 3.5% per annum capacity could be met in 2022. Under a low scenario of no growth in arisings capacity is not expected to be exceeded over the next 20 years.

Recycling capacity for lead acid batteries is all located in NSW, so lead acid batteries are transported from other jurisdictions to NSW or exported overseas under an export permit. Developments in WA should see less lead acid batteries transported from WA to NSW.

Mercury recycling facilities

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

Mercury processing capacity was identified in Vic (the majority) and a small amount in NSW. All other jurisdictions are likely transferring mercury wastes to Vic and NSW.

CMA Ecocycle are the main provider of mercury infrastructure with transfer facilities located around Australia and a processing facility in Melbourne. [redacted]

Recommendation 4: [redacted]

Recommendation 5: State and territory governments should require financial assurances from companies that process and store wastes to avoid the risk of 'orphaned' stockpiles.

Solvents/paints recycling facilities

At a national level, the assessment indicates that under all scenarios 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:

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 in all jurisdictions apart from ACT, SA, Tas and NT. In these jurisdictions, solvents/paint waste is sent interstate, managed within other infrastructure groups or taken to sites not identified in the capacity database.

Solvents/paints energy recovery facilities

At a national level, the assessment indicates that under the best and low scenarios over the next 20 years the potential capacity of Australia's current solvents/paints energy recovery infrastructure will be able to manage waste arisings. If paints, resins, inks, organic sludges grow very strongly (at 3.8%p.a.) capacity could be exceeded by 2030.

It is noted some solvents/paints recycling tonnages may actually be sent to energy recovery infrastructure. This could result in the infrastructure need exceeding capacity sooner than is estimated here.

Victoria has the only facility (GeoCycle) that recovers paints, resins, inks, organic sludges for the purposes of energy recovery. Other jurisdictions are likely to send these wastes to Victoria.

Spent potlining recycling facilities

For SPL wastes the current estimated arisings are based on the tonnages of SPL recycled in 2014. Waste tracking system data could not be used because much of the SPL recycling infrastructure is located on aluminium smelting sites (the generation sites) so no tracking data is collected.

Industry estimates around 900 kt of spent potlining are in storage/stockpiles in NSW and Vic (sufficient to more than half fill the Melbourne Cricket Ground. The best and low projection scenarios assume that these stockpile remains *in situ*. Under these scenarios it is estimated that the current SPL recycling infrastructure capacity will not be exceeded over the 20 year projection period. Under the high scenario it is assumed that the SPL stockpile is released over a 10 year period (at a rate of 90kt/yr.) beginning in 2017.

[redacted]

The storage of large quantities of spent potlining from aluminium smelting should be a social concern, especially given the recent decline of this industry. The three current operators able to process this waste report sufficient capacity to process the stockpile over a 10-15 year period. A mismatch between demand and capacity could cause inappropriate treatment or demand for exports. A nationally coordinated negotiation with the industry is recommended.

Recommendation 6: DoE should consult with the aluminium industry and NSW, Vic, Qld, Tas State Governments to develop a nationally agreed approach to the management of spent potlining stockpiles that ensures their eventual removal and ongoing recovery or treatment.

Organics recycling (NEPM K code wastes) facilities

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

As discussed in Section 4.2, the majority of the arisings of NEPM K code wastes are sent to infrastructure that has limited coverage in the capacity assessment database. 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 wastes as part of much larger non-hazardous waste volume.

In addition, some smaller operators that specialise in hazardous organic wastes may not be within the infrastructure database due to the diffuse nature of this infrastructure group. Capacity within this group was identified in Vic and NSW only.

Based on industry consultation and our assessment of organics recycling infrastructure, no national shortage of capacity in this infrastructure group is considered likely over the next 20 years.

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.

At a national level based on the best and low projections of arisings CPT infrastructure is estimated to be able to meet national demand over the next 20 years. Based on the high projection of arisings CPT national capacity could be exceeded in 2030. 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 the oil and gas (CSG) industry developments.

The infrastructure capacity assessment for this group 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 overestimate of capacity. Offsetting this is uncertainty about the amount of CSG industry wastes that will actually leave the development site and be sent to CPT facilities.

Whilst modelling suggests that current capacity is adequate nationally over the projection period, demand for processing wastes such as non-toxic salts and alkalis is likely to increase with activity in the mining and oil and gas industries. Some relocation of processing capacity and expertise is likely to be needed shifting CPT capacity from the traditional heavy industry hubs located close to capital cities and ports to the more remote locations of oil, CSG and other mining operations.

In the best estimate, current capacity in Qld would be fully subscribed by 2025, or 2022 if mining industry wastes grow strongly. Qld also appears to have a particular need for processing infrastructure for CSG industry wastes, preferably in the location of these operations.

The ACT, NT, SA could have an undersupply of local CPT capacity. This assessment is based on the national average percentages of waste sent to CPT, and is therefore uncertain. It is likely that wastes are being exported to Vic and NSW from these jurisdictions.

Tas, in particular, appears to have a shortage of CPT capacity. Again, this is based on the national average of the percentage of wastes sent to CPT for treatment. However, with [redacted] of CPT capacity identified, estimated arisings of 68kt, and recorded exports to the mainland in 2012/13 data of 12 kt, are evidence that Tas needs additional CPT capacity.

Recommendation 7: DoE and/or NSW and Qld EPAs should consult with the coal seam gas industry to develop a strategic plan for managing its wastes, including an evaluation of local chemical and physical treatment infrastructure vs transport to existing urban sites.

Recommendation 8: DoE and/or Tas EPA should further investigate the supply of chemical and physical treatment capacity for hazardous waste in Tasmania.

Clinical waste treatment facilities

Based on the current industry projection of arisings increasing at the rate 1.9% per annum and the potential capacity of clinical waste treatment – capacity could be exceeded by 2026. Based on the high projection, where arisings increase at 3.9% per annum, national capacity could be exceeded in 2020. Under the low scenario where growth is below the current industry projection (-0.1% per annum) national capacity is projected to meet demand over the next 20 years.

The infrastructure capacity assessment for this group has high uncertainty due to a poor response rate from industry and capacity overlap with the thermal destruction infrastructure (resulting in a likely under estimate of the infrastructure group capacity).

ACT, NT, SA, Vic, and WA all appear to have sufficient clinical waste treatment capacity. NSW, Qld, and Tas all appear to have insufficient local supply of clinical waste treatment capacity and are likely to be exporting significant quantities interstate.

Contaminated soils treatment facilities

Analysis indicates that under all scenarios over the next 20 years the potential capacity of Australia's current and planned contaminated soils treatment infrastructure will be able to treat waste arisings.

Importantly, these estimates assume no change to the current fate patterns of contaminated soil, which, based solely on Victorian data, is estimated to be 89% landfill. If the treatment proportions are higher in other jurisdictions, the above assessment of no national capacity constraints would be affected.

The infrastructure capacity assessment for this group has moderate uncertainty due to a moderate response rate during consultation, capacity overlap with POPs thermal destruction infrastructure, and diffuse soil treatment technologies including some 'mobile' capacity. One soil treatment facility was identified in Qld, NSW, WA, and Vic in the capacity database. Given the range of treatment technologies/techniques for contaminated soils treatment this number appears low.

Hazardous waste landfill facilities

This project capacity assessment examined hazardous waste landfills capacity to accept annual arisings of wastes – 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, licence limits. These constraints are not common and are understood not to be an issue for the sites included in this group.

The seven hazardous waste landfills surveyed for this project reported an annual capacity that modelling indicates is constrained under all scenarios. For all three scenarios, declines are projected for 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 the Oil and Gas (GSG) industry developments. We believe the modelling assessment for this infrastructure group is incorrect. The response rate from site operators was only 43%, meaning infrastructure group averages were used, and generally the responses provided data only on wastes currently received with little information on the potential annual acceptance rate. This is understandable as, unlike other infrastructure types, landfills are usually able to cater to varying capacity demands (within reason) and a site's potential annual capacity can be difficult to define.

Recognising the limitations of the capacity assessment modelling for landfills, operators were also queried about total airspace availability. The responses suggested no impending capacity constraints in jurisdictions that have a hazardous waste landfill (all jurisdictions except SA and Act). However, in most jurisdictions a single dedicated hazardous waste landfill accepts the majority of waste types (other than low level contaminated soils, asbestos and tyres).

SA may need to establish a hazardous waste landfill or transport wastes significant distances. Industry representatives raised concerns about the transport distances for hazardous waste disposal and commented on this issue for WA in particular, suggesting additional sites or appropriate transfer facilities are required there.

The capacity of Australia's hazardous waste landfills could be impacted by 'new' hazardous waste arisings that need to be sent to these specialist landfills. Increases in landfilling capacity requirements from CSG wastes, fly ash from energy from waste operations, and potentially POPs contaminated wastes (that are not sent for thermal destruction as assumed in this assessment) need to be considered in future planning for hazardous waste landfill capacity.

In addition to the above, given the significant time required and the political difficulty in establishing a new hazardous waste landfill, the risks associated with extreme weather events causing surges of hazardous waste quantities, or risks of legal challenges – it is recommended that DoE liaise with the jurisdictions about the risk profiles and anticipated closure dates of their specialist hazardous waste landfills.

Recommendation 9: DoE should work with the jurisdictions to assess the likely closure year of hazardous waste landfill facilities and examine the risk that these sites' capacities may be affected by issues such as extreme weather events and 'new' hazardous waste arisings.

Landfill facilities (NEPM code N, T)

This infrastructure group is not in the scope of hazardous waste database (see Section 3.2) and a quantitative assessment of arisings vs capacity is not possible. To complete a quantitative analysis of projected arisings of NEPM code N and T wastes versus 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 wastes as part of much larger non-hazardous waste volume.

General or municipal waste landfills are often also able to landfill low level contaminated soil, asbestos, and tyres. In Victoria tyres can be disposed to any landfill as long as they are shredded first. This is understood to be the case nation-wide.

Whilst this infrastructure group is not clearly defined as ‘hazardous waste infrastructure’ the capacity of these landfills to take a selection of hazardous wastes is important. Landfill facilities are assumed to receive 89% of contaminated soils, 96% of waste asbestos, and 100% of contaminated biosolids[5]. Based on industry and government consultation, a national shortage of this type of infrastructure over the next 20 years is considered unlikely.

Landfills for asbestos disposal
Unlike most wastes, 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.

POPs thermal destruction facilities

[redacted]

[redacted]

Whilst there appears to be a major gap in Australia's POPs thermal destruction capacity, the capacity assessment uncertainty for this group is very high. The following three issues need to be considered that all result in an under estimate of the POPs destruction capacity:

1. POPs TD capacity within Clinical waste TD facilities. SteriHealth currently have a research and

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[5] The contaminated biosolids waste group only includes estimated arisings from inorganic contamination. ‘POPs contaminated biosolids’ arisings are included in the M160a-c waste groups (see Table 1) which are assumed to be sent to POP thermal destruction facilities.

[6] Orica’s longstanding stockpile of waste in Sydney is HCB.

[7] [redacted]

development approval that allows them to treat PCB contaminated oil from the Tullamarine landfill leachate at their Clinical waste TD facility in Laverton, Melbourne. SteriHealth aims to provide POPs destruction services to the market following works approval from EPA. SteriHealth did not state the potential tonnages of POPs that could be destroyed at the facility. TPI (2014), states that SteriHealth recently successfully treated around 2000 litres of PCB contaminated oil during trials at the site.

2. POPs TD capacity within Soils treatment facilities. The RENEX pyrolysis rotary kiln that is being commissioned in Dandenong Melbourne will be aiming to treat POPs contaminated soils and liquids. The kiln with operate at 600 degrees C and the gases will then be incinerated at 1100-1200 degrees C, enabling the destruction of chlorinated organics such as PCBs. [redacted], however, it is unknown what tonnage of POP contaminated soils and liquids could be processed at the plant.

3. POPs TD capacity within cement kilns. Cement kiln infrastructure is not included in the capacity database scope. We understand that cement kilns in Australia are currently destroying some POPs including PFOS. The capacity of Australia's cement kilns to destroy POPs needs detailed assessment to enable a comparison of arisings to destruction capacity. Until this assessment is completed any analysis of additional capacity that is required under any of the projection scenarios will be inaccurate.

Recommendation 10: DoE should undertake work to quantify the Australia's POPs destruction capacity, including at sites excluded from the scope of the infrastructure database used in this project.

POPs contaminated biosolids

An important issue to note regarding the projected need for POP thermal destruction infrastructure is the impact of POP contaminated biosolids. As noted above, the scenarios for projected need for this infrastructure group vary significantly (from around 28,000 to 182,000 tonnes in 2034). The high estimate of 182,000 tonnes is mostly POP contaminated biosolids (around 170,000 tonnes of PFOS and HBCD contaminated biosolids).

Recommendation 11: If not already underway, DoE, water authorities, and EPAs should work to complete:

- analysis of the current levels of POP contamination in Australian biosolids
- an assessment of the required management of POP contaminated biosolids (based on the levels of contamination identified and assuming Australia ratifies the Stockholm Convention for newly listed POPs)
- a set of recommendations for any additional infrastructure that Australia will likely require for POPs thermal destruction.

Clinical waste thermal destruction facilities

Based on the industry projections of arisings increasing at 1.9% per annum, the current and planned national capacity for thermal destruction of clinical waste could be exceeded by 2024. Under the high projection, with arisings increasing at 3.9% per annum, capacity could be exceeded in 2019. Under the low scenario capacity meets demand over the next 20 years.

ACT, NSW, NT, Qld, and Tas may each be undersupplied with this type of infrastructure. However, apart from Qld, this is based on assumed proportions of clinical waste sent to thermal destruction. In these jurisdictions clinical wastes are probably being exported or landfilled, potentially following autoclave treatment.

In SA the assessment finds capacity is currently constrained. This is incorrect and likely to be the result of assuming the percentage of clinical waste sent for destruction based on other jurisdictions. Industry representatives commented that there is spare capacity for clinical waste thermal destruction in SA. Vic and WA appear to have sufficient clinical waste thermal destruction capacity under all scenarios.

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. This is inaccurate, and attributable to the capacity database having limited coverage of this group. Rawtec (2014 p.8) states that: "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".

Recognising the limitations of the database for this infrastructure group, during the industry consultation program industry representatives were asked to flag any major transport constraints.

Very long transport distances, particularly in WA, were raised several times as a major barrier to managing hazardous waste. WA has seven of the 43 transfer station facilities in the database. For such a large state this appears low when compared with Vic, for example, with eight transfer sites. Problematic transport distances are also likely to be a problem in Qld (with just seven sites) and a growing CSG industry.

If not already being undertaken, further investigation of strategic locations for transfer station facilities in WA, Qld and NT is recommended. Consultation with industry on establishing joint venture transfer stations to consolidate wastes from a range of mining sites/generators should be explored for WA and potentially Qld (for CSG waste generators).

Recommendation 12: DoE and/or WA and Qld State Governments should complete a detailed assessment and consultation with industry on the need for and, if required, the best location(s) for additional infrastructure for hazardous waste transfer or temporary storage.

1. Introduction

1.1 Project origins and scope

The Australian Government Department of the Environment (DoE) 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).

DoE is also the lead agency responsible for the implementation of the *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 June 2014, DoE commissioned a consortium to undertake the assessment, comprising: Blue Environment (lead consultant); Ascend Waste and Environment; and Randell Environmental Consulting. The project had three parts:

1. Prepare projections of hazardous waste arisings and fates over the coming 20 years.
2. Consult with industry to estimate Australia's current hazardous waste infrastructure capacity, its distribution and expected future.
3. Combine the results of the first two parts to identify the extent to which current infrastructure meets future needs, considering the nature and locations of particular infrastructure.

1.2 Project context and key definitions

Hazardous waste terminology

The term 'hazardous waste' is used by the Commonwealth to describe wastes that exhibit hazardous characteristics, and is widely used in the community. The term is taken to correspond with the wastes that the states and territories (the jurisdictions) regulate as requiring particularly high levels of management and control. The jurisdictions use varied terminology to describe these wastes, reflecting the fact that some are tracked and controlled not because they are hazardous in the normal sense of the word, but rather because they pose risks to public amenity (e.g. through odour). All these wastes are nevertheless considered to be hazardous wastes within the scope of the study. The terms used by the jurisdictions are:

- regulated waste (Queensland)
- trackable waste (New South Wales)
- prescribed waste (Victoria)
- listed waste (South Australia)
- controlled waste (ACT, NT, Tasmania and Western Australia).

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 (the jurisdictions). In order to ensure appropriate management of these wastes, 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 government. 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 wastes that are regulated and tracked as hazardous waste between the jurisdictions. Refer to Appendix A.3 for analysis of wastes that are tracked/not tracked in NSW, Qld, SA, Vic and WA tracking systems.

The meaning of waste 'arising'

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 offsite, it does not arise. Waste that is created on a site and remains stored there has not arisen.

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 (POPs), 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:

- polybrominated diphenyl ethers (PBDEs)
- hexabromocyclododecane (HBCD)
- perfluorooctanesulfonic acid or perfluorooctane sulfonate (PFOS).

A detailed discussion of 'new Stockholm' POPs waste is provided in Section 2.2 under the *Persistent Organic Pollutants (POPs) waste groups M160 a – d* breakout box.

Apart from 'new Stockholm' wastes this project also analysed potential arisings of lithium-ion batteries which are not currently regulated as hazardous wastes. 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, represent a safety hazard due to risks of causing explosions and or fire (ABRI 2014).

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* (the NEPM) was established to ensure that hazardous wastes transported between jurisdictions are properly identified, transported, and otherwise handled. Among other things, the NEPM established a coding system to be used for these wastes. 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).

Groupings of wastes and infrastructure applied in this project

To assess infrastructure need and capacity, grouping of both wastes 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 29 '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 DoE. In developing the waste groups for analysis in the project, DoE provided direction on the wastes that were 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 is summarised in Table 1.

Similarly, infrastructure was allocated into one of 17 'infrastructure groups' based on the main wastes received and the primary function[8]. Infrastructure group examples include 'Oil re-refining', 'POP thermal destruction', 'Clinical waste treatment' and 'Clinical waste thermal destruction'. See Table 45 for a description of the infrastructure groups.

Limitations and uncertainty

This assessment of projected hazardous waste infrastructure need vs. capacity is affected by the following:

1. the levels of uncertainty in the projected arisings of hazardous wastes
2. the levels of uncertainty in assuming how much of each waste's arisings will be managed by what infrastructure (the assumed fate)
3. the limitations and levels of uncertainty of 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.

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 wastes were 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 wastes – 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 is not included in the public version of this report.

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[8] The 'primary function' of the infrastructure refers to the waste fates that the infrastructure provides (e.g. recycling, treatment).

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.
- Section three describes the consultation and estimation processes that led to the estimates of current and potential infrastructure capacity, and displays this estimated capacity.
- Section four compares the findings of the previous two sections. Section five draws conclusions from these findings.

Appendices are used for much of the analytical complexities and detail in order to abbreviate the main body of the report.

1.4 Other project outputs

This report was submitted to DoE together with three Microsoft Excel files:

- a national collation of hazardous waste data constructed from the various jurisdictional data inputs, providing baseline data and showing data trends, hazardous waste sources by industry type, and waste fate
- a model generating projections of hazardous waste by group
- a file showing the industry consultations that occurred, the results of those consultations (i.e. an assessment of hazardous waste capacity), and containing a numerical analysis of capacity against projected future quantities.

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

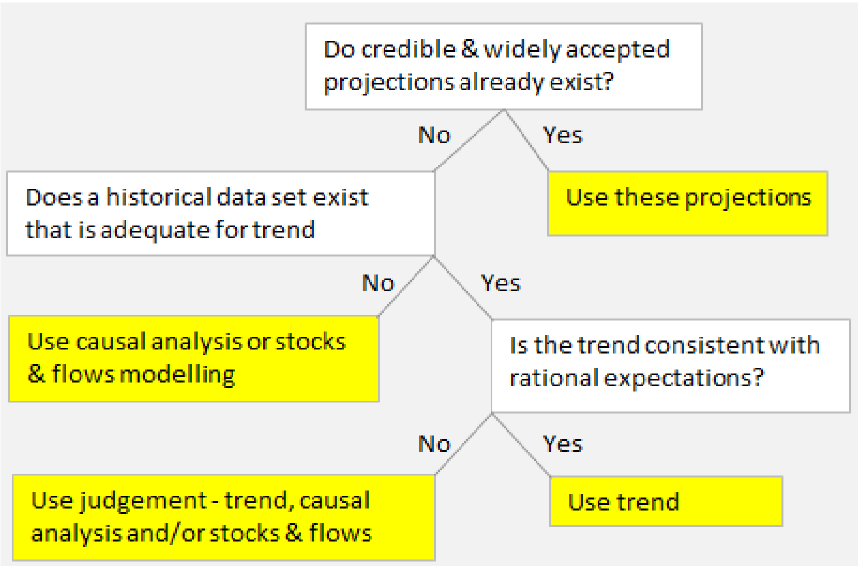
2. Projections of hazardous waste infrastructure needs

The project team developed projections of future arisings of hazardous waste which 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 the waste groups are currently managed – that is, their fate.

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 point (or baseline) quantity of tonnes was established from which to project future quantities. 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



Notes:

- *A 'stock and flow' model attempts to project material flows such as waste arisings through reference to consumption data and retention lifespans of materials and products in society.*
- *'Causal analysis' involves linking the future arisings of a waste type to factors likely to influence these arisings, for which credible projections already exist.*
- *'Rational expectations' refers to the ability to explain and understand apparent trends so that any assumption of their continuation can be made with confidence.*

2.2 Waste groups

Twenty-nine waste groups were defined for use in the projections. These followed the 'NEPM 15' list (see Section 1.2) but with some categories disaggregated where a component waste is of particular interest. In these cases, the disaggregated categories mostly followed the 'NEPM 75' group. Wastes were typically of particular interest where:

- the future quantities and available infrastructure are highly uncertain (e.g. the 'new' Stockholm wastes PFOS, POP-BDEs, HBCD, HCB) – discussed in the 'breakout box' below
- there are very specific public concerns (e.g. lead and lead compounds, asbestos)
- the waste is associated with a source industry with unusually strong growth projections, e.g. non-toxic salts 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 soils).

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

Table 1: Waste groups and the inclusion of waste of particular interest

	Waste group	Closest NEPM category	The component of particular interest
1	Plating & heat treatment	A	
2	Acids	B	
3	Alkalis	C	
4	Mercury & compounds	D120	Mercury wastes
5	Lead & compounds	D220	Lead wastes and waste lead acid batteries
6	Non-toxic salts	D300	Coal seam gas wastes
7	Other inorganic chemicals	Other D	Spent potlining wastes from aluminium industry.
8	Reactive chemicals	E	
9	Paints, resins, inks, organic sludges	F	
10	Organic solvents	G	
11	Pesticides	H	
12	Oils	J	Waste oil and oil/water mixtures
13	Animal effluent and residues (+ food processing waste)	K100	Large tonnage low hazard organic waste
14	Grease trap waste	K110	Large tonnage low hazard organic waste
15	Tannery & wool scouring wastes	K140 & 190	Large tonnage low hazard organic waste
16	PFOS	M160a	Perfluorooctanesulfonic acid (PFOS) including potential PFOS contaminated biosolids
17	POP-BDEs	M160b	Polybrominated diphenyl ethers (PBDEs) including potential PBDEs contaminated biosolids
18	HBCD	M160c	Hexabromocyclododecane (HBCD) including potential HBCD contaminated biosolids
19	HCB	M160d	Orica stockpile of Hexachlorobenzene
20	Other organic chemicals	Other M	
21	Contaminated soils	N120	Contaminated soils
22	Contaminated biosolids	N205a	Contaminated biosolids for potential inorganics contamination. POP contamination see M160a-c
23	Other industrial treatment residues	N205b	
24	Asbestos	N220	Waste asbestos
25	Other soil/sludges	Other N	
26	Clinical & pharmaceutical	R	
27	Tyres	T140	Tyres
28	Other miscellaneous	Other T	
29	Lithium-ion batteries	n/a	Waste lithium-ion batteries

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 *K100 Animal effluent and residues*.
- Contaminated biosolids – the solid residues of sewage treatment – 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* (N205b 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 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. If not appropriately managed, this waste represents a safety hazard due to risks of causing explosions and or fire (ABRI 2014).

Persistent Organic Pollutants (POPs) waste groups M160 a – d

This 'breakout box' details why the waste groups, M160a - d, were defined and analysed.

This waste group is captured in tracking systems as M160 Organo halogen compounds—other than substances referred to in this Table or Table 2, but is not mentioned elsewhere in this report because only very limited quantities are recorded in tracking systems. While there may some current issues with inaccurate coding, current quantities are inconsequential compared to those possible in future.

Three 'new' potentially hazardous waste streams may emerge over the next five years should the Australian Government determine to ratify the recent listing of a number of new chemicals onto the Stockholm Convention on Persistent Organic Pollutants (POPs).

POPs are hazardous and environmentally persistent substances which can be transported between countries by the earth's oceans and atmosphere. POPs accumulate in living organisms and have been traced in the fatty tissues of humans and other animals. There is general international agreement that they require global action to reduce their impact on humans and the environment. The new listings of relevance to this project are polybrominated diphenyl ethers (PBDEs, known as POP-BDEs), hexabromocyclododecane (HBCD) and perfluorooctanesulfonic acid (PFOS). Both the POP-BDEs and HBCD are brominated flame retardant chemicals, while PFOS has been used in various mist dispersal and surface coating applications, including (significantly) firefighting foams.

A fourth key waste belongs in this waste group, and while it is potentially 'emerging' in terms of tracked hazardous waste arisings and (more importantly) Australian fate infrastructure, it is actually a legacy problem waste. This is the hexachlorobenzene (HCB) waste stockpile at Orica's Port Botany facility in Sydney. No acceptable management solution – whether destruction or more appropriate storage – has been identified many decades since this material began accumulating in the 1960s.

The common property of this waste group is that it contains organic chemicals that contain halogen elements (usually fluorine, chlorine, bromine) as significant components in their structure. This waste type shares commonality with other waste types such as dioxins and furans (M170 and M180), PCB-like compounds (M100) and organochlorine pesticides (H100). The presence of the halogen species is usually the reason for the property of interest – and the reason for the toxicity.

Apart from the scientific consensus around their environmental impacts, POPs wastes are problematic for other reasons:

- They have been historically added at high (percentage) levels in products or 'articles' such as flame retardants in hard plastics and foams. At the end of their useful life, these articles are typically discarded to landfill, although there is substantial recycling of e-waste, which can contain these treated hard plastics. Such end-of-life articles are not currently treated or managed as hazardous waste, particularly since Australian ratification of the Stockholm listing of these chemicals is yet to occur.
- The ubiquitous nature of POPs means that they are not only present in waste articles, but can also present as waste from their broader use and dispersal, such as in landfill leachate, wastewater treatment plant discharge and, most importantly, in sewage sludge, which, after dewatering, is known as biosolids.
- Strong drivers exist for recycling end-of-life articles such as e-waste. However, if hazardous chemicals such as POPs are present in the recycled plastic commodity (recyclate) then the problem of exposure and dispersal is perpetuated through re-entrainment, albeit generally at lower concentrations than in the original product.

Projections of this waste over the next 20 years are provided in the Hazardous Waste Infrastructure Needs and Capacity Assessment report. Depending on scenario conditions, such as whether and when Australia ratify the latest Stockholm Convention listings and a raft of other uncertainties, the emergence of POPs waste could change the landscape of hazardous waste management in Australia.

Broadly speaking, the Stockholm Convention requires POP-containing wastes to be destroyed. From a fate perspective, ratification of the new Stockholm POPs could massively increase the demand on infrastructure capacity that already appears to be inadequate for the estimated current generation of polluted firewaters (a PFOS waste stream). It has been long understood that existing Australian infrastructure for halogenated chemical treatment is inadequate for dealing with the Orica HCB waste in technology, scale and cost.

These issues indicate an emerging potential problem in relation to management of POP waste as it arises, and to the set of current infrastructure available to treat it in an environmentally sound manner.

2.3 Data inputs to the projections

Overview of data sources

The data and information sources underpinning the projections are summarised in Table 2. A list of the literature and online materials examined is included in the bibliography, and a list of persons who helped with the project through one-on-one discussions is included in the acknowledgements. The most important data source for this part of the project– the jurisdictional waste data – is displayed in bold italics.

Table 2: Information and data underpinning the projections, and their uses

Information or data	Method for obtaining the info or data	Contribution to the projections
Projection methods used in other jurisdictions	Desktop research	Confirmation and potential revision of methods
Pre-existing projections (*see below*)		Considered or directly reused in building the projections
Planned or recent jurisdictional policies	Face-to-face or telephone consultation with policy staff at each jurisdiction – these are summarised in **Appendix A.2**.	Potential impacts on future hazardous waste arisings
Waste industry views and information	Consultation undertaken primarily to understand infrastructure capacity	Causal factors, trends, current stores
Expert views	Ad-hoc discussions	
Jurisdictional waste tracking data (*see below*)	***Provided by the jurisdictions***	***Establishment of baselines*** ***Understanding of industry sources*** ***Understanding of treatment types (fate)*** ***Understanding of trends***
Other jurisdictional waste data		Establishment of baselines
Waste arisings	Desktop research	
Projected long-term growth in national population & economic activity		Causal factors for waste arisings
Industry activity, trends, analyses and activity projections (*see below*)		
Other potential factors (e.g. construction & demolition activity)		Possible causal factors for waste arisings
Current stores of hazardous waste		Quantities that may need treatment

Pre-existing projections

Only two useful pre-existing projections were identified. These are summarised in Table 3.

Table 3: Pre-existing projections used in building our projections

Information source	Relevant waste group	Use in projections?
NC & SRU (2014)	Waste paints, resins, inks and organic sludges	High estimate
Thornton (2014)	Clinical & pharmaceutical	Best estimate

Jurisdictional data

As indicated in Table 2, data from jurisdictional tracking systems was foundational in establishing baselines for each waste group and in providing an understanding of trends. Waste tracking systems in Qld, NSW, SA, Vic and 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. These systems were established to ensure that hazardous waste is appropriately managed. Data from these systems was collected, collated and analysed, together with other jurisdictional waste data. This represents the first time that jurisdictional data on hazardous waste data from across Australia has been analysed in a time series.

A summary of the characteristics of the data received from each jurisdiction is given in Table 4. 'Data dumps' encompassing several million transactions over several years were received from Qld, NSW, Vic and WA. Each of the other jurisdictions provided data, but in lesser amounts or already collated to annual tonnages. The NT and Tas provided data from reports of 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 4: Metadata of the jurisdictional hazardous waste data received

Jurisdiction	Date range	Date	Waste type	Quantity	Source industry	Fate	Jurisdiction of generation apparent?	Comprehensive coverage of arisings?	Comments
ACT	2013		✓	✓			✓	✓	Data collated by waste type
NSW	2010-2014	✓	✓	✓	✓*	✓	✓	✓	Full 'data dump' (280,000 entries). Asbestos & contaminated soil data from landfill reports.
NT	2012-2014	✓	✓	✓		✓	✓		Covered only inter-state transfers
Qld	1999-2013	✓	✓	✓	✓*	✓	✓	✓	Full 'data dump' of 30 files, each with up to 83 worksheets, each with up to 65,000 entries. Contaminated soil data from landfill reports.
SA	2006-2014		✓	✓	✓			✓	Data collated by waste type
Tas	2012-2013	✓	✓	✓			✓		Covered only inter-state transfers
Vic	2003-2014	✓	✓	✓	✓	✓	✓	✓	Full 'data dump' (1.6 million entries). Some pre-2003 asbestos and contaminated soil data included from landfill reports.
WA	1999-2014	✓	✓	✓		✓*	✓	✓	Full 'data dump' (1.3 million entries)

Notes: Date ranges did not always encompass the entire calendar year.
An asterisk means the data in this field could not be readily analysed due to incompleteness or other reason.

As Table 4 shows, there was significant variability in the characteristics of the data received. This limited the comprehensiveness of the analysis that could be carried out. Further, a range of challenges with the data set affected its quality and the ease of interpretation, as summarised in Table 5. Despite these challenges, a far-reaching insight was obtained from the data set into the trends in hazardous waste data arisings and the sources and treatments of the different waste types. A collation of the data analysis is given in Appendix A.4.

Table 5: Data challenges, effects and responses

Data challenge	Response to this challenge / effects on the analysis
Differences in the methods used by jurisdictions to track and classify waste types	These challenges are canvassed in Appendix A.3, together with an account, for each issue, of why this was problematic for the analysis, an estimate of the scale of the issue, a discussion of how it has been dealt with in the past, and a description of how it was dealt with in completing this analysis.
Multiple counting of waste	
Potential storage release spikes (which undermine the interpretation of trends)	
Definitional challenges such as whether to report onsite disposal	
Differences in measurement methods (mass, volume, numbers of items)	
Differences in the methods used by jurisdictions to classify treatment types and source industries.	These differences limited and complicated the analyses, requiring multiple conversions to common platforms. In some cases the conversions were based on estimates.
Apparently imperfect levels of industry compliance with waste tracking requirements, especially in the early years of system operation.	This reduced the reliance that could be placed on the data baseline and apparent trends.
Apparent differences in the codes that reporters use in describing similar wastes.	
Potential variability in how users nominate a category for a particular waste type.	

Industry activity 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 6.

Table 6: Industry activity projections and analyses and their use in the projections

Industry	Related wastes	Primary information source(s)
Coal seam gas extraction	Non-toxic salts, alkalis	ABC (2014)
Aluminium smelting	Acids, Other inorganic chemicals	JCP (2012), Alcoa (2014)
Gas and oil extraction	Alkalis, oils	IBIS (2014)
Leather and leather substitute product manufacture	Tannery & wool scouring wastes	IBIS (2014)
Meat processing	Animal effluent and residues (+ food processing waste)	IBIS (2014)
Cement and lime industry	Alkalis	DoE (2012a)
Petroleum production and refining	Alkalis	MJA & SRU (2014)

2.4 Establishing the baseline

A starting point or baseline tonnage figure was established for each waste group in each jurisdiction based on the most recent datum, as shown in Table 7. The most common data source was the jurisdictional data, but other sources in some cases as shown in the footnotes to Table 7. The details of some adjustments to the baseline are described in Appendix A.3, which covers the data challenges faced and how we responded to them.

Table 7: Baseline tonnages for each waste group by jurisdiction

Year:*	ACT *2013*	NSW *2014*	NT *2012*	Qld *2013*	SA *2014*	Tas *2013*	Vic *2014*	WA *2013*
Plating & heat treatment	0	5	0	*4,826*	186	0	*0*	1,048
Acids	0	15,367	14	*13,019*	673	32	*10,815*	3,892
Alkalis	220	4,887	127	*167,388*	24,764	1	*7,229*	83,720
Mercury; mercury compounds	12	**1,016**	22	*315*	75	0	*32*	35
Lead; lead compounds	226	**52,870**	410	*7,528*	**37,301**	10,413	*2,006*	234
Non-toxic salts	0	25,134	0	*40,426*	362	3,780	*699*	10,962
Other inorganic chemicals	0	**10,727**	28	*4,375*	73,380	111,268	*2,118*	679
Reactive chemicals	0	27	0	*48*	5	0	*32*	0
Paints, resins, inks, org. sludges	171	14,082	37	*11,666*	2,897	0	*13,946*	1,895
Organic solvents	68	8,630	8	*12,957*	373	239	*3,663*	4,759
Pesticides	15	531	0	*1,150*	380	0	*581*	1,015
Oils	2,800	130,665	795	*250,980*	10,135	356	*74,567*	166,586
Animal effluent and residues	0	95,156	3,095	*109,724*	21,499	6,629	*37,280*	16,970
Grease trap waste	5,856	170,620	5,550	*133,181*	38,550	11,885	*104,358*	60,952
Tannery & wool scouring wastes	0	0	0	CIC	0	0	CIC	0
Other organic chemicals	24	12,737	82	*3,572*	2,474	32	*778*	2,050
Contaminated soils	1,953	555,300	12,381	327,585	145,387	131	*314,299*	3,310
Contaminated biosolids	*51,768*	*384,367*	*5,101*	*311,874*	*135,455*	*30,334*	*429,502*	*120,481*
Other ind. treatment residues	27,578	24,539	0	**128,880**	**47,195**	0	*0*	9,932
Asbestos	20	531,100	8,857	*113,408*	15,991	18,968	*68,127*	91,773
Other soil/sludges	9	29,828	29	*24,675*	2,576	7	*36,134*	**10,964**
Clinical & pharmaceutical	562	22,791	124	*26,258*	6,311	22	*11,461*	3,242
Tyres	3,695	*104,598*	*5,662*	*92,923*	*29,561*	*10,060*	*88,168*	*73,681*
Other miscellaneous	73	2,354	124	*2,729*	367	13	*888*	403
Totals (thousands of tonnes)	95	2,197	42	1,796	650	204	1,208	669

** Financial year ending in this year – except for NT, for which calendar year information is presented.*

The baselines for PFOS, POP-BDEs, HBCD, HCB and lithium-ion batteries were taken to be zero.

Code for data types:

- CIC – data withheld due to commercial confidentiality concerns
- Normal font – *from tracking system data*
- *Italics – from tracking system data, but adjusted to remove some multiple-counting by subtracting tonnes for which the recorded treatment was 'transfer'.*
- **Bold blue font** – *three-year average adopted because the relevant year's data appeared to include unrepresentative 'spikes' from storage releases.*
- Red underlined normal font – *from landfill reports*
- *Italics in grey shading – from an alternative source (biosolids derived from ANZBP 2013 – see Appendix A6; tyres from Hyder 2012)*
- Normal font in black shading – *derived from other jurisdictions' data, assuming arisings per capita equal the average across the jurisdictions for which data was available.*

2.5 Hazardous waste scenarios

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 quantities over a 20-year period, for example in relation to:

- factors that will influence the quantities of hazardous waste generated, such as the scale of economic and population growth, the level of activity of waste-producing industries in Australia, and whether they will become more efficient in their waste generation
- whether or not some wastes will be classified as hazardous
- the extent to which current waste stores will 'arise' through release into the waste stream.

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 2013-14 to 2033-34. They build on the analysis of jurisdictional hazardous waste data and other research as listed in Table 2, and applying the method shown in Figure 1. The scenarios were qualitatively defined qualitatively 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 store of waste is envisaged being 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.

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 10% and -3% annually.

For contaminated biosolids, the best estimate links to the proportion of newly produced biosolids that fall into the Victorian 'C3 standard', which prohibits their use on land. It then assumes 1% growth until 2024 followed by an annual fall of 1% as industrial wastewater quality improves.

For the 'new Stockholm wastes', the best estimate required a mid-range estimate of the concentration threshold to be applied; assumptions about concentrations in various materials and wastes; the stocks of some products and how they enter the waste stream; and growth rates of existing waste streams. Under the best estimate, PFOS and POP BDEs, but not HCBD, would be present in some biosolids above the hazardous waste threshold.

The combined best estimate for all waste groups is illustrated in Figure 2. The quantity of hazardous waste rises from about 5.7 million tonnes[9] (Mt) in 2013-14 to 9.9 Mt in 2033-34. This represents an average growth rate of 2.8% per year, larger than the projected average growth rate for population (1.5%), which is illustrated on the chart, and equivalent to the long-term projected economic growth rate.

[9] The 'starting point' of 5.7 Mt is less than the number stated in Australia's 2013 report to the Basel Convention because: A. The Basel report conservatively included all biosolids whereas these projections do not (see the report Appendix A.6); B. The initial year here is 2013-14, whereas Basel covers the 2013 calendar year; C. baseline figures for some waste groups and jurisdictions were assessed to be above the trend due to releases from storage and adjusted downwards (see report method section).

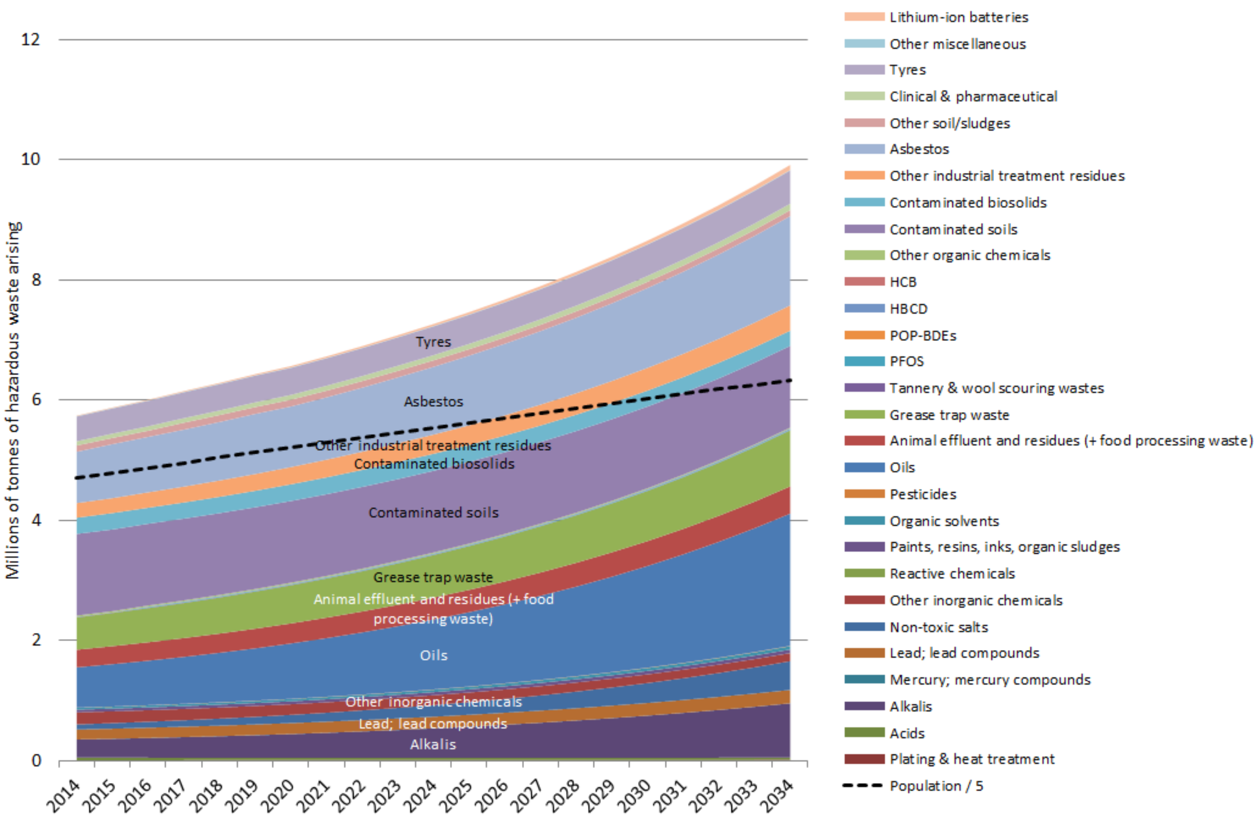
In interpreting the projection, it should be remembered that there is some multiple counting of the mass of some types of waste where transfers, storage and transformations occur.

The top six groups in terms of tonnes arising – alkalis, oils, grease trap waste, contaminated soils, asbestos and tyres – represent about three-quarters of the total at both the start and end of the projection period.

Some waste groups are projected to grow strongly over this period, including: lithium-ion batteries (average growth rate 12% per year); non-toxic salts (9.0%); oils (6.1%); and alkalis (5.7%). In addition, the combined M160 'new Stockholm wastes' (PFOS, POP-BDEs, HBCD and HCB) grow from 3,800 t in 2013-14 to 28,000 t in 2033-34, following Australia's assumed ratification of the new wastes in 2016-17.

Seven groups decline, including: tannery and wool scouring wastes (average decline of 4.1% per year); other organic chemicals (2%); and acids (0.9%).

Figure 2: Best estimate of national projections for all hazardous waste to 2034



High scenario

A highest credible estimate of waste arising was made for each waste group. In most cases the high estimate assumed a growth rate equal to that of the best estimate, plus 2% or 3% depending on the waste group. In cases where the best estimate was for no growth or a decline, the high scenario set an annual increase at the long-term economic growth rate. The combined high estimate is shown in Figure 3.

The high scenario is consistent with high economic and population growth. The manufacturing decline is much less pronounced. Mining activity – and particularly coal seam gas mining – is projected to continue growing strongly, causing strong growth in the quantities of associated wastes. Oils increase from 0.68 to 3.4 Mt over the projection timeframe, an average annual growth rate of 8.4%. Non-toxic salts, which are strongly associated with coal seam gas, rise from 86,000 to 695,000 tonnes in 2034, some 45% more than the best estimate and equivalent to an average increase of 11% per year. This is driven by estimates of similar growth rates in coal seam gas extraction.

A key feature of the high scenario is the assumption that three major stockpiles of hazardous waste are processed during the projection period. These are: spent potlining from the aluminium industry in four states; contaminated biosolids from very large stockpiles in Victoria; and HCB from the Orica stockpile in Sydney. The releases of these wastes – particularly the Victorian biosolids stockpile – over the indicative timeframe cause a sharp increase in total quantities in 2015-16 and the corresponding decline in 2030-31.

Under the high scenario, a much larger proportion of Victoria's 'new' biosolids are assumed to be contaminated, adding 0.18 Mt to the baseline. In addition, unlike the base case no future decline is projected in the proportion of biosolids that are hazardous.

The projections for the new Stockholm wastes assume lower threshold levels will apply, resulting in biosolids contamination by HBCD, which is not present in the best case, and by PFOS at much higher levels than in the best case[10]. The combined M160 'new Stockholm wastes' (PFOS, POP-BDEs, HBCD and HCB) increase to 0.18 Mt in 2033-34 under this scenario.

Under the high scenario, lithium-ion batteries are projected to become a major technology, producing a waste stream that grows from a current total of about 8,000 tonnes to 154,000 tonnes, an average growth rate of 16% per year.

Contaminated soils and asbestos are also generated in much higher volumes in the high estimate. A combined total of almost 4 Mt, in approximately equal proportions, contrasts with only about 2.8 Mt under the best estimate.

The only waste that declines is tannery and wool scouring wastes, which reduces at an average rate of 2.1% per year. The industry is projected to decline even under this optimistic scenario.

The overall growth rate is much higher than the best estimate, rising from an initial 7.1 Mt to 15.2 Mt over the 20-year projection period – an average annual increase of 3.9%. The top six groups at the end of the period are identical to those listed above in the best estimate (alkalis, oils, grease trap waste, contaminated soils, asbestos and tyres).

Low scenario

A lowest credible estimate of waste arising was made for each group. In most cases the low estimate assumed a growth rate equal to that of the best estimate, less 2% or 3%. In cases where the best estimate projected particularly high growth, the low scenario set an annual increase at the long-term economic growth rate.

The low scenario is consistent with low economic and population growth, decline in the manufacturing sector and relatively low growth in mining. The combined low estimate is illustrated in Figure 4. Similarly to the best estimate, it has the overall features of exponential growth but at the much lower average annual growth rate of 0.9%. There is an overall rise of in the quantity of hazardous waste from 4.4 to 5.3 Mt over the 20-year period.

Major differences from the best estimate scenario in 2034 include 0.36 Mt less non-toxic salts (a waste produced in large amounts by the coal seam gas industry) and 1.3 Mt less oils. Contaminated soils and asbestos also arise in much lower volumes, estimated at 1.1 Mt less than the best estimate.

[10] These quantities are not included in the 'contaminated biosolids' projection to avoid double-counting.

Figure 3: High estimate of national projections for all hazardous waste to 2034

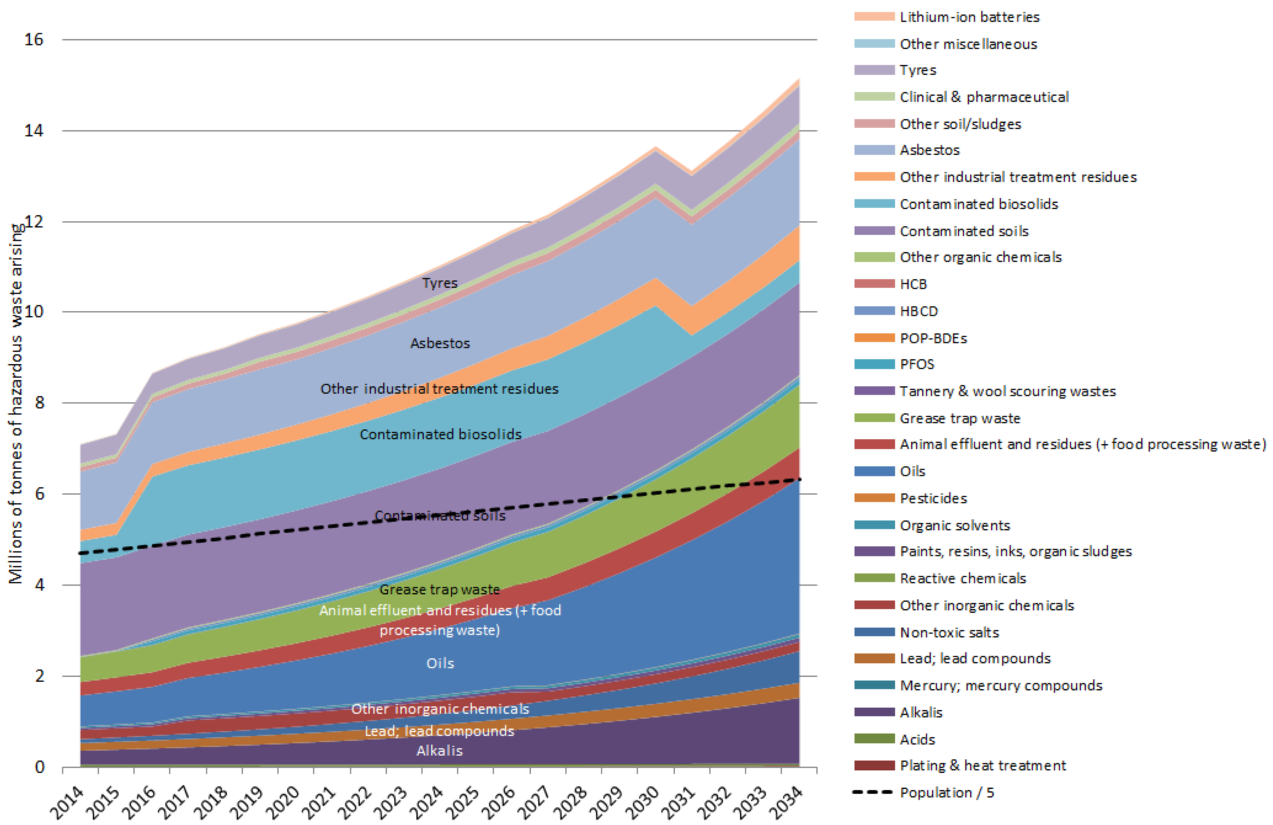
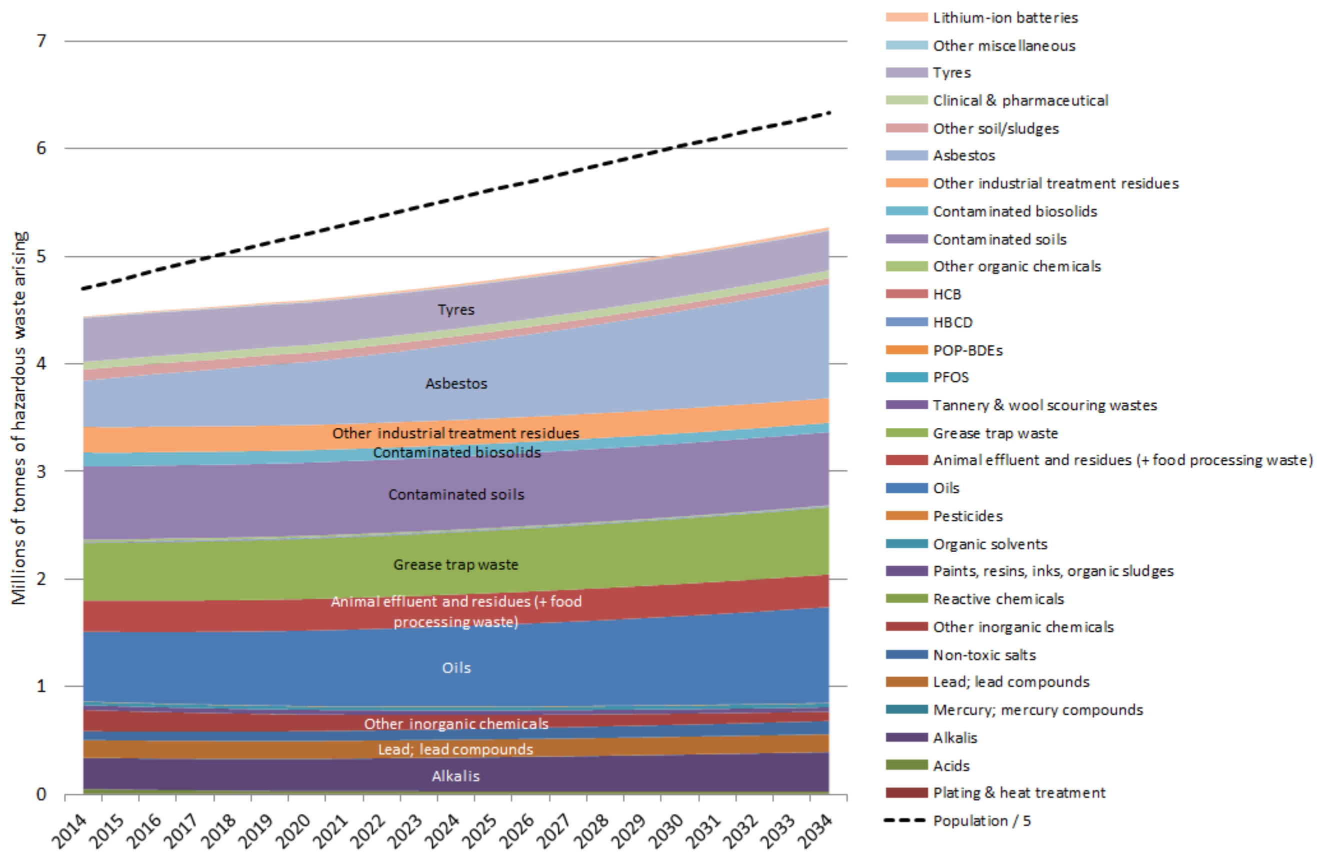


Figure 4: Low estimate of national projections for all hazardous waste to 2034



The baseline value for contaminated biosolids is estimated at half the best estimate, reflecting the uncertainty of the contamination levels in this material. Contaminant levels are projected to decline at 2% per year, based on assumptions of declining manufacturing and better management of the quality of sewage discharges from industry. The result is 0.17 Mt less contaminated biosolids in 2034 than the best estimate.

The threshold concentration value for the new Stockholm wastes is assumed to be higher under the low scenario. The result is that no PFOS and very little POP-BDEs is produced, and no biosolids would be contaminated with these wastes above the threshold levels. Several thousand tonnes of HBCD waste would still be produced annually in old expandable and extruded polystyrene .

Strong growth is still projected for lithium-ion batteries (average growth of 6.2% per year), and eight other groups are also projected to increase. Fifteen groups are projected as declining, including: PFOS (average reduction of 11% per year); tannery and wool scouring wastes (6.1%); other organic chemicals (5.1%); other inorganic chemicals (4.0%); and acids (3.8%). The six largest streams are the same as in the best and high estimates and remain about 75% of the total at the end of the period.

2.6 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 Vic[11]
   - 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 2013-14 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.

Where a waste group includes 'waste/s of particular interest' additional content is provided where it is needed to provide information about the waste generally and how the waste has been considered in the scenarios.

Development of the scenarios for the following waste groups involved more detailed and complex analysis:

- the 'new Stockholm wastes' (M160a PFOS, M160b PBDEs, M160c HBCD)
- contaminated biosolids
- lithium-ion batteries

This analysis is provided in **Appendices A.5 to A.7** respectively and needs to be reviewed to gain a complete understanding of the projections of these waste groups.

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

Again, in interpreting the scenarios, the likelihood of some multiple counting should be considered.

[11] The data obtained from these three jurisdictions included Australia and New Zealand Standard Industrial Classification (ANZSIC) codes, allowing this level of analysis. Other jurisdictions did not provide this data.

A. Plating and heat treatment

This group includes the following.

- *A100 Waste resulting from surface treatment of metals and plastics*: Overspray of coating materials together with excess material removed in cleaning of equipment.
- *A110 Waste from heat treatment and tempering operations containing cyanides*: Molten inorganic salts used to 'case harden' or 'face harden' iron or low-carbon steel or to control temperature in the tempering process.
- *A130 Cyanides (inorganic): Solutions of sodium and potassium cyanides are used in processes that do not result in their complete transformation or destruction and they are present in wastes from such processes.*

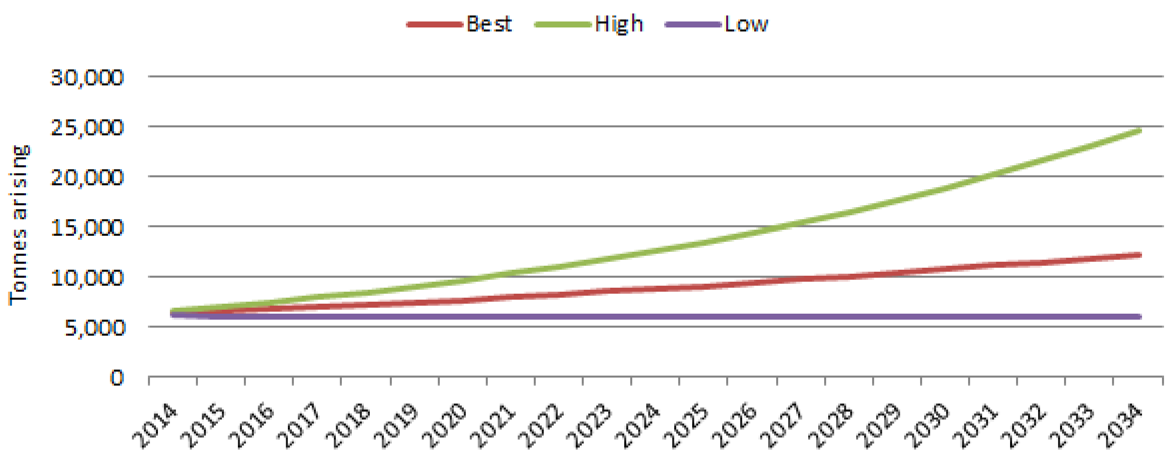
Summary analysis

Industry sources	Considerations	Comments	Approach
• Marine fishing • Mining; including coal and gold mining • Petroleum refining • Metal manufacturing • Metal coating and finishing	No sufficiently credible pre-existing projections were identified Assume Qld upward trend associated with mining boom	Construction of new buildings is a key driver for metal coating & finishing Victoria does not track A100 (Waste resulting from surface treatment of metals and plastics) A declining trend is apparent	Use judgement - trend and causal analysis

Table 8: Best, high and low projected rates of change for plating & heat treatment waste to 2034

	Applies to	Approach	2014	...	2034
Best	ACT, NSW, NT, SA, Tas, Vic	Economic growth mitigated by apparent downward trend	0.0%	...	0.0%
High		Economic growth	2.8%	...	2.8%
Low		Best estimate of annual rate of change - 3%	-3.0%	...	-3.0%
Best	Qld, WA	Mid-point between high and low estimates of annual change rate	3.5%	...	3.5%
High		Apparent trend continues over the projection period	7.0%	...	7.0%
Low		As per best estimate for other jurisdictions	0.0%	...	0.0%

Figure 5: Best, high and low national projection estimates of plating & heat treatment waste to 2034



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.

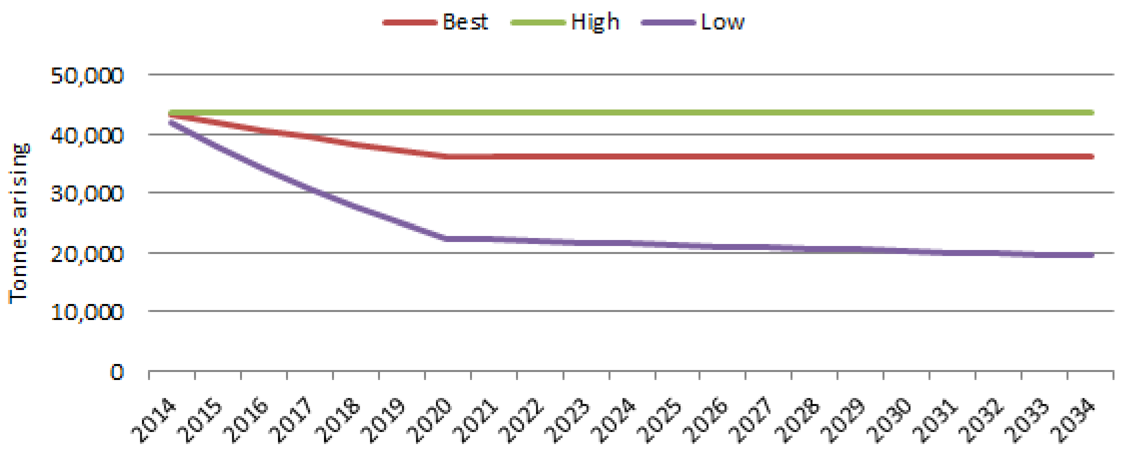
Summary analysis

Industry sources	Considerations	Comments	Approach
• Metal coating and finishing • Metal refining • Primary metal and metal product manufacturing • Coal mining	No sufficiently credible pre-existing projections were identified No historical data set exists that is adequate for discerning trends	Aluminium smelting is expected to decline, potentially very significantly (JCP 2012, Alcoa 2014)	Use judgement - trend and causal analysis

Table 9: Best, high and low projected rates of change for acid waste to 2034

	Applies to	Approach	2014	...	2021	...	2034
Best	ACT, NSW, NT, Qld, SA, Tas, Vic, WA	Eight-year decline associated with aluminium smelting	-3.0%	...	0.0%	...	0.0%
High		Assume smaller reduction in aluminium waste, plus economic growth	0.0%	...	0.0%	...	0.0%
Low		Large eight-year decline in aluminium smelting	-10.0%	...	-1.0%	...	-1.0%

Figure 6: Best, high and low national projection estimates of acid waste to 2034



C. Alkali waste

This group includes only the single NEPM 75 code *C100 Basic solutions or bases in solid form*.

Alkali wastes are produced in significant quantities from coal seam gas (CSG) extraction in Queensland, cement and lime kilns around Australia, aluminium refining and as a surface cleaner/ degreaser in a range of industries such as diverse as metal coating and finishing to fast food. See *D300 Non-toxic salts* for detailed CSG wastes discussion.

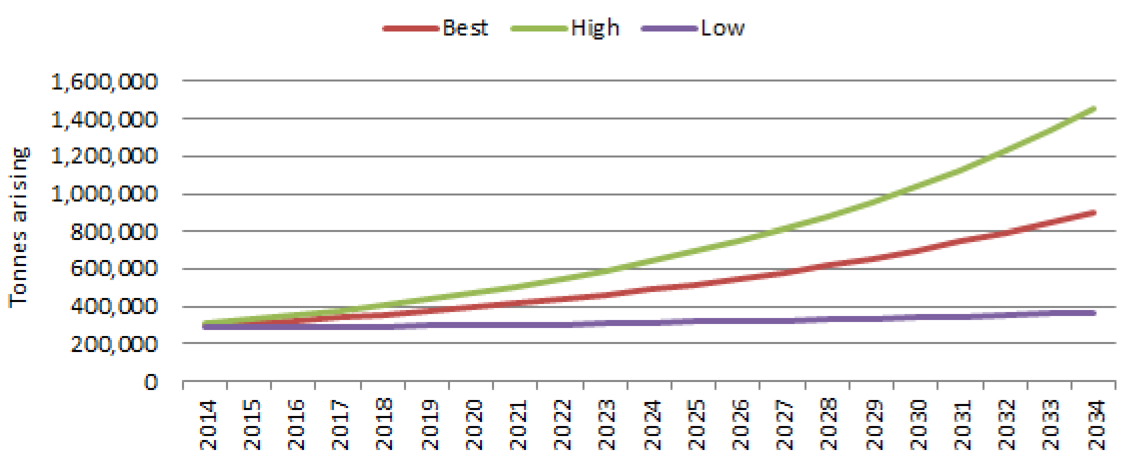
Summary analysis

Industry sources	Considerations	Comments	Approach
• Oil and gas extraction (including CSG) • Aluminium refining • Cement and lime manufacturing • Metal coating and finishing • Motor vehicle parts manufacturing • Fast food and food manufacturing (cleaning wastes)	No sufficiently credible pre-existing projections were identified No historical data set exists that is adequate for discerning trends	Oil & gas extraction (coal seam gas) expected to increase in Qld Petroleum refining is expected to decline High growth in coal seam gas industry activity is expected over the projection period (ABC 2014)	Use causal analysis Need different approach by jurisdiction due to stark differences in trends and sources

Table 10: Best, high and low projected rates of change for alkali waste to 2034

	Applies to	Approach	2014	...	2034
Best	Qld	Ongoing increase with oil & gas extraction	7.7%	...	7.7%
High		Stronger increase	10.0%	...	10.0%
Low		Economic growth	2.8%	...	2.8%
Best	SA	Increase with cement industry growth (best estimate)	2.0%	...	2.0%
High		Increase with cement industry growth (high estimate)	2.8%	...	2.8%
Low		Increase with cement industry growth (low estimate)	1.0%	...	1.0%
Best	ACT, NSW, NT, Tas, Vic, WA	Decline associated with petroleum refining	-1.4%	...	-1.4%
High		Economic growth	2.8%	...	2.8%
Low		Best estimate of annual rate of change - 3%	-4.4%	...	-4.4%

Figure 7: Best, high and low national projection estimates of alkalis waste to 2034



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*[12].

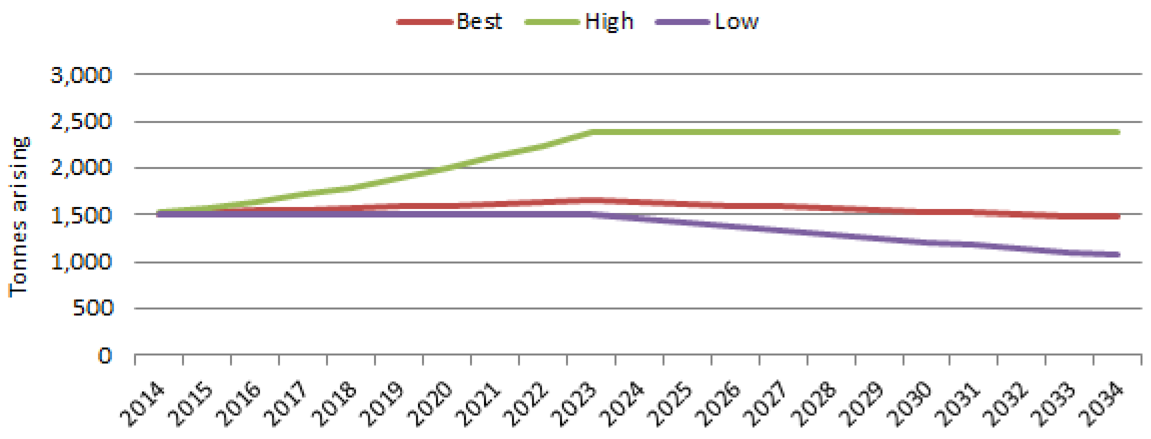
Summary analysis

Industry sources	Considerations	Comments	Approach
• Chemical product manufacturing • Fluorescent lamp collection programs • Petroleum refining • Fossil fuel electricity generation • Coal Mining; • Hospitals; Teaching institutions	No sufficiently credible pre-existing projections were identified No historical data set exists that is adequate for discerning trends	Fluorescent lamps are expected to be increasingly outcompeted by LED lights Fluorescent lamp recycling may nevertheless increase (current rates are low) Minamata ratification (if it occurs) is likely to drive increased collection of fluoro lamps Mining catalyst waste might be processed in Australia	Use causal analysis

Table 11: Best, high and low projected rates of change for mercury; mercury compounds waste to 2034

	Applies to	Approach	2014	...	2024	...	2034
Best	ACT, NSW, NT, Qld, SA, Tas, Vic, WA	Improved recovery but after 10 yrs, declining fluoro lamp production	1.0%	...	-1.0%	...	-1.0%
High		Best + 3%; Minamata in 5 yrs drives further temporary increase	4.0%	...	0.0%	...	0.0%
Low		Decline in fluorescent lamp production, no increase in recovery	0.0%	...	-3.0%	...	-3.0%

Figure 8: Best, high and low national projection estimates of mercury; mercury compounds waste to 2034



[12] http://www.mercuryconvention.org/Convention

D220. Lead; lead compounds

This group includes only the single NEPM code *D220 Lead; lead compounds*. A significant component of lead waste in Australia is from end of life lead acid batteries. Leaded glass is another waste stream that has emerged from the e-waste recycling industry, where cathode ray television/ monitor (CRT) glass contains large quantities of lead.

Australia has the world's largest deposits of both lead and zinc and as a result, both are mined and used locally and exported[13].

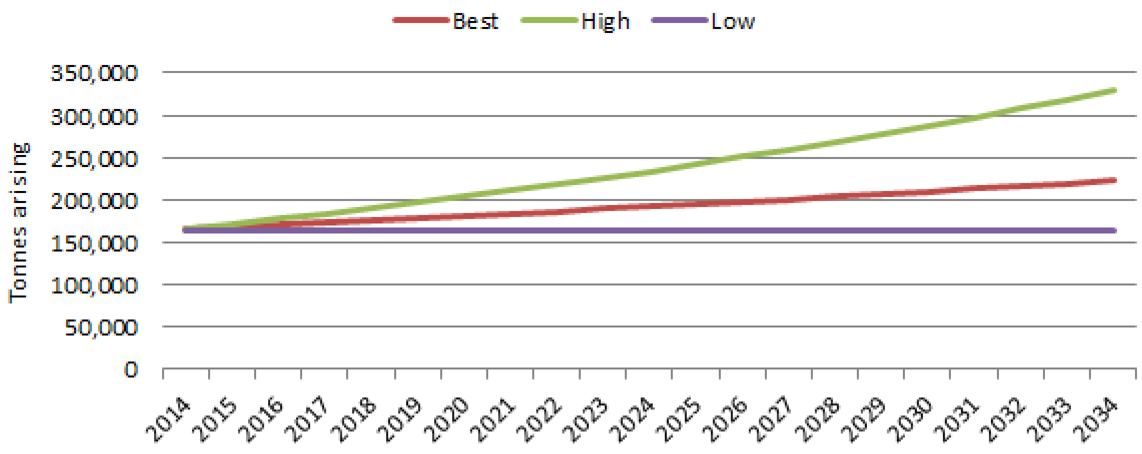
Summary analysis

Industry sources	Considerations	Comments	Approach
• Lead acid batteries • e-waste recycling • metal and coal mining • scrap metal collectors and recyclers • Copper, silver, lead and zinc smelting and refining	No sufficiently credible pre-existing projections were identified Historical data for Victoria exists that is adequate for discerning trends. No other historical data set exists.	New large refining capacity in NSW Contributes 27% to imports to NSW in 12-13; 50% in 10-11 Nystar lead smelter investment in SA	Use judgement - trend and causal analysis

Table 12: Best, high and low projected rates of change for lead; lead compounds waste to 2034

	Applies to	Approach	2014	...	2034
Best	ACT, NSW, NT, Qld, SA, Tas, Vic, WA	Population growth	1.5%	...	1.5%
High		Significant increase	3.5%	...	3.5%
Low		Best estimate of annual rate of change - 1.5%	0.0%	...	0.0%

Figure 9: Best, high and low national projection estimates of lead; lead compounds waste to 2034



13 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

D300. Non-toxic salts

This group includes only the single NEPM code *D300 Non-toxic salts*. The primary source of this waste is the coal seam gas (CSG) extraction industry. CSG wastes are discussed in the breakout box below.

Coal seam gas waste

CSG mining occurs predominantly in Queensland and to a lesser extent in NSW. Consequently, approximately 80% of CSG-based waste is generated in Queensland, in the Bowen and Surat Basins. CSG in Queensland is usually liquefied to allow easier transport, such as by ship, which means it is also referred to as liquefied natural gas (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 salt wastes are the most prevalent. These wastes are nominally captured in waste tracking systems as D300 non-toxic salts, described in section 4.6.

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.

Once at the surface, the water is stored in ponds and treated by desalination to enable reuse, to the extent possible. However, this process leaves a salt brine or solid salt waste as a by-product. This salty waste stream may also include hydrocarbons and heavy metals as residual contaminants from the original CSG extraction process.

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.

Because of these management difficulties, large quantities of CSG wastes are temporarily stored on site in brine ponds or other temporary structures offsite, awaiting a more definitive management fate. This storage aspect would appear to be borne out in the arisings numbers. Tracking systems indicate a current volume arising of this waste near 100,000 tonnes (i.e. what is being transported and tracked to an offsite pathway or fate). But industry and government estimates of water volumes extracted each year, multiplied by typical salinity of this water, yield a conservative estimate of approximately 21 million tonnes of salt over the next 30 years – or (on a flat annual average) 700,000 tonnes per year of waste salt. Some of this volume discrepancy is due to temporary storage onsite, which is not reflected in tracking system data.

For this project and the accompanying projections developed in the Hazardous Waste Infrastructure Needs and Capacity Assessment Project, the tracking system figure of approximately 100,000 tonnes has been used. Tracking data alone suggests in the order of 20% annual growth in non-toxic salts recent years, which is also consistent with the accompanying project's projections.

Analysis of data for CSG waste is largely covered by the D300 non-toxic salts data analysis (section 4.6) and the fate-specific data presentation in section 3.4, which shows that the fate of this waste is spread between:

- recycling (41%)
- storage or transfer (34%)
- landfill (22%).

Outside of the tracking system, depending on the location of the mining activity, discharge to ocean of salty water is also likely to be a fate for this waste.

Projections of this waste over the next 20 years are provided in the Hazardous Waste Infrastructure Needs and Capacity Assessment report (as D300). These foresee annual growth under the 'best' (or most likely) scenario of 10%. On a treatment-difficulty and sheer scale basis, CSG waste is a current and future management problem.

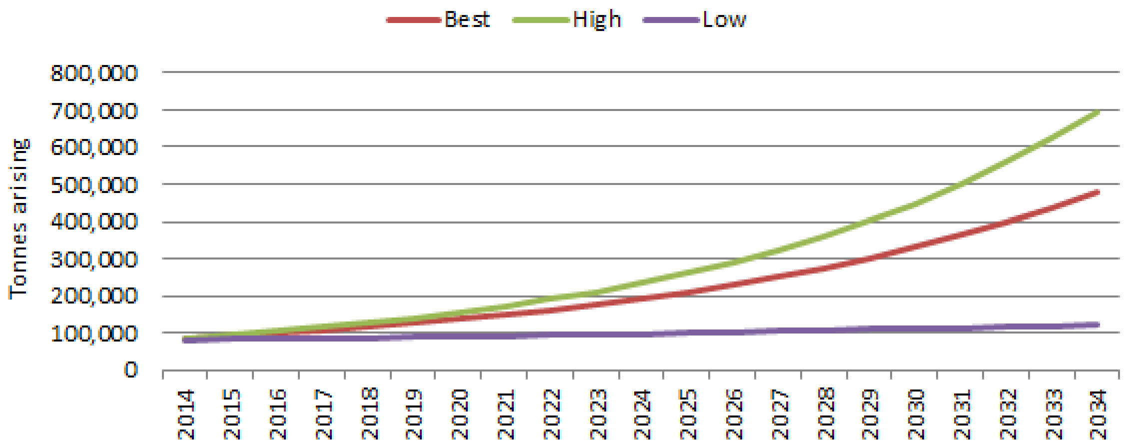
Summary analysis

Industry sources	Considerations	Comments	Approach
• CSG extraction • Aluminium smelting • Electricity supply • Mining • Iron and steel casting	No sufficiently credible pre-existing projections were identified Historical data set exists however may not be usable for discerning trends	Coal seam gas extraction is understood to be a major source High growth in coal seam gas industry activity is expected over the projection period (ABC 2014)	Use judgement - trend and causal analysis Need different approach by jurisdiction due to stark differences in trends and sources

Table 13: Best, high and low projected rates of change for non-toxic salt waste to 2034

	Applies to	Approach	2014	...	2034
Best	NSW, Qld	Ongoing increase with coal seam gas extraction	10.0%	...	10.0%
High		Stronger increase	12.0%	...	12.0%
Low		Economic growth	2.8%	...	2.8%
Best	ACT, NT, SA, Tas, Vic, WA	Decline continues	-2.0%	...	-2.0%
High		Reduced quantity maintained	0.0%	...	0.0%
Low		Best estimate of annual rate of change - 3%	-4.0%	...	-4.0%

Figure 10: Best, high and low national projection estimates of non-toxic salt waste to 2034



Other D. Other inorganic chemicals

This group includes waste and wastes contaminated with: Metal carbonyls; inorganic sulphides; perchlorates; chlorates; arsenic[14], cadmium[14], beryllium[14], antimony[14], thallium[14], selenium[14] and tellurium[14]; compounds of copper, cobalt, nickel, vanadium, boron, zinc, barium (excl. barium sulphate), chromium (hexavalent & trivalent), phosphorus (excl. mineral phosphates) & inorganic fluorine (excl. calcium fluoride). While this group is diverse, by volume around 90% (a substantial 144,834 tonnes) of the waste arising (in 2012-13) is contributed by D230 Zinc compounds.

Spent potlining (SPL) waste stockpiles were identified as a waste of particular interest and would be classified in this category, under *D110 Inorganic fluorine compounds excluding calcium fluoride*. SPL wastes are discussed in the breakout box overleaf.

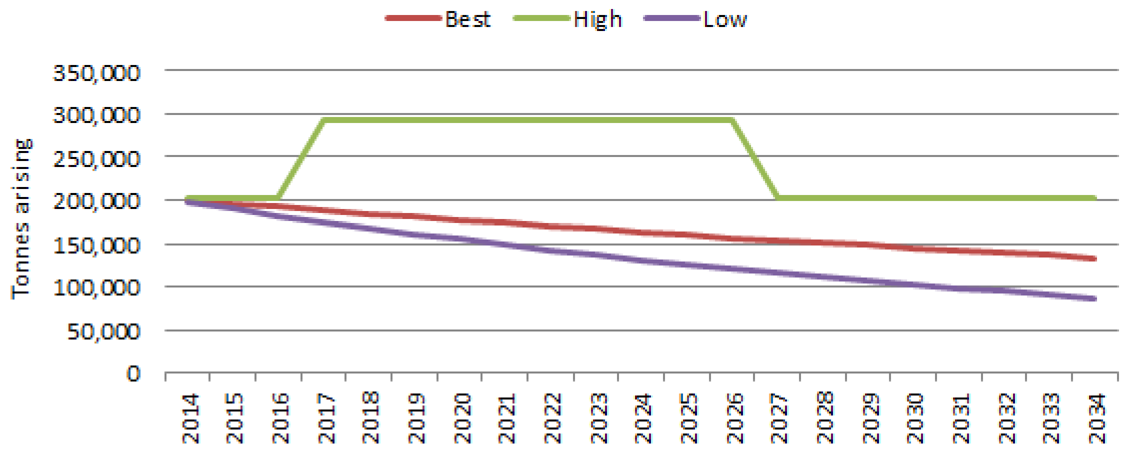
Summary analysis

Industry sources	Considerations	Comments	Approach
• 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	No sufficiently credible pre-existing projections were identified	From a range of mostly manufacturing sources	Use causal analysis
	Historical data set exists however may not be usable for discerning trends.	It is understood that 900kt of spent potlining, a hazardous waste from aluminium smelters is stored on site in NSW, Qld, Tas & Vic. Would fall into this waste group.	In the high scenario, assume spent potlining enters the waste stream.

Table 14: Best, high and low projected rates of change for other inorganic chemical waste to 2034

	Applies to	Approach	2014	...	2017	...	2027	...	2034
Best	ACT, NSW, NT, Qld, SA, Tas, Vic, WA	Decline with manufacturing	-2.0%	...	-2.0%	...	-2.0%	...	-2.0%
High		Best estimate of annual rate of change +2%	0.0%	...	0.0%	...	0.0%	...	0.0%
Low		Best estimate of annual rate of change - 2%	-4.0%	...	-4.0%	...	-4.0%	...	-4.0%
Best	NSW, Qld, Tas, Vic	Storage of spent potlining continues	0t	...	0t	...	0t	...	0t
High		Spent potlining treated over 10 yrs starting in 3	0t	...	22,500t	...	0t	...	0t
Low		Storage of spent potlining continues	0t	...	0t	...	0t	...	0t

Figure 11: Best, high and low national projection estimates of other inorganic chemical waste to 2034



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

[14] Also including compounds containing these elements.

Spent potlining (SPL) waste

Spent potlining (SPL) is a waste material generated from aluminium smelters, of which there are five in Australia. Aluminium smelting is the extraction of aluminium metal from aluminium oxide (also known as alumina). The process takes place in electrolytic cells that are known as pots. The pots are made up of steel shells with two linings, an outer insulating or refractory lining and an inner carbon lining that acts as the cathode. During the operation of the cell, substances, including aluminium and fluorides, are absorbed into the cell lining. After some years of operation, the potlining fails and is removed. The removed material is SPL, a hazardous waste due to:

- the presence of fluoride and cyanide compounds that are leachable in water
- its corrosiveness – it exhibits high pH due to the presence of alkali metals and oxides
- its reactivity with water - producing inflammable, toxic and explosive gases.

The toxic, corrosive and reactive nature of SPL means that particular care must be taken in its handling, transportation and storage. SPL has been recognised a major environmental concern for the industry for decades, but has recovery potential because of its fluoride and energy content.

SPL waste is included within the broad group Other D (other inorganic chemicals), which includes many NEPM codes (see section 4.7). It was not isolated as a waste group because historically, reported quantities of D110 Inorganic fluorine compounds excluding calcium fluoride (to tracking systems) have been sporadic and at low levels, not worthy of a waste group in their own right. This is because suitable treatment infrastructure in Australia is limited and, as a consequence, wastes have been stockpiled onsite or exported for recycling (in Spain or the UK), meaning they do not materially register on tracking systems.

Consultation with industry in the Hazardous Waste Infrastructure Needs and Capacity Assessment project indicates that the primary issue with this waste was the scale of the stockpile – industry estimates a stockpile of 900,000 tonnes of this hazardous waste, sufficient to more than half fill the Melbourne Cricket Ground.

Despite some exports and massive onsite storages, a steady stream of local recycling does occur. Alcoa's Australian website states that a significant and growing amount of SPL has been recycled at its Point Henry smelter near Geelong in Victoria: *"In 2009, 7,449 tonnes of spent potlining (SPL) were recycled. A by-product of the smelting process, SPL is made of carbon and refractory materials. We engaged a contractor to process SPL at our Point Henry operations to produce mineral products and a fuel that has reduced emissions for the cement industry. An extra 242 tonnes of SPL was recycled in 2009 compared with 2008, which was 1727 tonnes more than in 2007."* This recycling quantity does not 'arise' in tracking system data since it is recycled onsite from onsite SPL stores.

Projections of 'Other D' waste group over the next 20 years are provided in the Hazardous Waste Infrastructure Needs and Capacity Assessment report. While the low and best scenario assume that stockpiling will continue, the 'high' scenario assumes local processing of the stockpiles commences in three years' time and takes 10 years to exhaust, creating a sustained 10 year spike in arisings.

The storage of large quantities of spent potlining from aluminium smelting should be a social concern, given the decline of this industry. The three current operators able to process this waste report sufficient capacity to process the stockpile over a 10-15 year period. A mismatch between demand and capacity could cause inappropriate treatment or demand for exports. A nationally coordinated negotiation with the industry would be advisable.

It is recommended that DoE consult with the aluminium industry and NSW, Vic, Qld, Tas state governments to develop a nationally agreed approach to the management of SPL stockpiles that ensures their eventual removal and the ongoing recovery or treatment of SPL wastes.

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.

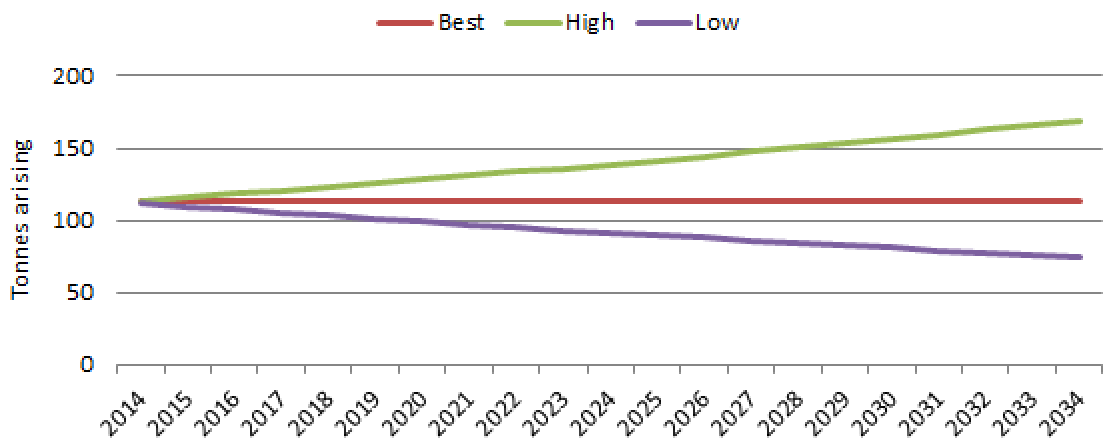
Summary analysis

Industry sources	Considerations	Approach
• 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 Historical data sets show apparent rise in waste in Qld but decline is seen elsewhere	Use judgement - trend and causal analysis

Table 15: Best, high and low projected rates of change for reactive chemical waste to 2034

	Applies to	Approach	2014	...	2034
Best	ACT, NSW, NT, Qld, SA, Tas, Vic, WA	Stable	0.0%	...	0.0%
High		Best estimate of annual rate of change + 2%	2.0%	...	2.0%
Low		Best estimate of annual rate of change - 2%	-2.0%	...	-2.0%

Figure 12: Best, high and low national projection estimates of reactive chemical waste to 2034



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.*

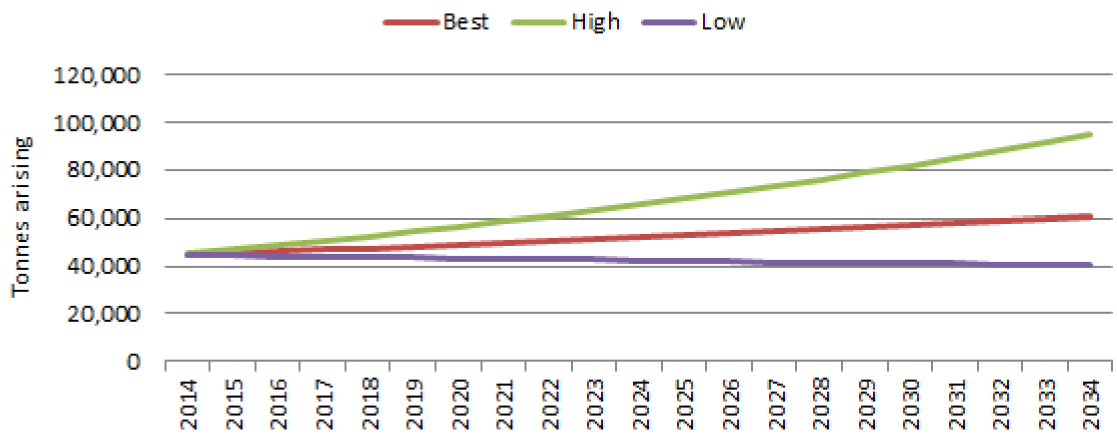
Summary analysis

Industry sources	Considerations	Comments	Approach
• Motor vehicle manufacturing • Paint ink and resin manufacturing • Chemical and chemical product manufacturing • Printing • Machinery and equipment manufacturing • Metal product manufacturing • Pulp and paper manufacturing • Aircraft manufacturing • Furniture manufacturing	Comprehensive projections do not exist - NC & SRU (2014) projects 10 years of consumption of paints producing most of F100. It also projects sales growth from 47 to 68kt in 10 years annually (this equals a 3.8% growth) Historical data shows general increasing trend however this may have changed from 2012-13	Quantities are relatively stable Vehicle manufacturing to close	Use a range: NC & SRU (2014) estimate - fall due to manufacturing decline

Table 16: Best, high and low projected rates of change for paints, resins, inks and organic sludge waste to 2034

	Applies to	Approach	2014	...	2034
Best	ACT, NSW, NT, Qld, SA, Tas, Vic, WA	Population growth	1.5%	...	1.5%
High		NC & SRU (2014) projection	3.8%	...	3.8%
Low		Best estimate of annual rate of change - 2%	-0.5%	...	-0.5%

Figure 13: Best, high and low national projection estimates of paints, resins, inks and organic sludge waste to 2034



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. They are often distinguished on the basis of halogenation in their chemical structure, with halogenated organic solvents more of a health and environmental concern than non-halogenated organic solvents. As a result, both usage and waste from halogenated organic solvents tend to be declining in favour of non-halogenated alternatives.

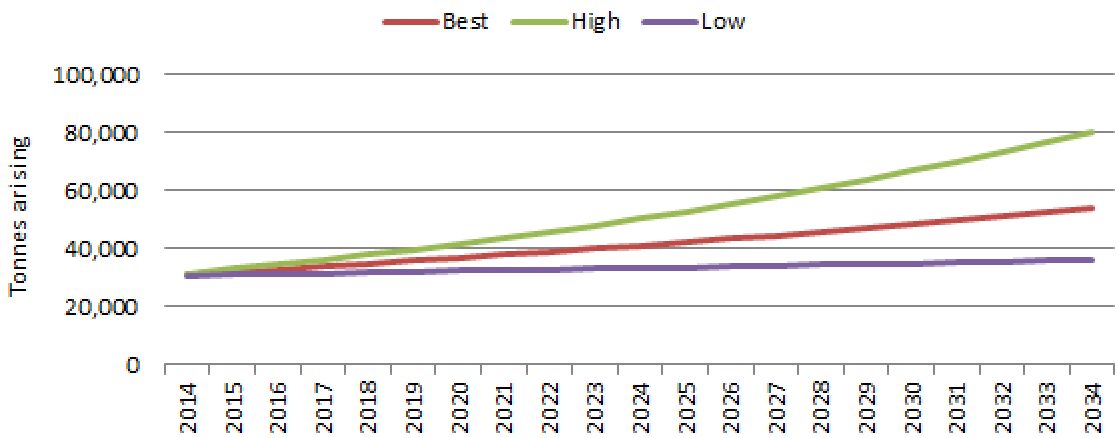
Summary analysis

Industry sources	Considerations	Approach
• Fertiliser manufacturing • Agrichemical formulation • Chemical and chemical product manufacturing • Oil and gas extraction • Printing • Motor vehicle manufacturing • Dry cleaning	No sufficiently credible pre-existing projections were identified No historical data set exists that is adequate for discerning trends	Use causal analysis

Table 17: Best, high and low projected rates of change for organic solvent waste to 2034

	Applies to	Approach	2014	...	2034
Best	ACT, NSW, NT, Qld, SA, Tas, Vic, WA	Economic growth	2.8%	...	2.8%
High		Best estimate of annual rate of change + 2%	4.8%	...	4.8%
Low		Best estimate of annual rate of change - 2%	0.8%	...	0.8%

Figure 14: Best, high and low national projection estimates of organic solvent waste to 2034



H. Pesticides

This group includes three potentially diverse types of waste:

- H100: waste from the production, formulation and use of biocides and 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 wastes from organic phosphorus compounds used as lubricants, plasticizers, flame retardants and, most notably, as organophosphate pesticides.

H170 is different again in that it covers wastes from timber preservation which in Australia has historically been dominated by chromated copper arsenate (CCA) treatment. Its overlap in this NEPM category is presumably due to the function of CCA preservation of timber, where the copper acts as a fungicide, the arsenic an insecticide (both types of biocide) and the chromium chemically fixes these to the wood to stabilise them.

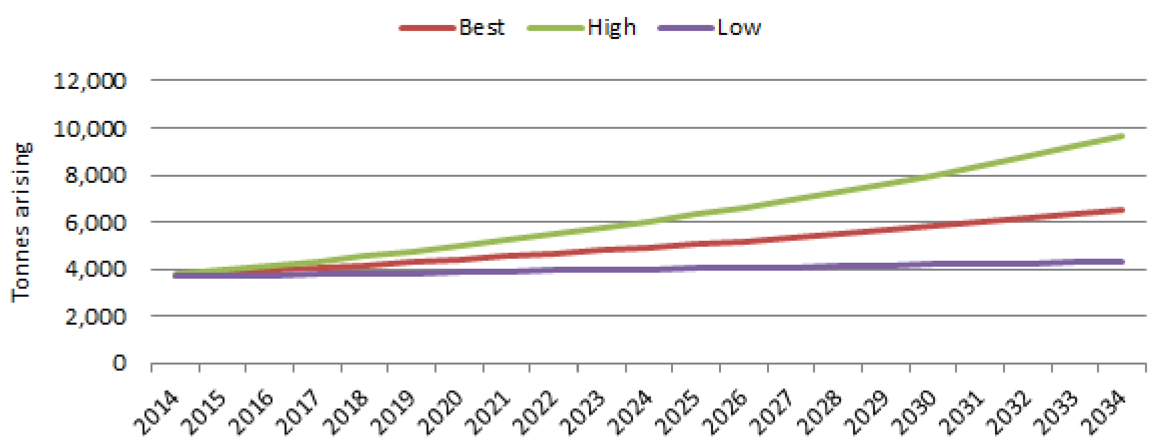
Summary analysis

Industry sources	Considerations	Comments	Approach
Services to agriculture; wood product manufacture; waste sector	No sufficiently credible pre-existing projections were identified No historical data set exists that is adequate for discerning trends	The cause of the dominance of and spike in Qld for several of the projected years is unknown – this is possible due to regulatory change Quantities are driven by agriculture sector	Use causal analysis

Table 18: Best, high and low projected rates of change for pesticide waste to 2034

	Applies to	Approach	2014	...	2034
Best	ACT, NSW, NT, Qld, SA, Tas, Vic, WA	Economic growth	2.8%	...	2.8%
High		Best estimate of annual rate of change + 2%	4.8%	...	4.8%
Low		Best estimate of annual rate of change - 2%	0.8%	...	0.8%

Figure 15: Best, high and low national projection estimates of pesticide waste to 2034



J. Oils

This waste group includes the following NEPM 75 codes:

- *J100 Waste mineral oils unfit for their original intended use; waste oil/water* (39%)
- *J120 hydrocarbons/water mixtures or emulsions* (60%)
- *J160 waste tarry residues arising from refining, distillation, and any pyrolytic treatment* (1%).

J100 is dominated by used oil from vehicles. J120 is typically wastewaters that have been contaminated with oils, such as truck and vehicle washwaters, skimmer and interceptor waters, vehicle coolant waters and potentially shipping bilge water. 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 wastes 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 Queensland. Mining makes up 30% of recorded sources in Queensland.

Product Stewardship for Oil Program

The DoE website provides the following information regarding the Product Stewardship for Oil Program:

The Product Stewardship for Oil Program was introduced by the Australian Government in 2001 to provide incentives to increase used oil recycling. The program aims to encourage the environmentally sustainable management and re-refining of used oil and its re-use. The arrangements comprise a levy-benefit system, where an 8.5 cents per litre levy on new oil, helps fund benefit payments to used oil recyclers. These arrangements provide incentives to increase used oil recycling in the Australian community.

Recycling operations claiming benefits must be both:

- *recycling used oil; and*
- *either directly using the recycled product, or selling that recycled product for end use.*

To be considered for benefits, the recycler must undertake the final processing (recycling) stage prior to end use and the product must be used by that recycler or sold for end use (i.e. not just processed and stockpiled) [15].

The Product Stewardship for Oil program provides a financial incentive (of 50 cents/litre) for industry to re-refine waste oil for sale.

Summary analysis

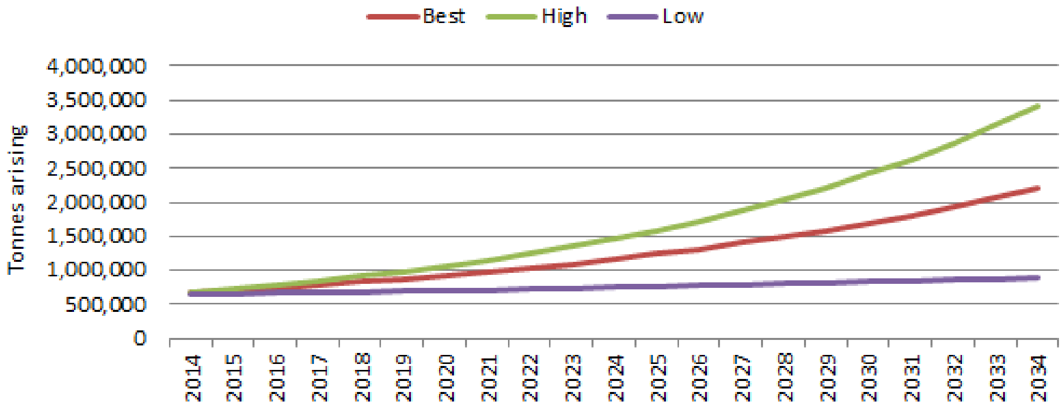
Industry sources	Considerations	Approach
• Mining • Manufacturing (various) • Transport • Retail (vehicle servicing shops) • Waste sector.	No sufficiently credible pre-existing projections were identified No historical data set exists that is adequate for discerning trends	Use causal analysis

Table 19: Best, high and low projected rates of change for oil waste to 2034

	Applies to	Approach	2014	...	2034
Best	Qld, WA	Increase with mining	7.7%	...	7.7%
High		Stronger increase	10.0%	...	10.0%
Low		Economic growth	2.8%	...	2.8%
Best	ACT, NSW, NT, SA, Tas, Vic	Stable - increase in some areas; declining manufacturing	0.0%	...	0.0%
High		Best estimate of annual rate of change + 2%	2.0%	...	2.0%
Low		Best estimate of annual rate of change - 2%	-2.0%	...	-2.0%

[15] Source: DoE website http://www.environment.gov.au/protection/used-oil-recycling/product-stewardship-oil-program accessed May 2015

Figure 16: Best, high and low national projection estimates of oil waste to 2034



K100. Animal effluent and residues (+ food processing waste)

This waste group is represents the NEPM code *K100 Animal effluent and residues (abattoir effluent, poultry and fish processing wastes)*, plus the wastes unique to Queensland *regulated* waste: *Liquid food processing waste* and Victoria: *Food and beverage processing wastes, including animal and vegetable oils and derivatives*, both so-called K200. Animal effluent and residues 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 neither NSW nor SA track this waste group.

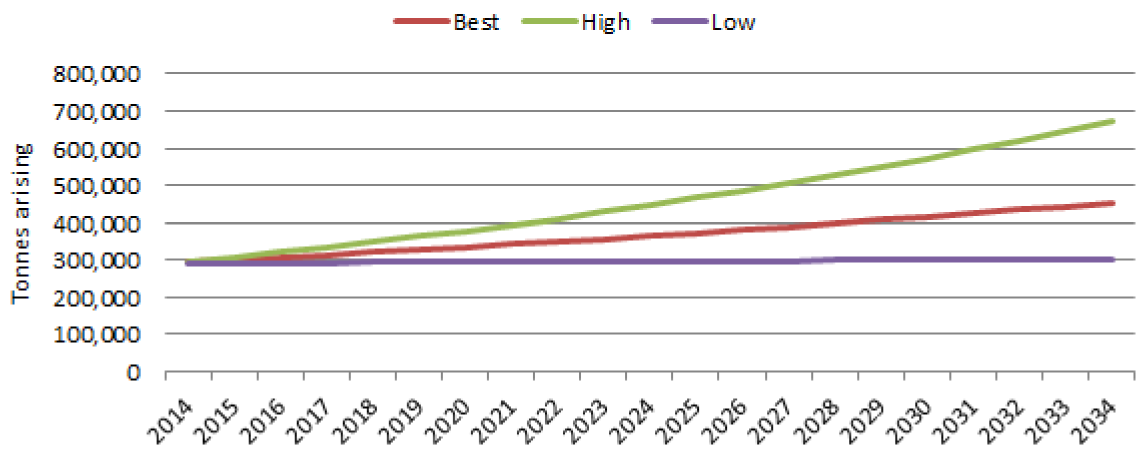
Summary analysis

Industry sources	Considerations	Comments	Approach
• Food product manufacturing (meat, poultry and dairy processing) • Waste sector	No sufficiently credible pre-existing projections were identified No historical data set exists that is adequate for discerning trends	This waste is not tracked in NSW or SA	Use causal analysis

Table 20: Best, high and low projected rates of change for animal effluent and residue (+ food processing waste) waste to 2034

	Applies to	Approach	2014	...	2034
Best	ACT, NSW, NT, Qld, SA, Tas, Vic, WA	Meat processing industry growth	2.2%	...	2.2%
High		Best estimate of annual rate of change + 2%	4.2%	...	4.2%
Low		Best estimate of annual rate of change - 2%	0.2%	...	0.2%

Figure 17: Best, high and low national projection estimates of animal effluent and residue (+ food processing waste) waste to 2034



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. These wastes include 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. Like other NEPM K wastes, grease trap is not tracked in NSW or SA.

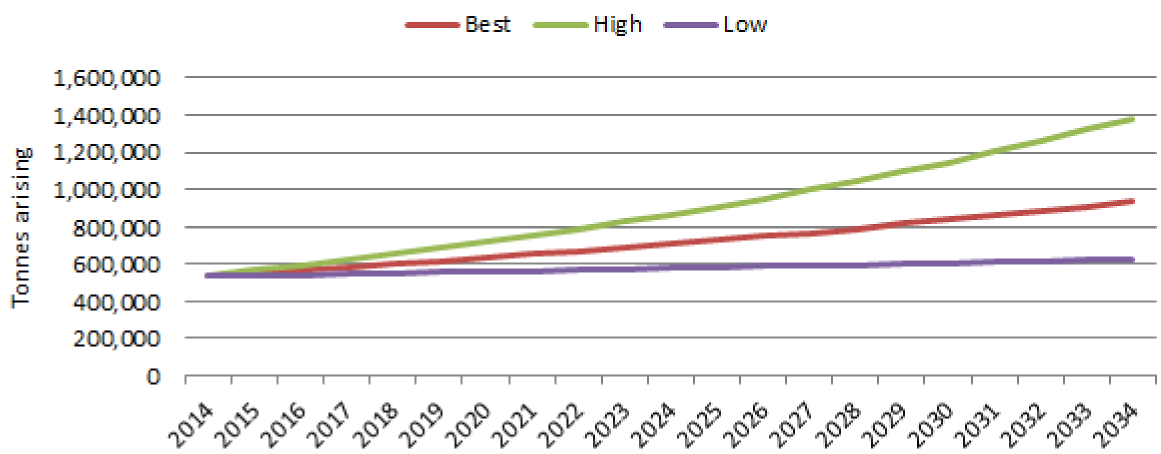
Summary analysis

Industry sources	Considerations	Comments	Approach
• Food product manufacturing • Cafes and restaurants • Supermarkets and grocery stores • Waste sector (as collectors and aggregators from cafes and restaurants)	No sufficiently credible pre-existing projections were identified No historical data set exists that is adequate for discerning trends	This waste is not tracked in NSW or SA	Use causal analysis

Table 21: Best, high and low projected rates of change for grease trap waste to 2034

	Applies to	Approach	2014	...	2034
Best	ACT, NSW, NT, Qld, SA, Tas, Vic, WA	Economic growth	2.8%	...	2.8%
High		Best estimate of annual rate of change + 2%	4.8%	...	4.8%
Low		Best estimate of annual rate of change - 2%	0.8%	...	0.8%

Figure 18: Best, high and low national projection estimates of grease trap waste to 2034



K140 & 190. Tannery and wool scouring wastes

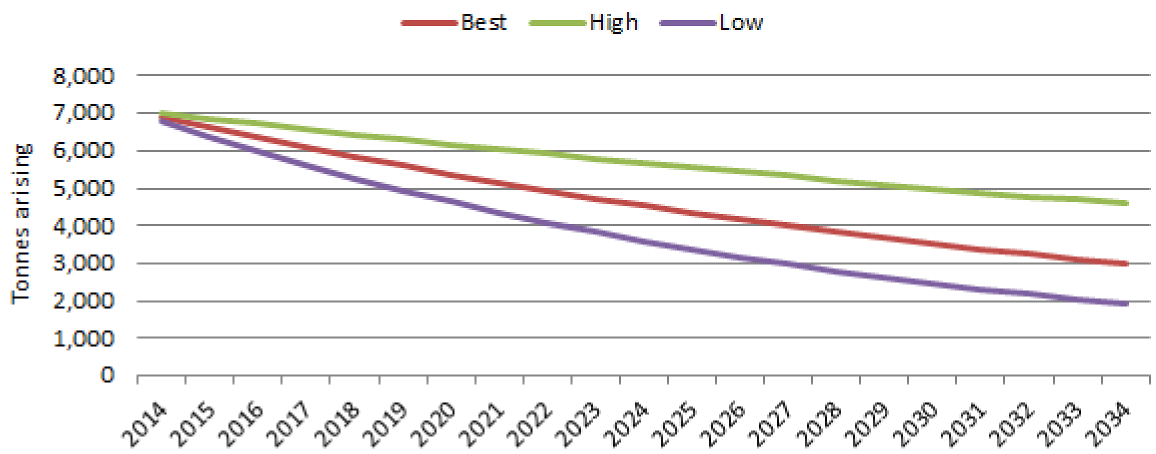
Summary analysis

Industry sources	Considerations	Comments	Approach
Leather tanning; fur dressing; and leather product manufacturing	No sufficiently credible pre-existing projections were identified	This waste is not tracked in NSW	Use judgement - trend and causal analysis
	Historical data set suggests a declining trend	The Australian wool scouring industry is in a long-term decline	
		The leather & leather substitute product manufacturing industry has also 'struggled over the past five years' (IBISWorld)	

Table 22: Best, high and low projected rates of change for tannery and wool scouring waste to 2034

	Applies to	Approach	2014	...	2034
Best	ACT, NSW, NT, Qld, SA, Tas, Vic, WA	Short-term projection for leather & leather substitute product manuf.	-4.1%	...	-4.1%
High		Best estimate of annual rate of change + 2%	-2.1%	...	-2.1%
Low		Best estimate of annual rate of change - 2%	-6.1%	...	-6.1%

Figure 19: Best, high and low national projection estimates of tannery and wool scouring waste to 2034



M160a. Perfluorooctanesulfonic acid or perfluorooctane sulfonate (PFOS)

PFOS is a man-made fluorosurfactant and global pollutant. PFOS was the key ingredient in Scotch guard, 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 on Persistent Organic Pollutants* 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. **Review Appendix A.5** for a detailed discussion of PFOS and the data sources and assumptions used in providing the projections below.

Summary analysis

Industry sources	Considerations	Comments	Approach
Biosolids - newly produced from wastewater treatment plants; aqueous film forming foams (AFFF) from fire-brigades, airports, docks, defence, petrochemicals, mining; wash waters from fire-fighting scenes	Credible projections do not exist for biosolids. Some stocks and flows modelling summary data provided by DoE for AFFF & firewaters. Trend data is not easily discernible (maybe partly in N140 'fire debris & firewaters' and M250 'surfactants').	See Appendix A.5 for details of data sources and assumptions. It is assumed that a concentration limit above which contaminated wastes would be considered hazardous (i.e. a Low POP Concentration Limit or LPCL) would be agreed within 2 years. Calculations suggest the LPCL would be relevant only for biosolids. AFFF & firewaters will contain PFOS above any LPCL to be set	Assume Australia ratifies Stockholm in two years, but stocks currently being destroyed regardless of ratification decision. AFFF foams still an allowable use under Stockholm anyway. Because of large firewater volumes, PFOS high scenario assumes decreased AFFF concentrate sent for destruction and increase in diluted foam usage. For biosolids, use causal analysis, historical biosolids production data and literature data on POPs concentrations. Use range of LPCLs to define scenarios

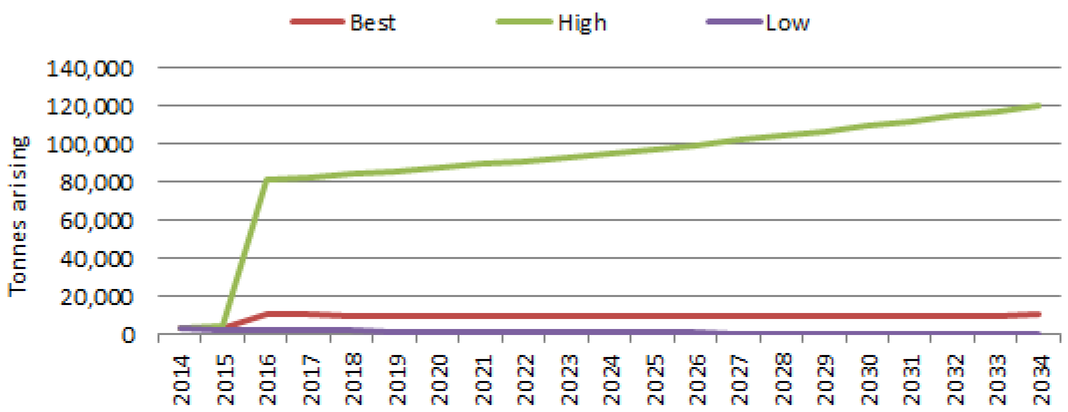
Table 23: Approaches used to project PFOS waste

Approach re. PFOS in AFFF	Applies to	Approach
Best	National total only	Stock destruction at current rate (usage at current rate)
High		No stock destruction from 2015 (entire stock used in firefighting)
Low		No stock destruction from 2015 (25% decrease in usage from best estimate)
Approach re. PFOS in firewaters	**Applies to**	**Approach**
Best	National total only	Stock destruction at current rate (usage at current rate)
High		No stock destruction from 2015 (entire stock used in firefighting)
Low		No stock destruction from 2015 (25% decrease in usage from best estimate)
Approach re. biosolids	**Applies to**	**Approach**
Best	National total only	LPCL = 10mg/kg; grows with population
High		LPCL = 1mg/kg; grows with population +1%
Low		LPCL = 100mg/kg; negligible biosolids above this level

Table 24: Best, high and low projected tonnes for PFOS waste to 2034

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Approach re. PFOS in AFFF																					
Best	38	34	31	27	25	22	20	18	16	15	13	12	11	10	9	8	7	6	6	5	5
High	38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Low	38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Approach re. PFOS in firewaters																					
Best	3,768	3,391	3,052	2,747	2,472	2,225	2,002	1,802	1,622	1,460	1,314	1,182	1,064	958	862	776	698	628	565	509	458
High	3,768	4,521	4,069	3,662	3,296	2,966	2,670	2,403	2,162	1,946	1,752	1,576	1,419	1,277	1,149	1,034	931	838	754	679	611
Low	3,768	2,543	2,289	2,060	1,854	1,669	1,502	1,351	1,216	1,095	985	887	798	718	646	582	524	471	424	382	344
Approach re. biosolids																					
Best	0	0	7,521	7,633	7,748	7,864	7,982	8,102	8,223	8,347	8,472	8,599	8,728	8,859	8,992	9,127	9,264	9,403	9,544	9,687	9,832
High	0	0	76,696	78,613	80,578	82,593	84,658	86,774	88,943	91,167	93,446	95,782	98,177	100,631	103,147	105,726	108,369	111,078	113,855	116,701	119,619
Low	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Figure 20: Best, high and low national projection estimates of PFOS waste to 2034



M160b. Persistent organic pollutants - bromodiphenyl ethers (various forms) (POP-BDEs)

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 (articles) including electrical and electronic equipment (EEE), 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 Persistent Organic Pollutants (POPs) 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. 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. **Review Appendix A.5** for a detailed discussion of POP-BDEs and the data sources and assumptions used in providing the projections below.

Summary analysis

Industry sources	Considerations	Comments	Approach
Biosolids - newly produced from wastewater treatment plants; waste electric and electronic equipment (WEEE)	No sufficiently credible pre-existing projections were identified No historical data set exists that is adequate for discerning trends	See Appendix A.5for details of data sources and assumptions Literature suggests POP-BDE levels in biosolids are typically lower than lowest LPCL under consideration. POP-BDEs unlikely to be used in future WEEE, but may contaminate recycled plastic above LPCLs	Assume LPCL is agreed in 2 years' time; Australia ratifies Stockholm in 2 years' time Use causal analysis

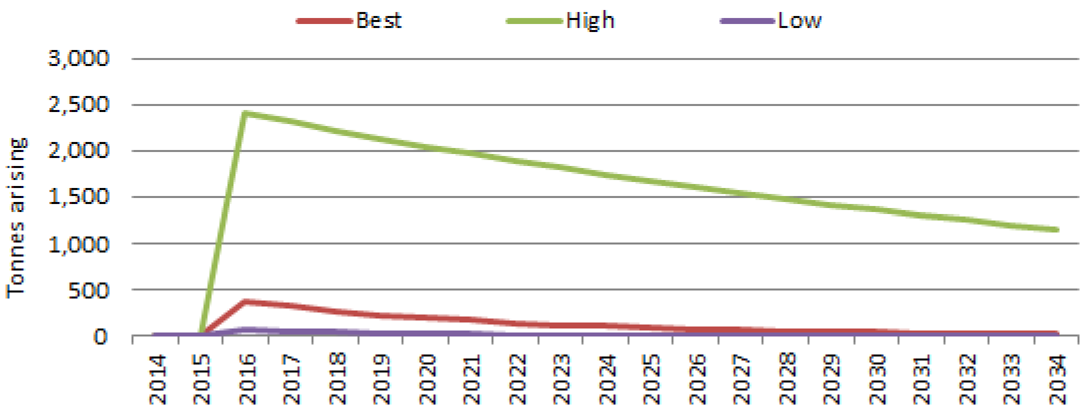
Table 25: Approaches used to project POP-BDEs waste

Approach re. biosolids	Applies to	Approach
Best	National total only	L set at 50mg/kg (zero arisings)
High		LPCL set at 10mg/kg (zero arisings)
Low		LPCL is set at 200mg/kg (zero arisings)
Approach re. WEEE	**Applies to**	**Approach**
Best	National total only	LPCL = 50mg/kg; RIS estimated recycling rates (80% by 2022)
High		LPCL = 10mg/kg; lower than RIS recycling rate (50% by 2022)
Low		LPCL 200mg/kg; higher than RIS recycling rate (95% by 2022)

Table 26: Best, high and tonnes for POP-BDEs waste to 2034

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Approach re. biosolids																					
Best	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
High	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Low	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Approach re. WEEE																					
Best	0	0	379	322	274	233	198	168	143	121	103	88	75	63	54	46	39	33	28	24	20
High	0	0	2,415	2,318	2,225	2,136	2,051	1,969	1,890	1,814	1,742	1,672	1,605	1,541	1,479	1,420	1,363	1,309	1,257	1,206	1,158
Low	0	0	74	55	41	31	23	17	13	10	7	6	4	3	2	2	1	1	1	1	0

Figure 21: Best, high and low national projection estimates of POP-BDEs waste to 2034



M160c. Hexabromocyclododecane (HBCD)

Although not a POP-BDE, another flame retardant known as HBCD, which has been historically used for flame retardence in extruded and expanded polystyrene foams, was listed added to Annex B of the *Stockholm Convention on Persistent Organic Pollutants* 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. **Review Appendix A.5** for a detailed discussion of HBCD and the data sources and assumptions used in providing the projections below.

Summary analysis

Industry sources	Considerations	Comments	Approach
Waste: Biosolids - newly produced from wastewater treatment plants; domestic and industrial building insulation materials presenting as part of C&I waste	Historical data does not exist as it is not currently tracked as a hazardous waste Credible projections do not exist, however data has been provided by BoE on HBCP neat chemical import trends	See Appendix A.5for details of data sources and assumptions Limited literature available suggests HBCD in biosolids could be present at similar or slightly higher concentrations than POP-BDEs HBCD would be present in building insulation materials above any of the range of LPCLs presently under consideration	Assume LPCL is agreed in 2 years' time; Australia ratifies Stockholm in 2 years' time Historical import trend data on expanded polystyrene (EPS) from DoE working draft note extract from ACIL Allen RIS and NICNAS neat chemical import data Historical biosolids production data and literature data on POP concentrations; range of LPCLs to help define scenarios Use causal analysis

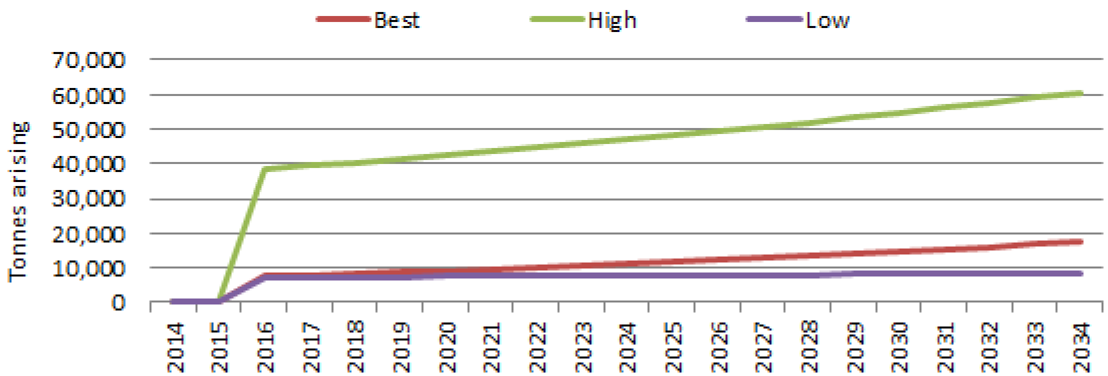
Table 27: Approaches used to project HBCD waste

Approach re. biosolids	Applies to	Approach
Best	National total only	LPCL = 50mg/kg (negligible biosolids above this level)
High		LPCL = 10mg/kg; grows with population +1%
Low		LPCL = 200mg/kg (negligible biosolids above this level)
Approach re. end of life EPS	**Applies to**	**Approach**
Best	National total only	Economic growth
High		Best estimate of annual rate of change + 2%
Low		Best estimate of annual rate of change - 2%

Table 28: Best, high and low projected tonnes for HBCD waste to 2034

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Approach re. biosolids																					
Best	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
High	0	0	30,468	31,230	32,011	32,811	33,631	34,472	35,334	36,217	37,122	38,051	39,002	39,977	40,976	42,001	43,051	44,127	45,230	46,361	47,520
Low	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Approach re. end of life EPS																					
Best	0	0	7,609	7,974	8,357	8,758	9,178	9,619	10,081	10,564	11,072	11,603	12,160	12,744	13,355	13,996	14,668	15,372	16,110	16,883	17,694
High	0	0	7,908	8,129	8,357	8,591	8,831	9,079	9,333	9,594	9,863	10,139	10,423	10,715	11,015	11,323	11,640	11,966	12,301	12,646	13,000
Low	0	0	7,316	7,374	7,433	7,493	7,553	7,613	7,674	7,735	7,797	7,860	7,922	7,986	8,050	8,114	8,179	8,244	8,310	8,377	8,444

Figure 22: Best, high and low national projection estimates of HBCD waste to 2034



M160d. Hexachlorobenzine (HCB)

HCB was one of the 12 POPs originally listed in annexes to the Stockholm Convention in 2004. Australia ratified and became a party to the Convention 2004. Australia has a stockpile of HCB, 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.

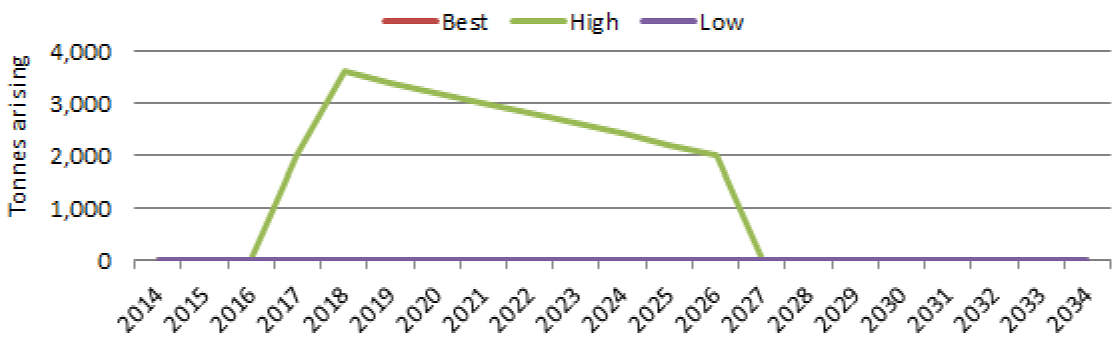
Summary analysis

Industry sources	Considerations	Approach
Orica stockpile	No sufficiently credible pre-existing projections were identified No historical data set exists that is adequate for discerning trends	High scenario - Orica stockpile bleeds into Australian waste stream over 10 years starting in three. 2014 stockpile (t) =15,000; annual stockpile growth =10%; stockpile at start of destruction period (t) =19,965 Other scenarios - stockpile is exported or storage continues

Table 29: Best, high and low projected rates of change and tonnes for HCB waste to 2034

	Applies to	Approach	2014	…	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	…	2034
Best High Low	ACT, NT, Qld, SA, Tas, Vic, WA	No waste	0	…	…	…	…	…	…	…	…	…	…	…	…	…	0
High	NSW		0	…	1,977	3,594	3,394	3,194	2,995	2,795	2,595	2,396	2,196	1,997	0	…	0

Figure 23: Best, high and low national projection estimates of HCB waste to 2034



Other M. Other organic chemicals

This waste group includes the broad catch-all of the following NEPM 75 codes:

- *M100 waste substances and articles containing or contaminated with polychlorinated biphenyls, polychlorinated naphthalenes, polychlorinated terphenyls and/or polybrominated biphenyls*
- *M150 phenols, phenol compounds including chlorophenols*
- *M160 organohalogen compounds*
- *M160 & M170 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).*

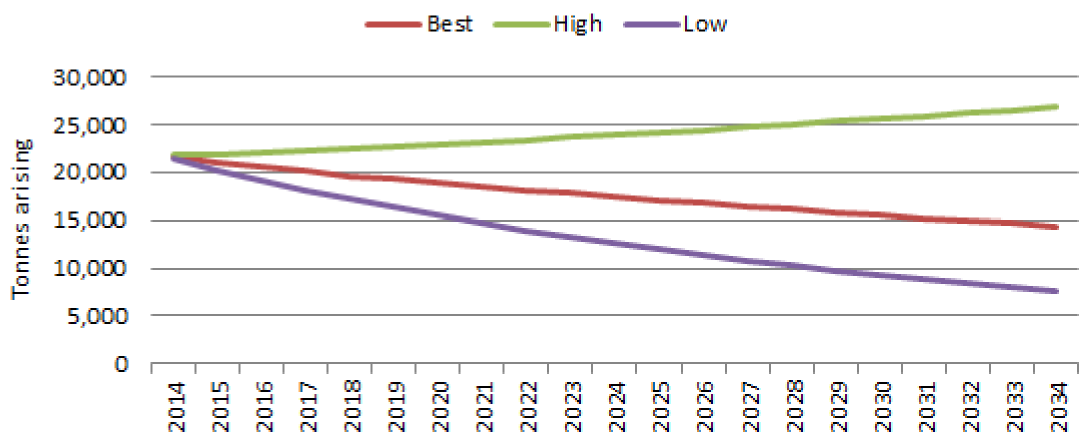
Summary analysis

Industry sources	Considerations	Comments	Approach
• Airline industry • Iron and steel casting • Chemical manufacturing • Soap and detergent manufacturing • Various other manufacturing • Electricity supply	No sufficiently credible pre-existing projections were identified Historical data set suggests stable or a slight decline in tonnages For Victoria, exponential decay is apparent	Historical data for 'all M' is identical (or close to) future data for 'other M' Likely to be influenced by firefighting foams	Use judgement - trend and causal analysis

Table 30: Best, high and low projected rates of change for other organic chemical waste to 2034

	Applies to	Approach	2014	...	2019	...	2034
Best	Vic	Exponential decay trend for five years, then stable	-13.0%	...	0.0%	...	0.0%
High		Best estimate of annual rate of change + 5%	-8.0%	...	5.0%	...	5.0%
Low		Best estimate of annual rate of change - 5%	-18.0%	...	-5.0%	...	-5.0%
Best	ACT, NSW, NT, Qld, SA, Tas, WA	Decline with manufacturing	-2.0%	...	...	...	-2.0%
High		Best estimate of annual rate of change + 3%	1.0%	...	...	...	1.0%
Low		Best estimate of annual rate of change - 3%	-5.0%	...	...	...	-5.0%

Figure 24: Best, high and low national projection estimates of other organic chemical waste to 2034



M120. Contaminated soils

This group comprises *N120 Soils contaminated with a controlled waste*. NSW and Queensland do not specifically track contaminated soils, but both were able to report data from landfill records. Queensland is unique in Australia in including acid sulphate soils in this category. These have their own characteristics and particular management problems.

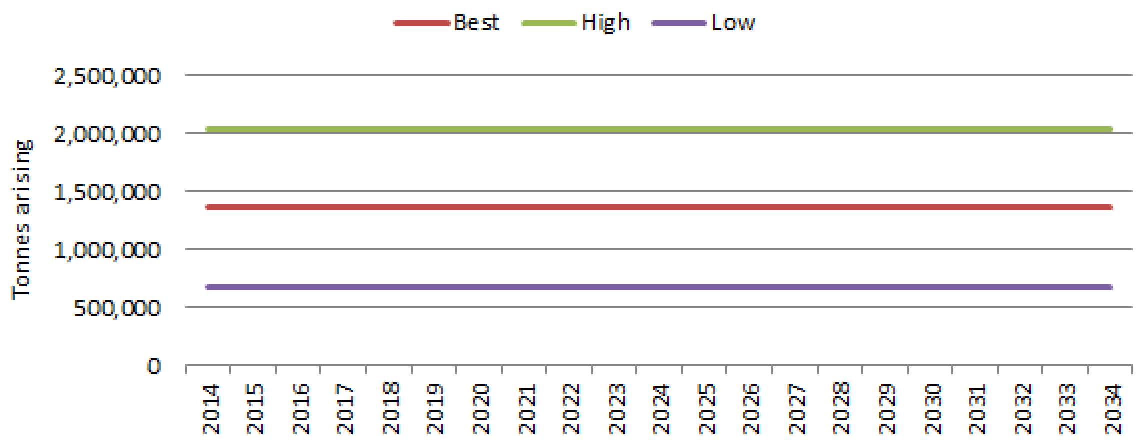
Summary analysis

Industry sources	Considerations	Comments	Approach
Construction; mining; retail trade; electricity supply	No sufficiently credible pre-existing projections were identified No historical data set exists that is adequate for discerning trends	NSW 2010-11 data includes estimate from outside the tracking system (from WGGRA). Not included in other years Vic data prior to 2003-04 is from a previous Blue Environment study (used with permission), but includes only 'low-level contaminated soil' (the dominant fraction) Qld data includes acid sulphate soils NEPM for onsite management keeping some material onsite Apparent transfer of some material to Qld	Use judgement - trend and causal analysis

Table 31: Best, high and low projected rates of change for contaminated soil waste to 2034

	Applies to	Approach	2014	...	2034
Best	ACT, NSW, NT, Qld, SA, Tas, Vic, WA	Stable	2.8%	...	2.8%
High		As per best estimate, + 50%	2.8%	...	5.8%
Low		As per best estimate, - 50%	2.8%	...	-0.2%

Figure 25: Best, high and low national projection estimates of contaminated soil waste to 2034



N205a. Contaminated biosolids

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. 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. Soils or other wastes so contaminated would be regulated as hazardous. Consequently, the hazardous waste group 'contaminated biosolids' was created for this project, with arisings estimates modelled from national (total) 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 POPs, that would make them a hazardous waste based on NSW or Victorian waste contaminant classification/ categorisation concentrations.

While a hazard risk versus 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 his was the two major Victorian treatment plant biosolids stockpiles (for Eastern and Western Treatment Plants respectively), which have excellent 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 the reality that many biosolids guidelines applied by states and territories have inadequate coverage of hazardous chemicals. For example Western Australian and South Australian guidelines, do not consider arsenic, mercury or lead, although these are the heavy metals within much of Victoria'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 POPs, 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 'POP contaminated biosolids' are included with the projections for M160 a-c (above) and, to avoid double counting, are not included in the projection for contaminated biosolids below.

Review Appendix A.6 for a detailed discussion of contaminated biosolids projections including the data sources and assumptions used in providing the projections below.

Summary analysis

Industry sources	Considerations	Comments	Approach
Wastewater treatment	Credible projections exist (see DoE 2012b) but are incomplete A partial historical database exists	Unlike other waste types listed, the biosolids baseline is potential hazardous waste only. The future extent of hazard classification is uncertain Note: biosolids in 'new' M160 wastes are subtracted to avoid double-counting	Use judgement - trend and causal analysis (description of individual scenario approach described below)

Best estimate approach:

- Contaminated biosolids are defined as those within the Vic C3 contaminant category (EPA Vic 2004).
- In Victoria it is assumed that all and only the biosolids from Melbourne's Western Treatment Plant are contaminated. In WA, the proportion of biosolids contaminated equals the proportion stockpiled. In other jurisdictions, the proportion equals that of Victoria multiplied by an indicator representing the relative degree of industrialisation, as follows: NSW: 1; Qld: 0.5; ACT, NT, SA, Tas: 0.25.
- Historical stockpiles remain stockpiled & do not enter the waste stream
- Quantities grow annually by 1% until 2024, then decline annually by 1% as sewage quality improves.
- 2013 calendar year input data are assumed representative of 2013-14.

High estimate approach:

- Contaminated biosolids comprises either: all biosolids produced less those allocated to restricted uses (agriculture, landscaping, land rehab); or best estimate, whichever is higher.
- Stockpiles enter the waste stream beginning in 2016 and are fully treated by 2032, i.e. over 15 years
- Quantities grow annually in proportion to population growth with no improvement of sewage quality

Low estimate approach:

- Contaminated biosolids are estimated at half the best estimate quantity.
- Historical stockpiles remain stockpiled & do not enter the waste stream.
- Contaminant levels reduce more quickly than expected due to declining heavy industry and manufacturing, resulting in an annual net reduction in contaminated biosolids of -2%.

Table 32: Best, high and low projected rates of change for contaminated biosolids waste to 2034

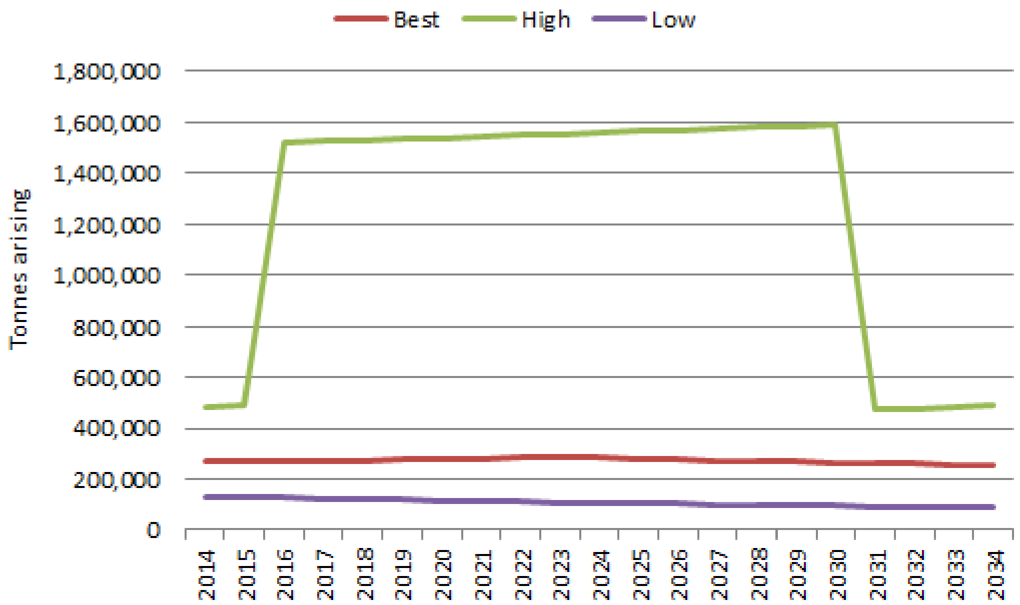
	Applies to	Approach	2014	...	2024	...	2034
Best	ACT, NSW, NT, Qld, SA, Tas, Vic, WA	Growth rates (see approach)	1.0%	...	-1.0%	...	-1.0%
High			1.5%	...	...	...	1.5%
Low			-2.0%	...	...	...	-2.0%

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

Table 33: Best, high and low projected tonnes for contaminated biosolids waste to 2034

		2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Additional estimate for high and low scenarios using current data as baseline																						
Best	ACT	3,239	3,272	3,305	3,338	3,371	3,405	3,439	3,473	3,508	3,543	3,507	3,472	3,438	3,403	3,369	3,336	3,302	3,269	3,237	3,204	3,172
Best	NSW	96,209	97,171	98,143	99,124	100,115	101,116	102,127	103,149	104,180	105,222	104,170	103,128	102,097	101,076	100,065	99,064	98,074	97,093	96,122	95,161	94,209
Best	NT	319	322	326	329	332	335	339	342	346	349	346	342	339	335	332	329	325	322	319	316	313
Best	Qld	39,032	39,422	39,816	40,214	40,617	41,023	41,433	41,847	42,266	42,688	42,262	41,839	41,421	41,006	40,596	40,190	39,788	39,391	38,997	38,607	38,221
Best	SA	8,476	8,561	8,647	8,733	8,820	8,909	8,998	9,088	9,179	9,270	9,178	9,086	8,995	8,905	8,816	8,728	8,641	8,554	8,469	8,384	8,300
Best	Tas	1,898	1,917	1,936	1,956	1,975	1,995	2,015	2,035	2,055	2,076	2,055	2,035	2,014	1,994	1,974	1,955	1,935	1,916	1,896	1,877	1,859
Best	Vic	107,506	108,581	109,667	110,764	111,871	112,990	114,120	115,261	116,414	117,578	116,402	115,238	114,086	112,945	111,815	110,697	109,590	108,494	107,409	106,335	105,272
Best	WA	12,640	12,766	12,894	13,023	13,153	13,284	13,417	13,551	13,687	13,824	13,685	13,549	13,413	13,279	13,146	13,015	12,885	12,756	12,628	12,502	12,377
High	ACT	13,224	13,422	13,624	13,828	14,035	14,246	14,460	14,677	14,897	15,120	15,347	15,577	15,811	16,048	16,289	16,533	16,781	17,033	17,288	17,548	17,811
High	NSW	98,186	99,658	101,153	102,671	104,211	105,774	107,360	108,971	110,605	112,265	113,949	115,658	117,393	119,153	120,941	122,755	124,596	126,465	128,362	130,288	132,242
High	NT	1,064	1,080	1,097	1,113	1,130	1,147	1,164	1,181	1,199	1,217	1,235	1,254	1,273	1,292	1,311	1,331	1,351	1,371	1,391	1,412	1,434
High	Qld	39,225	39,813	40,411	41,017	41,632	42,256	42,890	43,534	44,187	44,849	45,522	46,205	46,898	47,602	48,316	49,040	49,776	50,523	51,280	52,050	52,830
High	SA	8,518	8,646	8,776	8,907	9,041	9,177	9,314	9,454	9,596	9,740	9,886	10,034	10,185	10,337	10,492	10,650	10,809	10,972	11,136	11,303	11,473
High	Tas	15,153	15,381	15,611	15,845	16,083	16,324	16,569	16,818	17,070	17,326	17,586	17,850	18,117	18,389	18,665	18,945	19,229	19,518	19,810	20,108	20,409
High	Vic	285,865	290,153	294,506	298,923	303,407	307,958	312,577	317,266	322,025	326,855	331,758	336,735	341,786	346,912	352,116	357,398	362,759	368,200	373,723	379,329	385,019
High	WA	25,139	25,516	25,899	26,287	26,682	27,082	27,488	27,900	28,319	28,744	29,175	29,612	30,057	30,508	30,965	31,430	31,901	32,380	32,865	33,358	33,859
Low	ACT	1,572	1,540	1,509	1,479	1,450	1,421	1,392	1,364	1,337	1,310	1,284	1,258	1,233	1,209	1,184	1,161	1,138	1,115	1,092	1,071	1,049
Low	NSW	46,676	45,742	44,827	43,931	43,052	42,191	41,347	40,520	39,710	38,916	38,137	37,375	36,627	35,895	35,177	34,473	33,784	33,108	32,446	31,797	31,161
Low	NT	155	152	149	146	143	140	137	134	132	129	127	124	122	119	117	114	112	110	108	105	103
Low	Qld	18,936	18,557	18,186	17,823	17,466	17,117	16,774	16,439	16,110	15,788	15,472	15,163	14,860	14,562	14,271	13,986	13,706	13,432	13,163	12,900	12,642
Low	SA	4,112	4,030	3,949	3,870	3,793	3,717	3,643	3,570	3,499	3,429	3,360	3,293	3,227	3,162	3,099	3,037	2,976	2,917	2,859	2,801	2,745
Low	Tas	921	902	884	867	849	832	816	799	783	768	752	737	723	708	694	680	667	653	640	627	615
Low	Vic	52,156	51,113	50,091	49,089	48,107	47,145	46,202	45,278	44,373	43,485	42,616	41,763	40,928	40,110	39,307	38,521	37,751	36,996	36,256	35,531	34,820
Low	WA	6,132	6,009	5,889	5,771	5,656	5,543	5,432	5,323	5,217	5,113	5,010	4,910	4,812	4,716	4,621	4,529	4,438	4,350	4,263	4,177	4,094

Figure 26: Best, high[16] and low national projection estimates of contaminated biosolids waste to 2034



The peculiar shape of the high estimate is associated with releases from the large Victorian stockpile of contaminated biosolids

[16] The large temporary increase in the high scenario is associated with the release into the waste stream of contaminated biosolids that are currently stored on-site at two locations in Victoria.

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).

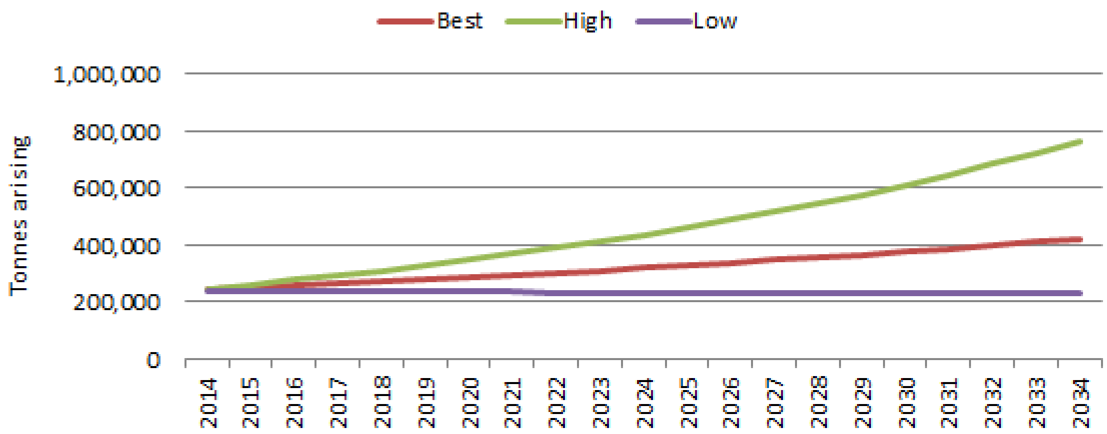
Summary analysis

Industry sources	Considerations	Approach
• Waste treatment and disposal services • Electricity supply • Wastewater treatment plants • Oil and gas extraction (CSG)	No sufficiently credible pre-existing projections were identified No historical data set exists that is adequate for discerning trends	Use causal analysis

Table 34: Best, high and low projected rates of change for other industrial treatment residue waste to 2034

	Applies to	Approach	2014	...	2034
Best	ACT, NSW, NT, Qld, SA, Tas, Vic, WA	Economic growth	2.8%	...	2.8%
High		Best estimate of annual rate of change + 3%	5.8%	...	5.8%
Low		Best estimate of annual rate of change - 3%	-0.2%	...	-0.2%

Figure 27: Best, high and low national projection estimates of other industrial treatment residue waste to 2034



N220. Asbestos

This waste group captures the single NEPM code 75 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. 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 asbestos-contaminated soils. Sources of asbestos are construction/ demolition related as well as any residential, commercial or industrial buildings that are involved in removal of asbestos containing material.

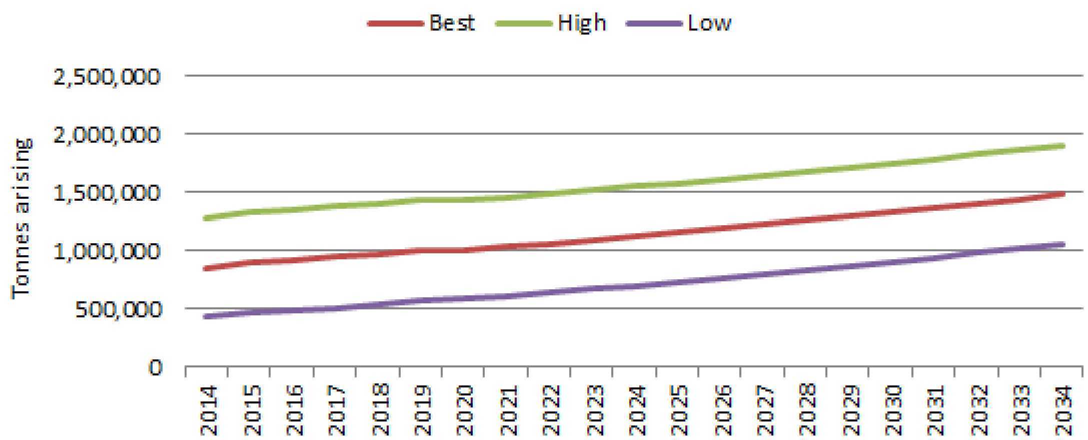
Summary analysis

Industry sources	Considerations	Comments	Approach
• Construction and demolition (including asbestos removal services) • Property development • Hospitals • Schools • Defence • Numerous sectors involved in asbestos removal from their buildings	No sufficiently credible pre-existing projections were identified There may be historical data set which are adequate for discerning trends	No evidence to suggest the supply of waste asbestos peaking or slowing Average 60-year lifespan of buildings suggests increasing quantities in the coming years NSW does not generally track asbestos Combined Vic, SA, Qld data between 05-06 and 12-13 is consistent with average 17% annual increase Estimates of >1,000 Mr Fluffy homes in ACT and NSW may need demolition (~30-60kt	Use judgement - trend and causal analysis Assume additional Mr Fluffy waste in the ACT over 5 years. See range estimates in Belot 2014

Table 35: Best, high and low projected rates of change for asbestos waste to 2034

	Applies to	Approach	2014	2015	...	2020	...	2034
Best	ACT, NSW, NT, Qld, SA, Tas, Vic, WA	Economic growth	2.8%	...	...	...	...	2.8%
High		As per best estimate, with adjustment below	2.8%	...	...	...	...	5.8%
Low		As per best estimate, with adjustment below	2.8%	...	...	...	...	-0.2%
Best	ACT	Mr Fluffy rehabilitation - assume 100kt over 5 yrs starting in 1	0t	20,000t	...	0t	...	0t
High		Mr Fluffy rehabilitation - assume 150kt over 5 yrs starting in 1	0t	30,000t	...	0t	...	0t
Low		Mr Fluffy rehabilitation - assume 50kt over 5 yrs starting in 1	0t	10,000t	...	0t	...	0t
Additional estimate for high and low scenarios using current data as baseline								
High		Best estimate (absolute) + 50%						
Low		Best estimate (absolute) - 50%						

Figure 28: Best, high and low national projection estimates of asbestos waste to 2034



Other N. Other soil/sludges

This waste group collects those remaining N group NEPM 75 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.*

This waste group is problematic due to the variable waste types included and in hindsight it would have been more practical to disaggregate this projection group further. For example projecting hazardous waste packing arisings and fly ash arisings in the same group causes a lack of clarity in the projection of both waste types. This waste group contains a waste of particular interest – fly ash, which is discussed in the breakout box overleaf.

Summary analysis

Industry sources	Considerations	Comments	Approach
• Waste industry • Chemical product manufacturing • Metals manufacturing • Petroleum refining • Paper & paper product manufacturing	No sufficiently credible pre-existing projections were identified A declining trend is apparent in historical data	''Other soil/sludges' is not the ideal name but is consistent with the NEPM High variability over time Energy-from-waste facilities likely in NSW & WA (*Inside Waste* Oct 14 p.19), producing 3% fly ash (Kalogirou et al. 2010)	Use judgement - trend and causal analysis

Table 36: Best, high and low projected rates of change for other soil/sludge waste to 2034

	Applies to	Approach	2014	...	2017	...	2019	...	2034
Approach excl. fly ash from new energy-from-waste facilities									
Best	ACT, NSW,	Slight decline apparent	-1.0%	...	...	...	...	...	-1.0%
High	NT, Qld, SA,	Best estimate of annual rate of change + 2%	1.0%	...	...	...	...	...	1.0%
Low	Tas, Vic, WA	Best estimate of annual rate of change - 2%	-3.0%	...	...	...	...	...	-3.0%
Approach re. fly ash from new energy-from-waste facilities									
Best	WA	Port Hedland & Kwinana facilities open in 3 yrs, processing 500kt/yr	0t	...	15,000t	...	...	...	15,000t
High	WA	Best estimate + E Rockingham facility opens in 5 yrs, processing 225 kt/yr	0t	...	15,000t	...	21,750t	...	21,750t
High	NSW	E Creek facility opens in 5 yrs, processing 1200 kt/yr	0t	...	...	...	36,000t	...	36,000t

Fly ash

Fly ash is a residue generated from combustion comprising fine particles that mix and rise with combustion flue gases in chimneys and post-combustion chambers of thermal plant, and are captured by particle filtration equipment such as electrostatic precipitators. Fly ash usually refers to ash produced during combustion of coal, the bulk of which is arises in power stations. However, this is specifically excluded from the relevant NEPM hazardous waste classification N150 fly ash, excluding fly ash generated from Australian coal fired power stations.

Fly ash often contains hazardous materials such as heavy metals at low concentrations, but still typically at levels sufficient to classify it as a hazardous waste, derived from their composition in input fuel – either as constituent of fine combustion particles or as gaseous combustion products themselves. The major constituents are crystalline silica and oxides of iron and calcium.

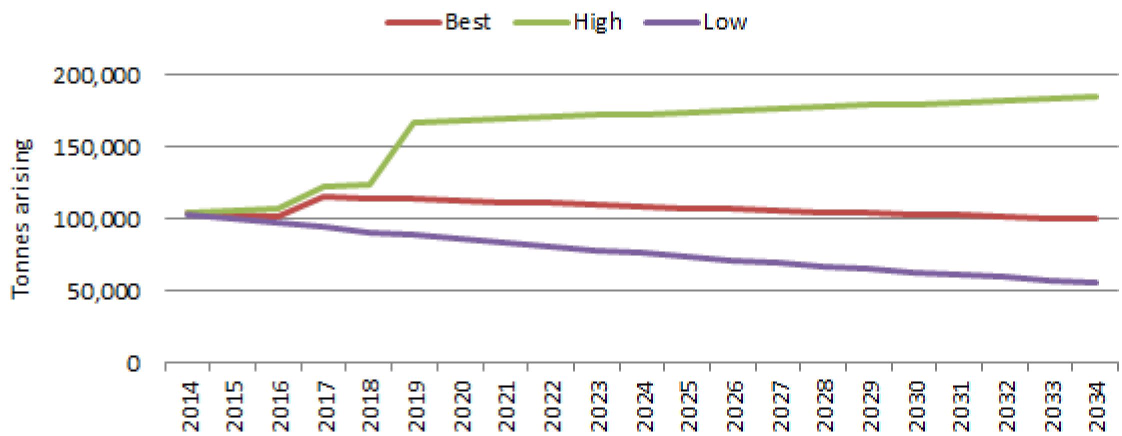
Fly ash is identified through tracking data as having been produced quite consistently at a rate of 5,000 – 6,000 tonnes per year nationally over the last few years. Incineration, meat processing, cement kilns, coal-fired power stations (despite the waste classification name), asphalt plants, iron and steel manufacturing and petroleum refining are identified by this data as the main generating sources. In the context of this report and the broader hazardous waste infrastructure and data projects, N150 is aggregated into Other N - Other soil/sludges waste group, because its quantity based on tracking data alone is only 0.07% of national hazardous waste arisings.

However, the quantities of fly ash generated from coal-fired electricity generation in Australia are likely to dwarf this figure by more than three orders of magnitude. Industry estimates of fly ash generation from coal fired power stations in Australia is almost 11 million tonnes . This exceeds the total amount of all other hazardous waste arisings that make up the national total in this report (7.19 million tonnes), and is almost 10 times the quantity of contaminated soil.

The fate of fly ash is either storage in onsite storage ponds or landfills, offsite hazardous waste landfill, or reuse in concrete, structural fill or road base. The latter has high potential, since fly ash can be used as a partial replacement for the sand, limestone and cement content in concrete. By reducing the need for cement production (a highly energy-intensive process), the reuse of fly ash reduces greenhouse gas emissions. Fly ash also enhances the performance of concrete in regard to workability, shrinkage and durability. In 2013, more than half of Australian generated fly ash was used for a beneficial purpose24.

Clearly, this is a very large quantity to be definitionally ‘missing’ from national estimates of hazardous waste. Also clearly, this material has both hazardous characteristics and resource-recovery benefits.

Figure 29: Best, high and low national projection estimates of other soil/sludge waste to 2034



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; been returned by patients or discarded. These wastes are often generated directly from pharmacies, hospitals, medical centres and hospital dispensaries.

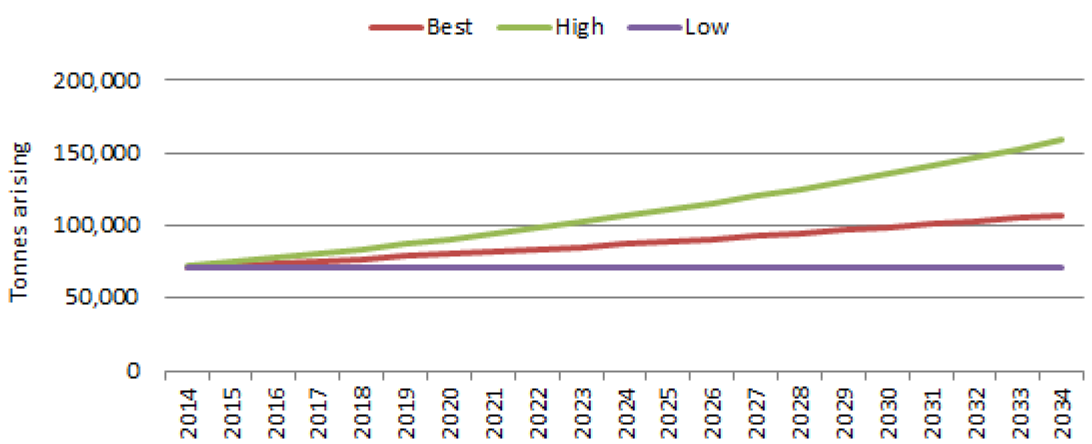
Summary analysis

Industry sources	Considerations	Comments	Approach
• Hospitals, health care centres and clinics • Nursing homes and aged care facilities • Dentists • Pharmacies	Credible projection exists (Thornton 2014)	NSW does not track most of this waste There is potential to reduce hazardous waste by better separation in hospitals etc.	Use Thornton 2014 growth rates for best estimate.

Table 37: Best, high and low projected rates of change for clinical and pharmaceutical waste to 2034

	Applies to	Approach	2014	...	2017	...	2023	...	2034
Best	ACT, NSW, NT, Qld, SA, Tas, Vic, WA	Industry expert projections	1.9%	...	2.0%	...	2.1%	...	2.1%
High		Best estimate of annual rate of change + 2%	3.9%	...	4.0%	...	4.1%	...	4.1%
Low		Best estimate of annual rate of change - 2%	-0.1%	...	0.0%	...	0.1%	...	0.1%

Figure 30: Best, high and low national projection estimates of clinical and pharmaceutical waste to 2034



T140. Tyres

This group is the sole NEPM category *T140 Tyres*. Tyres or '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 Queensland and Western Australia and the recorded arisings indicate that they are significantly under-reported in tracking data, when compared with credible recent estimates of arisings produced by Hyder Consulting (2012)[17]. Consequently, in reporting to Basel and the 2012-13 dataset for this report, data from the Hyder report was used to estimate arisings.

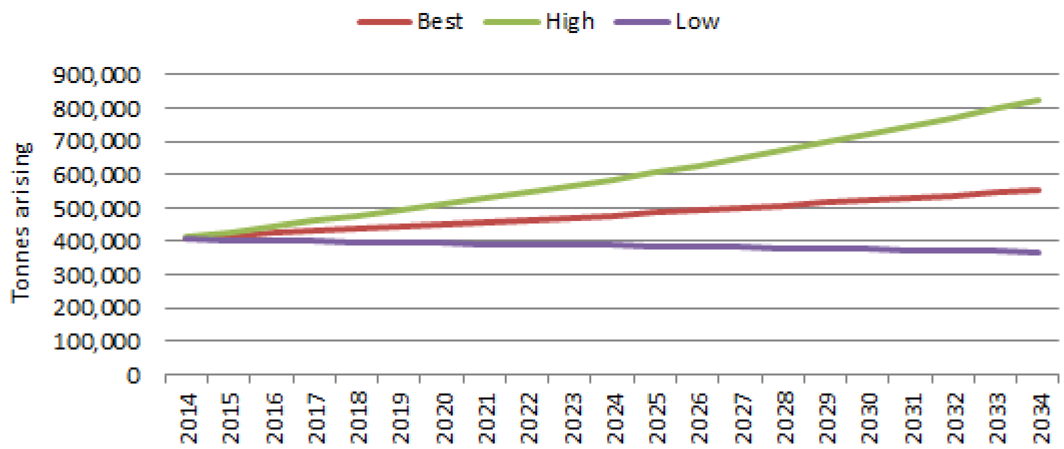
Summary analysis

Industry sources	Considerations	Comments	Approach
Motor vehicle servicing industry	No sufficiently credible pre-existing projections were identified	Only historical Qld and WA data available. Variability likely to be associated with stockpiles	Use causal analysis
	No historical data set exists that is adequate for discerning trends	Assumption that growth in km/person/yr has peaked	

Table 38: Best, high and low projected rates of change for tyre waste to 2034

	Applies to	Approach	2014	...	2034
Best	ACT, NSW, NT, Qld, SA, Tas, Vic, WA	Population growth	1.5%	...	1.5%
High		Best estimate of annual rate of change + 2%	3.5%	...	3.5%
Low		Best estimate of annual rate of change - 2%	-0.5%	...	-0.5%

Figure 31: Best, high and low national projection estimates of tyre waste to 2034



[17] Table 2 of Hyder Consulting (2012) *Study into Domestic and International Fate of End- of-Life Tyres*, prepared for COAG, available from: http://www.scew.gov.au/resource/study-domestic-and-international-fate-end-life-tyres-final-report

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, with smaller quantities of T200 and T120.

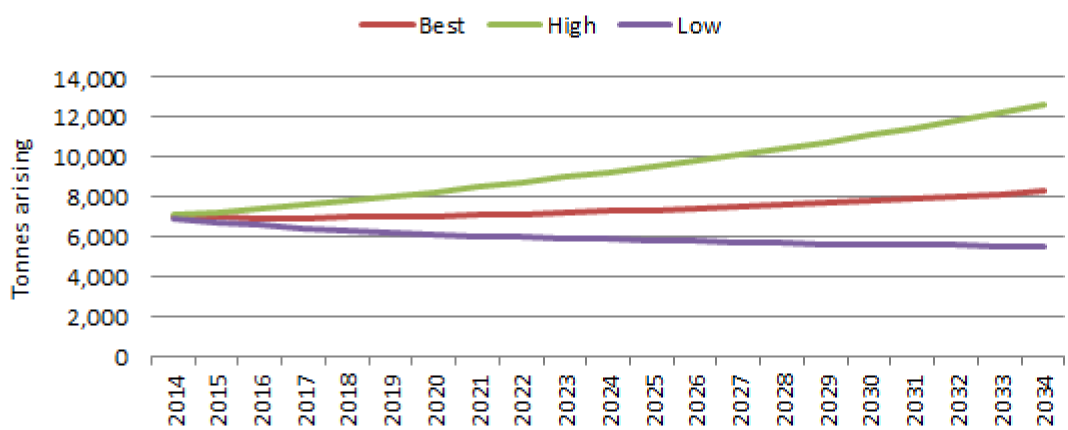
Summary analysis

Industry sources	Considerations	Comments	Approach
• Waste sector • Public administration & other education • Mining • Explosives manufacturing • Printing • Water supply, sewerage & drainage services	No sufficiently credible pre-existing projections were identified No historical data set exists that is adequate for discerning trends	Declining trend in Victoria; stable elsewhere	Use causal analysis

Table 39: Best, high and low projected rates of change for other miscellaneous waste to 2034

	Applies to	Approach	2014	...	2034
Best	Vic	Exponential decay trend	-15.0%	...	-15.0%
High		Best estimate of annual rate of change + 10%	-5.0%	...	-5.0%
Low		Best estimate of annual rate of change - 5%	-20.0%	...	-20.0%
Best	ACT, NSW, NT, Qld, SA, Tas, WA	Population growth	1.5%	...	1.5%
High		Best estimate of annual rate of change + 2%	3.5%	...	3.5%
Low		Best estimate of annual rate of change - 2%	-0.5%	...	-0.5%

Figure 32: Best, high and low national projection estimates of other miscellaneous waste to 2034



Lithium-ion batteries (not regulated as hazardous waste)

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, represent a safety hazard due to risks of causing explosions and or fire (ABRI 2014). **Review Appendix A.7** for more discussion of lithium-ion projection assumptions.

Summary analysis

Considerations	Comments	Approach
Projections for lithium-ion batteries are considered for three differing sizes: • handheld batteries • automotive batteries • large and industrial batteries. • NC & SRU (2014) recently completed a report that focused on stocks and flows of handheld batteries of 5 kilograms or less. • Automotive batteries - Baylis (2012) provides analysis of global lithium consumption and also provides global projections of the number of electric vehicles that will be sold. • Large and industrial batteries - Baylis 2012 provides analysis of global lithium consumption and also provides estimates of global projections of the amounts of grid storage from lithium-ion batteries. MHC (2012) provides the content and charts that support the Baylis 2012 analysis of increasing lithium-ion grid battery storage.	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).	Use judgement - trend and causal analysis. Apply different approach to each battery categories as applicable

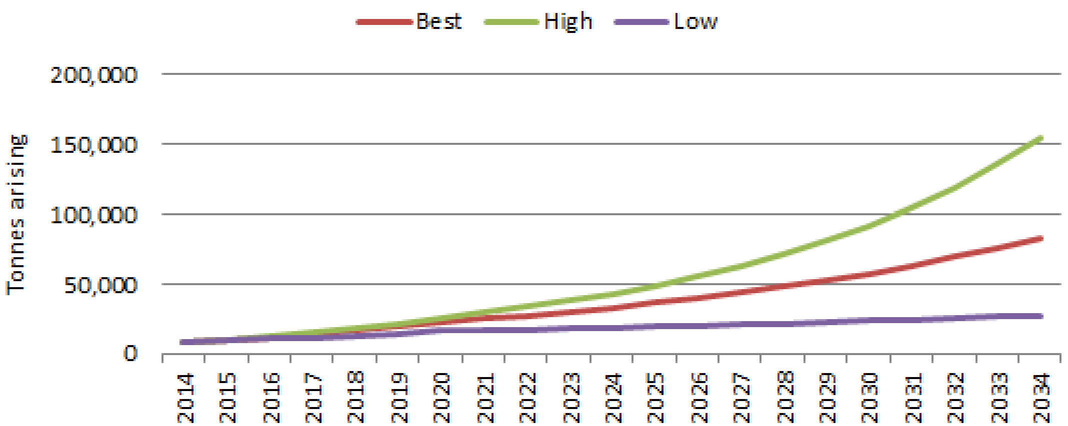
Table 40: Approaches used to project lithium-ion battery waste for different battery types

	Approach used
Handheld batteries	
Best	Projections follow NC & SRU (2014) projections of CAGR until 2020; growth continues thereafter but an alternative technology takes this proportion of the market share: 50%
High	Projections follow NC & SRU (2014) projections of CAGR until 2034
Low	Projections follow NC & SRU (2014) projections of CAGR until 2020; uses for Li-ion batteries then cease to expand but existing uses remain so growth is proportion to population
Automotive batteries	
Best	Follow Baylis 2012 best projections until 2020; thereafter growth continues at the same rate but assume the proportion of market share by alternative technologies is: 50%
High	Follow Baylis 2012 high projections until 2020; thereafter growth continues at the same rate but assume the proportion of market share by alternative technologies is: 50%
Low	Follow Baylis 2012 low projections until 2020; thereafter growth continues at the same rate but assume the proportion of market share by alternative technologies is: 50%
Large and industrial batteries	
Best	Projections follow MHC 2012 best projections until 2034
High	Projections follow MHC 2012 best projections until 2034
Low	Projections follow MHC 2012 best projections until 2034

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

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Handheld batteries																					
Best	2,770	3,235	3,777	4,411	5,151	6,015	7,024	7,613	8,252	8,944	9,694	10,507	11,388	12,343	13,379	14,501	15,717	17,035	18,464	20,013	21,692
High	2,770	3,235	3,777	4,411	5,151	6,015	7,024	8,202	9,578	11,185	13,061	15,252	17,811	20,798	24,287	28,362	33,119	38,675	45,163	52,739	61,586
Low	2,770	3,235	3,777	4,411	5,151	6,015	7,024	7,129	7,236	7,345	7,455	7,567	7,680	7,795	7,912	8,031	8,152	8,274	8,398	8,524	8,652
Automotive batteries																					
Best	4,920	5,908	7,095	8,521	10,233	12,289	14,759	16,242	17,873	19,669	21,645	23,820	26,213	28,847	31,745	34,934	38,444	42,306	46,557	51,234	56,382
High	4,920	6,090	7,540	9,334	11,556	14,306	17,711	19,818	22,176	24,815	27,768	31,072	34,770	38,907	43,537	48,718	54,515	61,002	68,261	76,383	85,473
Low	4,920	5,357	5,833	6,351	6,916	7,530	8,199	8,564	8,944	9,342	9,757	10,190	10,643	11,116	11,610	12,126	12,664	13,227	13,815	14,429	15,070
Large and industrial batteries																					
Best	500	562	632	710	798	897	1,009	1,134	1,275	1,433	1,611	1,811	2,035	2,288	2,572	2,891	3,250	3,653	4,107	4,616	5,189
High	500	570	651	743	847	967	1,103	1,259	1,436	1,639	1,870	2,133	2,434	2,777	3,169	3,615	4,125	4,707	5,370	6,127	6,991
Low	500	551	608	670	738	814	897	989	1,090	1,201	1,324	1,459	1,609	1,773	1,955	2,155	2,375	2,618	2,886	3,181	3,506
Total Li-ion batteries																					
Best	8,190	9,705	11,504	13,642	16,182	19,202	22,792	24,989	27,400	30,046	32,950	36,138	39,637	43,478	47,695	52,326	57,411	62,995	69,128	75,864	83,263
High	8,190	9,896	11,968	14,488	17,554	21,288	25,838	29,279	33,191	37,639	42,699	48,458	55,014	62,483	70,993	80,695	91,759	104,383	118,793	135,249	154,049
Low	8,190	9,143	10,218	11,432	12,805	14,359	16,120	16,682	17,270	17,888	18,536	19,216	19,932	20,685	21,477	22,311	23,191	24,119	25,099	26,134	27,228

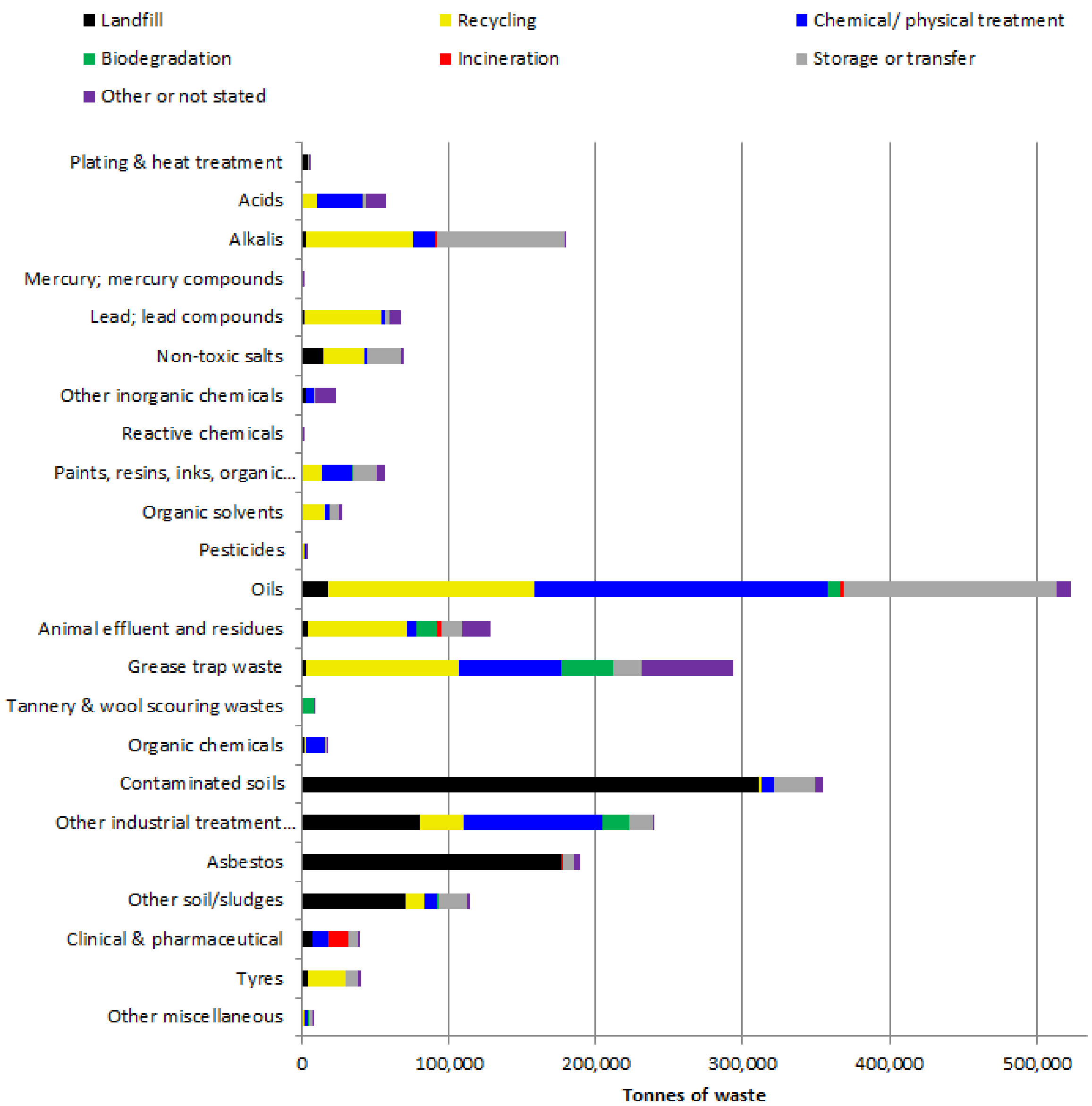
Figure 33: Best, high and low national projection estimates of lithium-ion battery waste to 2034



2.7 Fate of hazardous wastes (NSW, Vic, Qld)

The project team analysed jurisdictional tracking system data to determine the 'treatment types' (or fates) recorded for each waste group in the tracking system data. Fate data was comprehensively available from NSW, Qld and Vic. The overall tonnage by fate in these jurisdictions was compiled for 2012-13 and is presented in Figure 34 and Table 42. Some manipulation of Qld and Vic data was needed to establish uniform categories based on the NSW system. These fate categories do not align neatly with the fates reported in national waste reporting (waste reuse, recycling, energy recovery and disposal). Overall, the quantity presented represents about half of the total tonnes generated in Australia. The potential for multiple counting within the data should be considered in interpreting the data. For example, waste that is sent to chemical/physical treatment may be landfilled after treatment and the tonnage would be included under both fates in the figure below. From an infrastructure capacity assessment perspective, both the CPT and landfill tonnages are relevant and need to be considered.

Figure 34: The fate of tracked hazardous waste in NSW, Qld and Vic, 2012-13 (tonnes)[18]



[18] Some figures are incomplete due to lack of tracking data. 'Tannery and wool scouring wastes' & 'asbestos' exclude NSW; 'contaminated soils' exclude NSW & Qld; 'other industrial treatment residues' exclude Vic; 'tyres' data are incomplete for all.

The widely different quantities of the various waste groups means that arisings of 'reactive chemicals' are too small to be seen.

Table 42: The fate of tracked hazardous waste in NSW, Qld and Vic, 2012-13 (tonnes)[18]

	Landfill	Recycling	Chemical/ physical treatment	Biodegradation	Incineration	Storage or transfer	Other or not stated
Plating & heat treatment	3,982	54	197	24	42	701	2
Acids	652	10,241	30,324	74	89	1,814	13,993
Alkalis	2,846	72,686	15,269	263	645	87,364	268
Mercury; mercury compounds	93	78	108	5	13	238	30
Lead; lead compounds	2,121	52,348	2,129	68	43	2,605	8,431
Non-toxic salts	14,897	27,298	2,025	218	48	22,847	1,605
Other inorganic chemicals	2,708	635	5,130	173	24	610	13,752
Reactive chemicals	3	5	81	0	0	130	11
Paints, resins, inks, organic sludges	936	12,990	20,350	269	401	16,531	5,377
Organic solvents	52	15,714	3,046	8	146	6,638	1,582
Pesticides	152	2,015	324	0	30	313	199
Oils	18,269	140,320	199,245	8,818	2,037	144,854	10,341
Animal effluent and residues	3,980	67,472	6,699	13,510	3,493	14,216	18,881
Grease trap waste	3,192	103,770	69,723	35,327	54	19,569	62,170
Tannery & wool scouring wastes							
Organic chemicals	1,633	1,021	12,552	15	5	1,425	221
Contaminated soils	311,391	1,475	8,623	210	0	28,131	5,070
Other industrial treatment residues	79,664	30,078	94,492	18,422	334	16,087	236
Asbestos	176,251	151	324	103	563	7,871	3,982
Other soil/sludges	70,785	12,710	8,600	597	169	19,445	2,109
Clinical & pharmaceutical	6,841	200	10,935	83	13,405	7,007	748
Tyres	3,891	25,978	2	2	87	8,051	2,027
Other miscellaneous	517	1,389	2,359	229	69	2,740	118

Notes: Tannery and wool scouring data is withheld due to commercial confidentiality concerns

The tracking system data contained no evidence of waste exports. Review of reports from the Basel Convention suggest this is not a common pathway for hazardous waste[19].

Figure 35 and Table 43 present similar data expressed in terms of the percentage of the tonnes of each waste group arising that is sent to each fate category. The fate category 'other or not stated' is removed[20]. The figure also shows the project team's estimates of the likely fate of the six waste groups that are not included in the tracking system data, assuming they are appropriately dealt with as hazardous wastes. These are:

- PFOS, POP-BDEs, HBCD and HCB – allocated to incineration, since the Stockholm Convention requires their 'destruction'
- contaminated biosolids – allocated to landfill
- lithium-ion batteries – allocated to recycling.

Figure 35 and Table 43 represent the best available national average for fate, and are used in the analysis detailed in Section 4.

[19] See http://archive.basel.int/natreporting/questables/dnn-frBody.html. Australia exported 21kt of hazardous waste in 2010.
[20] The entry for fate given for most of these tonnages is blank. Most of the remainder appear to be errors.

Figure 35: The fate of tracked hazardous waste in NSW, Qld and Vic, 2012-13 (percentages)

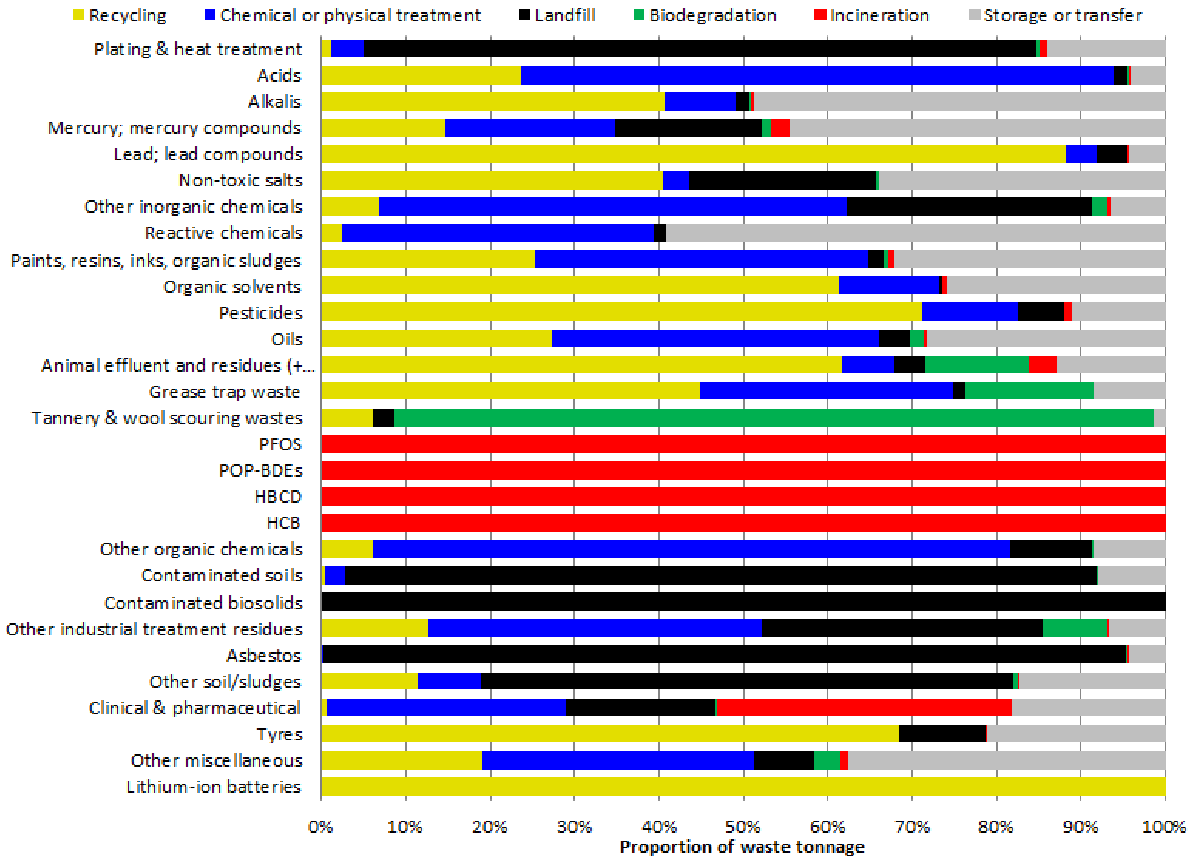


Table 43: The fate of tracked hazardous waste in NSW, Qld and Vic, 2012-13 (percentages)

	Landfill	Recycling	Chemical/ physical treatment	Biodegradation	Incineration	Storage or transfer
Plating & heat treatment	80%	1%	4%	0%	1%	14%
Acids	2%	24%	70%	0%	0%	4%
Alkalis	2%	41%	9%	0%	0%	49%
Mercury; mercury compounds	17%	15%	20%	1%	2%	44%
Lead; lead compounds	4%	88%	4%	0%	0%	4%
Non-toxic salts	22%	41%	3%	0%	0%	34%
Other inorganic chemicals	29%	7%	55%	2%	0%	7%
Reactive chemicals	2%	2%	37%	0%	0%	59%
Paints, resins, inks, organic sludges	2%	25%	40%	1%	1%	32%
Organic solvents	0%	61%	12%	0%	1%	26%
Pesticides	5%	71%	11%	0%	1%	11%
Oils	4%	27%	39%	2%	0%	28%
Animal effluent and residues	4%	62%	6%	12%	3%	13%
Grease trap waste	1%	45%	30%	15%	0%	8%
Tannery & wool scouring wastes	3%	6%	0%	90%	0%	1%
Organic chemicals	10%	6%	75%	0%	0%	9%
Contaminated soils	89%	0%	2%	0%	0%	8%
Other industrial treatment residues	33%	13%	40%	8%	0%	7%
Asbestos	95%	0%	0%	0%	0%	4%
Other soil/sludges	63%	11%	8%	1%	0%	17%
Clinical & pharmaceutical	18%	1%	28%	0%	35%	18%
Tyres	10%	68%	0%	0%	0%	21%
Other miscellaneous	7%	19%	32%	3%	1%	38%

The fate proportions for NSW, Qld, and Vic are each similarly presented in Figure 36 to Figure 38. Where there is no information about the fate of a waste group it is because the group is not tracked in that state.

Interesting differences are apparent in the ways the management of the various waste groups are recorded. NSW has higher proportions of chemical and physical treatment for several waste groups than both Qld and Vic. In Qld wastes groups are often listed as recycled and in Vic they are often listed as recycled or transferred.

These differences could reflect variability how these waste groups are actually managed, but in some cases they may be the result of differences in how jurisdictions classify fates or how users of tracking systems use the classification options. Comparisons of fate proportions between jurisdictions need to be undertaken carefully because inconsistencies could lead to misleading conclusions.

Waste fates are explored further in Section 4.

Figure 36: The fate of tracked hazardous waste in NSW, 2012-13 (percentages)

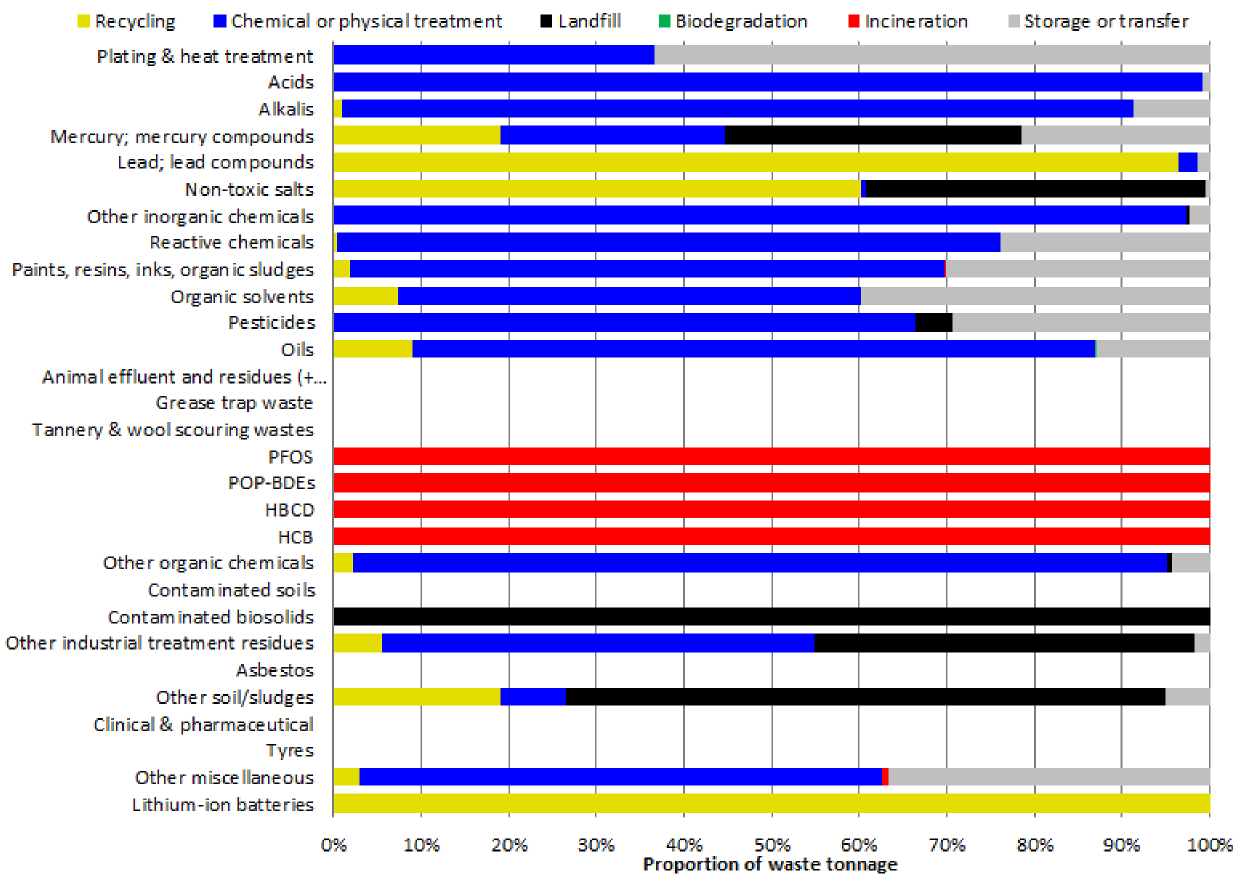


Figure 37: The fate of tracked hazardous waste in Qld, 2012-13 (percentages)

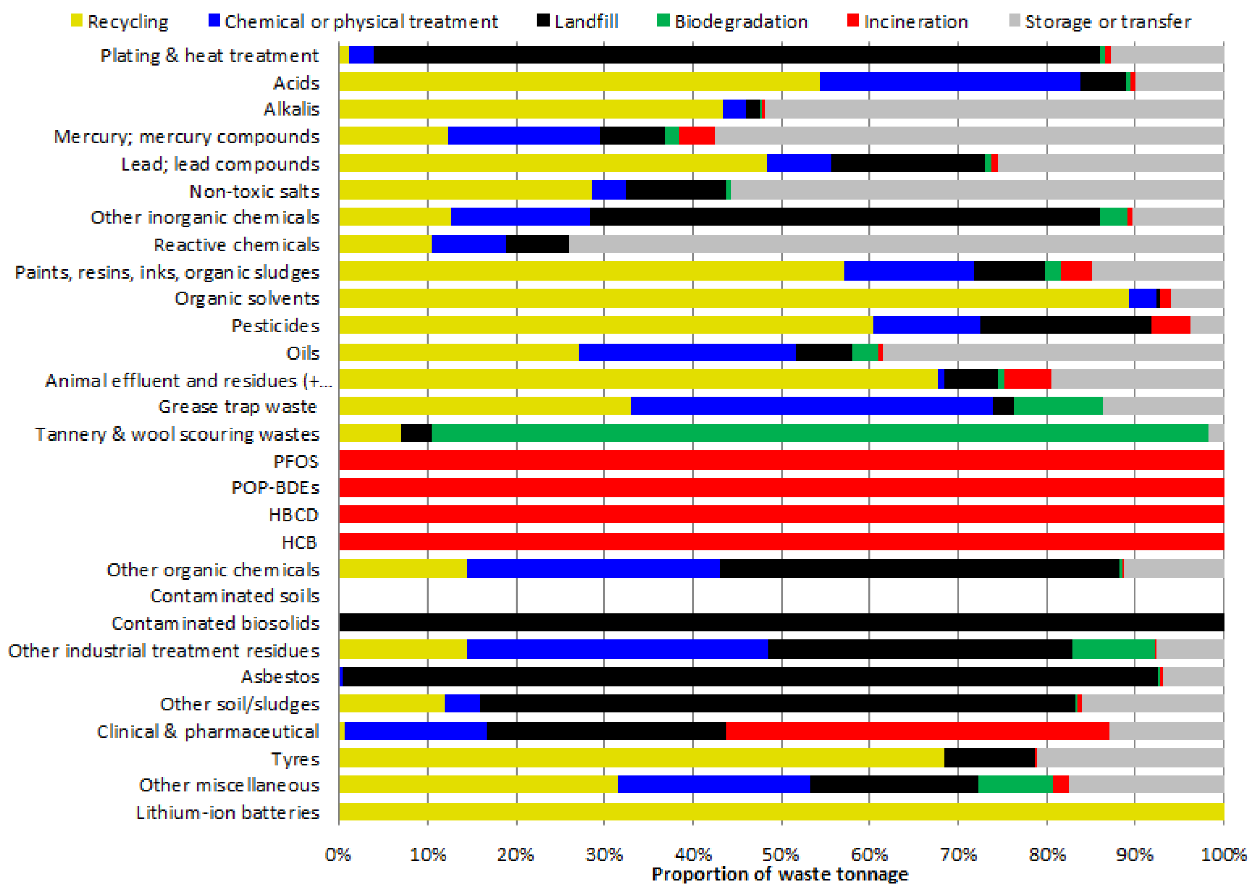
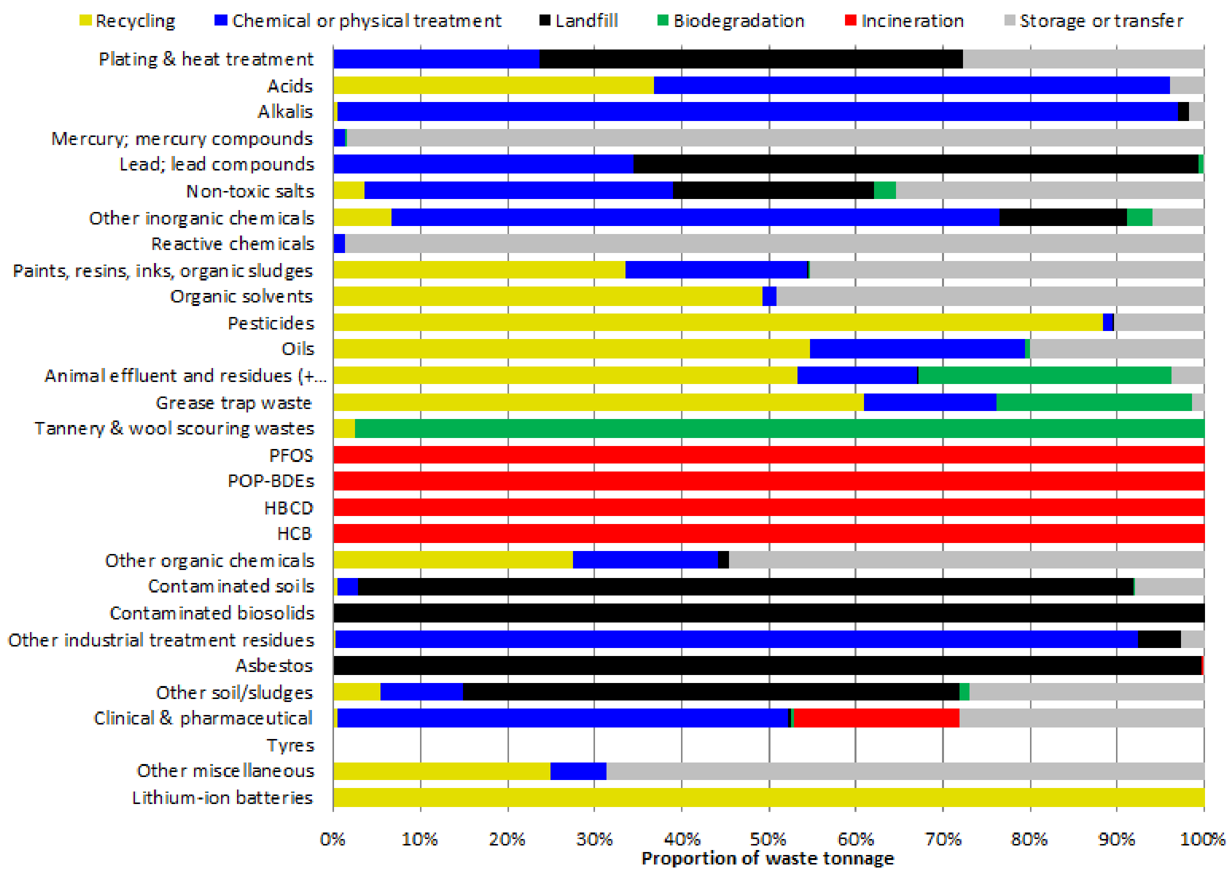


Figure 38: The fate of tracked hazardous waste in Vic, 2012-13 (percentages)



3. Hazardous waste infrastructure assessment

This section reports on an assessment of the current and potential[21] capacity of Australia's hazardous waste infrastructure. 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 3.8. The purpose of the assessment was to allow comparison with projected arisings, which is reported in Section 4.

3.1 Scope of infrastructure assessment

The infrastructure assessment scope was set by a preceding project that produced a database of hazardous waste infrastructure (Rawtec 2014)[22]. The scope was defined as follows:

> *"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 tabulates the scope limitations as shown below.

Table 44: Limitations to the scope of the 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.*

[21] Potential infrastructure capacity: Refers to the maximum capacity that the current infrastructure set and those facilities that are under development could process on an annual basis.

[22] Available from: http://www.environment.gov.au/protection/publications/hazardous-waste-infrastructure-australia

"Waste Item	*Comments*
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.*
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."*

Where infrastructure additional to the Rawtec (2014) database was identified by the project team, it was added to the database. See Section 3.4 for further discussion on this infrastructure.

3.2 Infrastructure groups

To enable the assessment of projected infrastructure need versus capacity, it was necessary to group the infrastructure included in the Rawtec (2014) database. The database provided information on infrastructure 'treatment activities' and on the types of waste received (by NEPM 15 codes and, for some sites, by NEPM 75 codes). This information was combined with industry survey responses to produce a set of hazardous waste 'infrastructure groups' that could be used to compare waste group arisings and fates to infrastructure capacity.

The infrastructure was grouped by: 1. wastes received and 2. primary function[23]. For example, 'e-waste recycling', 'POP thermal destruction', 'clinical waste treatment' and 'clinical waste thermal destruction'. The groups are listed in Table 45, which is ordered following the 'waste hierarchy'[24]. As noted in the descriptions in the table, some overlap in the functions provided by infrastructure included the groups remains. See Section 4.1 for further discussion of how the infrastructure groups were used in the assessment.

The infrastructure groups are not always consistent with the categorisation of treatment activities in the original Rawtec (2014) listing. In particular, the broad category 'CPT' (chemical or physical treatment) – which Rawtec attributed to about 40% of the listed sites – needed to be disaggregated to enable the identification and analysis of infrastructure servicing specific waste groups[25].

The Rawtec (2014) database set the scope of the infrastructure types included in the capacity database, and therefore the infrastructure groups in Table 45. The database also defined coverage limitations within a particular infrastructure group. These coverage limitations are flagged in grey in the table below. The implications of the database scope and coverage limitations are discussed further in Section 4.

[23] The 'primary function' of the infrastructure refers to the waste fates provided (e.g. waste recycling, waste treatment).

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

[25] For example, the database listed both the Southern Oil waste oil re-refining facility and the Transpacific Homebush Bay facility (which treats many wastes groups) as CPT. To be able to analyse the potential capacity constraints for the waste oil group, as distinct from sites receiving other waste groups, it was necessary to allocate the Southern Oil facility to a more specific infrastructure group (i.e. oil re-recycling).

Table 45: Infrastructure groups

Infrastructure group	Description
Recovery: recycling and energy recovery (ER)	
Hazwaste packaging fac.	Facilities that recycle industrial packing that contains residual hazardous wastes. Containers are typically refurbished and reused or materials are recycled.
E-waste fac.	Major e-waste physical/chemical and manual disassembly processing facilities. Facilities receive inorganic hazardous wastes, such as copper, cobalt, and lead. Note: "*only major e-waste physical/chemical and manual disassembly processing facilities were included in the scope*" Rawtec (2014).
Oil re-refining fac.	Facilities that re-refine (recycle) waste oil. Facilities that dewatering and filter waste oil (only) are **not included in this group** as the primary function is assumed to be transfer waste oil onto oil re-refining facilities. Grouping overlap: some of the capacity of these facilities could also be allocated to transfer station or temporary storage.
Lead fac.	Facilities that recycle lead. Typically the lead is from used lead acid batteries.
Mercury fac.	Facilities that recycle mercury. Used fluorescent light fittings are usually a key waste.
Solvents/paints fac.	Facilities that recycle paints, resins, inks, organic sludges and/or organic solvents.
Solvents/paints fac. (ER)	Facilities that recover solvents, paints, organics solvents for the purposes of energy recovery. The energy recovery may occur off-site from the facility. Grouping overlap: this group includes infrastructure that also receives pesticides and POPs for blending and with solvents/paint wastes for thermal destruction.
Spent potlining fac.	Facilities that recycle spent potlining waste from the aluminium industry.
Organics fac. (NEPM code K wastes)	Facilities that recycle a range of low hazard organic wastes such as grease trap waste, cooking oil, animal effluents, etc. Grouping overlap: some of the capacity of these facilities could also be allocated to transfer station or temporary storage. Coverage limitation: "*Grease trap was captured where the … facility also treated other hazardous wastes. Grease trap to composting facilities was not included*" Rawtec (2014).
Treatment (T)	
Chemical and Physical Treatment (CPT) plant[26]	Sophisticated and significant capital expenditure facilities that provide a range of chemical and physical treatments to a broad range of waste groups. This is a large and critical infrastructure group. Often licensed to receive almost all NEPM 15 waste codes. Rawtec (2014) lists most CPT sites as receiving codes B, C, D, E, F, G, H, J, K, L, M, N, R, and T. Processes can include all chemical treatments (e.g. oxidation, reduction, precipitation, neutralisation, etc.) and physical treatments (e.g. sedimentation, filtration, adsorption, immobilisation, etc.) Grouping overlap: some of the capacity of these facilities could also be allocated to recycling (solvents/paints) and transfer station or temporary storage. No POPs thermal destruction capacity has been identified at these sites but this could change in future.
Clinical waste fac. (T)	Facilities that treat clinical waste typically using an autoclave.
Soils treatment fac.	Facilities that treat contaminated soils. Treatment processes include biodegradation and thermal destruction of contaminants. Grouping overlap: this group includes the Renex waste treatment facility, which also has some capacity for POPs thermal destruction.
Disposal: landfill, thermal destruction (TD)	
Hazwaste landfill disposal fac.	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 disposal fac. (NEPM codes N, T only)	Landfill facilities that are generally only licensed to dispose low level contaminated soils, asbestos, and tyres (NEPM 15 codes N and T). These landfills also generally dispose of non-hazardous wastes which are typically the majority of the tonnages disposed at the

[26] CPT plants are assumed to take D300 Non-toxic salts, which is the waste group that accounts for CSG wastes.

Infrastructure group	Description
	site. Rawtec (2014 p.7) states that the database does **not** include "*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".* This infrastructure group is out of the scope of infrastructure database, however, the database lists 27 such landfills (16 of which are in Victoria). Whilst these 27 sites are included in the database, there are a large (unknown) number of landfills fitting this infrastructure group in Australia that are not listed and the infrastructure group remains out of the scope of the capacity assessment.
POPs fac (TD).[27]	Facilities that are able to destroy persistent organic compounds (POPs) by thermal destruction. Coverage limitation: "*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"* Rawtec (2014).
Clinical waste fac. (TD)	Facilities that dispose of medical waste by thermal destruction. Grouping overlap: this group includes facilities that may also have Clinical waste treatment capacity (autoclave) and thermal destruction capacity for other wastes, including POPs.
Transfer station or temporary storage fac.[28]	Facilities for the transfer or temporary storage of hazardous wastes. Some of these facilities receive a wide range of wastes, others only specific wastes. Grouping overlap: as noted above, several other infrastructure groups also provide transfer and storage capacity. **Waste oil dewatering and filtering (only)** are included in this group as the primary function is assumed to be transfer waste oil onto oil re-refining facilities. Coverage limitation: "*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"* Rawtec (2014).

Notes: shaded grey infrastructure groups have coverage limitations as noted. Landfill fac. (NEPM codes N, T only) inf. group is outside of the capacity assessment scope

3.3 Industry consultation method

The Rawtec (2014) database provided 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 and waste type received (by NEPM 15 category for most sites and by NEPM 75 code for some). For this project it was necessary to enhance the database with information on current and potential infrastructure capacities[29], requiring a major consultation program.

The Rawtec database was consolidated from 208 individual site entries to 126 company entries. In order to organise how the companies should be consulted, they were classified by uniqueness and operational scale and shown in and Table 46.

[27] Note: cement kilns disposing of POPs by thermal destruction are not included in the infrastructure assessment (see Section 3.1).

[28] Rawtec (2014) lists waste storage as a treatment activity for around 60% of CPT sites and 20% of recycling sites. Whilst these sites do offer both CPT or recycling and storage, it presents another challenge in assessing sites processing capacity v's the transfer or storage capacity. Where possible sites have been grouped under the transfer or storage group, however, it is noted that significant transfer and storage capacity is likely to be within CPT and recycling groups capacity.

[29] Potential infrastructure capacity is the maximum tonnage of hazardous waste that the current infrastructure set and those facilities that are under development could process on an annual basis.

Table 46: Method for classifying companies by uniqueness

Ranking	Criteria	# of companies
A	Company uses ≥4 treatment technologies OR receives ≥9 material types	12
B	Company uses 2-3 treatment technologies OR receives 2-8 material types	50
C	Company uses one treatment technology or receives only one material type	61
D	Company has no data on received treatment type or received material types	3

Table 47: Method for classifying companies by operational scale

Ranking	Criteria	# of companies
Large	Company has sites in ≥3 states OR has ≥3 sites	15
Medium	Company has ≥2 sites	50
Small	All others	61

The resultant classifications were overlain and reviewed to produce overall categories to be consulted by different methods, as shown in Table 48.

Table 48: Industry consultation rankings

Consultation approach	Ranking	# of companies
Face-to-face interview	1	25
Email/online survey and phone	2	49
Email/ online survey	3	52
	Total	126

Face-to-face interviews

For the 25 companies contacted for face-to-face interviews, Paul Randell interviewed the company representative(s). Before the interviews, Paul provided an overview of the project by phone and an email including:

1. a letter from DoE introducing the project team and requesting input
2. an introduction to the project
3. an extract from the Rawtec infrastructure database including the information already gathered for the company's infrastructure and capabilities.
4. the set of 10 consultation questions for the company to consider before the interview (see).

During the interview, a detailed project overview was provided and the intent of each of the consultation questions was explained. Where possible, responses to the questions were gathered and recorded during the interview. Because of the number of sites or the confidential nature of the information sought, most companies opted to complete the survey following the interview.

Online survey

Using the contact details contained in the Rawtec database, representatives from companies in Ranking 2 and 3 were contacted directly via email (where possible). The email provided potential respondents with an introduction and an overview of the project, a letter from the Department of the Environment encouraging participation and a link to the SurveyMonkey website where they could respond to the 10 questions shown in Table 49. Companies were contacted via phone to obtain or confirm the correct email address where necessary.

Following the email or telephone introduction to the project, respondents in ranking group 2 were contacted up to two times via telephone and email as a follow-up reminder to complete the survey. Respondents in ranking group 3 were sent up to two follow-up email reminders only.

The survey questions

All companies (ranking 1, 2, and 3) were asked 10 questions relating to the operations and capacity of each of their sites, as listed in Table 49. Companies with several sites answered the questions several times, once for each site.

Table 49: Questions asked of industry consultation survey respondents

#	Question	Guidance notes provided
1	Please outline the plant, processes & equipment used at the site	
2	Please estimate the average annual quantity of hazardous waste received over the last three years, preferably in tonnes and by waste type.	
3	Please state the maximum annual quantity of hazardous waste that you are licensed to receive at the site, preferably in tonnes and by waste type.	(This is to help us understand if the existing infrastructure could receive additional annual tonnages if your licence allowed it).
4	Please discuss the potential annual capacity of the infrastructure at the site, preferably in tonnes and by waste type.	
5	Please outline and explain how you expect the quantities of hazardous waste you receive to change in the future.	(This is to help us understand if you intend to add additional infrastructure capacity or alternatively if you have plans to reduce the capacity of, or shut down, the infrastructure. For landfill operators estimate the amount of hazardous waste you expect to receive before the site closes).
6	Please list the main outputs from the hazardous waste delivered to the site, and the fate of these outputs (e.g. disposal to sewer or landfill, recycling, energy recovery).	
7	Please outline 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? If so please provide details of the waste type and estimated tonnages.	(Stockpiles could be located on the site or on another site).
9	Please outline your thoughts regarding future hazardous waste generation and management in Australia. Please discuss knowledge of particular waste types.	(This is to help us develop projections of future hazardous waste generation and fate).
10	Would you like to bring to government attention any concerns or issues affecting the market for the hazardous wastes you deal with?	

3.4 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 DoE and the project team.

A summary of the survey responses is given in Table 50. Overall we achieved a response rate 64% (i.e. we collected survey responses from 64% of sites surveyed). Importantly, we collected survey data from 23 of the 25 rank 1 companies (92%). This is an excellent response rate for a voluntary survey.

Table 50: Summary of survey results by site

Survey response	n/a	None	Incomplete	Complete	Total	Response rate
# sites	1	82	3	155	241	64%

Additional sites identified

In addition to the 208 sites listed in the Rawtec (2014) database, during consultation an additional 14 operating sites and 19 new sites (planned, constructed or commissioned) falling within the scope of the database were identified. These sites were surveyed and the current and potential capacity added to the capacity database and assessment. The total number of sites included in the final database was 241, as noted in the table above.

Sites no longer operational or not taking hazardous wastes

During consultation a total of nine sites were identified as no longer operational or not taking hazardous waste bringing the total number of sites receiving hazardous waste in the database to **232**.

3.5 Compiling capacity estimates

A first cut of the capacity estimates were compiled by summing the data provided by survey respondents. As Table 50 shows, however, no response was received in relation to 36% of the sites so their capacity needed estimating. For some of the 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 potential capacity. Where this was not the case, current and potential capacity was assumed to equal the average of the sites that provided data for that infrastructure group. At the conclusion of this process, actual data forms 70% of the estimated total potential capacity.

3.6 National capacity estimates of hazardous waste infrastructure

The overall national results of the hazardous waste infrastructure assessment are set out in Table 51. For each infrastructure group, the table states the number of sites, the amount of waste currently received, and the potential capacity. It includes an assessment of the quality of the capacity data based on the definitions at the foot of the table. The quality assessment details for each infrastructure group the percentages of site data that was 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 confidentialities.

Table 51: National capacity estimate of hazardous waste infrastructure

Hazardous waste infrastructure group	No. sites	Est. currently received (kt/yr)[30]	Est. potential capacity (kt/yr)[31 32]	Data sources: Ind. survey res.	Data sources: Site licence data	Data sources: Inf. group av.	3-yr. av. rec'ts (kt/yr)	Av. capacity (kt/yr)
Recovery: recycling and energy recovery (ER)								
Hazwaste packaging fac.	31	22	55	42%	0%	58%	0.7	1.8
E-waste fac.	12	64	161	58%	0%	42%	5	14
Oil re-refining fac.	13	363	694	62%	31%	8%	29	59
Lead fac.	4	106	188	75%	25%	0%	23	51
Mercury fac.	2			50%	50%	0%		
Solvents/paints fac.	5	10	16	60%	20%	20%	2	4
Solvents/paints fac. (ER)	1			100%	0%	0%		
Spent potlining fac.	5			80%	20%	0%		
Organics fac.	12	205	273	17%	33%	50%	14	24
Treatment								
Chemical Physical Treatment (CPT) plant	49	1,159	1,559	73%	12%	14%	27	31
Clinical waste fac. (T)	10	26	26	30%	10%	60%	3	3
Soils treatment fac.	4	74	185	50%	50%	0%	12	63
Disposal: landfill, thermal destruction (TD)								
Hazwaste landfill fac.	7	208	274	43%	0%	57%	30	39
Landfill fac. (NEPM codes N, T)	27	433	761	44%	7%	48%	16	29
POPs fac. (TD)	1			100%	0%	0%		
Clinical waste fac. (TD)	6	17	30	100%	0%	0%	3	5
Transfer station or temporary storage fac.	43	232	335	72%	9%	19%	5	8
Total	**232**	**3,052**	**4,780**	**59%**	**11%**	**29%**		

Notes: shaded grey infrastructure groups have coverage limitations. Landfill fac. (NEPM codes N, T only) inf. group is outside of the capacity assessment scope

Data quality definitions by source

Survey res.	**Highest quality**. Processing, licensed, and potential capacity data supplied during consultation
Licence data	**Moderate quality**. Maximum licensed processing capacity data identified in licence or published company information
Inf. group av.	**Low quality.** Licensed processing capacity assumed to be the average of the tonnage processed by inf. with the same inf. group

Comparing total capacity and total arisings

In Section 2, the current arisings of hazardous waste in Australia were discussed. The best estimate of current arisings (5.7 Mt) is much higher than the approximately 3.0 Mt of waste shown above as currently received.

[30] Estimate based on a three year average of wastes received at the site.

[31] **Potential capacity:** refers to the maximum capacity that the current infrastructure set and those facilities that are under development could process on an annual basis. The maximum capacity at current operating infrastructure has been combined with the capacity of planned infrastructure, that industry identified during consultation, to protect the commercial information regarding planned site developments. Industry stated that planned infrastructure information is particularly sensitive and must be protected. Of the 232 sites identified, a total of 20 sites (only) are new sites that industry identified as planned capacity.

[32] **Landfill 'potential capacity'**: refers to the potential tonnages that the site can landfill in a year. It does not refer to the total amount of waste the site can receive before closure. Where the potential capacity is exceeded, it indicates that the landfill(s) would need to increase capabilities to dispose more waste each year. This could require amendment to EPA site licences.

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 soils – which are generated in large volumes – are sent to sites that are not included in the database. Detailed analysis of this issue is provided in Section 4.

3.7 Jurisdictional capacity estimates of hazardous waste infrastructure

Table 52 shows the capacity assessment data broken down by jurisdiction.

To protect commercial confidentialities, in the public version of this report, the infrastructure group data for tonnages of waste currently received and potential capacity have been removed.
Whilst 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 confidentialities are 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 potential capacity).

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

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

The analysis shows the following:

- Vic and NSW dominate in the provision of hazardous waste infrastructure. Both Vic and NSW have approximately 30% each of the number of sites, current tonnage received, and potential capacity.
- Qld and WA follow providing similar proportions of hazardous waste infrastructure both providing around 15% sites and around 17% of the current tonnage received and potential capacity.
- SA provides 8% of hazardous waste infrastructure sites and around 5% of current tonnage received and potential capacity.
- ACT, NT and Tas all provided less than 5% of hazardous waste infrastructure sites and less than 1% of the current tonnage received and potential capacity.

Regarding the infrastructure group capacity concentrations (locations):

- NSW has over 50% of the current and potential lead, SPL and hazwaste organics recovery capacity.
- Qld has 100% of the POPs current and potential thermal destruction capacity that was included in the database.
- Vic has over 50% of current and potential capacity for hazardous waste packaging, mercury, and solvents and paints recovery. Victoria also has more than 50% of the potential soil treatment capacity.
- WA has more than 50% of the currently received capacity for contaminated soils treatment identified in the database.

Table 52: Jurisdictional capacity estimate of hazardous waste infrastructure

Hazardous waste infrastructure groups	ACT A	ACT B	ACT C	NSW A	NSW B	NSW C	NT A	NT B	NT C	Qld A	Qld B	Qld C	SA A	SA B	SA C	Tas A	Tas B	Tas C	Vic A	Vic B	Vic C	WA A	WA B	WA C	Australia A	Australia B	Australia C
Recovery: recycling and energy recovery (ER)																											
Hazwaste packaging fac.	-	-	-	7	[redacted]	[redacted]	1	[redacted]	[redacted]	2	[redacted]	[redacted]	3	[redacted]	[redacted]	1	[redacted]	[redacted]	15		[redacted]	2	[redacted]	[redacted]	31	22	55
E-waste fac.	1	[redacted]	[redacted]	4	[redacted]	[redacted]	-	-	-	2	[redacted]	[redacted]	2	[redacted]	[redacted]	-	-	-	3	[redacted]	[redacted]	-	-	-	12	64	161
Oil re-refining fac.	-	-	-	4	[redacted]	[redacted]	-	-	-	1	[redacted]	[redacted]	2	[redacted]	[redacted]	1	[redacted]	[redacted]	2	[redacted]	[redacted]	3	[redacted]	[redacted]	13	363	694
Lead fac.	-	-	-	3			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	[redacted]	[redacted]	4	106	188
Mercury fac.	-	-	-	1	[redacted]	[redacted]	-	-	-	-	-	-	-	-	-	-	-	-	1			-	-	-	2	[redacted]	[redacted]
Solvents/paints fac.	-	-	-	2	[redacted]	[redacted]	-	-	-	1	[redacted]	[redacted]	-	-	-	-	-	-	1	[redacted]	[redacted]	1	[redacted]	[redacted]	5	10	16
Solvents/paints fac. (ER)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1			-	-	-	1	[redacted]	[redacted]
Spent pot lining fac.	-	-	-	3			-	-	-	-	-	-	-	-	-	-	-	-	2	[redacted]	[redacted]	-	-	-	5	[redacted]	[redacted]
Organics fac.	-	-	-	8			-	-	-	-	-	-	-	-	-	-	-	-	4	[redacted]	[redacted]	-	-	-	12	205	273
Treatment																											
CPT plant	-	-	-	14	[redacted]	[redacted]	1	[redacted]	[redacted]	10	[redacted]	[redacted]	3	[redacted]	[redacted]	1	[redacted]	[redacted]	8	[redacted]	[redacted]	12	[redacted]	[redacted]	49	1,159	1,559
Clinical waste fac. (T)	1	[redacted]	[redacted]	2	[redacted]	[redacted]	1	[redacted]	[redacted]	2	[redacted]	[redacted]	1	[redacted]	[redacted]	-	-	-	2	[redacted]	[redacted]	1	[redacted]	[redacted]	10	26	26
Soils treatment fac.	-	-	-	1	[redacted]	[redacted]	-	-	-	1	[redacted]	[redacted]	-	-	-	-	-	-	1	[redacted]		1		[redacted]	4	74	185
Disposal: landfill, thermal destruction (TD)																											
Hazwaste landfill fac.	-	-	-	1	[redacted]	[redacted]	1	[redacted]	[redacted]	1	[redacted]	[redacted]	-	-	-	1	[redacted]	[redacted]	1	[redacted]	[redacted]	2	[redacted]	[redacted]	7	208	274
Landfill fac. (NEPM code N, T)	1	[redacted]	[redacted]	-	-	-	-	-	-	3	[redacted]	[redacted]	2	[redacted]	[redacted]	-	-	-	16			5	[redacted]	[redacted]	27	433	761
POPs fac. (TD)	-	-	-	-	-	-	-	-	-	1			-	-	-	-	-	-	-	-	-	-	-	-	1	[redacted]	[redacted]
Clinical waste fac. (TD)	-	-	-	1	[redacted]	[redacted]	-	-	-	1	[redacted]	[redacted]	1	[redacted]	[redacted]	-	-	-	2	[redacted]	[redacted]	1	[redacted]	[redacted]	6	17	30
Transfer station or temporary	1	[redacted]	[redacted]	10	[redacted]	[redacted]	2	[redacted]	[redacted]	7	[redacted]	[redacted]	4	[redacted]	[redacted]	4	[redacted]	[redacted]	8	[redacted]	[redacted]	7	[redacted]	[redacted]	43	232	335
Total	4	24	38	61	969	1,377	6	37	54	32	474	777	18	175	241	8	12	23	67	819	1,393	36	542	877	232	3,052	4,780
Percentage of national total	2%	1%	1%	26%	32%	29%	3%	1%	1%	14%	16%	16%	8%	6%	5%	3%	0%	0%	29%	27%	29%	16%	18%	18%			

A = Number of sites

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 = Potential capacity (kt/yr) (i.e. the reported potential capacity or, if unavailable, the licensed processing capacity or, if unavailable, the reported 3-year average receipts or, if unavailable, the mean

Greater than 50% of sites in Australia

Greater than 50% of potential capacity in Australia

Greater than 50% of currently received capacity in Australia

Infrastructure group capacity data removed to ensure commercial confidentiality is protected

Notes: shaded grey infrastructure groups have coverage limitations. Landfill fac. (NEPM codes N, T only) inf. group is outside of the capacity assessment scope

3.8 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.

Falling demand for hazardous waste infrastructure

As Australia's manufacturing sector slows, hazardous wastes commonly generated by manufacturing in Australia (acids, alkalis, solvents) are in decline. Across the country, industry reported falling amounts of hazardous manufacturing wastes sent for treatment. In some instances sharp declines were reported.

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.

The Alreco facility in Moolap Victoria (recovering Aluminium recycling wastes) exemplifies this issue. The site is due to close this year as the company's key clients (Alcoa and Simms) have closed operations that supplied the sites feedstock (MHM 2014).

Stockpiles of spent potlining, mercury wastes and end-of-life tyres

Industry estimates around 900,000 tonnes of spent potlining – a waste from aluminium smelting – are in stored in stockpiles across Australia. 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 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.

Industry and environment agencies also flagged stockpiles of tyres as a major problem. Stockpiles of waste tyres create a significant environmental and human health issue if they catch fire, which is not uncommon. EPA Victoria 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"*[33]

Inconsistent landfill levies driving interstate disposal of hazardous wastes

There are large differences in the cost of landfill disposal of hazardous waste in Australia. In Victoria the landfill levy for Category B hazardous waste is \$250/tonne and in Queensland the landfill levy is \$0/tonne. Industry commented that transport costs could be as low as \$80/tonne from Vic to Qld. If transport costs

[33] 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)

are indeed this low, landfills in Qld (charging the same gate fee[34] as Vic landfills) could potentially offer tipping at $170/tonne less that tipping costs in Victoria. Several industry stakeholders commented on this as a serious policy/governance issue for hazardous waste management in Australia.

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 wastes such as household waste so investments carry a higher risk and are less secure. Industry commented on a range of regulatory issues that can undermine investment in hazardous waste infrastructure, listed below. It is beyond the scope of this project to provide detailed analysis of these issues or to validate the accuracy of industry comments.

1. Allowing landfilling of hazardous organic wastes for which there are recovery options, including the recovery of energy.
2. Permitting the exports of hazardous wastes for which there is recovery infrastructure in Australia.
3. Exporting unprocessed waste oil without export permits as ‘fuel oil’, which is not permitted under the Basel Convention and undermines oil recycling (which represents higher order recovery).
4. The recycling targets set in the National Television and Computer Recycling Scheme are too low resulting in stockpiling of e-wastes at transfer stations or the disposal of collected e-waste to landfill.
5. The regulation of clinical waste is highly inconsistent across Australia resulting in clinical wastes being sent interstate.

Additional coal seam gas waste infrastructure needed

A number of industry stakeholders commented on the need to improve infrastructure to service coal seam gas (CSG) industry wastes, including brine wastes and hydrocarbon impacted drilling muds. Industry commented that these wastes are likely to increase as Australia’s gas export capabilities increase. One of the key challenges in treating brine wastes is the large volumes (weight) and remote locations of the wastes, which make transport costly.

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 often commented on the need for asbestos collection infrastructure in remote areas where there is no landfill licensed to take asbestos.

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.

Expanding POPs destruction capacity

The only facility identified that focuses only on POPs destruction is the Toxfree operated BCD plasma arc plant in Qld. No other designated POPs destruction facilities are proposed, however, additional capacity is planned within other infrastructure.

SteriHealth currently has research and development approval to treat PCB-contaminated leachate from Melbourne’s Tullamarine landfill at their incineration facility in Laverton. SteriHealth aims to provide POPs

[34] Gate fee: refers to the cost of tipping net of landfill levy.

destruction services to the market following works approval from EPA. SteriHealth did not state the potential tonnages of POPs that could be destroyed at the facility. TPI (2014) stated that SteriHealth recently successfully treated around 2000 litres of PCB contaminated oil during trials at the site.

A RENEX pyrolysis rotary kiln is being commissioned in Dandenong, Melbourne, and will aim to treat POPs contaminated soils and liquids. The kiln with operate at 600^{o}C and the gases will be incinerated at 1100-1200^{o}C, enabling the destruction of chlorinated organics such as PCBs. Renex has stated an overall potential capacity [redacted], but it is unknown what tonnage of POP contaminated soils and liquids could be processed at the plant.

Western Australia: distance and low tonnages of hazardous waste is a major challenge

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"*

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 steps for completing the assessment and also provides analysis of the limitations and levels of uncertainty of the assessment. As discussed in 4.2 there are 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.

Step 1: determine the assumed fate of waste groups

The fate of 2012-13 waste arisings are known for NSW, Qld and Vic and are included in Figure 35 to Figure 38 (above).

The fate allocations for NSW, Qld, Vic and the national average all required a number of adjustments which are summarised in Table 53. The adjustments were needed for various reasons, including that:

- some smaller allocations of waste fates are apparently mistaken (e.g. mercury waste is unlikely to have been incinerated)
- the infrastructure group 'chemical or physical treatment' is broad, and likely to include some waste fates apart from treatment (e.g. some recycling or biodegradation)
- similarly, some waste allocated to 'treatment' are better considered 'recycling'
- some allocations are very small and not material to this assessment.

Note: the projections for waste group T140 Tyres was excluded from the capacity assessment at this stage. Historical fate data for tyres was only available from Qld and, more importantly, tyres are not sent hazardous waste infrastructure apart from the Landfill fac. (NEPM codes N, T only) group, which is out of the scope of the capacity assessment.

Step 2: map waste groups fate data to infrastructure groups

For each waste group, the adjusted fates were 'mapped' to an infrastructure group. In other words, the infrastructure group most likely to receive the particular fate was selected. Examples:

- the Plating & heat treatment waste group with a fate of chemical or physical treatment was mapped to CPT plant fac.
- the Plating & heat treatment waste group with a fate of disposal was mapped to Hazwaste landfill fac.
- the Asbestos waste group with a disposal fate was mapped to the Landfill fac. (NEPM codes N, T only).

The full mapping process is illustrated in Table 54.

Table 55 (in Section 4.2) shows the outcome of steps 1 and 2 above for each waste group and shows the national average fate proportions mapped to infrastructure groups. Note: where jurisdictional-specific fate proportions were available (NSW, Qld, Vic), this data was used. For SA, WA, NT, Tas, ACT, the weighted average proportions shown in the table were applied.

Step 3: combine waste group projections, assumed fate, 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 proportions of fate determined in Step 1 (above) are assumed to remain constant over the projection period of 20 years. It is likely that the actual proportions of fate will change over the projection period and by varying amounts in different jurisdictions. A change in the fate proportions 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 current and future fates of waste groups limits the accuracy of the capacity assessment.

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 potential capacity of the infrastructure group to obtain an estimate of when potential capacity would be exceeded by the allocated arisings.

Table 53: Adjustments made to the jurisdictional fate data to enable assessment of need vs. capacity

	Waste group	Fate data allocation	Adjusted assumed fate
A	Plating & heat treatment	Recycling & incineration	Sent to CPT
B	Acids	Recycling & incineration	
C	Alkalis	Recycling	
D120	Mercury; mercury compounds	Incineration	Sent to a mercury fac.
D220	Lead; lead compounds	Incineration	Sent to CPT
D300	Non-toxic salts	Recycling	
Other D	Other inorganic chemicals	Incineration	
E	Reactive chemicals	Recycling	
F	Paints, resins, inks, organic sludges	Incineration	Processed for energy (blended with other high calorific value wastes to make fuel)
G	Organic solvents	Incineration	Processed for energy (blended with other high calorific value wastes to make fuel)
H	Pesticides	Recycling & incineration	Processed for energy (blended with other high calorific value wastes to make fuel)
J	Oils	CPT	Sent to be re-refined
K100	Animal effluent and residues (+ food processing waste)	Incineration	Processed for energy (blended with other high calorific value wastes to make fuel)
Other M	Other organic chemicals	Recycling	Sent to CPT
N120	Contaminated soils	Recycling	Sent to a soil treatment facility
N205b	Other industrial treatment residues	Recycling	Sent to CPT
N220	Asbestos	Treatment	Sent to landfill
Other N	Other soil/sludges	Incineration	Sent to CPT
R	Clinical & pharmaceutical	Recycling	Sent to a clinical waste facility
Other T	Other miscellaneous	Recycling	Sent to CPT
		Incineration	Processed for energy (blended with other high calorific value wastes to make fuel)
All waste groups		Incineration	Incineration is assumed to be thermal destruction unless assumed (above) to be sent to CPT or an energy recovery facility.
All waste groups		Biodegradation	Mostly sent to composting facilities that are not included in the scope of the capacity assessment. Therefore all tonnages are not included in capacity assessment.

Table 54: Mapping of fate to infrastructure group by waste groups

	Waste group	Recycling	Energy recovery	Treatment	Landfill	Thermal destruction	Storage or transfer
A	Plating & heat treatment						
B	Acids						
C	Alkalis						
D120	Mercury; mercury compounds	Mercury fac.					
D220	Lead; lead compounds	Lead fac.			Hazwaste landfill fac.		
D300	Non-toxic salts						
Other D	Other inorganic chemicals	E-waste fac.		CPT plant			
E	Reactive chemicals						Transfer station or temporary storage fac.
F	Paints, resins, inks, organic sludges	Solvents/ paints fac.	Solvents/ paints fac. (ER)				
G	Organic solvents						
H	Pesticides		Solvents/ paints fac. (ER)				
J	Oils	Oil re-refining					
K100	Animal effluent and residues (+ food processing waste)	Organics fac.	Solvents/ paints fac. (ER)	CPT plant	Hazwaste landfill fac.		
K110	Grease trap waste						
K140 & 190	Tannery & wool scouring wastes						
M160a-d	PFOS, POP-BDEs, HBCD, HCB					POPs fac. (TD)	
Other M	Other organic chemicals			CPT plant	Hazwaste landfill fac.		Transfer station or temporary storage fac.
N120	Contaminated soils			Soils treatment fac.	Landfill fac. (NEPM code N, T only)		
N205a	Contaminated biosolids						
N205b	Other industrial treatment residues			CPT plant	Hazwaste landfill fac.		
N220	Asbestos				Landfill fac. (NEPM code N, T only)		
Other N	Other soil/sludges	Hazwaste packaging fac.		CPT plant			Transfer station or temporary storage fac.
R	Clinical & pharmaceutical			Clinical waste fac. (T)	Hazwaste landfill fac.	Clinical waste fac. (TD)	
Other T	Other miscellaneous	Organics fac.	Solvents/paints fac. (ER)	CPT plant			
	Lithium-ion batteries	E-waste fac.					

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 wastes
2. the levels of uncertainty of the assumed fate proportions and allocation to infrastructure (i.e. how much of each waste group's arisings will be managed by what infrastructure)
3. the limitations and levels of uncertainty of the assessment of the current hazardous waste infrastructure capacity.

These three dimensions of uncertainty are discussed below.

Uncertainty in projections of hazardous waste arisings

The levels of uncertainty of the projected arisings of hazardous wastes 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 fate) of 'new' hazardous wastes such as PFOS wastes or contaminated biosolids wastes are particularly uncertain as there is 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 these wastes, 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 Table 5.

Uncertainty in the assumed fate proportions and mapping to infrastructure

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

The assessment of the adequacy of infrastructure relies on fate proportion data from only three states (NSW, Qld, Vic). It assumes the proportions of waste fate and the receiving infrastructure groups remain constant over time. In reality, changing market conditions, innovation and policy efforts are likely to change these proportions and potentially the infrastructure that manage the wastes.

This project has attempted to reduce uncertainty related to changes in the fate of waste groups by consulting with DoE and jurisdictional EPA (or equivalent) staff regarding likely changes in the management requirements of hazardous wastes (see A.2).

Limitations and uncertainty of the infrastructure capacity estimates

The following factors limit and impact on the levels of certainty in the infrastructure capacity estimates:

1. **Capacity database coverage**.

   Some hazardous wastes that are included in the waste group arisings are managed by facilities excluded from the infrastructure database. As detailed in Section 3, many landfills that accept low level contaminated soils, asbestos and tyres, for example, are not included in the scope of the infrastructure database.

   Some hazardous wastes that are included in the waste group arisings are managed by infrastructure groups with limited coverage in the infrastructure capacity database. As detailed in Section 3, the database has limited coverage hazardous waste organics recycling facilities, POP thermal destruction facilities and transfer and storage facilities.

This 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 39 illustrates which infrastructure groups are out of the capacity assessment scope or have limited coverage. Table 55 and Figure 40 details which waste groups are most affected by these limitations.

2. **Capacity data quality.** The infrastructure capacity data collated in this report is of varying accuracy. Table 51 details the proportions of what is assumed to be high, moderate, and low quality data for each infrastructure group.
3. **Infrastructure group capacity overlap.** As discussed in Section 3.2, hazardous waste infrastructure were grouped by both wastes received and primary function[35]. There is some overlap in the functions provided by the infrastructure included the groups. Some groups may provide capacity for more than the primary function identified – for example, oil re-refining facilities often have a transfer and storage capacity. In these cases, the capacity of the primary function is over estimated. It follows that where the capacity of an infrastructure group is included within other groups (e.g. transfer station and temp storage capacity is provided by many other groups) the capacity of the group is under estimated. Removal of this 'overlap' in infrastructure group capacity would require data on:
   - the types of infrastructure on site
   - the types of wastes received (at a detailed level, i.e. NEPM 75 level)
   - the amounts of each waste received
   - the proportions of the fate of each waste (i.e. how much went to recycling, energy recovery, thermal destruction, disposal and transfer).

   With this information, the capacity of each site could be allocated to a number infrastructure groups and the overlap removed, greatly increasing the accuracy of the capacity estimates. The information gathered through industry consultation – which was already a significant impost on company's time – enabled grouping of each site by primary function only.

   For infrastructure groups of particular interest, such as POPs destruction, it is recommended that DoE follow-up with sites included in infrastructure groups flagged as having some POPs destruction capacity to better determine the specific potential POPs destruction capacity of each site.
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 so their capacity is missing.

For each infrastructure group the limitations and uncertainties of the capacity estimates discussed above are assessed in Table 56. An overall assessment of uncertainty for capacity estimates is provided for each group (from low through to very high). This overall assessment of capacity uncertainty is an important consideration when assessing the period when the waste group projections are likely to exceed the infrastructure group capacity, and is included assessment in Section 4.3

[35] The 'primary function' of the infrastructure is related to waste fates. The primary function refers to the waste fates that the infrastructure provides (e.g. waste recycling, waste treatment).

Figure 39: Hazardous waste groups arisings, coverage in capacity database, and extent of assessment

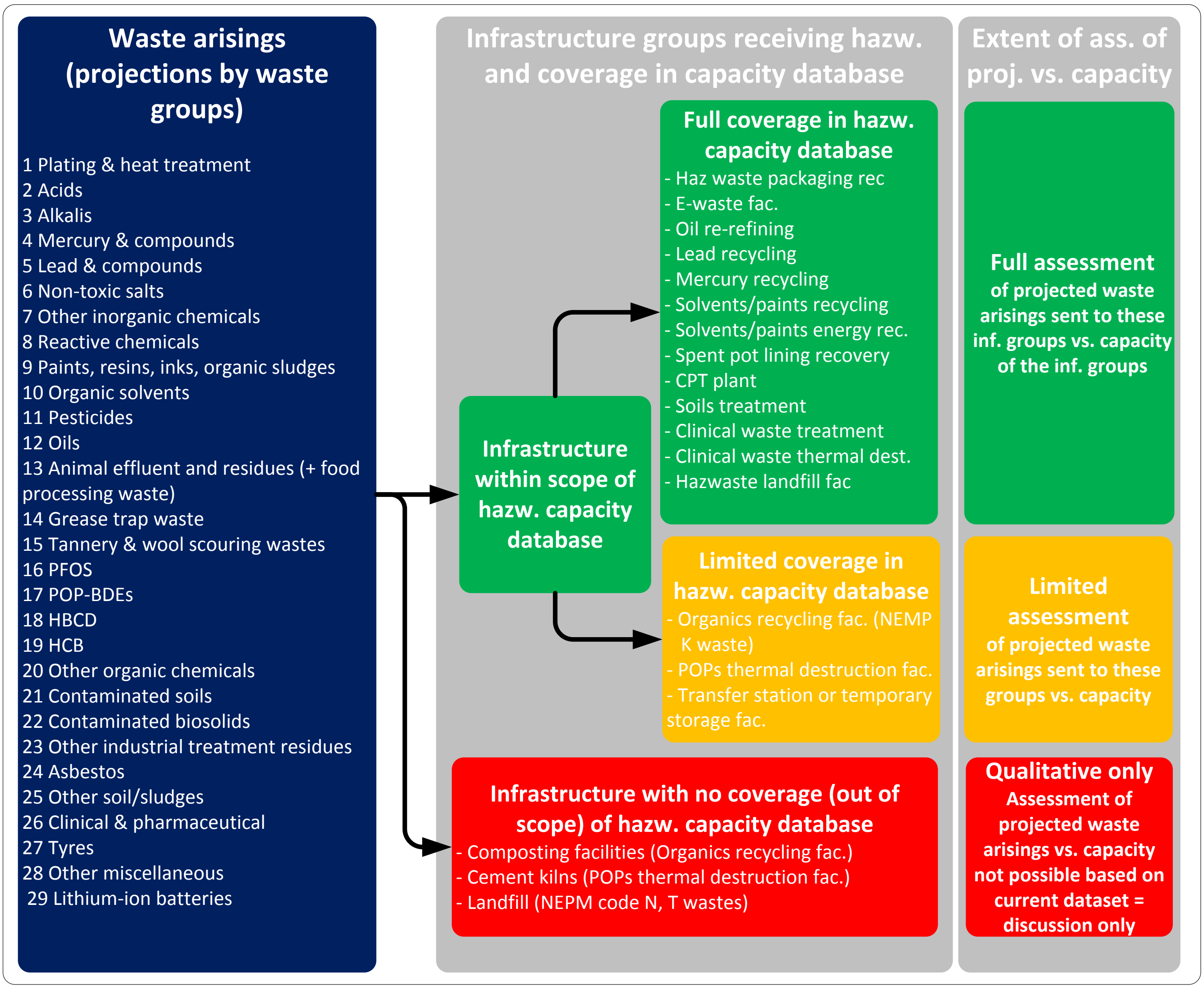


Table 55: Waste groups allocation to infrastructure groups and national average fate proportions

	A Plating & heat treat. 2015 aris. 6kt	B Acids 2015 aris. 42kt	C Alkalis 2015 aris. 313kt	D120 Mercury 2015 aris. 1.5kt	D220 Lead 2015 aris. 168kt	D300 Non-toxic salts 2015 aris. 92kt	Other D Inorganic chems. 2015 aris. 196kt	E Reactive chems. 2015 aris. 0.1kt	F Paints, resins, inks 2015 aris. 47kt	G Organic solvents 2015 aris. 32kt	H Pesticides 2015 aris 4kt	J Oils 2015 aris. 704kt	K100 Animal eff. + food.. 2015 aris. 300kt	K110 Grease trap 2015 aris. 552kt	K140, 190 Tannery... 2015 aris. 7kt	M160s PFOS, BDEs, HBCD, HCB. 2015 aris PFOS 3kt, BDEs, HBCD,..	Other M Organic chems. 2015 aris. 21 kt	N120 Contam. Soils 2015 aris. 1360kt	N205a Contam. Biosolids 2015 aris. 272kt	N205b Ind. treat res... 2015 aris. 232kt	N220 Asbestos 2015 aris. 899kt	Other N soil/sludge 2015 aris. 103kt	R Clinical & pharma. 2015 aris. 73kt	T140 Tyres 2015 aris. 417kt	Other T Miscellaneous 2015 aris. 7kt	Lithium-ion batts. 2015 aris. 10kt
Hazw. Packg. Recycling fac.																						11%				
E-waste recycling fac.							7%																			100%
Oil re-refining fac.												66%														
Lead recycling fac.					88%																					
Mercury recycling fac.				15%																						
Solv/paints rec. fac.									25%	61%																
Spent pot lining recycling fac.							(6)																			
Solv/paints energy recovery fac.									1%	1%	73%		3%												1%	
CPT fac.	6%	94%	49%	22%	4%	44%	56%	39%	40%	12%	11%		6%	30%			82%			52%		8%			51%	
Clinical waste treatment fac.																							30%			
Soils treatment fac.																		3%								
Clinical waste TD fac.																							34%			
Hazards waste landfill fac.	80%	2%	2%	17%	4%	22%	29%	2%	2%		5%	4%	4%	1%	3%		10%			33%		63%	17%		7%	
Organics recycling fac.													62%	45%	6%											
POPs TD fac.																100%										
Transfer or temp storage fac.	14%	4%	49%	45%	4%	34%	7%	59%	32%	26%	11%	28%	13%	8%	1%		8%	8%		7%	4%	18%	19%		38%	
Landfill fac. (NEPM code N, T)																		89%	100%		96%			(7)		
Extent of ass. of proj. arisings vs. inf. capacity	Full (1)	Full (1)	Full (1)	Full (1)	Full (1)	Full (1)	Full (1)	Full (1)	Full (1)	Full (1)	Full (1)	Full (1)	Limited (2)	Limited (2)	Limited (2)	Limited (3)	Full (1)	Limited (2)	Qualitative (5)	Full (1)	Qualitative (4)	Full (1)	Full (1)	Qualitative (4)	Limited (2)	Full (1)

Notes:

1: Full assessment, however, limited assessment of transfer infrastructure capacity.
2: Limited due large tonnages sent to inf. out of hazw. inf. dataset coverage.
3: Limited assessment for 'new hazwastes' due to large tonnages assumed sent to inf. out of hazwaste inf. dataset coverage in future.
4: Qualitative assessment only due to the waste arisings all being sent to an inf. group that is out of the inf. dataset scope.
5: Qualitative assessment only due to the future waste arisings all being sent to an inf. group that is out of the inf. dataset scope.
6: Spent pot lining wastes have historically not been transported to off-site SPL recycling facilities and hence have not been significant in tracking system fate data. Under waste projections SPL waste tonnages arisings are assumed to be 100% sent to SPL recycling facilities
7. Tyres were excluded from fate allocation because (a) the proportion for which data is available is very low; (b) the proportion going to hazardous waste infrastructure is very low

'New hazardous waste' (i.e. have not been managed as hazardous waste in the past).

Figure 40: Proportions of waste groups sent to infrastructure that has full (green), limited (yellow) or no coverage (red) in the infrastructure capacity database

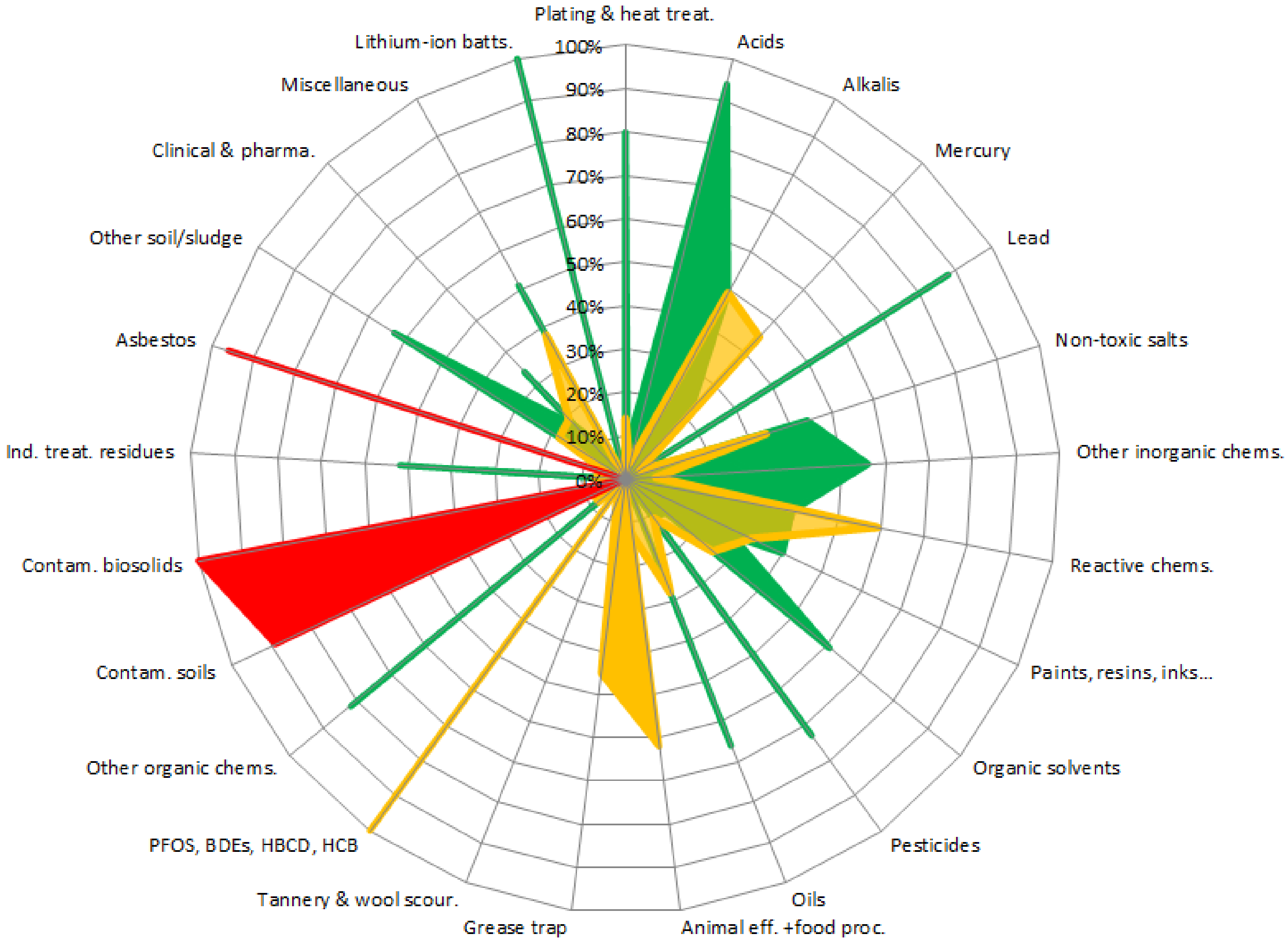


Table 56: Infrastructure capacity estimates assessment of uncertainty

Hazardous waste infrastructure group	1. Coverage in capacity database	2. Ind. response for capacity data	3. Infrastructure grouping overlap? (Y/N) Implication? (capacity over or under estimate)[36]	4. Very diffuse inf. group? (Y/N)	Uncertainty of infrastructure capacity estimate
Recovery: recycling and energy recovery (ER)					
Hazwaste packaging facility	Full	42%	N	Y	**Moderate**
E-waste facility	Full	58%	Y, over est.	N	**Moderate**
Oil re-refining facility	Full	80%	Y, over est.	N	**Moderate**
Lead facility	Full	75%	N	N	**Low**
Mercury facility	Full	50%	N	N	**Low**
Solvents/paints facility	Full	60%	Y , under est.	Y	**High**
Solvents/paints facility (energy recovery)	Full	100%	Y, over est.	N	**Low**
Spent potlining facility	Full	80%	N	N	**Low**
Organics facility (NEPM code K wastes)	Limited	18%	Y, over est.	Y	**Very high**
Treatment					
Chemical or physical treatment plant	Full	73%	Y, over est.	N	**Moderate**
Clinical waste facility (treatment)	Full	30%	Y , under est	N	**High**
Soils treatment facility	Full	67%	Y , over est.	Y	**Moderate**
Disposal: landfill, thermal destruction (TD)					
Hazardous waste landfill	Full	38%	Y, under est.	N	**High**
Hazardous waste landfill (NEPM code N, T)	Na	Na	Na	Na	**Na**
POPs facility (thermal destruction)	Limited	100%	Y, under est.	N	**Very high**
Clinical waste facility (thermal destruction)	Full	100%	Y, over est.	N	**Low**
Transfer station or temporary storage fac.	Limited	66%	Y, under est.	Y	**Very high**

[36] Where an infrastructure groups can provided capacity for more than the primary function identified (e.g. Oil re-refining facilities often have a transfer and storage capacity) the capacity of the primary function is over estimated. It follows that where the capacity of an infrastructure group is included within other groups (e.g. transfer station and temp storage capacity is provided by many other groups) the capacity of the group is under estimated.

4.3 National assessment by infrastructure group

A national assessment of potential capacity of each infrastructure groups against estimated arisings is given in Table 57. The table includes the following for each infrastructure group:

- The potential capacity of the infrastructure included in the group and the uncertainty for the capacity estimates (from low to very high)
- The estimated arisings in 2015 of the wastes that are assumed to be sent to the infrastructure group
- The year in which estimated arisings exceed estimated capacity. This value is given for all three scenarios (best, high and low estimates).
- A discussion of the assessment and any specific recommendations.

Table 57: National assessment of projected arisings vs. infrastructure capacity

Infrastructure group	Potential capacity (kt/yr.)	Capacity estimate uncertainty (low - v. high)	Estimated arisings in 2015 (kt)	Est. year arisings > capacity Best	High	Low	Assessment discussion and recommendations
Recovery: recycling and energy recovery (ER)							
Hazwaste packaging fac.	55	Moderate	11 to 12	>2034	>2034	>2034	Analysis indicates that under all scenarios over the next 20 years the potential capacity of Australia's current and planned hazardous waste packaging recycling infrastructure will be able to recycle waste arisings. There may be some regional limitations (see jurisdictional analysis below). The infrastructure capacity assessment for this group has moderate uncertainty due to a low response rate during consultation and the infrastructure group being highly diffuse increasing the probability of capacity not being included in the capacity database.
E-waste fac. Major physical/chemical and manual disassembly processing facilities	161	Moderate	22 (low) to 24 (high)	>2034	2034	>2034	Analysis indicates that under the best and low scenarios over the next 20 years the potential capacity of Australia's current hazardous e-waste (major physical/chemical and manual disassembly processing) infrastructure will be able to recycle waste arisings. Capacity could become constrained by 2034 if e-waste arisings grow very strongly. There may be some regional limitations (see jurisdictional analysis). **Important:** estimates assume no change in the current estimated proportions of fate of e-waste, which is mostly landfill. Changes to product stewardship agreements or landfill bans on e-waste could significantly change these estimates. The infrastructure capacity assessment for this group has moderate uncertainty due to: a moderate response rate during consultation; and the infrastructure group capacity having some overlap with other functions (such as PCB oil decontamination) resulting in a likely overestimate of the infrastructure group capacity.

Infrastructure group	Potential capacity (kt/yr.)	Capacity estimate uncertainty (low - v. high)	Estimated arisings in 2015_(kt)	Est. year arisings > capacity Best	 High	 Low	Assessment discussion and recommendations
Oil re-recycling fac. Facilities that re-refine waste oil. Note: facilities that dewatering and filter waste oil (only) are **not included** in this group as the primary function is assumed to be transfer waste oil onto oil re-refining facilities.	694	Moderate	434 (low) to 482 (high)	2023	2020	>2034	Based mainly on projected increases in waste arisings in Qld and WA (mining industry), the best estimate scenario projects that waste oil re-refining capacity in Australia could be exceeded in 2023 or by 2020 under the high scenario. Changes in the growth rates of mining could significantly affect this assessment. Under a low arisings scenario (in which Qld and WA arisings increase at the projected rate of national economic growth), waste oil re-refining capacity in Australia is sufficient beyond 2034. The infrastructure capacity assessment for this group has moderate uncertainty due to the group's capacity having some overlap with the transfer station or temporary storage infrastructure group resulting in a potential overestimate of the infrastructure group capacity. Offsetting the potential overestimation of this group's capacity is the allocating of all NEPM J codes recycling tonnages to this group. Some of the J code 'recycling' fate is likely to be *J120 Waste oil/water, hydrocarbons/water mixtures or emulsions* that are taken to facilities that filter and dewater only (rather than re-refine), resulting in an overestimate of arisings of oils sent to re-refining. In addition, some waste oil 'recycling' may actually be sent for energy recovery which, again, would yield an overestimate of demand for re-refining.
Lead fac.	188	Low	146 to 151	2031	2022	>2034	Based on the best estimate projection of arisings increasing at the rate of population growth, the current and planned lead recycling infrastructure could be met by 2031. Based on the high estimate projection of arisings increasing strongly at 3.5% per annum capacity could be exceeded in 2022. Under a low scenario of no growth in arisings capacity is not expected to be exceeded over the next 20 years. There may be some regional limitations (see jurisdictional analysis).
Mercury fac.		Low	0.22 to 0.23	>2034	>2034	>2034	Analysis indicates that over the next 20 years the potential 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).
Solvents/paints fac. (Recycling)	16	High	31 to 32	2015	2015	2015	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: 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.

Infrastructure group	Potential capacity (kt/yr.)	Capacity estimate uncertainty (low - v. high)	Estimated arisings in 2015 (kt)	Est. year arisings > capacity Best	High	Low	Assessment discussion and recommendations
							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).
Solvents/paints fac. (Energy Recovery)	[redacted]	Low	13	>2034	2030	>2034	Analysis indicates that under the best and low scenarios over the next 20 years the potential capacity of Australia's current solvents/paints energy recovery infrastructure will be able to manage waste arisings. If paints, resins, inks, organic sludges grow very strongly (at 3.8%p.a.) capacity could be exceeded by 2030. There may be some regional limitations (see jurisdictional analysis). We note above that some solvents/paints recycling tonnages may actually be sent to energy recovery infrastructure. This could result in the infrastructure need exceeding capacity sooner than is estimated here[37].
Spent potlining fac.	[redacted]	Low	115	>2034	2017	>2034	For SPL wastes the current estimated arisings are based on the tonnages of SPL recycled in 2014. Waste tracking system data could not be used because much of the SPL recycling infrastructure is located on aluminium smelting sites (the generation sites) so no tracking data is collected. Industry estimates around 900 kt of spent potlining are in storage/stockpiles in Australia. The best and low projection scenarios assume that these stockpile remains *in-situ*. Under these scenarios it is estimated that the current SPL recycling infrastructure capacity will not be exceeded over the 20 year projection period. Under the high scenario it is assumed that the SPL stockpile is released over a 10 year period (at a rate of 90kt/yr.) beginning in 2017. [redacted]
Organics fac. (NEPM code K wastes) Facilities that recycle a range of low hazard organic wastes such	273	Very high	421 to 445	2015	2015	2015	Projections indicate that under all scenarios the current capacity of organics recycling infrastructure (for NEPM K code organics) is being exceeded. This inaccuracy is linked to the very high uncertainty of the capacity assessment. As discussed in Section 4.2, the majority of the arisings of NEPM K code wastes are sent to infrastructure that has limited coverage in the capacity assessment database. 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

[37] We maintain two infrastructure groups for solvents/paints despite the uncertain allocations, because the types of infrastructure and fate are fundamentally different (recycling; energy recovery).

Infrastructure group	Potential capacity (kt/yr.)	Capacity estimate uncertainty (low - v. high)	Estimated arisings in 2015 (kt)	Est. year arisings > capacity Best	High	Low	Assessment discussion and recommendations
as grease trap waste, cooking oil, animal effluents, etc. Composting facilities are **not included.**							small amount of low level hazardous wastes as part of much larger non-hazardous waste volume. In addition, some smaller operators that specialise in hazardous organic wastes 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 that there is likely to be a national shortage of this infrastructure group over the next 20 years. There may be some regional limitations (see jurisdictional analysis).
Treatment							
CPT plant	1559	Moderate	671 to 734	>2034	2030	>2034	Based on the best and low projections of arisings CPT infrastructure is estimated to be able to meet national demand over the next 20 years. Based on the high projection of arisings CPT national capacity could be exceeded in 2030. 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. There may be some regional limitations (see jurisdictional analysis). The infrastructure capacity assessment for this group 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 overestimate of capacity. Offsetting this is uncertainty about the amount of CSG industry wastes that will actually leave the development site and be sent to CPT facilities.
Clinical waste fac. (T)	26	High	20 to 22	2026	2020	>2034	Based on the current industry projection of arisings increasing at the rate 1.9% per annum and the potential capacity of clinical waste treatment – capacity could be exceeded by 2026. Based on the high projection, where arisings increase at 3.9% per annum, national capacity could be exceeded in 2020. Under the low scenario where growth is below the current industry projection (-0.1% per annum) national capacity is projected to meet demand over the next 20 years. The infrastructure capacity assessment for this group has high uncertainty due to a poor response rate from industry and capacity overlap with the thermal destruction infrastructure (resulting in a likely under estimate of the infrastructure group capacity).
Soils treatment fac.	185	Moderate	20 to 59	>2034	>2034	>2034	Analysis indicates that under all scenarios over the next 20 years the potential capacity of Australia's current and planned contaminated soils treatment infrastructure will be able to treat waste arisings.

Infrastructure group	Potential capacity (kt/yr.)	Capacity estimate uncertainty (low - v. high)	Estimated arisings in 2015 (kt)	Est. year arisings > capacity Best	High	Low	Assessment discussion and recommendations
							There may be some regional limitations (see jurisdictional analysis). Importantly, these estimates assume no change in the current fate patterns of contaminated soil, which is mostly sent landfill. Landfill bans on contaminated soils would significantly change these estimates. No jurisdiction noted any intention to ban soils from landfill during consultation. The infrastructure capacity assessment for this group has moderate uncertainty due to a moderate response rate during consultation, capacity overlap with POPs thermal destruction infrastructure, and diffuse soil treatment technologies including some 'mobile' capacity.
Disposal: landfill, thermal destruction (TD)							
Hazwaste landfill fac.	274	High	284 to 308	2015	2015	2015	This capacity assessment examined hazardous waste landfills' ability to accept annual arisings of wastes – 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. The seven hazardous waste landfills surveyed for this project reported an annual capacity that modelling indicates is constrained under all scenarios. For all three scenarios, declines are projected for 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 the Oil and Gas (GSG) industry developments. We believe the modelling assessment for this infrastructure group is incorrect. The response rate from site operators was only 43%, meaning infrastructure group averages were used, and generally the responses provided data only on wastes currently received with little information on the potential annual acceptance rate. This is understandable as, unlike other infrastructure types, landfills are usually able to cater to varying capacity demands (within reason) and a site's potential annual capacity can be difficult to define. Perhaps more important than the above analysis are industry comments regarding the expected life of the landfill sites. As discussed in note 2 below, this is not the same as the potential capacity estimates analysed above. Landfill operators were asked how much waste could be received at the site before the sites 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. None of the sites surveyed in this category responded with a definitive response of planned closure within the

Infrastructure group	Potential capacity (kt/yr.)	Capacity estimate uncertainty (low - v. high)	Estimated arisings in 2015 (kt)	Est. year arisings > capacity			Assessment discussion and recommendations
				Best	High	Low	
							new 20 years. However, responses were generally vague on this issue 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 difficultly 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. It is recommended that DoE 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.
Landfill fac. (NEPM code N, T). Landfill facilities that are generally only licensed to dispose low level contaminated soils, asbestos, and tyres (NEPM 15 codes N and T).	761	Na (out of scope)	1176 to 3580	2015	2015	2015	This infrastructure group is not in the scope of hazardous waste database (see Section 3.2). The 27 sites included in the capacity estimate provided adjacent appear to be included in error. As discussed in Section 3.2, a significant number of landfills are licensed to take hazardous wastes only in NEPM codes N and T that are not included in the infrastructure database. For example, 16 of the 27 landfill in this category are in Victoria and zero landfills in the category are identified in NSW. The infrastructure database therefore represents an unknown portion of total capacity for these materials. To complete a quantitative analysis of projected arisings of NEPM code N and T wastes versus 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 wastes as part of much larger non-hazardous waste volume. 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. There may be some regional limitations (see jurisdictional analysis).
POPs fac. (TD) Contains company specific information	[redacted]	Very high	2.5 to 5	2015	2015	2015	The projections for POPs are more complex than any other projection group and are detailed in Appendix 5. [redacted] Whilst this may identify a gap in Australia's POPs thermal destruction capacity, the capacity assessment

Infrastructure group	Potential capacity (kt/yr.)	Capacity estimate uncertainty (low - v. high)	Estimated arisings in 2015_(kt)	Est. year arisings > capacity			Assessment discussion and recommendations
				Best	High	Low	
							uncertainty for this group is very high. The following three issues need to be considered that will all result in an under estimate of the POPs destruction capacity: **1. POPs TD capacity within Clinical waste TD facilities.** SteriHealth currently have a research and development approval that allows them to treat PCB contaminated oil from the Tullamarine landfill leachate at their Clinical waste TD facility in Laverton, Melbourne. SteriHealth aims to provide POPs destruction services to the market following works approval from EPA. SteriHealth did not state the potential tonnages of POPs that could be destroyed at the facility. TPI (2014) stated that SteriHealth recently successfully treated around 2000 litres of PCB contaminated oil during trials at the site. **2. POPs TD capacity within Soils treatment facilities.** The RENEX pyrolysis rotary kiln that is being commissioned in Dandenong Melbourne will be aiming to treat POPs contaminated soils and liquids. The kiln with operate at 600 degrees C and the gases will then be incinerated at 1100-1200 degrees C, enabling the destruction of chlorinated organics such as PCBs. Renex have stated a potential capacity of [redacted], however, it is unknown what tonnage of POP contaminated soils and liquids could be processed at the plant. **3. POPs TD capacity within cement kilns.** Cement kiln infrastructure is not included in the capacity database scope. We understand that cement kilns in Australia are currently destroying some POPs including PFOS. The capacity of Australia's cement kilns to destroy POPs needs detailed assessment to enable a comparison of arisings to destruction capacity. Until this assessment is completed any analysis of additional capacity that is required under any of the projection scenarios will be inaccurate. It is recommended that DoE follow-up with sites included in infrastructure groups flagged as having some POPs destruction capacity to better determine the potential POPs destruction capacity of each site.
Clinical waste fac. (TD)	30	Low	25 to 26	2024	2019	>2034	Based on the industry projections of arisings increasing at 1.9% per annum, the current and planned national capacity for thermal destruction of clinical waste could be exceeded by 2024. Under the high projection, with arisings increasing at 3.9% per annum, capacity could be exceeded in 2019. Under the low scenario capacity meets demand over the next 20 years. There may be some regional exceptions/limitations (see jurisdictional analysis).
Transfer station or temporary storage fac.	335	Very high	608 to 809	2015	2015	2015	Projections indicate that under all scenarios the current national transfer/temporary storage capacity of hazardous waste infrastructure is exceeded. We do not believe these projections are accurate due mainly to the capacity database having limited coverage of this group. Rawtec (2014 p.8) states the following

Infrastructure group	Potential capacity (kt/yr.)	Capacity estimate uncertainty (low - v. high)	Estimated arisings in 2015 (kt)	Est. year arisings > capacity Best	High	Low	Assessment discussion and recommendations
							regarding the scope of this infrastructure group: "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". This infrastructure group is also not the focus of this project. 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 seven of the 43 transfer station facilities in the database. For such a large state this appears low when compared with Vic, for example, with eight transfer sites. 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 wastes from a range of waste companies and generators should be explored for WA and potentially Qld (to reduce costs of CGS waste transport). It is recommended that DoE and/or WA and Qld state 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.

Notes:

1. Analysis assumes that the current national average proportions of fate (i.e. how much is recovered, disposed) remain static. This limits the quantitate 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 'potential 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 potential capacity is exceeded, it indicates that the landfill/s would need to increase capabilities to dispose more waste each year. This may require amendment to the sites EPA licence.

4.4 Jurisdictional assessment by waste groups

An assessment of potential capacity in each jurisdiction against estimated wastes arising is given in the tables overleaf Table 59 to Table 66. Each table includes the following for each infrastructure group:

- the potential capacity of the infrastructure included in the group
- the estimated 2015 arisings assumed to be sent to each infrastructure group
- the year in which estimated waste arisings exceed estimated capacity under best, high and low estimates
- a discussion.

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.

Limitations of using national average fate proportions for hazardous wastes

The uncertainty in the assumed fate proportions and mapping to infrastructure, discussed in 4.2, is particularly important for the jurisdictional assessment. The fate proportions of 2012-13 waste arisings have been determined from jurisdictional tracking system data for NSW, Qld and Vic only and are included Figure 36 to Figure 38 (above). The national average of the fate proportions is assumed to be the combined weighted average of the NSW, Qld and Vic fate proportions. Table 55 (in Section 4.2) shows the national average fate proportions mapped to the infrastructure groups likely to receive the waste. For the ACT, NT, SA, Tas and WA, the weighted average proportions shown in Table 43 were applied to the estimated arisings data for the jurisdiction.

In reality, waste in the ACT, NT, SA, Tas and WA may be managed in a different suite of infrastructure. We note, for example, that Table 63 shows that in SA in 2015 an estimated tonnage of 2.2kt of clinical waste is sent to thermal destruction based on the estimated national average proportions (see Table 55). The current potential capacity of thermal destruction infrastructure for clinical waste in SA is 1kt/yr. Industry has commented that current capacity is underutilised. The numerical assessment that clinical waste thermal destruction capacity is oversupplied in SA is incorrect, suggesting that the proportion of clinical waste sent to thermal destruction is lower than the national average value.

It is recommended that DoE should work with the jurisdictions to improve hazardous waste tracking system data and ensure that the fate proportions of hazardous wastes can be derived from the tracking system data.

Assessment of NEPM data for net interstate movements of hazardous wastes

The NEPM data is published in *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 41 and Table 58 show the NEPM data for the 2012-13 period for each jurisdiction, illustrating firstly the total imports and exports, then the net imports/exports by NEPM 15 waste code. The NEPM 2012-13 data for each jurisdiction is discussed in each of the jurisdictions' tables that follow.

Figure 41: NEPM 2012-13 total imports and exports by jurisdiction

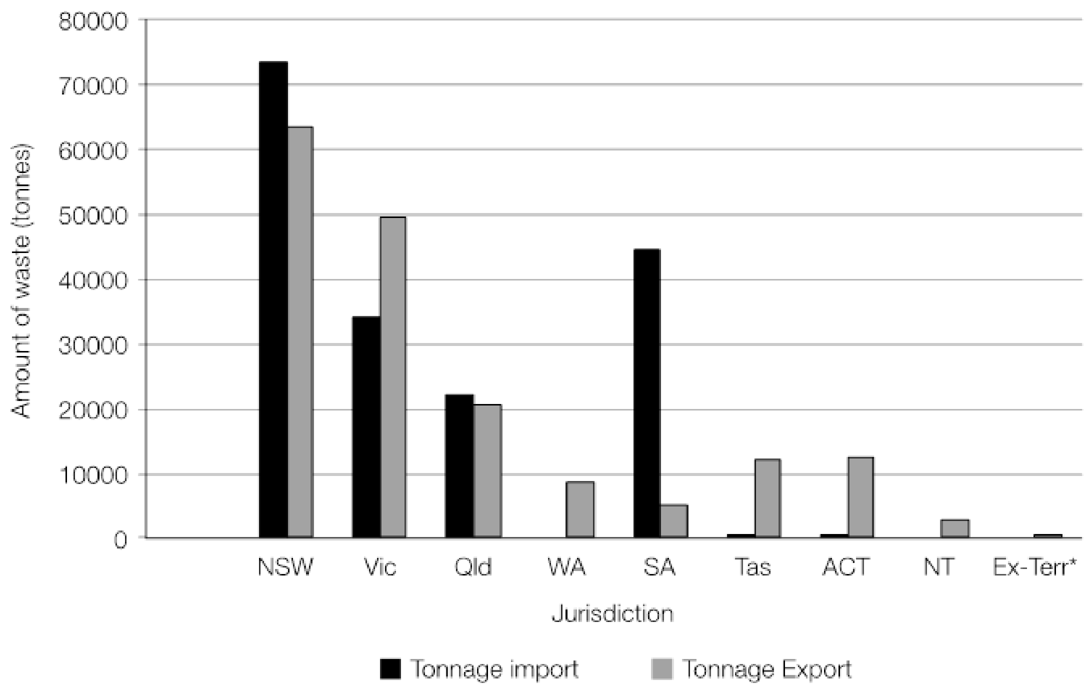


Table 58: NEPM 2012-13 net imports/exports by jurisdiction and NEMP 15 code

		Net imports/exports (tonnes) (negative values are net imports)							
Code	**Description**	**NSW**	**Vic**	**Qld**	**WA**	**SA**	**Tas**	**ACT**	**NT**
A	Plating & heat treatment	22	-46	-87	0	-1	112	0	0
B	Acids	-7,268	7,526	-269	44	-78	-8	1	52
C	Alkalis	-552	328	-97	23	-124	0	246	177
D	Inorganic chemicals	-6,613	9,720	11,251	5,782	-31,846	11,140	258	308
E	Reactive chemicals	13	-3	-13	5	-2	0	0	0
F	Paints, resins, inks organic sludge	-459	2,066	232	755	-2,910	2	182	131
G	Organic solvents	1,500	-1,211	-363	532	-796	273	64	0
H	Pesticides	730	-1,071	30	261	46	0	1	4
J	Oils	4,145	-2,725	-2,743	904	-3,763	168	2,179	1,835
K	Putrescible/organic waste	-3,201	-549	-2,035	0	185	0	5,600	0
L	Industrial washwater	299	-514	215	0	0	0	0	0
M	Organic chemicals	-530	-26	200	116	3	41	41	154
N	Soil/sludge	2,100	2,405	-7,023	214	79	197	1,964	64
R	Clinical & pharmaceutical	434	-536	-238	27	52	44	77	139
T	Misc.	-548	34	-918	31	-99	11	1,407	81
	TOTAL (t)	**-9,928**	**15,399**	**-1,858**	**8,696**	**-39,253**	**11,981**	**12,018**	**2,945**
(yellow)	Net tonnage waste imported								
(green)	Net tonnage exported								

Table 59: ACT assessment of projected arisings vs. infrastructure capacity

Infrastructure group	ACT				
	Potential capacity (kt)	2015 best est. arisings (kt)	Best	High	Low
Recovery: recycling and energy recovery (ER)					
Hazwaste packaging fac.	[redacted]	0.001	No state inf.	No state inf.	No state inf.
E-waste fac.	[redacted]	0.2	>2034	>2034	>2034
Oil re-refining fac.	[redacted]	1.9	No state inf.	No state inf.	No state inf.
Lead fac.	[redacted]	0.2	No state inf.	No state inf.	No state inf.
Mercury fac.	[redacted]	0.002	No state inf.	No state inf.	No state inf.
Solvents/paints fac.	[redacted]	0.1	No state inf.	No state inf.	No state inf.
Solvents/paints fac. (ER)	[redacted]	0.01	No state inf.	No state inf.	No state inf.
Spent pot lining fac.	[redacted]	0	No state inf.	No state inf.	No state inf.
Organics fac. (NEPM code K wastes)	[redacted]	3	No state inf.	No state inf.	No state inf.
Treatment	[redacted]				
CPT plant	[redacted]	2.1	No state inf.	No state inf.	No state inf.
Clinical waste fac. (T)	[redacted]	0.2	>2034	>2034	>2034
Soils treatment fac.	[redacted]	0.1	No state inf.	No state inf.	No state inf.
Disposal: landfill, thermal destruction (TD)	[redacted]				
Hazwaste landfill fac.	[redacted]	0.3	No state inf.	No state inf.	No state inf.
Landfill fac. (NEPM code N, T)	[redacted]	24	>2034	2015	>2034
POPs fac. (TD)	[redacted]	0.06	No state inf.	No state inf.	No state inf.
Clinical waste fac. (TD)	[redacted]	0.2	No state inf.	No state inf.	No state inf.
Transfer station or temporary storage fac.	[redacted]	2.7	2015	2015	>2034
Total net Landfill fac. (NEPM code N, T)		11			
NEPM 12-13 net imp./exp. (kt)	12 (export)				
Discussion	The above assessment indicates the following regarding hazwaste recovery, treatment, disposal and transfer infrastructure in the ACT. **Recovery** - Hazwaste packaging, oils (for re-refining), lead, mercury, solvents, and organics wastes are all sent interstate for recovery. - E-waste infrastructure capacity is likely to be sufficient under all scenarios. **Treatment** - Waste requiring CPT and contaminated soils are sent interstate for treatment. - Clinical waste treatment infrastructure capacity is likely to be sufficient under all scenarios. **Disposal (landfill and thermal destruction)** - Hazardous wastes apart from NEPM codes N and T (asbestos, tyres, and low level contaminated soils) are likely landfilled interstate. - Clinical waste are likely sent interstate for destruction where required. - POPs (PFOS, BDEs, HBCD, HCB) will be sent interstate for destruction where required. **Transfer station or temporary storage** - Capacity estimates are incomplete due to limited infrastructure coverage and some capacity being provided within other infrastructure groups. **NEPM 2012-13** data indicates that the bulk of the estimated 11 kt of waste arisings in 2015 (net of what is managed at Landfill fac. (NEPM code N,T i.e. asbestos, tyres, low level cont. soils) is exported to other jurisdictions for management. **'Mr Fluffy' Asbestos waste:** Landfill fac. (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.				
Notes:	*Estimates of arisings are based on the national average fate proportions (i.e. the average of how much goes to recycling, energy recovery, landfill, etc.) This increases uncertainty as proportions of fate can vary significantly across jurisdictions. National average used because either the waste are not tracked in the jurisdiction or no fate data was available in the jurisdiction.*				

Table 60: NSW assessment of projected arisings vs. infrastructure capacity

Infrastructure group	NSW				
	Potential capacity (kt)	2015 best est. arisings (kt)	Best	High	Low
Recovery: recycling and energy recovery (ER)					
Hazwaste packaging fac.	[redacted]	6	>2034	2019	>2034
E-waste fac.	[redacted]	3	>2034	>2034	>2034
Oil re-refining fac.	[redacted]	113	>2034	2021	>2034
Lead fac.	[redacted]	52	>2034	>2034	>2034
Mercury fac.	[redacted]	0.2	2015	2015	2015
Solvents/paints fac.	[redacted]	1	>2034	>2034	>2034
Solvents/paints fac. (ER)	[redacted]	3.13	No state inf.	No state inf.	No state inf.
Spent pot lining fac.	[redacted]	0	>2034	>2034	>2034
Organics fac. (NEPM code K wastes)	[redacted]	139	2019	2017	2034
Treatment	[redacted]				
CPT plant	[redacted]	151	>2034	>2034	>2034
Clinical waste fac. (T)	[redacted]	7	2015	2015	2015
Soils treatment fac.	[redacted]	16	>2034	>2034	>2034
Disposal: landfill, thermal destruction (TD)	[redacted]				
Hazwaste landfill fac.	[redacted]	52	2015	2015	2015
Landfill fac. (NEPM code N, T)	[redacted]	1112	No state inf.	No state inf.	No state inf.
POPs fac. (TD)	[redacted]	1	No state inf.	No state inf.	No state inf.
Clinical waste fac. (TD)	[redacted]	8	2015	2015	2015
Transfer station or temporary storage fac.	[redacted]	130	2015	2015	2015
Total net Landfill fac. (NEPM code N, T)		681			
NEPM 12-13 net imp./exp. (kt)	10 (import)				
Discussion	The above assessment indicates the following regarding hazwaste recovery, treatment, disposal and transfer infrastructure in NSW. **Recovery** - E-waste, Lead, Solvents/paints, SPL, and Organics recycling infrastructure capacity is likely to be sufficient. - Hazwaste packaging recycling capacity is likely to be sufficient. The capacity exceedance under the high scenario is inaccurate and is due waste group (Other N soil/sludges) including a increase in fly ash from energy from waste facilities in 2019 (see Section 2.6). - Oil (re-refining) capacity is likely to be sufficient under best and low scenarios, however, could be met by 2021 under the high scenario due to 10%pa projected growth in waste oils in Qld/WA. - Mercury and solvent/paints waste (sent to energy recovery) are likely sent interstate. **Treatment** - CPT plant capacity is likely to be sufficient and this includes CSG mining industry wastes growing very strongly and some volumes being sent offsite to CPT plants. - Clinical waste treatment capacities could be constrained and these wastes are likely being sent interstate. NEPM 2012-13 data for clinical waste (R codes) confirms net exports from NSW to other jurisdictions. - Contaminated soils treatment capacity could be sufficient, however, as flagged this is based on the national average fate proportions and may be inaccurate. **Disposal (landfill and thermal destruction)** - Hazwaste landfill could be have insufficient annual hazwaste landfill disposal capacity currently. However the arisings to Hazwaste landfill are impacted by national fate proportions and hence may be inaccurate. - POPs (PFOS, BDEs, HBCD, HCB) will be sent interstate for thermal destruction where required. - Clinical waste TD capacity could be currently constrained, assuming the national average fate proportions for NSW as clinical waste is not tracked in NSW. **Transfer station or temporary storage** - Capacity estimates are incomplete due to limited infrastructure coverage and some capacity being provided within other infrastructure groups. **NEPM 2012-13** data indicates that NSW is a net importer of hazardous wastes, however, NSW exports significant amounts of organics solvents, pesticides, oils, soils, and clinical wastes to other jurisdictions.				
Notes:	*Estimates of arisings are based on the national average fate proportions (i.e. the average of how much goes to recycling, energy recovery, landfill, etc.) This increases uncertainty as proportions of fate can vary significantly across jurisdictions. National average used because either the waste are not tracked in the jurisdiction or no fate data was available in the jurisdiction.*				

Table 61: NT assessment of projected arisings vs. infrastructure capacity

Infrastructure group	NT				
	Potential capacity (kt)	2015 best est. arisings (kt)	Best	High	Low
Recovery: recycling and energy recovery (ER)					
Hazwaste packaging fac.	[redacted]	0.003	>2034	>2034	>2034
E-waste fac.	[redacted]	0.1	No state inf.	No state inf.	No state inf.
Oil re-refining fac.	[redacted]	0.5	No state inf.	No state inf.	No state inf.
Lead fac.	[redacted]	0.4	No state inf.	No state inf.	No state inf.
Mercury fac.	[redacted]	0.003	No state inf.	No state inf.	No state inf.
Solvents/paints fac.	[redacted]	0.01	No state inf.	No state inf.	No state inf.
Solvents/paints fac. (ER)	[redacted]	0.1	No state inf.	No state inf.	No state inf.
Spent pot lining fac.	[redacted]	0	No state inf.	No state inf.	No state inf.
Organics fac. (NEPM code K wastes)	[redacted]	5	No state inf.	No state inf.	No state inf.
Treatment	[redacted]				
CPT plant	[redacted]	2	2015	2015	2015
Clinical waste fac. (T)	[redacted]	0.04	>2034	>2034	>2034
Soils treatment fac.	[redacted]	0.4	No state inf.	No state inf.	No state inf.
Disposal: landfill, thermal destruction (TD)	[redacted]				
Hazwaste landfill fac.	[redacted]	0.3	>2034	>2034	>2034
Landfill fac. (NEPM code N, T)	[redacted]	20	No state inf.	No state inf.	No state inf.
POPs fac. (TD)	[redacted]	0.04	No state inf.	No state inf.	No state inf.
Clinical waste fac. (TD)	[redacted]	0.05	No state inf.	No state inf.	No state inf.
Transfer station or temporary storage fac.	[redacted]	3	>2034	>2034	>2034
Total net Landfill fac. (NEPM code N, T)		11			
NEPM 12-13 net imp./exp. (kt)	3 (export)				

Discussion

The above assessment indicates the following regarding hazwaste recovery, treatment, disposal and transfer infrastructure in the NT.

Recovery

- Hazwaste Packaging infrastructure capacity is likely to be sufficient under all scenarios.
- All other recovery occurs interstate or at sites not covered or missing from the hazwaste infrastructure database.

Treatment

- CPT plant and Contaminated soils treatment infrastructure could be currently constrained (this assessment is based on the national average of the percentage of arisings sent to treatment).
- Clinical waste treatment infrastructure capacity is likely to be sufficient under all scenarios.

Disposal (landfill and thermal destruction)

- Hazwaste landfill has sufficient <u>annual</u> disposal capacity over the projection period. Note, this does not mean that the landfill has over 20 years life remaining.
- POPs (PFOS, BDEs, HBCD, HCB) will be sent interstate for thermal destruction where required.
- Clinical waste are sent interstate for destruction where required.

Transfer station or temporary storage

- Capacity is likely to be sufficient under all scenarios.

NEPM 2012-13 data indicates that around 3kt (of the estimated 11kt of arisings in 2015) is exported to other jurisdictions and NT imports no hazardous waste. This suggests that some of the remaining 8kt of estimated waste arisings are managed by sites not covered/missing from the hazwaste infrastructure database.

Notes: *Estimates of arisings are based on the national average fate proportions (i.e. the average of how much goes to recycling, energy recovery, landfill, etc.) This increases uncertainty as proportions of fate can vary significantly across jurisdictions. National average used because either the waste are not tracked in the jurisdiction or no fate data was available in the jurisdiction.*

Table 62: Qld assessment of projected arisings vs. infrastructure capacity

Infrastructure group	Qld				
	Potential capacity (kt)	2015 best est. arisings (kt)	Best	High	Low
Recovery: recycling and energy recovery (ER)					
Hazwaste packaging fac.	[redacted]	3	2015	2015	2015
E-waste fac.	[redacted]	2	>2034	2030	>2034
Oil re-refining fac.	[redacted]	150	2015	2015	2015
Lead fac.	[redacted]	4	No state inf.	No state inf.	No state inf.
Mercury fac.	[redacted]	0.04	No state inf.	No state inf.	No state inf.
Solvents/paints fac.	[redacted]	19	2015	2015	2015
Solvents/paints fac. (ER)	[redacted]	8	No state inf.	No state inf.	No state inf.
Spent pot lining fac.	[redacted]	0	No state inf.	No state inf.	No state inf.
Organics fac. (NEPM code K wastes)	[redacted]	124	No state inf.	No state inf.	No state inf.
Treatment	[redacted]				
CPT plant	[redacted]	248	2025	2022	>2034
Clinical waste fac. (T)	[redacted]	5	2015	2015	2015
Soils treatment fac.	[redacted]	9	>2034	2015	>2034
Disposal: landfill, thermal destruction (TD)	[redacted]				
Hazwaste landfill fac.	[redacted]	120	2015	2015	2015
Landfill fac. (NEPM code N, T)	[redacted]	442	2015	2015	2015
POPs fac. (TD)	[redacted]	1	2016	2016	>2034
Clinical waste fac. (TD)	[redacted]	12	2015	2015	2015
Transfer station or temporary storage fac.	[redacted]	342	2015	2015	2015
Total net Landfill fac. (NEPM code N, T)		1047			
NEPM 12-13 net imp./exp. (kt)	2 (import)				

Discussion

The above assessment indicates the following regarding hazwaste recovery, treatment, disposal and transfer infrastructure in Qld.

Recovery

- Hazwaste packaging infrastructure could be constrained currently.
- E-waste capacity is likely to be sufficient assuming no change in recovery rate.
- Oil re-refining capacity could be currently constrained locally. However, almost all of the transfer capacity in Qld is for waste oil before it is taken to a re-refining or another fate in Qld or interstate meaning that Qld should be able to manage waste oil arisings.
- Qld has very high recycling fate proportions for solvents/paints. Solvent/paints recycling capacity could be constrained locally. Another possibility is that a significant amount of the est. 19kt recycled are processed for energy recovery in infrastructure not included in the capacity database.
- Lead, mercury, SPL waste recycling occurs interstate.
- 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 12/13.

Treatment

- CPT plant capacity could be constrained by 2025 or by 2022 if mining industry wastes grow very strongly and some wastes are managed off-site at CPT plants.
- Clinical waste treatment capacity could be limited in Qld under all scenarios.
- Soils treatment capacity in Qld should be sufficient except under the high scenario.

Disposal (landfill and thermal destruction)

- Could have insufficient annual hazwaste landfill disposal capacity.
- POPs TD capacity could be constrained by 2016, for local wastes alone. See section 4.2 discussion of infrastructure group capacity overlap and POPs TD capacity within other infrastructure groups.
- Clinical waste TD capacity could be currently constrained locally.

NEPM 2012-13 data showed a net import of 2kt of hazwaste into Qld. Major imports were NEPM codes N Soils/sludge, J Oils and K Organic wastes. Major exports included D Inorganic chemicals (likely to be lead acid batteries and E-wastes).

Notes: *Estimates of arisings are based on the national average fate proportions (i.e. the average of how much goes to recycling, energy recovery, landfill, etc.) This increases uncertainty as proportions of fate can vary significantly across jurisdictions. National average used because either the waste are not tracked in the jurisdiction or no fate data was available in the jurisdiction.*

Table 63: SA assessment of projected arisings vs. infrastructure capacity

Infrastructure group	SA				
	Potential capacity (kt)	2015 best est. arisings (kt)	Best	High	Low
Recovery: recycling and energy recovery (ER)					
Hazwaste packaging fac.	[redacted]	0.3	>2034	>2034	>2034
E-waste fac.	[redacted]	6	>2034	>2034	>2034
Oil re-refining fac.	[redacted]	7	>2034	>2034	>2034
Lead fac.	[redacted]	82	No state inf.	No state inf.	No state inf.
Mercury fac.	[redacted]	0.01	No state inf.	No state inf.	No state inf.
Solvents/paints fac.	[redacted]	1	No state inf.	No state inf.	No state inf.
Solvents/paints fac. (ER)	[redacted]	1	No state inf.	No state inf.	No state inf.
Spent pot lining fac.	[redacted]	0	No state inf.	No state inf.	No state inf.
Organics fac. (NEPM code K wastes)	[redacted]	31	No state inf.	No state inf.	No state inf.
Treatment	[redacted]				
CPT plant	[redacted]	99	2015	2015	2015
Clinical waste fac. (T)	[redacted]	2	>2034	2025	>2034
Soils treatment fac.	[redacted]	4	No state inf.	No state inf.	No state inf.
Disposal: landfill, thermal destruction (TD)	[redacted]				
Hazwaste landfill fac.	[redacted]	46	No state inf.	No state inf.	No state inf.
Landfill fac. (NEPM code N, T)	[redacted]	154	2015	2015	2015
POPs fac. (TD)	[redacted]	0.2	No state inf.	No state inf.	No state inf.
Clinical waste fac. (TD)	[redacted]	2.2	2015	2015	2015
Transfer station or temporary storage fac.	[redacted]	49	2015	2015	2015
Total net Landfill fac. (NEPM code N, T)		330			
NEPM 12-13 net imp./exp. (kt)	39 (import)				
Discussion	The above assessment indicates the following regarding hazwaste recovery, treatment, disposal and transfer infrastructure in SA. **Recovery** - Hazwaste packaging , Oil re-refining, and E-waste recycling capacity is likely to be sufficient for projection period. SA imports significant tonnages of E-waste, if national targets for E-waste recycling are changed, SA E-waste capacity could become constrained more quickly than above. - Mercury, and organics wastes are likely being sent interstate. - Lead waste is likely being managed in part by the E-waste infrastructure group and in part by capacity that is not included in the capacity database. - Solvents/paints infrastructure capacity may be missing from the database or capacity is provided by SA's CPT facilities. NEPM 2012-13 data indicates SA is a net importer of solvents/paints wastes. - Organics fac. infrastructure capacity also appears to be incomplete. **Treatment** - CPT plant waste capacity could be constrained currently, however, this is based on the national average of the percentage of arisings sent to CPT for treatment. - Clinical waste treatment facility capacity could be constrained by 2033 or by 2024 if clinical and pharmaceutical wastes increase strongly over the projection period. **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. - Clinical TD capacity is flagged above as currently constrained. <u>This is incorrect</u> and likely to be the result of having to assume the national average for the percentage of clinical waste arisings that are sent for destruction. Industry have commented that there is <u>spare capacity</u> for clinical waste thermal destruction in SA. This indicates that in SA less than the national average of clinical wastes are being destroyed (i.e. wastes are sent to other infrastructure or interstate). - POPs (PFOS, BDEs, HBCD, HCB) will be sent interstate for thermal destruction where required. **Transfer station or temporary storage** - Capacity estimates are incomplete due to limited infrastructure coverage and some capacity being provided within other infrastructure groups. **NEPM 2012-13** showed a net import of 39kt of hazwaste into SA. The main imports were NEPM D Inorganic chemicals (includes E-waste), and some F Paints, resins and J Oils.					
Notes:	*Estimates of arisings are based on the national average fate proportions (i.e. the average of how much goes to recycling, energy recovery, landfill, etc.) This increases uncertainty as proportions of fate can vary significantly across jurisdictions. National average used because either the waste are not tracked in the jurisdiction or no fate data was available in the jurisdiction.*				

Table 64: Tas assessment of projected arisings vs. infrastructure capacity

Infrastructure group	Tas				
	Potential capacity (kt)	2015 best est. arisings (kt)	Best	High	Low
Recovery: recycling and energy recovery (ER)					
Hazwaste packaging fac.	[redacted]	0.001	>2034	>2034	>2034
E-waste fac.	[redacted]	8	No state inf.	No state inf.	No state inf.
Oil re-refining fac.	[redacted]	0.2	>2034	>2034	>2034
Lead fac.	[redacted]	9	No state inf.	No state inf.	No state inf.
Mercury fac.	[redacted]	0.000002	No state inf.	No state inf.	No state inf.
Solvents/paints fac.	[redacted]	0.2	No state inf.	No state inf.	No state inf.
Solvents/paints fac. (ER)	[redacted]	0.2	No state inf.	No state inf.	No state inf.
Spent pot lining fac.	[redacted]	0	No state inf.	No state inf.	No state inf.
Organics fac. (NEPM code K wastes)	[redacted]	10	No state inf.	No state inf.	No state inf.
Treatment	[redacted]				
CPT plant	[redacted]	66	2015	2015	2015
Clinical waste fac. (T)	[redacted]	0.01	No state inf.	No state inf.	No state inf.
Soils treatment fac.	[redacted]	0.004	No state inf.	No state inf.	No state inf.
Disposal: landfill, thermal destruction (TD)	[redacted]				
Hazwaste landfill fac.	[redacted]	33	2015	2015	2015
Landfill fac. (NEPM code N, T)	[redacted]	21	No state inf.	No state inf.	No state inf.
POPs fac. (TD)	[redacted]	0.08	No state inf.	No state inf.	No state inf.
Clinical waste fac. (TD)	[redacted]	0.01	No state inf.	No state inf.	No state inf.
Transfer station or temporary storage fac.	[redacted]	12	>2034	>2034	>2034
Total net Landfill fac. (NEPM code N, T)		138			
NEPM 12-13 net imp./exp. (kt)	12 (export)				
Discussion	The above assessment indicates the following regarding hazwaste recovery, treatment, disposal and transfer infrastructure in Tas. **Recovery** - Hazwaste packaging , Oil re-refining, capacity is likely to be sufficient. - E-waste, lead, mercury, and solvents/paint wastes are likely sent interstate. - Organics waste infrastructure is likely missing from database due to limited coverage. NEPM 2012-13 data indicates organics are not exported interstate for management. **Treatment** - 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 [redacted] of capacity identified, an estimated arisings of 68kt and a total net export to the mainland in NEPM 2012/13 data of 12 kt, it does indicate that Tas could have the need for additional CPT capacity. - Clinical waste likely to be sent interstate for treatment. **Disposal (landfill and thermal destruction)** - Hazwaste landfill could be constrained currently for <u>annual</u> disposal capacity. - POPs (PFOS, BDEs, HBCD, HCB) will be sent interstate for thermal destruction where required. - Clinical waste likely to be sent interstate for thermal destruction where required. **Transfer station or temporary storage** - Capacity is sufficient under all scenarios, however, this is based on national average of the percentage of arisings sent to transfer or temporary storage. Tas is likely to have a higher percentage of wastes transferred than the national average. **NEPM 2012-13** showed a net export of 12kt of hazwaste from Tas. This is to be mostly NEPM code D wastes.				
Notes:	*Estimates of arisings are based on the national average fate proportions (i.e. the average of how much goes to recycling, energy recovery, landfill, etc.) This increases uncertainty as proportions of fate can vary significantly across jurisdictions. National average used because either the waste are not tracked in the jurisdiction or no fate data was available in the jurisdiction.*				

Table 65: Vic assessment of projected arisings vs. infrastructure capacity

Infrastructure group	Vic				
	Potential capacity (kt)	2015 best est. arisings (kt)	Best	High	Low
Recovery: recycling and energy recovery (ER)					
Hazwaste packaging fac.	[redacted]	2	>2034	>2034	>2034
E-waste fac.	[redacted]	3	>2034	>2034	>2034
Oil re-refining fac.	[redacted]	59	>2034	>2034	>2034
Lead fac.	[redacted]	0	No state inf.	No state inf.	No state inf.
Mercury fac.	[redacted]	0.00001	>2034	>2034	>2034
Solvents/paints fac.	[redacted]	7	2015	2015	2015
Solvents/paints fac. (ER)	[redacted]	0.5	>2034	>2034	>2034
Spent pot lining fac.	[redacted]	0	>2034	>2034	>2034
Organics fac. (NEPM code K wastes)	[redacted]	86	2029	2023	>2034
Treatment	[redacted]				
CPT plant	[redacted]	59	>2034	>2034	>2034
Clinical waste fac. (T)	[redacted]	6	2033	2024	>2034
Soils treatment fac.	[redacted]	9	>2034	>2034	>2034
Disposal: landfill, thermal destruction (TD)	[redacted]				
Hazwaste landfill fac.	[redacted]	23	>2034	>2034	>2034
Landfill fac. (NEPM code N, T)	[redacted]	458	>2034	2015	>2034
POPs fac. (TD)	[redacted]	1	No state inf.	No state inf.	No state inf.
Clinical waste fac. (TD)	[redacted]	2	>2034	>2034	>2034
Transfer station or temporary storage fac.	[redacted]	67	>2034	2024	>2034
Total net Landfill fac. (NEPM code N, T)		324			
NEPM 12-13 net imp./exp. (kt)	15 (export)				
Discussion	The above assessment indicates the following regarding hazwaste recovery, treatment, disposal and transfer infrastructure in Vic. **Recovery** - Hazwaste packaging , E-waste, Oil re-refining, Mercury, Solvents/paints ER, and SPL recovery infrastructure is likely to be sufficient. - Lead wastes are likely to be sent interstate to SA or NSW for recycling. - Organics infrastructure capacity could be constrained by 2023, however, capacity data is has only limited coverage in the database. **Treatment** - CPT plant and Soil treatment capacity is likely to be sufficient. - Clinical waste treatment capacity could be constrained by 2033 or 2024 if clinical waste grows strongly. **Disposal (landfill and thermal destruction)** - Hazwaste landfill facility annual disposal capacity over projection period should be sufficient. - POPs (PFOS, BDEs, HBCD, HCB) will be sent interstate for thermal destruction where required. - Clinical waste TD capacity should be sufficient for projection period. **Transfer station or temporary storage** - Transfer and temporary storage capacity should be sufficient under all scenarios. Under the high scenario capacity could be met by 2024, however, given that the capacity of this infrastructure group has only limited coverage and significant 'overlap' the capacity is likely higher and would not be met before 2034. **NEPM 2012-13** showed a net exports of 15kt. Main exports included NEPM group B Acids and D Inorganic chemicals. Main imports included NEPM J Oils and significant tonnages of H Pesticides.				
Notes:	*Estimates of arisings are based on the national average fate proportions (i.e. the average of how much goes to recycling, energy recovery, landfill, etc.) This increases uncertainty as proportions of fate can vary significantly across jurisdictions. National average used because either the waste are not tracked in the jurisdiction or no fate data was available in the jurisdiction.*				

Table 66: WA assessment of projected arisings vs. infrastructure capacity

Infrastructure group	WA				
	Potential capacity (kt)	2015 best est. arisings (kt)	Best	High	Low
Recovery: recycling and energy recovery (ER)					
Hazwaste packaging fac.	[redacted]	1	>2034	2020	>2034
E-waste fac.		1	No state inf.	No state inf.	No state inf.
Oil re-refining fac.		128	2027	2024	>2034
Lead fac.		0.2	>2034	>2034	>2034
Mercury fac.		0.01	No state inf.	No state inf.	No state inf.
Solvents/paints fac.		4	2015	2015	2015
Solvents/paints fac. (ER)		1	No state inf.	No state inf.	No state inf.
Spent pot lining fac.		0	No state inf.	No state inf.	No state inf.
Organics fac. (NEPM code K wastes)		40	No state inf.	No state inf.	No state inf.
Treatment					
CPT plant		79	>2034	>2034	>2034
Clinical waste fac. (T)		1	>2034	>2034	>2034
Soils treatment fac.		0.10	>2034	>2034	>2034
Disposal: landfill, thermal destruction (TD)					
Hazwaste landfill fac.		24	>2034	2032	>2034
Landfill fac. (NEPM code N, T)		108	2015	2015	2019
POPs fac. (TD)		0.4	No state inf.	No state inf.	No state inf.
Clinical waste fac. (TD)		1	>2034	>2034	>2034
Transfer station or temporary storage fac.		116	2015	2015	2015
Total net Landfill fac. (NEPM code N, T)		396			
NEPM 12-13 net imp./exp. (kt)	9 (export)				
Discussion	The above assessment indicates the following regarding hazwaste recovery, treatment, disposal and transfer infrastructure in WA. **Recovery** - Hazwaste packaging capacity is likely to be sufficient under all scenarios. - Lead recycling capacity is sufficient under all scenarios. Note: the 2015 arisings for lead are based on WA tracking system data, however, they appear to be very low and this assessment has high uncertainty. - E-waste, mercury, solvents/paints wastes are likely sent interstate for recycling. - Oil re-refining capacity could be constrained by 2027 or 2024 if mining sector grows very strongly. **Treatment** - CPT plant, Clinical waste treatment and Soils treatment capacity should be sufficient across projection period. **Disposal (landfill and thermal destruction)** - Hazwaste landfill annual disposal capacity should be sufficient across the projection period. - POPs (PFOS, BDEs, HBCD, HCB) will be sent interstate for thermal destruction where required. - Clinical waste TD capacity should be sufficient over projection period. **Transfer station or temporary storage** - Capacity estimates are incomplete due to limited infrastructure coverage and some capacity being provided within other infrastructure groups. **NEPM 2012-13** showed a net exports of 9kt with the main export being NEPM code D Inorganic chemicals.				
Notes:	*Estimates of arisings are based on the national average fate proportions (i.e. the average of how much goes to recycling, energy recovery, landfill, etc.) This increases uncertainty as proportions of fate can vary significantly across jurisdictions. National average used because either the waste are not tracked in the jurisdiction or no fate data was available in the jurisdiction.*				

5. Conclusions and recommendations

5.1 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 difficult to characterise, changeable 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, which are given below, should be taken as indicative. The various dimensions of the uncertainty included in the assessment are discussed in detail in Section 4.

Recommendation 1: DoE should work with the jurisdictions to improve hazardous waste tracking system data so that fate is consistently recorded and categorised.

5.2 Hazwaste packaging recycling facilities

The national assessment indicates that under all scenarios over the next 20 years the potential capacity of Australia's current and planned hazardous waste packaging recycling infrastructure will be able to recycle waste arisings. The infrastructure capacity assessment for this group has moderate uncertainty due to a low response rate during consultation and the infrastructure group being highly diffuse increasing the probability of capacity not being included in the capacity database.

A shortfall in current capacity to recycle hazardous waste packaging is apparent in Qld. Contaminated containers are voluminous and cannot be cost-effectively transported. Some survey respondents commented on a broader need for improved recovery options for small hazardous waste packaging and small packages of waste hazardous goods, however, planned infrastructure included in the potential capacity should provide the capacity and coverage required.

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 potential capacity of Australia's current hazardous e-waste (major physical/chemical and manual disassembly processing) infrastructure will be able to recycle waste arisings. Capacity could become constrained by 2034 if e-waste arisings grow very strongly.

It must be noted that estimates assume no change to the current estimated proportions of fate of e-waste, which is mostly landfill. Changes to product stewardship agreements or landfill bans on e-waste would significantly change these estimates. The infrastructure capacity assessment for this group has moderate uncertainty due moderate response rate during consultation and the infrastructure group capacity having some overlap with other functions (such as PCB oil decontamination) resulting in a likely overestimate of the infrastructure group capacity.

A shortfall in current capacity to apparent in NT and WA. e-waste in these jurisdictions is likely sent interstate or is sent to landfill.

Lithium-ion batteries infrastructure

The potential arisings of lithium-ion batteries, which are not currently regulated as hazardous wastes, are assessed is this report due their potential to have a significant impact on hazardous and non-hazardous waste infrastructure. Waste lithium-ion batteries are projected to increase at an average growth rate of 12% 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).

Whilst this assessment does not indicate a shortfall in the overall e-waste processing capacity in Australia, at the time of writing there are no e-waste facilities with lithium-ion recycling capacity. All lithium-ion batteries that are recovered are 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 2: The potential hazards posed by lithium-ion batteries, and the best means of managing these hazards, needs further assessment. Following the assessment of hazard, assessment of the collection and processing infrastructure needs for lithium-ion batteries in Australia should be completed.

5.4 Oil re-refining facilities

At a national level, based on projected increases in waste oil arisings in Qld and WA (from the mining industry), the best estimate scenario projects that waste oil re-refining capacity in Australia could be exceeded in 2023 or by 2020 under the high scenario. Changes in the rates of growth of the mining industry in Qld and WA could have a significant impact on this assessment. Under a low arisings scenario (which includes Qld and WA arisings increasing at national rate of economic growth) waste oil re-refining capacity in Australia is likely to be sufficient beyond 2034.

The infrastructure capacity assessment for this group has moderate uncertainty due to the group's capacity having some overlap with the transfer station or temporary storage infrastructure group resulting in a potential overestimate of the infrastructure group capacity.

Offsetting the potential overestimation of this group’s capacity is the allocating of all NEPM J codes recycling tonnages to this group. Some of the J code 'recycling' tonnage is likely to be *J120 Waste oil/water, hydrocarbons/water mixtures or emulsions* that is taken to facilities that are filtering and dewatering only (not re-refining) resulting in an overestimate of the arisings of oils being sent to re-refining. In addition some waste oils ‘recycling’ may actually be sent for energy recovery which, again, would result in an overestimate of waste oil re-refining demand.

No re-refining capacity was identified in the ACT or NT, from which waste oils are likely transported interstate. Qld oil re-refining capacity could be currently constrained locally. However, almost all of the transfer station and temporary storage capacity in Qld is for waste oil prior to transport to re-refining or some alternative in Qld or interstate, suggesting that Qld should be able to manage waste oil arisings. WA’s oil re-refining capacity could be constrained by 2027 or 2024 if mining sector grows very strongly. Vic, NSW, SA, Tas oil re-refining capacity should be sufficient.

The Product Stewardship for Oil Program was introduced by the Australian Government in 2001. It provides a financial incentive (of 50 cents/litre) for industry to re-refine waste oil for sale. There appears to be some uncertainty as to what activities and materials are eligible, and it is possible that some subsidies are being expended on mixtures of oil and water and potentially storage and transfer activities.

Recommendation 3: DoE should assess waste oil infrastructure to clarify which sites are providing re-refining of oils for sale that qualify them for the product stewardship payment.

5.5 Lead recycling facilities

At a national level, based on the best estimate projection of arisings increasing at the rate of population growth the current and planned lead recycling infrastructure could be exceeded by 2031. Based on the high estimate projection of arisings increasing strongly at 3.5% per annum capacity could be met in 2022. Under a low scenario of no growth in arisings capacity is not expected to be exceeded over the next 20 years.

Recycling capacity for lead acid batteries is all located in NSW, so lead acid batteries are transported from other jurisdictions to NSW or exported overseas under an export permit. Developments in WA should see less lead acid batteries transported from WA to NSW.

5.6 Mercury recycling facilities

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

Mercury processing capacity was identified in Vic (the majority) and a small amount in NSW. All other jurisdictions are likely transferring mercury wastes to Vic and NSW.

CMA Ecocycle are the main provider of mercury infrastructure with transfer facilities located around Australia and a processing facility in Melbourne. [redacted]

Recommendation 4: [redacted]

Recommendation 5: State and territory governments should require financial assurances from companies that process and store wastes to avoid the risk of 'orphaned' stockpiles.

5.7 Solvents/paints recycling facilities

At a national level, the assessment indicates that under all scenarios 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:

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 in all jurisdictions apart from ACT, SA, Tas and NT. 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 Solvents/paints energy recovery facilities

At a national level, the assessment indicates that under the best and low scenarios over the next 20 years the potential capacity of Australia's current solvents/paints energy recovery infrastructure will be able to manage waste arisings. If paints, resins, inks, organic sludges grow very strongly (at 3.8%p.a.) capacity could be exceeded by 2030.

It is noted some solvents/paints recycling tonnages may actually be sent to energy recovery infrastructure. This could result in the infrastructure need exceeding capacity sooner than is estimated here.

Victoria has the only facility (GeoCycle) that recovers paints, resins, inks, organic sludges for the purposes of energy recovery. Other jurisdictions are likely to send these wastes to Victoria.

5.9 Spent potlining recycling facilities

For SPL wastes the current estimated arisings are based on the tonnages of SPL recycled in 2014. Waste tracking system data could not be used because much of the SPL recycling infrastructure is located on aluminium smelting sites (the generation sites) so no tracking data is collected.

Industry estimates around 900 kt of spent potlining are in storage/stockpiles in NSW and Vic (sufficient to more than half fill the Melbourne Cricket Ground. The best and low projection scenarios assume that these stockpile remains *in situ*. Under these scenarios it is estimated that the current SPL recycling infrastructure capacity will not be exceeded over the 20 year projection period. Under the high scenario it is assumed that the SPL stockpile is released over a 10 year period (at a rate of 90kt/yr.) beginning in 2017. [redacted]

The storage of large quantities of spent potlining from aluminium smelting should be a social concern, especially given the recent decline of this industry. The three current operators able to process this waste report sufficient capacity to process the stockpile over a 10-15 year period. A mismatch between demand and capacity could cause inappropriate treatment or demand for exports. A nationally coordinated negotiation with the industry is recommended.

Recommendation 6: DoE should consult with the aluminium industry and NSW, Vic, Qld, Tas State Governments to develop a nationally agreed approach to the management of spent potlining stockpiles that ensures their eventual removal and ongoing recovery or treatment.

5.10 Organics recycling (NEPM K code wastes) facilities

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

As discussed in Section 4.2, the majority of the arisings of NEPM K code wastes are sent to infrastructure that has limited coverage in the capacity assessment database. 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 wastes as part of much larger non-hazardous waste volume.

In addition, some smaller operators that specialise in hazardous organic wastes may not be within the infrastructure database due to the diffuse nature of this infrastructure group. Capacity within this group was identified in Vic and NSW only.

Based on industry consultation and our assessment of organics recycling infrastructure, no national shortage of capacity in this infrastructure group is considered likely over the next 20 years.

5.11 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.

At a national level based on the best and low projections of arisings CPT infrastructure is estimated to be able to meet national demand over the next 20 years. Based on the high projection of arisings CPT national capacity could be exceeded in 2030. 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 the oil and gas (CSG) industry developments.

The infrastructure capacity assessment for this group 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 overestimate of capacity. Offsetting this is uncertainty about the amount of CSG industry wastes that will actually leave the development site and be sent to CPT facilities.

Whilst modelling suggests that current capacity is adequate nationally over the projection period, demand for processing wastes such as non-toxic salts and alkalis is likely to increase with activity in the mining and oil and gas industries. Some relocation of processing capacity and expertise is likely to be needed shifting CPT capacity from the traditional heavy industry hubs located close to capital cities and ports to the more remote locations of oil, CSG and other mining operations.

In the best estimate, current capacity in Qld would be fully subscribed by 2025, or 2022 if mining industry wastes grow strongly. Qld also appears to have a particular need for processing infrastructure for CSG industry wastes, preferably in the location of these operations.

The ACT, NT, SA could have an undersupply of local CPT capacity. This assessment is based on the national average percentages of waste sent to CPT, and is therefore uncertain. It is likely that wastes are being exported to Vic and NSW from these jurisdictions.

Tas, in particular, appears to have a shortage of CPT capacity. Again, this is based on the national average of the percentage of wastes sent to CPT for treatment. However, with [redacted] of CPT capacity identified, estimated arisings of 68kt, and recorded exports to the mainland in 2012/13 data of 12 kt, are evidence that Tas needs additional CPT capacity.

Recommendation 7: DoE and/or NSW and Qld EPAs should consult with the coal seam gas industry to develop a strategic plan for managing its wastes, including an evaluation of local chemical and physical treatment infrastructure vs transport to existing urban sites.

Recommendation 8: DoE and/or Tas EPA should further investigate the supply of chemical and physical treatment capacity for hazardous waste in Tasmania.

5.12 Clinical waste treatment facilities

Based on the current industry projection of arisings increasing at the rate 1.9% per annum and the potential capacity of clinical waste treatment – capacity could be exceeded by 2026. Based on the high projection, where arisings increase at 3.9% per annum, national capacity could be exceeded in 2020. Under the low scenario where growth is below the current industry projection (-0.1% per annum) national capacity is projected to meet demand over the next 20 years.

The infrastructure capacity assessment for this group has high uncertainty due to a poor response rate from industry and capacity overlap with the thermal destruction infrastructure (resulting in a likely under estimate of the infrastructure group capacity).

ACT, NT, SA, Vic, and WA all appear to have sufficient clinical waste treatment capacity. NSW, Qld, and Tas all appear to have insufficient local supply of clinical waste treatment capacity and are likely to be exporting significant quantities interstate.

5.13 Contaminated soils treatment facilities

Analysis indicates that under all scenarios over the next 20 years the potential capacity of Australia's current and planned contaminated soils treatment infrastructure will be able to treat waste arisings.

Importantly, these estimates assume no change to the current fate patterns of contaminated soil, which, based solely on Victorian data, is estimated to be 89% landfill. If the treatment proportions are higher in other jurisdictions, the above assessment of no national capacity constraints would be affected.

The infrastructure capacity assessment for this group has moderate uncertainty due to a moderate response rate during consultation, capacity overlap with POPs thermal destruction infrastructure, and diffuse soil treatment technologies including some 'mobile' capacity. One soil treatment facility was identified in Qld, NSW, WA, and Vic in the capacity database. Given the range of treatment technologies/techniques for contaminated soils treatment this number appears low.

5.14 Hazardous waste landfill facilities

This project capacity assessment examined hazardous waste landfills capacity to accept annual arisings of wastes – 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, licence limits. These constraints are not common and are understood not to be an issue for the sites included in this group.

The seven hazardous waste landfills surveyed for this project reported an annual capacity that modelling indicates is constrained under all scenarios. For all three scenarios, declines are projected for 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 the Oil and Gas (GSG) industry developments. We believe the modelling assessment for this infrastructure group is incorrect. The response rate from site operators was only 43%, meaning infrastructure group averages were used, and generally the responses provided data only on wastes currently received with little information on the potential annual acceptance rate. This is understandable as, unlike other infrastructure types, landfills are usually able to cater to varying capacity demands (within reason) and a site's potential annual capacity can be difficult to define.

Recognising the limitations of the capacity assessment modelling for landfills, operators were also queried about total airspace availability. The responses suggested no impending capacity constraints in jurisdictions that have a hazardous waste landfill (all jurisdictions except SA and Act). However, in most jurisdictions a single dedicated hazardous waste landfill accepts the majority of waste types (other than low level contaminated soils, asbestos and tyres).

SA may need to establish a hazardous waste landfill or transport wastes significant distances. Industry representatives raised concerns about the transport distances for hazardous waste disposal and commented on this issue for WA in particular, suggesting additional sites or appropriate transfer facilities are required there.

The capacity of Australia's hazardous waste landfills could be impacted by 'new' hazardous waste arisings that need to be sent to these specialist landfills. Increases in landfilling capacity requirements from CSG wastes, fly ash from energy from waste operations, and potentially POPs contaminated wastes (that are not sent for thermal destruction as assumed in this assessment) need to be considered in future planning for hazardous waste landfill capacity.

In addition to the above, given the significant time required and the political difficulty in establishing a new hazardous waste landfill, the risks associated with extreme weather events causing surges of hazardous waste quantities, or risks of legal challenges – it is recommended that DoE liaise with the jurisdictions about the risk profiles and anticipated closure dates of their specialist hazardous waste landfills.

Recommendation 9: DoE should work with the jurisdictions to assess the likely closure year of hazardous waste landfill facilities and examine the risk that these sites' capacities may be affected by issues such as extreme weather events and 'new' hazardous waste arisings.

5.15 Landfill facilities (NEPM code N, T)

This infrastructure group is not in the scope of hazardous waste database (see Section 3.2) and a quantitative assessment of arisings vs capacity is not possible. To complete a quantitative analysis of projected arisings of NEPM code N and T wastes versus 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 wastes as part of much larger non-hazardous waste volume.

General or municipal waste landfills are often also able to landfill low level contaminated soil, asbestos, and tyres. In Victoria tyres can be disposed to any landfill as long as they are shredded first. This is understood to be the case nation-wide.

Whilst this infrastructure group is not clearly defined as 'hazardous waste infrastructure' the capacity of these landfills to take a selection of hazardous wastes is important. Landfill facilities are assumed to receive 89% of contaminated soils, 96% of waste asbestos, and 100% of contaminated biosolids[38]. Based on industry and government consultation, a national shortage of this type of infrastructure over the next 20 years is considered unlikely.

Landfills for asbestos disposal

Unlike most wastes, 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

[38] The contaminated biosolids waste group only includes estimated arisings from inorganic contamination. 'POPs contaminated biosolids' arisings are included in the M160a-c waste groups (see Table 1) which are assumed to be sent to POP thermal destruction facilities.

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.

5.16 POPs thermal destruction facilities

[redacted]

[redacted]

Whilst there appears to be a major gap in Australia's POPs thermal destruction capacity, the capacity assessment uncertainty for this group is very high. The following three issues need to be considered that all result in an under estimate of the POPs destruction capacity:

1. POPs TD capacity within Clinical waste TD facilities. SteriHealth currently have a research and development approval that allows them to treat PCB contaminated oil from the Tullamarine landfill leachate at their Clinical waste TD facility in Laverton, Melbourne. SteriHealth aims to provide POPs destruction services to the market following works approval from EPA. SteriHealth did not state the potential tonnages of POPs that could be destroyed at the facility. TPI (2014), states that SteriHealth recently successfully treated around 2000 litres of PCB contaminated oil during trials at the site.

2. POPs TD capacity within Soils treatment facilities. The RENEX pyrolysis rotary kiln that is being commissioned in Dandenong Melbourne will be aiming to treat POPs contaminated soils and liquids. The kiln with operate at 600 degrees C and the gases will then be incinerated at 1100-1200 degrees C, enabling the destruction of chlorinated organics such as PCBs. [redacted], however, it is unknown what tonnage of POP contaminated soils and liquids could be processed at the plant.

3. POPs TD capacity within cement kilns. Cement kiln infrastructure is not included in the capacity database scope. We understand that cement kilns in Australia are currently destroying some POPs including PFOS. The capacity of Australia's cement kilns to destroy POPs needs detailed assessment to enable a comparison of arisings to destruction capacity. Until this assessment is completed any analysis of additional capacity that is required under any of the projection scenarios will be inaccurate.

Recommendation 10: DoE should undertake work to quantify the Australia’s POPs destruction capacity, including at sites excluded from the scope of the infrastructure database used in this project.

[39] Orica’s longstanding stockpile of waste in Sydney is HCB.

[40] Both these estimates assume Australia ratifies the new Stockholm POPs. The high estimate of 182,000 tonnes includes around 170,000 tonnes of POP contaminated biosolids (due to PFOS and HBCD contamination).

POPs contaminated biosolids

An important issue to note regarding the projected need for POP thermal destruction infrastructure is the impact of POP contaminated biosolids. As noted above, the scenarios for projected need for this infrastructure group vary significantly (from around 28,000 to 182,000 tonnes in 2034). The high estimate of 182,000 tonnes is mostly POP contaminated biosolids (around 170,000 tonnes of PFOS and HBCD contaminated biosolids).

Recommendation 11: If not already underway, DoE, water authorities, and EPAs should work to complete:

- analysis of the current levels of POP contamination in Australian biosolids
- an assessment of the required management of POP contaminated biosolids (based on the levels of contamination identified and assuming Australia ratifies the Stockholm Convention for newly listed POPs)
- a set of recommendations for any additional infrastructure that Australia will likely require for POPs thermal destruction.

5.17 Clinical waste thermal destruction facilities

Based on the industry projections of arisings increasing at 1.9% per annum, the current and planned national capacity for thermal destruction of clinical waste could be exceeded by 2024. Under the high projection, with arisings increasing at 3.9% per annum, capacity could be exceeded in 2019. Under the low scenario capacity meets demand over the next 20 years.

ACT, NSW, NT, Qld, and Tas may each be undersupplied with this type of infrastructure. However, apart from Qld, this is based on assumed proportions of clinical waste sent to thermal destruction. In these jurisdictions clinical wastes are probably being exported or landfilled, potentially following autoclave treatment.

In SA the assessment finds capacity is currently constrained. This is incorrect and likely to be the result of assuming the percentage of clinical waste sent for destruction based on other jurisdictions. Industry representatives commented that there is spare capacity for clinical waste thermal destruction in SA. Vic and WA appear to have sufficient clinical waste thermal destruction capacity under all scenarios.

5.18 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. This is inaccurate, and attributable to the capacity database having limited coverage of this group. Rawtec (2014 p.8) states that: "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".

Recognising the limitations of the database for this infrastructure group, during the industry consultation program industry representatives were asked to flag any major transport constraints.

Very long transport distances, particularly in WA, were raised several times as a major barrier to managing hazardous waste. WA has seven of the 43 transfer station facilities in the database. For such a large state this appears low when compared with Vic, for example, with eight transfer sites. Problematic transport distances are also likely to be a problem in Qld (with just seven sites) and a growing CSG industry.

If not already being undertaken, further investigation of strategic locations for transfer station facilities in WA, Qld and NT is recommended. Consultation with industry on establishing joint venture transfer stations to consolidate wastes from a range of mining sites/generators should be explored for WA and potentially Qld (for CSG waste generators).

Recommendation 12: DoE and/or WA and Qld State Governments should complete a detailed assessment and consultation with industry on the need for and, if required, the best location(s) for additional infrastructure for hazardous waste transfer or temporary storage

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Appendices

A.1 Definition of the waste groups with reference to NEPM codes

'15' code	NEPM 15 description	'75' code	Waste description (NEPM Schedule A, List 1)	Projection groups
A	Plating and heat treatment	A100	Waste resulting from surface treatment of metals and plastics	Plating & heat treatment (A)
		A110	Waste from heat treatment and tempering operations containing cyanides	
		A130	Cyanides (inorganic)	
B	Acids	B100	Acidic solutions or acids in solid form	Acids (B)
C	Alkalis	C100	Basic solutions or bases in solid form	Alkalis (C)
D	Inorganic chemicals	D100	Metal carbonyls	Combined with: 'Other organic chemicals (other D)'
		D110	Inorganic fluorine compounds excluding calcium fluoride	
		D120	Mercury; mercury compounds	Mercury; mercury compounds (D120)
		D130	Arsenic; arsenic compounds	Combined with: 'Other organic chemicals (other D)'
		D140	Chromium compounds (hexavalent and 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	Lead; lead compounds
		D230	Zinc compounds	Combined with: 'Other organic chemicals (other D)'
		D240	Selenium; selenium compounds	
		D250	Tellurium; tellurium compounds	
		D270	Vanadium compounds	
		D290	Barium compounds (excluding barium sulphate)	
		D300	Non-toxic salts	Non-toxic salts
		D310	Boron compounds	Other inorganic chemicals (other D)
		D330	Inorganic sulfides	
		D340	Perchlorates	
		D350	Chlorates	
		D360	Phosphorus compounds excluding mineral phosphates	

'15' code	NEPM 15 description	'75' code	Waste description (NEPM Schedule A, List 1)	Projection groups
E	Reactive chemicals	E100	Waste containing peroxides other than hydrogen peroxide	Reactive chemicals (E)
F	Paints, resins, inks, organic sludges	F100	Waste from the production, formulation and use of inks, dyes, pigments, paints, lacquers and varnish	Paints, resins, inks, organic sludges (F)
		F110	Waste from the production, formulation and use of resins, latex, plasticisers, glues and adhesives	
G	Organic solvents	G100	Ethers	Organic solvents (G)
		G110	Organic solvents excluding halogenated solvents	
		G150	Halogenated organic solvents	
		G160	Waste from the production, formulation and use of organic solvents	
H	Pesticides	H100	Waste from the production, formulation and use of biocides and phytopharmaceuticals	Pesticides (H)
		H110	Organic phosphorous compounds	
		H170	Waste from manufacture, formulation and use of wood-preserving chemicals	
J	Oils	J100	Waste mineral oils unfit for their original intended use	Oils (J)
		J120	Waste oil/water, hydrocarbons/water mixtures or emulsions	
		J160	Waste tarry residues arising from refining, distillation, and any pyrolytic treatment	
K	Putrescible/ organic waste	K100	Animal effluent and residues (abattoir effluent, poultry and fish processing wastes)	Animal effluent and residues (+ food processing waste) (K100)
		K110	Grease trap waste	Grease trap waste (K110)
		K140	Tannery wastes (including leather dust, ash, sludges and flours)	Tannery & wool scouring wastes (K140 & 190)
		K190	Wool scouring wastes	
M	Organic chemicals	M100	Waste substances and articles containing or contaminated with polychlorinated biphenyls, polychlorinated naphthalenes, polychlorinated terphenyls and/or polybrominated biphenyls	Combined with: 'Other organic chemicals (other M)'
		M150	Phenols, phenol compounds including chlorophenols	
		M160	Organo halogen compounds—other than substances referred to in this Table or Table 2 - PFOS	PFOS (M160a)
				POP-BDEs (M160b)
				HBCD (M160c)
				HCB (M160d)
		M170	Polychlorinated dibenzo-furan (any congener)	Other organic chemicals (other M)
		M180	Polychlorinated dibenzo-p-dioxin (any congener)	

'15' code	NEPM 15 description	'75' code	Waste description (NEPM Schedule A, List 1)	Projection groups
		M210	Cyanides (organic)	
		M220	Isocyanate compounds	
		M230	Triethylamine catalysts for setting foundry sands	
		M250	Surface active agents (surfactants), containing principally organic constituents and which may contain metals and inorganic materials	
		M260	Highly odorous organic chemicals (including mercaptans and acrylates)	
N	Soil/ sludge	N100	Containers and drums that are contaminated with residues of substances referred to in this list	Combined with: 'Other soil/sludges (other N)'
		N120	Soils contaminated with a controlled waste	Contaminated soils (N120)
		N140	Fire debris and fire wash waters	Combined with: 'Other soil/sludges (other N)'
		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	Contaminated biosolids (N205a)
				Other industrial treatment residues (N205b)
		N220	Asbestos	Asbestos (N220)
		N230	Ceramic-based fibres with physico-chemical characteristics similar to those of asbestos	Other soil/sludges (other N)
R	Clinical and pharmaceutical	R100	Clinical and related wastes	Clinical & pharmaceutical (R)
		R120	Waste pharmaceuticals, drugs and medicines	
		R140	Waste from the production and preparation of pharmaceutical products	
T	Miscellaneous	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	Combined with: 'Other miscellaneous (other T)'
		T120	Waste from the production, formulation and use of photographic chemicals and processing materials	
		T140	Tyres	Tyres (T140)
		T200	Waste of an explosive nature not subject to other legislation	Other miscellaneous (other T)

A.2 Notes from consultation with jurisdictions

Jurisd.	Source	1. Have you recently implemented, or do you plan to implement in the near future, any policies you expect to significantly affect the arisings, pathways or fates of any types of hazardous waste? If so, please provide some detail.	2. Are you aware of, or do you anticipate, any potential infrastructure shortages or significant changes in the coming years in your jurisdiction? If so, please provide some detail.	3 a. Have you developed any projections of future arisings or fates of hazardous waste in your jurisdiction? If so, could we please have a copy?	3 b. If not, do you have strong expectations about the future arisings or fates of any types of hazardous waste that are inconsistent with current trends?	4. Are you aware of any major transport constraints and risks relating to hazardous wastes in your jurisdiction? If so, please provide some detail.	5. Would you like to bring to the attention of the Australian Government any concerns or issues affecting the market for hazardous wastes in Australia?
Vic	4/9/14 meeting with Mark Bannister, Jerome Fakhry & Cecilia Elwood	New NEPM for contam sites increases the contam levels applicable where you can retain soils onsite. Is reducing volumes of cat C soil. Also leading to legal challenges to EPA over definitions of cat C soil in relation to background concentrations. Direct Beneficial Reuse may be leading to diversion of manufacturing waste to 'outside the system'. No data so can't confirm. Secondary Beneficial Use has not had much uptake. Illegal waste dumping program may lead to additional disposal. Big issue with soils, including 'stockpiling'.	Biggest issue is Stockholm Convention waste e.g. firefighting foams. High temperature treatment will be needed but none is available and no-one is taking the lead. National issue. Not suitable for cement kilns. Don't have a policy re. Lyndhurst - the focus is reducing quantities. Lyndhurst keep extending. May be data from community reference group commitments. CRT glass may become an issue. No treatment available. No ideas about e-waste plastics.	Mark will check with Finance.		NSW has got more restrictive about what goes over the border, so now some wastes are being transported 500km to Lyndhurst. On-site treatments are available for some soils. Not much uptake.	The lack of a level playing field is the main issue. Market can't respond when there is no certainty. Facilities can be undercut by other states. Some wastes need national solutions because the volumes are low. The available treatments are mostly primitive - dewatering & adding concrete. 30 years behind Europe. Due to low and dispersed volumes. National coordination is needed.
NT	Email from Emma Young 04/09/14	Nothing at the moment. We are, however, currently developing a waste strategy for the NT that will be released for consultation in October sometime which may identify some wastes as problematic. We are also currently undertaking a review of our Waste Management and Pollution Control Act. A discussion paper on this will be released in the next month.	No information on this sorry it would be great to have additional infrastructure but due to the low population base in the Territory and substantial distances/remoteness etc. this poses problems			High costs of transport due to long distances. Most hazardous waste goes interstate	Nothing to highlight at this stage. We don't have access to markets much up here and many items gets transported interstate
Tas		No response	No response	No response	No response	No response	No response

Jurisd.	Source	1. Have you recently implemented, or do you plan to implement in the near future, any policies you expect to significantly affect the arisings, pathways or fates of any types of hazardous waste? If so, please provide some detail.	2. Are you aware of, or do you anticipate, any potential infrastructure shortages or significant changes in the coming years in your jurisdiction? If so, please provide some detail.	3 a. Have you developed any projections of future arisings or fates of hazardous waste in your jurisdiction? If so, could we please have a copy?	3 b. If not, do you have strong expectations about the future arisings or fates of any types of hazardous waste that are inconsistent with current trends?	4. Are you aware of any major transport constraints and risks relating to hazardous wastes in your jurisdiction? If so, please provide some detail.	5. Would you like to bring to the attention of the Australian Government any concerns or issues affecting the market for hazardous wastes in Australia?
NSW	Meeting and email from Tony Hodgson on 15/09/14	Nothing new that would affect arisings. With respect to transport and disposal/treatment, a new proximity principle is being introduced as part of the remake of the Protection of the Environment Operations (Waste) Regulation. This principle will mostly affect non-hazardous waste but may have some impact on common hazardous waste streams such as oily water. The details are still being finalised but it is primarily designed to prevent high volume non-hazardous wastes from being transported long distances for purely commercial reasons.	As previously advised, the long term future of the Homebush Bay Liquid Treatment Plant is under review. I don't know of any other significant changes planned for infrastructure.	No.	The feedback from industry is that with respect to hazardous liquid waste, volumes are decreasing although I'm not sure whether this, at least, due in part to perceptions caused by some additional capacity opening in the Hunter. The trend of reduced waste from the manufacturing and aluminium smelting industries as these sector contract is likely to continue, although there will be a hump in smelter waste when plants are decommissioned.	None.	Any relaxation of export controls on hazardous waste streams that can be treated in Australia could have an adverse impact on the local processing/recycling industry, e.g. used lead acid batteries.

Jurisd.	Source	1. Have you recently implemented, or do you plan to implement in the near future, any policies you expect to significantly affect the arisings, pathways or fates of any types of hazardous waste? If so, please provide some detail.	2. Are you aware of, or do you anticipate, any potential infrastructure shortages or significant changes in the coming years in your jurisdiction? If so, please provide some detail.	3 a. Have you developed any projections of future arisings or fates of hazardous waste in your jurisdiction? If so, could we please have a copy?	3 b. If not, do you have strong expectations about the future arisings or fates of any types of hazardous waste that are inconsistent with current trends?	4. Are you aware of any major transport constraints and risks relating to hazardous wastes in your jurisdiction? If so, please provide some detail.	5. Would you like to bring to the attention of the Australian Government any concerns or issues affecting the market for hazardous wastes in Australia?
Qld	Written response from Kylie Hughes, 2/9/14	The Department is currently undertaking a review of the way regulated (hazardous) wastes are classified in Queensland. The results of this review and work to develop a testing framework based on concentration thresholds could see the reclassification of low risk wastes from regulated to non-regulated wastes. A re-classification will see a significant decrease in the total amount of regulated waste generated in Queensland. Currently Queensland's legislative framework requires that trackable wastes be regulated wastes. Any change in classification may result in the removal of some waste from the trackable list as well. Wastes that are determined to be non-regulated will not be required to be managed as regulated, so opening up potentially new pathways for management and markets. Queensland is also about to make changes to the mechanism by which wastes can be approved for a beneficial use. The Waste Reduction and Recycling Act 2011 will provide for the development of end of waste codes for materials that have a beneficial use (replacing the existing beneficial use approval process). Waste subject to an end of waste code will be classified as a resource not a waste which could further reduce the arisings of regulated wastes in Queensland.	No – this is not anticipated.	No – we don't have projections for future arisings of regulated waste. We collect data on regulated waste through surveys of treatment and disposal facilities and through the waste tracking data. This allows us to see trends but not make predictions around future generation or management approaches. The review of the regulated waste framework is also likely to affect future projections.		Distance is always a transport constraint for Queensland. The majority of regulated waste recycling and treatment facilities are located in southeast Queensland, making it costly to transport some of these wastes for a potentially more beneficial use than disposal.	The changes to the beneficial use approval process and potential changes to the classification of regulated wastes could impact on the reporting of hazardous wastes. We will need to be mindful of our reporting obligations in relation to hazardous wastes and ensure there is an appropriate mechanism to capture information about these wastes.

Jurisd.	Source	1. Have you recently implemented, or do you plan to implement in the near future, any policies you expect to significantly affect the arisings, pathways or fates of any types of hazardous waste? If so, please provide some detail.	2. Are you aware of, or do you anticipate, any potential infrastructure shortages or significant changes in the coming years in your jurisdiction? If so, please provide some detail.	3 a. Have you developed any projections of future arisings or fates of hazardous waste in your jurisdiction? If so, could we please have a copy?	3 b. If not, do you have strong expectations about the future arisings or fates of any types of hazardous waste that are inconsistent with current trends?	4. Are you aware of any major transport constraints and risks relating to hazardous wastes in your jurisdiction? If so, please provide some detail.	5. Would you like to bring to the attention of the Australian Government any concerns or issues affecting the market for hazardous wastes in Australia?
SA	08/09/14 Meeting with Steven Sergi and John Vanso	No significant policy changes in progress. Noted the SA Environment Protection (Waste to Resources) Policy 2010 and landfill bans on e-waste which may have will have impacts of the fate of this stream. Zero waste SA are trying to establish another facility to receive household chemicals.	Consistent with national discussion there are a couple of proposals for EfW facilities, however they are not targeting haz waste. They could take some haz waste that have high calorific value. SA currently exports haz waste to other states and this may increase if alternatives open up in other states. 'Grease trap' waste not managed as hazardous waste in SA. SA Water have completed the business case for an AD facility to take large amounts of biosolids which they intend to mix with grease trap and other organics, this is likely to change the future fate of biosolids in SA significantly. [redacted]	SA government have no existing projections.	Coal seam gas waste could increase due to mining in the SE. Sophie martin good SA EPA contact re CSG 0401 695 754. No other comments on likely trends of wastes.	Asbestos comes to SA from NT, but this is not due to infrastructure shortages. Not aware of any significant constraints.	Organo Chloride Pesticides (OCPs) wastes heading to Queensland from all over the country. Flagged the issue of haz wastes generally being sent to Qld where the fate is not well understood as an issue that needs attention.

Jurisd.	Source	1. Have you recently implemented, or do you plan to implement in the near future, any policies you expect to significantly affect the arisings, pathways or fates of any types of hazardous waste? If so, please provide some detail.	2. Are you aware of, or do you anticipate, any potential infrastructure shortages or significant changes in the coming years in your jurisdiction? If so, please provide some detail.	3 a. Have you developed any projections of future arisings or fates of hazardous waste in your jurisdiction? If so, could we please have a copy?	3 b. If not, do you have strong expectations about the future arisings or fates of any types of hazardous waste that are inconsistent with current trends?	4. Are you aware of any major transport constraints and risks relating to hazardous wastes in your jurisdiction? If so, please provide some detail.	5. Would you like to bring to the attention of the Australian Government any concerns or issues affecting the market for hazardous wastes in Australia?
WA	Comms. from **Jill Lethlean of Consilium.** WA Dept. of Env. Regulation (DER) were unable to respond. Jill until recently worked for DER and provided peer review of this report.	The WA Government has made several amendments to the Environmental Protection (Controlled Waste) Regulations 2004 over the past few years. The main objective of these updates has been to clarify existing requirements. According to an information sheet on WA DER's website (http://www.der.wa.gov.au/images/documents/our-services/regulatory-reform/2013_Information_for_Stakeholders_DER.pdf) WA DER intends to undertake a comprehensive review of how controlled waste is regulated in WA. If regulations are stricter, this is likely to channel more hazardous waste towards dedicated facilities. The review is slated to occur "post-2014", which presumably is anytime from now. Therefore, it is probably timely for the Australian Government to engage with the WA Government on the regulation of hazardous waste. The Waste Authority has formed a partnership with the Pilbara Development Commission to establish priorities for waste management in the Pilbara. This may include facilities for hazardous waste. http://www.wasteauthority.wa.gov.au/news/pilbara-waste-priorities/	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 addition, the current operators, EMRC, are not enthusiastic owners. 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.	The only report I am aware of is the waste generation in the Pilbara report prepared by Talis: http://www.wasteauthority.wa.gov.au/news/pilbara-waste-priorities/ As you would be aware, the current controlled waste tracking system is not well suited to extracted information on the net generation of waste.	With the easing of the mining boom, there may be less generation in certain types of hazardous waste. However, that is extremely difficult to predict.	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.	It appears that WA is not the only jurisdiction that does not have accurate data on hazardous waste generation and treatment. It would be helpful if the AG could facilitate better data collection and management on hazardous waste.

A.3 Tracking system data challenges

This report involved an unprecedented collection, compilation and assessment of hazardous waste data in Australia. As flagged in Table 5, this appendix explores some of the challenges faced during the collection, collation and analysis process. The issues covered are:

1. Differences in the methods used by jurisdictions to track and classify waste types
2. Multiple counting of waste within the data sets when waste moves between more than one site
3. Potential storage release spikes (which undermine the interpretation of trends)
4. How to deal with on-site waste disposal
5. Differences in measurement methods (mass, volume, numbers of items)

1. Differences in the methods used by jurisdictions to track and classify waste types

For the most part Australian states and territories classify hazardous wastes similar to those adopted by the NEPM. However, there are many instances where the classifications vary from NEPM descriptions, making it difficult to match corresponding waste types across jurisdictions. In addition, there are there are discrepancies in relation to the wastes that are tracked or only tracked in certain circumstances (such as when transported across interstate borders).

Why is this problematic?

These inconsistencies in waste classification, definition, regulation, waste tracking systems, management priorities and the resourcing of hazardous waste management have a marked effect on the quality of a national data collation. Historically evolved differences make data collection, collation and comparison difficult.

What is the scale of the issue?

A detailed account of these jurisdictional differences is contained in *Improving Australia's reporting on hazardous waste under the Basel Convention*, Appendix A (*Reporting hazardous waste under the Basel Convention - guidance to states and territories*). The Australian Capital Territory, Northern Territory and Tasmania do not currently have a tracking system in place. Figure 42 compares what the jurisdictions track.

How have we dealt with this issue?

We applied a mapping procedure developed in the *Improving Australia's reporting on hazardous waste under the Basel Convention* project. This procedure translates jurisdictionally classified wastes into a common framework based on NEPM 75 codes and fills gaps in jurisdictional waste reporting through estimation methods also documented in this report package.

Figure 42: Jurisdictional tracking by NEPM 75 analysis

Waste tracked by jurisdiction tracking system | Data not collected

"15" code	NEPM 15 waste description	"75" code	Waste description (NEPM Schedule A, List 1)	ACT	NSW	NT	Qld	SA	Tas	Vic	WA
			NEPM Codes	Status of waste data tracking (within jurisdiction)							
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, polychlor								
		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 conta								
		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								
R	Clinical and pharmaceutical	R100	Clinical & related wastes								
		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								

2. Multiple-counting of hazardous waste

A given mass of hazardous waste may be counted more than once in the hazardous waste tracking data on which the project significantly relies. This will lead to multiple-counting where the pathway of a hazardous waste includes one or more of the following:

(a) waste transfer, whereby a facility accepts waste then sends it unchanged to another waste company, potential with prior on-site accumulation (likely to be encompassed mainly within treatment codes R12, R13, D14)

(b) waste storage, whereby a facility accepts waste for storage but may then later send it for processing or disposal (codes D4, D12, D15)

(c) waste treatment producing hazardous waste that is sent for further processing or disposal, such as dewatering or addition of binding substances such as lime prior to landfilling (codes D9A, D9B, D9C).

Why is this problematic?

As discussed in Section 1.2 (*The meaning of waste 'arising'*), it is not necessarily problematic for this project if waste is counted more than once. This project examines infrastructure capacity and need, and if a waste requires more than once piece of hazardous waste infrastructure it is reasonable to count the quantity more than once.

However, multiple-counting could be problematic for developing projections to the extent that:

- multiple counting is not associated with infrastructure that is the focus of this project – in particular, waste transfer (codes R12, R13 and D14)
- the pathways of waste treatment may change in the future
- the projections rely on trends that are disguised by significant changes to the pathways of waste treatment in the past
- users assume that the projections account for a single mass of waste (or, putting it another way, users assume that waste arising is the same as waste generation).

Multiple-counting is also be problematic for reporting under the Basel Convention etc., which ideally would cover waste generation, rather than waste arising.

What is the scale of the issue?

The scale of the issue is not straightforward to ascertain but some insights can be gained through analysing the data provided by the jurisdictions.

Table 67 shows, to the extent the data supports, the proportions of waste tracked in each jurisdiction that falls in the codes listed above as likely to be associated with multiple counting. The table indicates that multiple-counting is a non-trivial issue.

How have we dealt with this issue?

Of the three pathways that give rise to the risk of multiple-counting, only one (waste transfer) is not strongly associated with an infrastructure need. Furthermore, our capacity to 'correct' for multiple-counting is limited by the quality and quantity of available data. Our approach to the issue, therefore, was:

(a) exclude waste transfer data from the baseline to the extent possible (Victoria and Queensland)

(b) recognise and clearly communicate that our projections include multiple-counting

(c) reduce the reliance on the data baseline and apparent trends.

Table 67: The fraction of waste allocated to treatment types associated with risk of multiple-counting, based on available tracking data for financial year 2012-13

Treatment code:	Storage D4, D12, D15	Transfer R12, R13, D14	Treatment outputs D9A, D9B, D9C	No treatment code listed
ACT	*No data*			
NSW	8%	*No data*		1%
NT	*No data*			
Qld	17%	2%	14%	0%
SA	*No data*			
Tas	*No data*			
Vic	7%	3%	10%	9%

3. Release spikes from storage

Waste may be released from storage in a large volume in a particular year, for example if a large company stores material until such time as the treatment volume can be economically processed.

Why is this problematic?

Release spikes will mask the underlying trends. If the release year is the projection baseline, the entire projection could be exaggerated.

What is the scale of the issue?

It is difficult to categorically assess the scale of this issue without detailed transaction-level analysis of waste tracking certificates. However, several of the data charts in Appendix A.4 contain one-year increases in data consistent with releases from storage. As an example, analysis shows that a large spike in the quantity of D220 waste in NSW in one year was associated with a large volume transported from interstate.

How have we dealt with this issue?

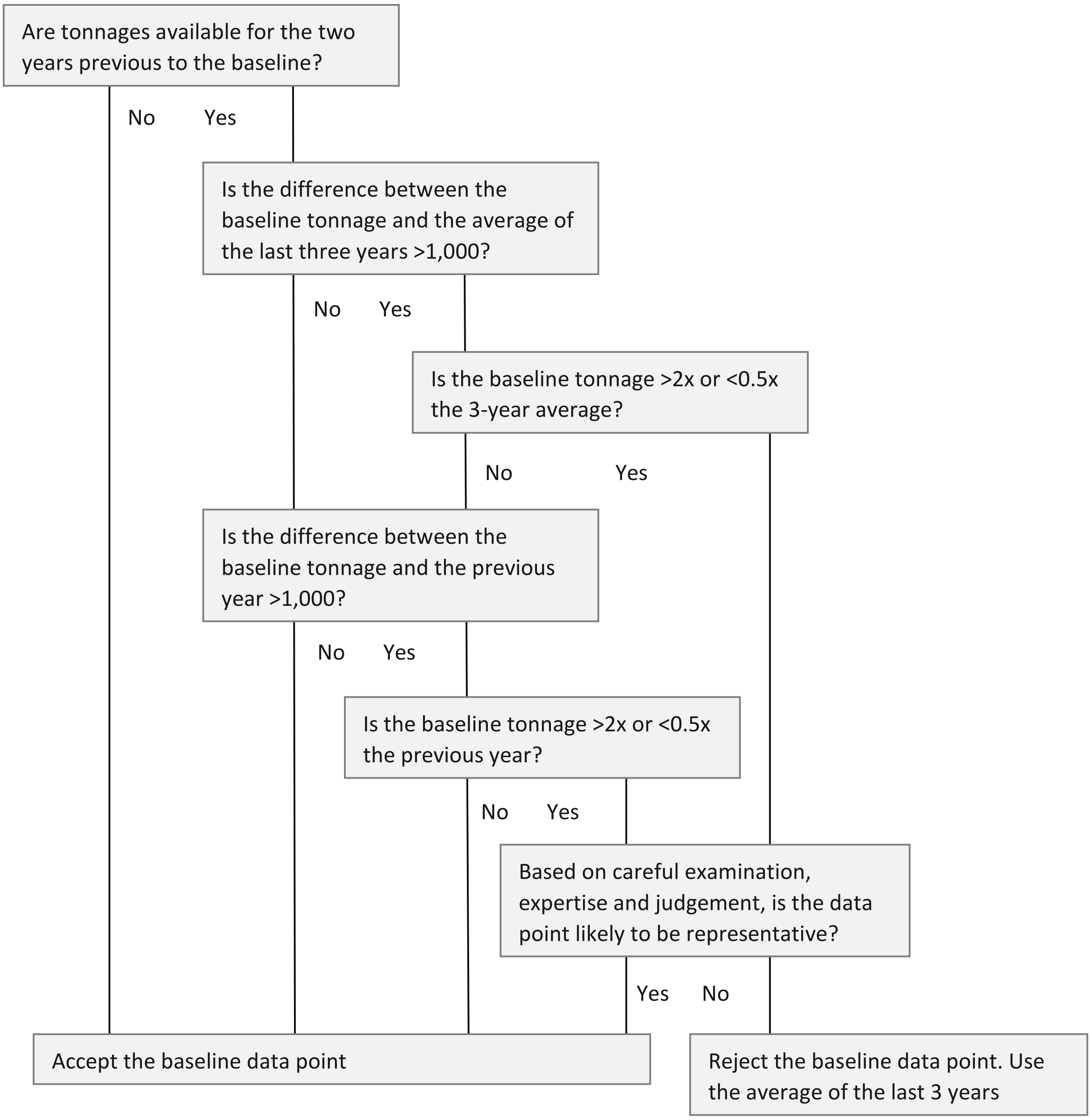
The storage release issue requires some reduction in the reliance placed on apparent trends currently include likely storage releases.

For the purpose of establishing a baseline for projecting future quantities of waste, additional consideration was required. The project team established a procedure for validating the data point from which to project with a view to avoiding projecting from data points that are not representative of typical flows due to releases from storage (or other reasons). This procedure follows the decision tree mapped out in Figure 43.

The procedure resulted in changes to the baseline datum in relation to:

- D120, D220 and 'other D' in NSW
- N205b in Qld
- N205b in SA
- 'Other N' in WA.

Figure 43: Process flow diagram for assessing the representativeness of baseline data points and correcting those considered not representative



4. How to deal with onsite disposal of hazardous waste

At the jurisdictional level, hazardous waste management and classification is built around the risks associated its transport. In other words, in terms of tracking data, a hazardous waste is not deemed to be a hazardous waste until it is loaded onto a truck for treatment off-site.

Consequently, this raises an issue regarding the hidden aspect of hazardous waste. Is a waste hazardous because of its inherent characteristics, where it is generated on-site, or is it only hazardous when it is collected by a truck when those inherent characteristics have the potential to cause harm off-site?

Arguably there are mechanisms in place onsite to manage risks posed by a hazardous material, but these relate primarily to workplace health and safety.

Why is this problematic?

A substantial quantity of hazardous waste is generated and managed on-site in industrial settings that do not appear in waste tracking data. This means that it is not recorded or reported (and potentially managed) as hazardous waste.

What is the scale of the issue?

As an example, 6,450t of fly ash, which typically contains levels of heavy metals that classify it as a hazardous waste, is identified through tracking data as produced in 2011 across Victoria, New South Wales, Queensland, South Australia and Western Australia. However, actual quantities of fly ash generated from coal-fired electricity generation in Australia, which are largely managed onsite and therefore not deemed a hazardous waste for the purpose of this study, dwarf this quantity by approximately three orders of magnitude.

How have we dealt with this issue?

Only tracked data and clearly generated, transported but not tracked data (via estimation) have been included in projections.

Differences in measurement methods

Waste data is variably recorded in jurisdictional tracking systems by mass (kilograms or tonnes), volume (litres or cubic metres) or by number of items (in particular, with waste drums that previously contained hazardous waste). Often multiple methods are used for a particular jurisdiction and waste code.

Why is this problematic?

The analysis of trends and projections within categories requires a consistent measurement framework.

How have we dealt with this issue?

Quantities were converted to the common unit of tonnes based on the conversion factors tabulated below.

Table 68: Method for converting measurement units into tonnes

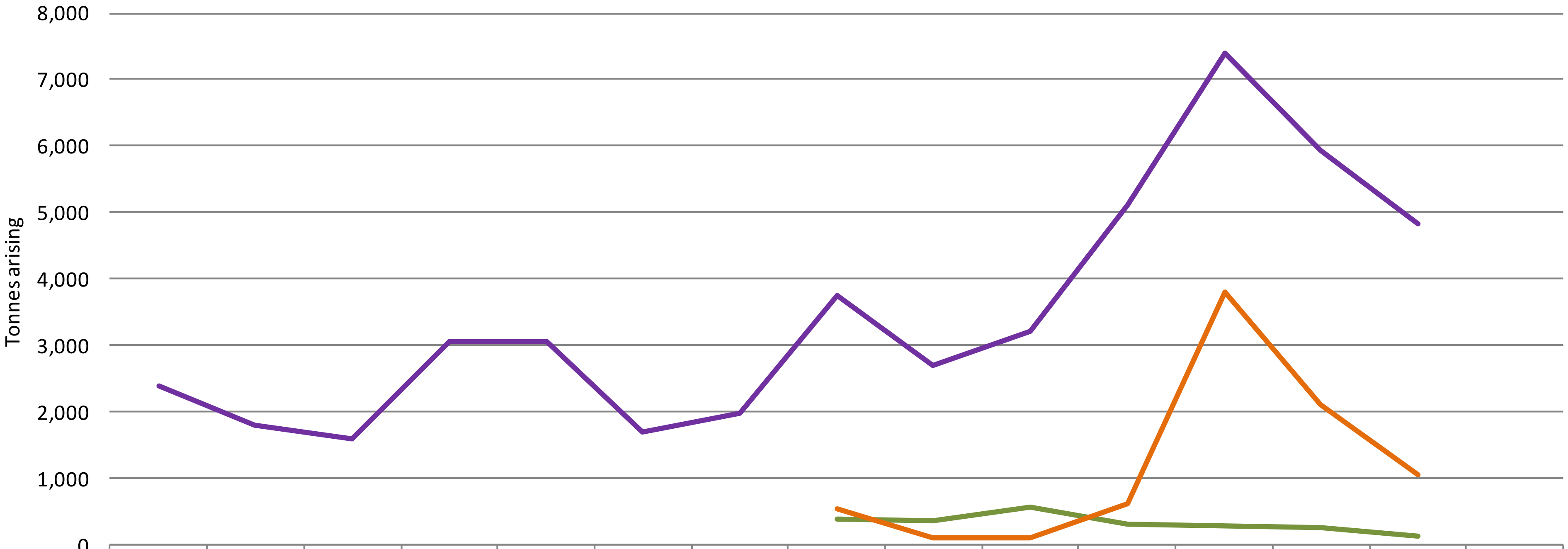
Data unit	Conversion mechanism
Kilograms	Multiplied by 1,000
Litres	These are mostly liquids. A density of 1t / m^3 was assumed.
Cubic metres	A density of 1 t m^{-3} was assumed
Empty drums	A density of 17 kg m^{-3} was assumed

A.4 Historical arisings of hazardous waste

Note: historical arisings do not exist for ‘M160a – PFOS’, ‘M160b – POP-BDEs’, ‘M160c – HBCD’, ‘M160d – HCB’, ‘N205b – Other industrial treatment residues’ or ‘Lithium-ion batteries’.

A. Plating and heat treatment

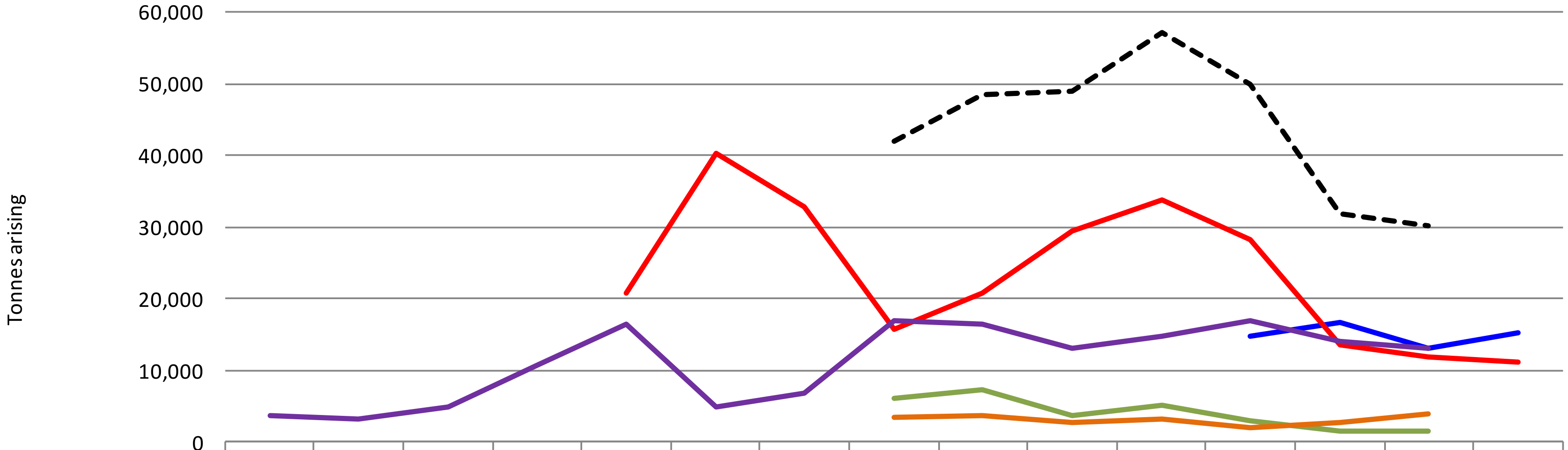
Figure 44: Historical arisings of plating and heat treatment waste



	1999-00	2000-01	2001-02	2002-03	2003-04	2004/05	2005/06	2006/07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14
SA								378	347	554	301	277	249	138	
Qld	2,383	1,807	1,590	3,049	3,059	1,688	1,984	3,752	2,687	3,206	5,108	7,407	5,933	4,826	
WA								545	91	96	604	3,804	2,105	1,048	

B. Acids

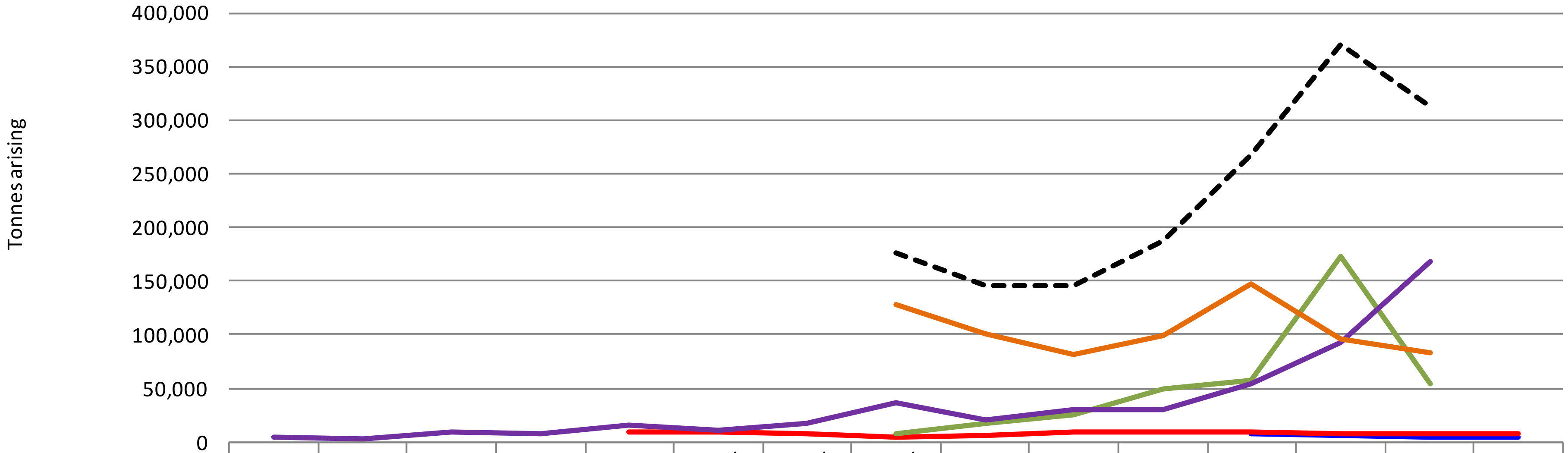
Figure 45: Historical arisings of acids waste



	1999-00	2000-01	2001-02	2002-03	2003-04	2004/05	2005/06	2006/07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14
NSW												14,769	16,668	13,166	15,367
Vic					20,849	40,361	32,917	15,720	20,852	29,489	33,826	28,171	13,697	11,787	11,080
SA								6,072	7,419	3,733	5,246	2,915	1,482	1,485	
Qld	3,758	3,256	4,986	10,722	16,444	4,904	6,835	16,902	16,585	13,031	14,871	16,907	13,959	13,111	
WA								3,421	3,643	2,644	3,146	1,924	2,830	3,892	
Vic, SA, Qld, WA								42,116	48,499	48,897	57,088	49,917	31,968	30,275	

C. Alkalis

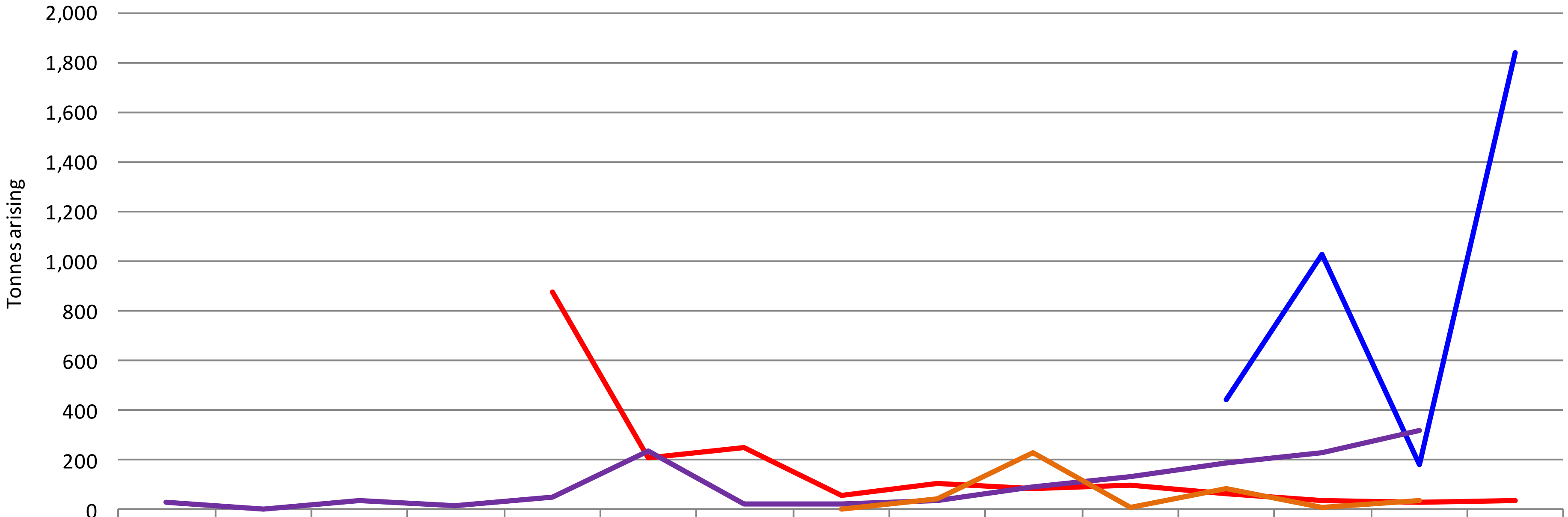
Figure 46: Historical arisings of alkalis waste



	1999-00	2000-01	2001-02	2002-03	2003-04	2004/05	2005/06	2006/07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14
NSW												6,830	5,638	4,134	4,887
Vic					8,667	9,284	8,035	4,805	5,936	8,560	9,496	9,047	8,139	6,955	7,330
SA								7,304	17,897	25,249	49,136	56,728	172,909	54,685	
Qld	4,117	2,209	8,362	7,492	15,352	10,573	17,845	35,774	20,040	29,668	30,009	53,963	92,339	167,619	
WA								127,894	101,112	81,492	99,503	147,479	96,307	83,720	
Vic, SA, Qld, WA								175,777	144,985	144,969	188,143	267,217	369,694	312,979	

D120. Mercury; mercury compounds

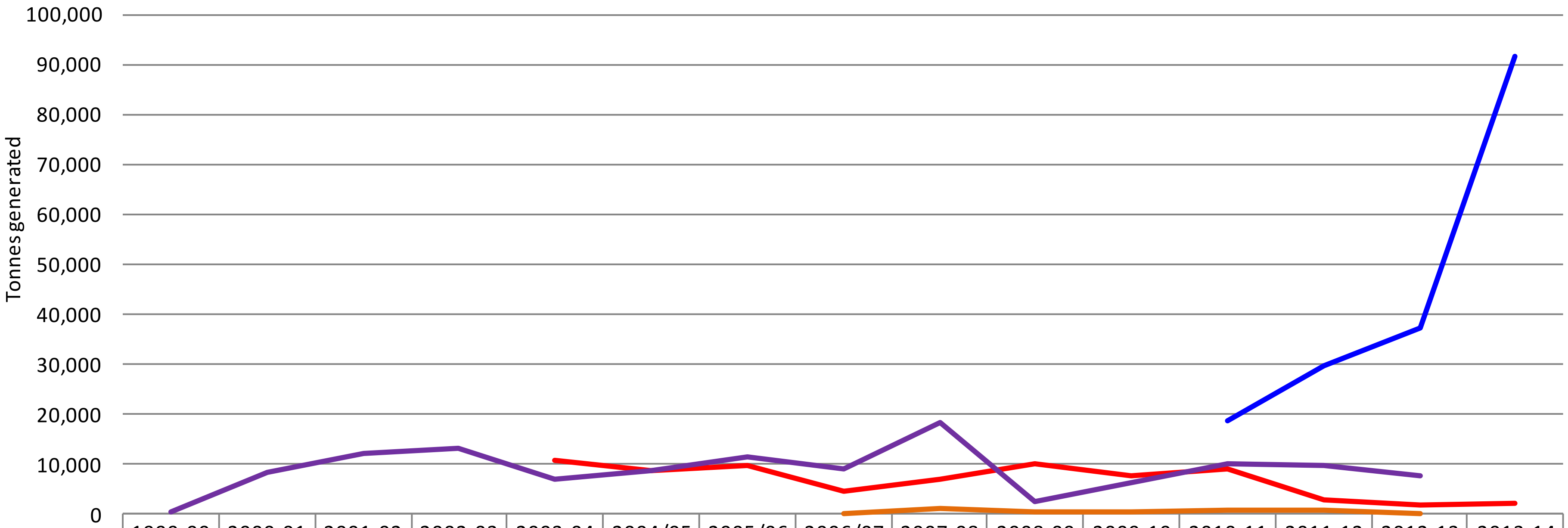
Figure 47: Historical arisings of mercury; mercury compounds waste



	1999-00	2000-01	2001-02	2002-03	2003-04	2004/05	2005/06	2006/07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14
NSW												444	1,025	182	1,841
Vic					874	211	248	55	104	84	97	62	37	27	38
Qld	29	0	38	16	51	235	27	24	41	94	131	192	229	319	
WA								1	47	230	11	84	8	35	

D220. Lead; lead compounds

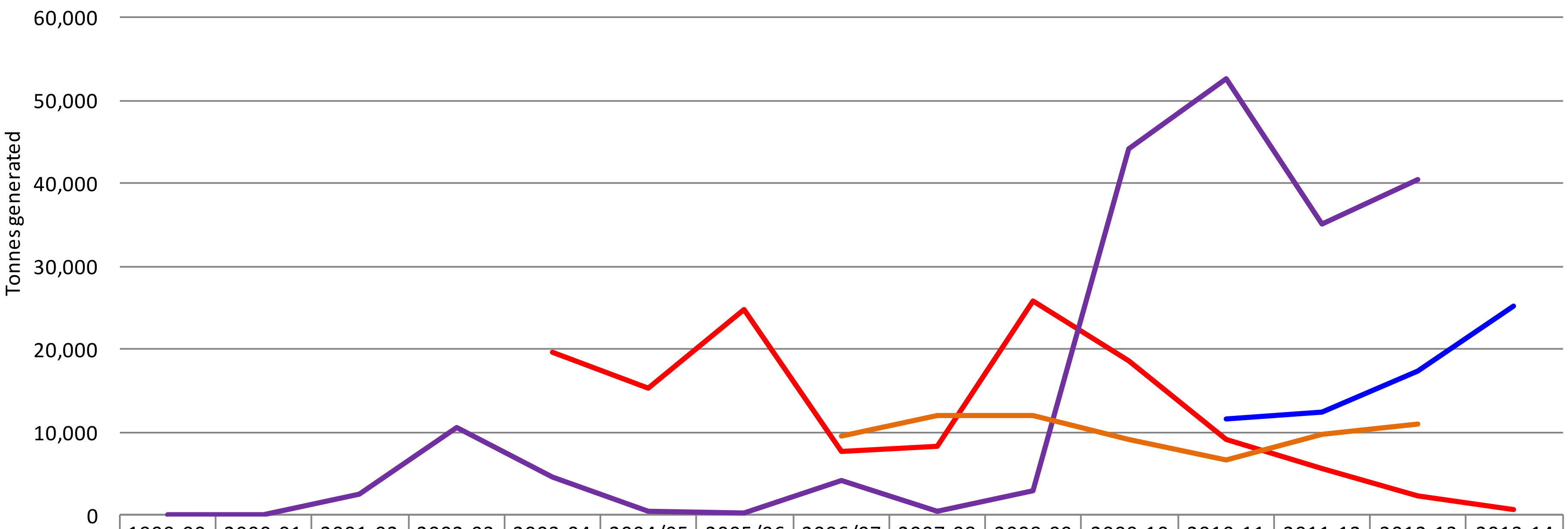
Figure 48: Historical arisings of lead; lead compounds waste



	1999-00	2000-01	2001-02	2002-03	2003-04	2004/05	2005/06	2006/07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14
NSW												18,680	29,818	37,347	91,445
Vic					10,678	8,580	9,833	4,389	7,119	10,151	7,723	9,016	2,916	1,743	2,013
Qld	319	8,450	11,989	12,989	7,002	8,753	11,453	9,050	18,468	2,342	6,211	9,908	9,542	7,560	
WA								190	1,108	281	451	866	806	234	

D300. Non-toxic salts

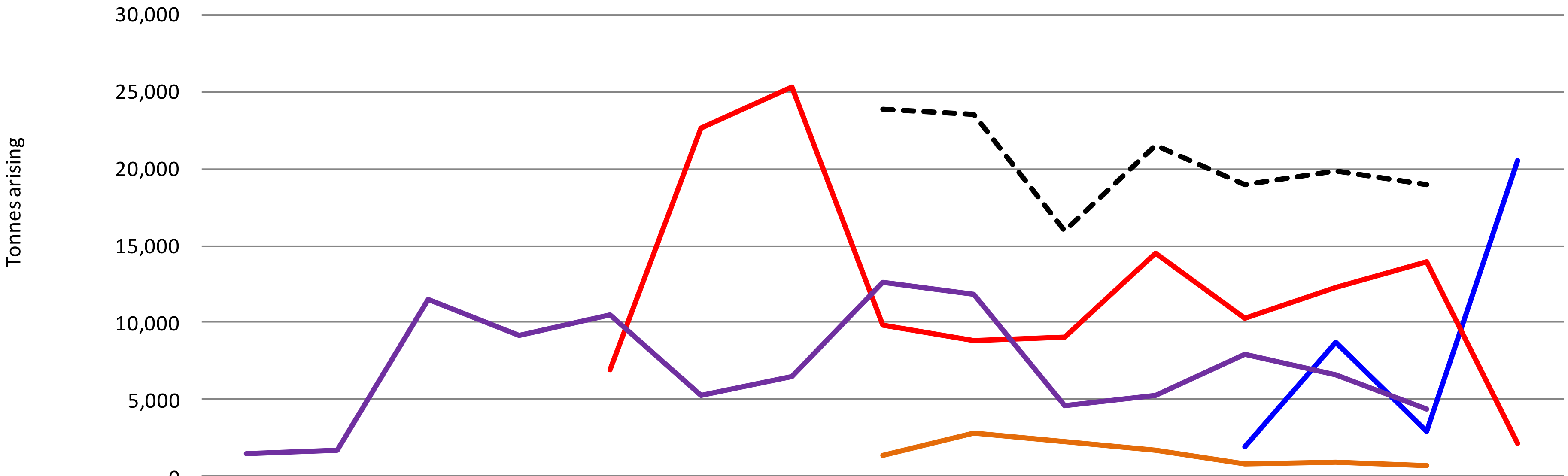
Figure 49: Historical arisings of non-toxic salts waste



	1999-00	2000-01	2001-02	2002-03	2003-04	2004/05	2005/06	2006/07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14
NSW												11,553	12,430	17,312	25,134
Vic					19,603	15,230	24,841	7,594	8,317	25,844	18,622	9,034	5,542	2,328	738
Qld	17	0	2,539	10,492	4,598	442	157	4,089	378	2,988	44,275	52,762	35,033	40,426	
WA								9,465	12,056	11,940	9,108	6,610	9,754	10,962	

Other D. Other inorganic chemicals

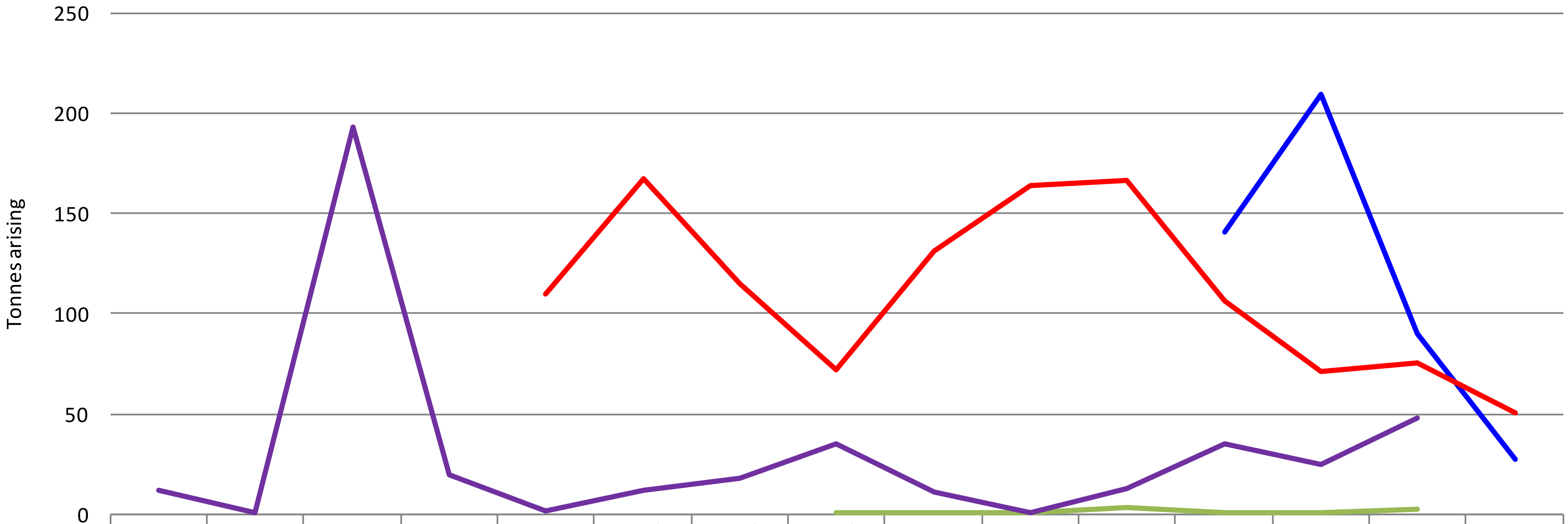
Figure 50: Historical arisings of other inorganic chemical waste



	1999-00	2000-01	2001-02	2002-03	2003-04	2004/05	2005/06	2006/07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	
NSW												1,901	8,700	2,996	20,484
Vic					6,923	22,602	25,324	9,804	8,817	9,047	14,509	10,228	12,259	13,910	2,123
Qld	1,521	1,663	11,553	9,139	10,444	5,282	6,483	12,578	11,806	4,630	5,326	7,898	6,617	4,375	
WA								1,435	2,833	2,322	1,707	795	961	679	
Vic, Qld, WA								23,817	23,455	15,999	21,541	18,920	19,837	18,964	

E. Reactive chemicals

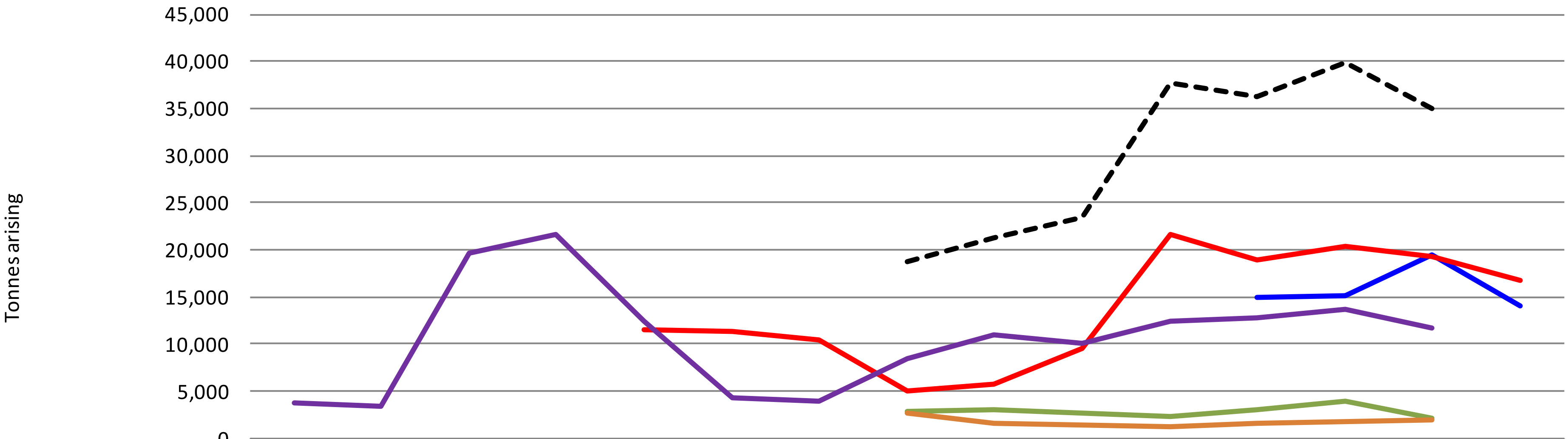
Figure 51: Historical arisings of reactive chemicals waste



	1999-00	2000-01	2001-02	2002-03	2003-04	2004/05	2005/06	2006/07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14
NSW												141	210	90	27
Vic					109	167	115	72	131	164	166	106	72	76	50
SA								0	1	1	3	1	1	2	
Qld	12	0	193	19	1	12	18	35	11	1	13	35	25	48	

F. Paints, resins, inks, organic sludges

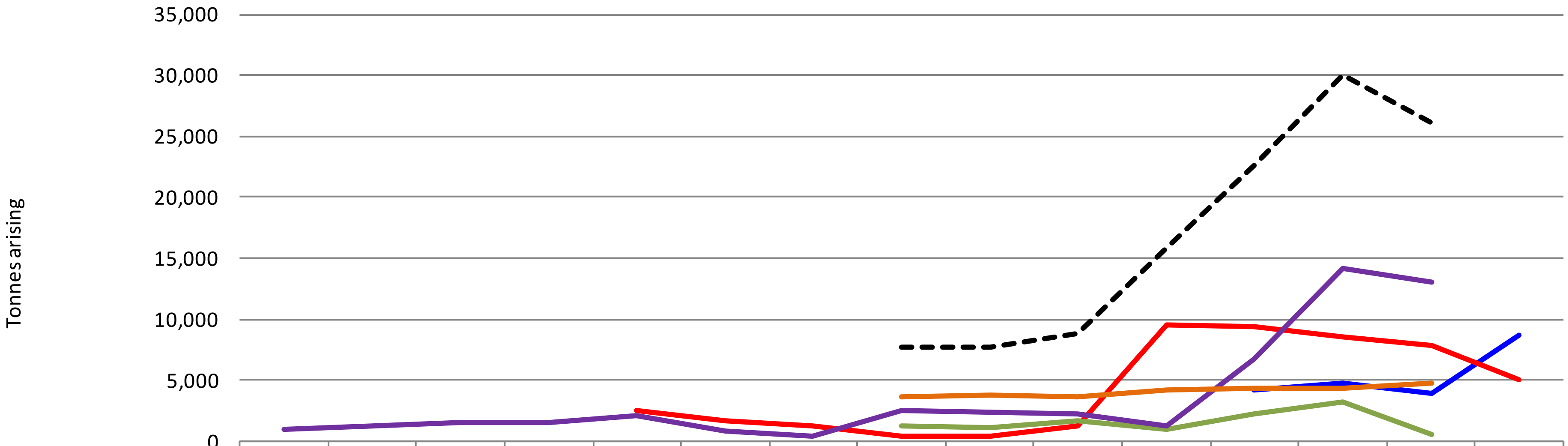
Figure 52: Historical arisings of paints, resins, inks, organic sludge waste



	1999-00	2000-01	2001-02	2002-03	2003-04	2004/05	2005/06	2006/07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14
NSW												14,965	15,191	19,409	14,082
Vic					11,500	11,308	10,404	4,938	5,801	9,514	21,685	18,915	20,410	19,245	16,737
SA								2,762	2,951	2,565	2,335	3,033	3,903	2,129	
Qld	3,678	3,418	19,605	21,645	12,346	4,255	3,931	8,490	10,888	10,058	12,479	12,717	13,717	11,700	
Vic, SA, Qld, WA								18,806	21,170	23,462	37,722	36,312	39,801	34,968	
WA								2,616	1,530	1,325	1,223	1,648	1,771	1,895	

G. Organic solvents

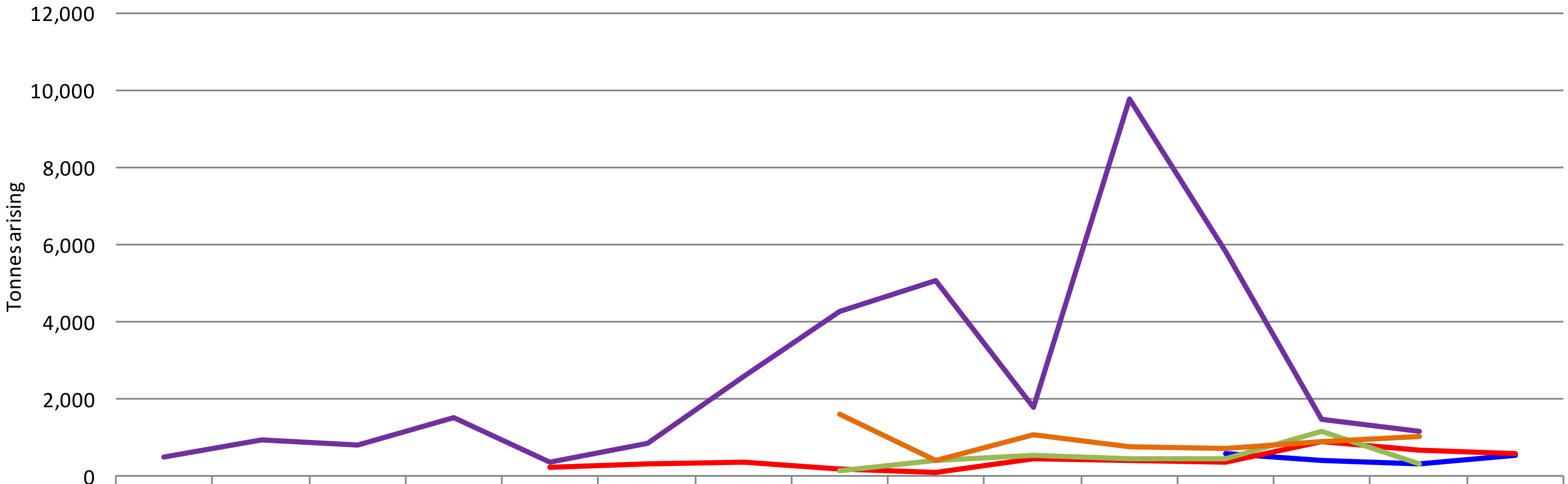
Figure 53: Historical arisings of organic solvent waste



	1999-00	2000-01	2001-02	2002-03	2003-04	2004/05	2005/06	2006/07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14
NSW	0											4,199	4,765	3,954	8,630
Vic					2,422	1,662	1,228	407	403	1,270	9,503	9,360	8,456	7,842	5,007
SA								1,210	1,082	1,641	927	2,257	3,178	481	
Qld	881	1,241	1,433	1,560	2,105	748	323	2,494	2,373	2,246	1,232	6,639	14,164	12,983	
WA								3,612	3,769	3,610	4,189	4,300	4,250	4,759	
Vic, SA, Qld, WA								7,723	7,628	8,767	15,851	22,555	30,048	26,066	

H. Pesticides

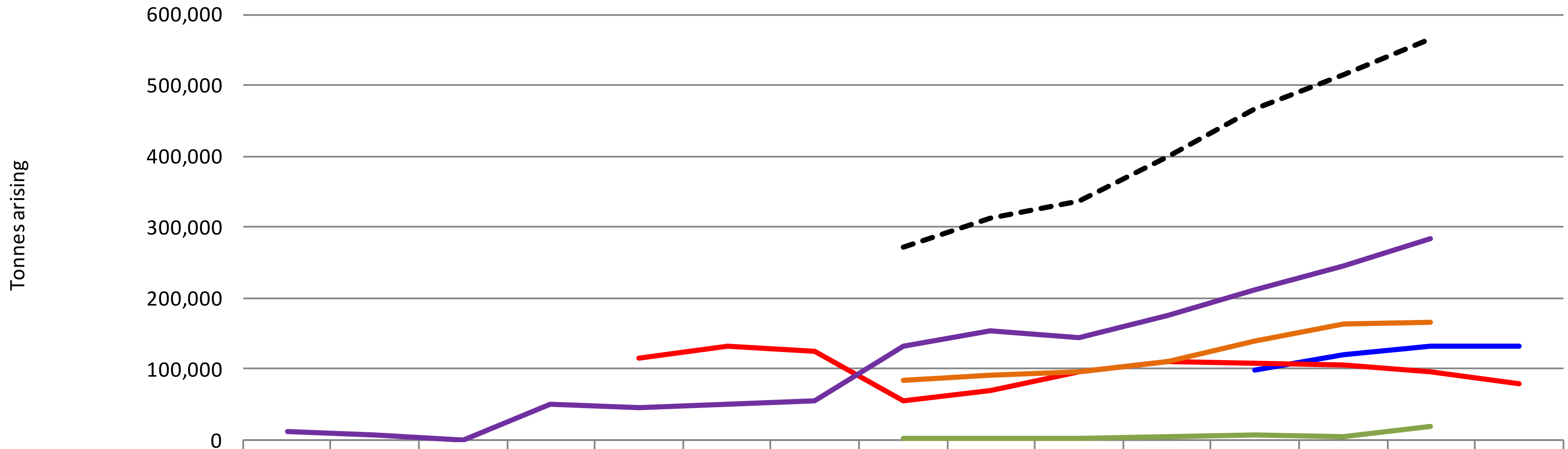
Figure 54: Historical arisings of pesticide waste



	1999-00	2000-01	2001-02	2002-03	2003-04	2004/05	2005/06	2006/07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14
NSW												573	424	313	531
Vic					247	304	386	171	115	456	402	365	893	687	591
SA								146	404	533	470	474	1,177	302	
Qld	484	947	815	1,523	350	857	2,585	4,262	5,060	1,809	9,801	5,823	1,494	1,150	
WA								1,595	431	1,061	755	742	897	1,015	

J. Oils

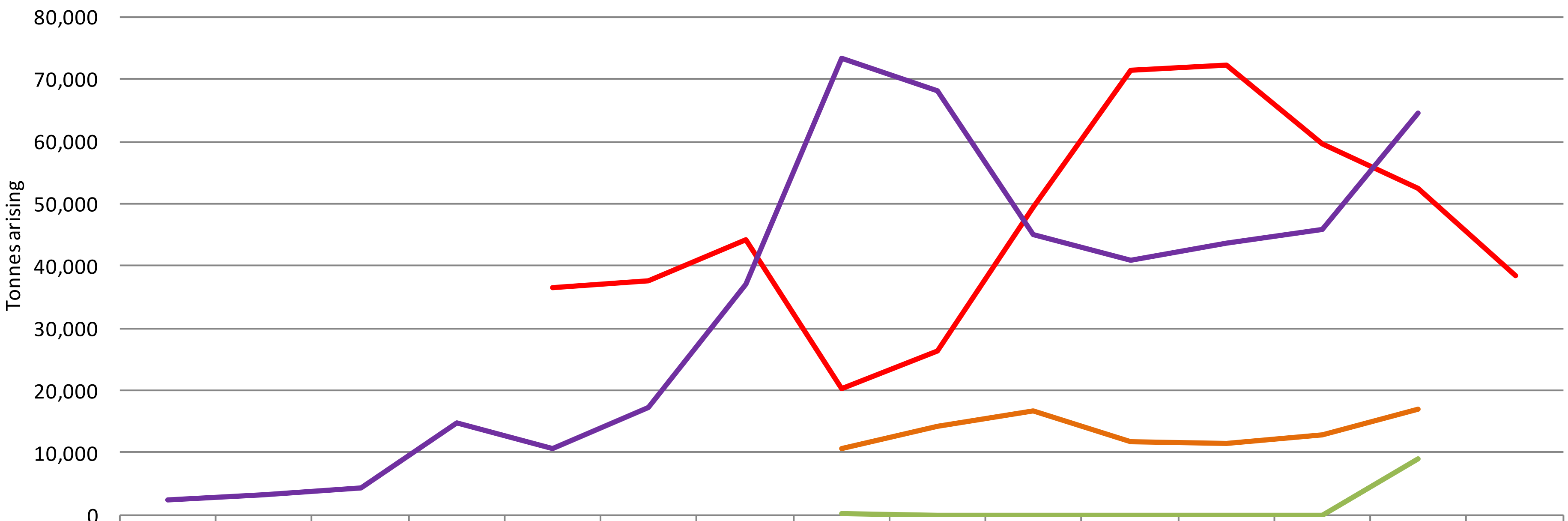
Figure 55: Historical arisings of Oil waste



	1999-00	2000-01	2001-02	2002-03	2003-04	2004/05	2005/06	2006/07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14
NSW												97,582	119,029	131,153	130,665
Vic					114,149	132,441	123,678	53,954	68,255	94,519	110,163	108,659	104,101	95,870	78,826
SA								1,448	819	1,718	4,291	7,143	4,900	19,130	
Qld	11,812	6,330	349	49,922	44,006	49,178	54,705	131,605	153,141	144,657	174,200	211,971	244,004	283,050	
WA								83,716	90,565	95,475	110,031	139,717	162,396	166,586	
Vic, SA, Qld, WA								270,723	312,780	336,369	398,685	467,491	515,402	564,636	

K100. Animal effluent and residues (+ food processing waste)

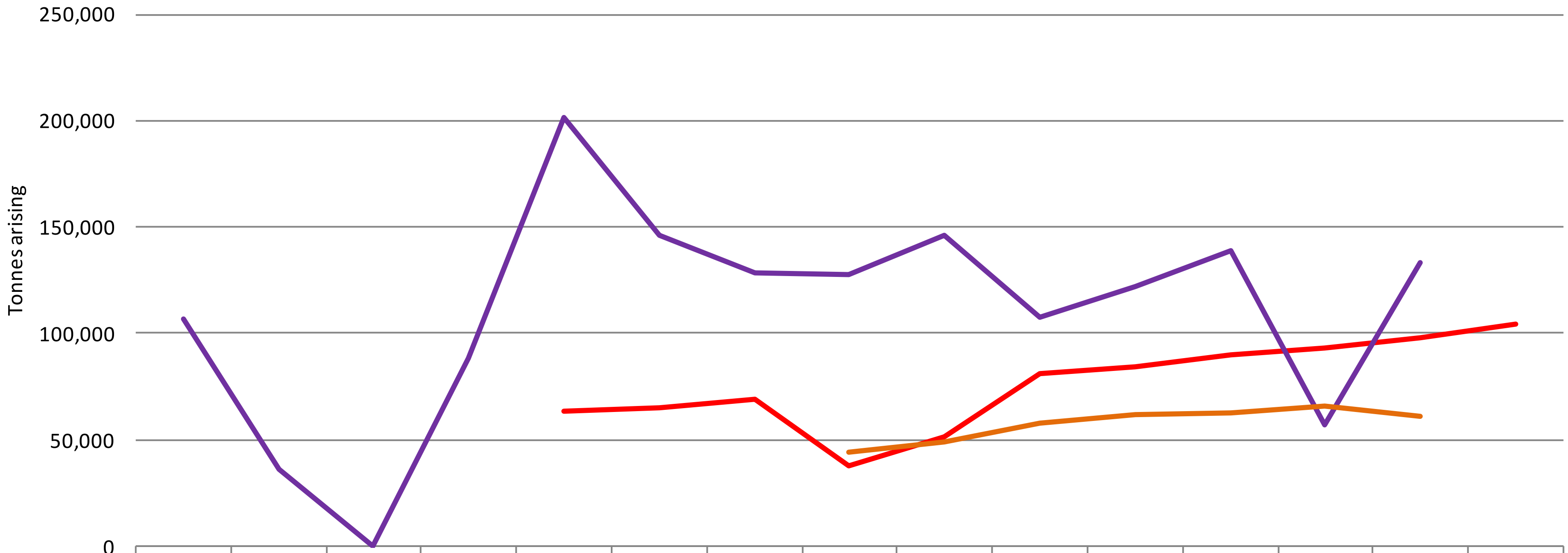
Figure 56: Historical arisings of animal effluent and residues (+ food processing waste) waste



	1999-00	2000-01	2001-02	2002-03	2003-04	2004/05	2005/06	2006/07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14
Vic					36,473	37,560	44,217	20,260	26,318	49,433	71,611	72,430	59,744	52,441	38,349
SA								90	7	7			0	8,987	
Qld	2,299	3,141	4,290	14,821	10,530	17,361	37,016	73,307	68,057	45,086	40,930	43,630	45,767	64,525	
WA								10,573	14,255	16,588	11,689	11,561	12,902	16,970	

K110. Grease trap waste

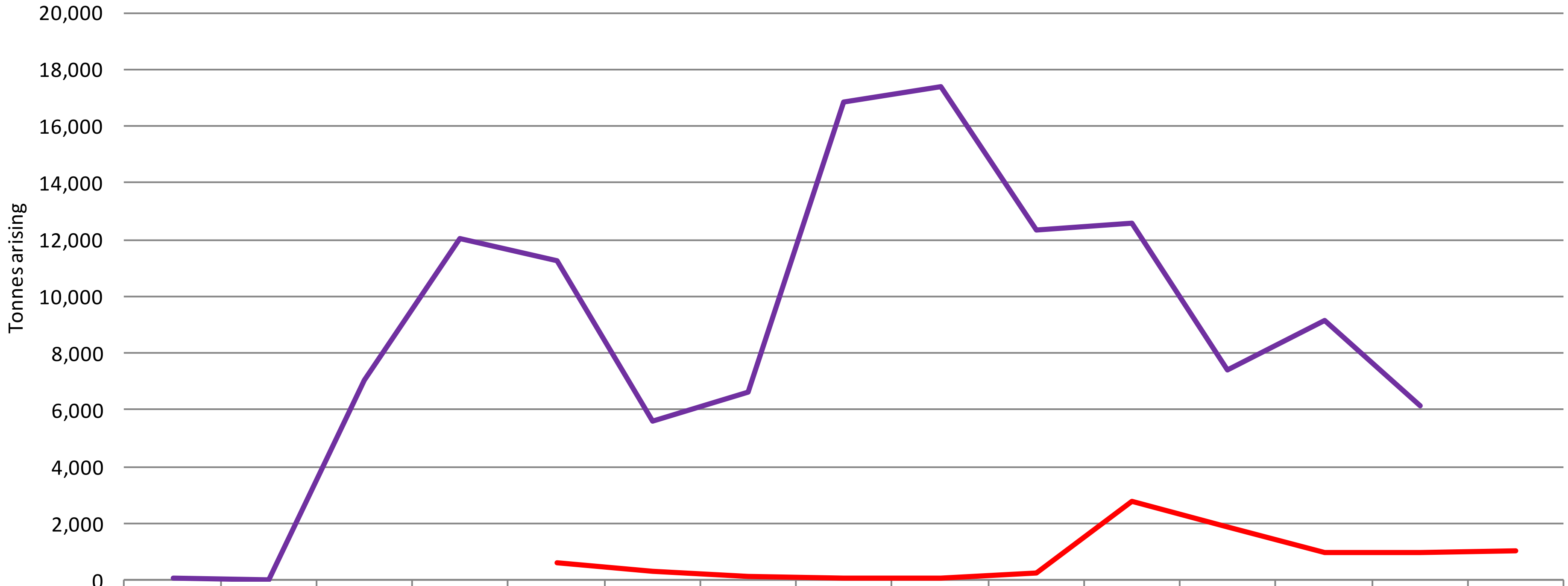
Figure 57: Historical arisings of grease trap waste



	1999-00	2000-01	2001-02	2002-03	2003-04	2004/05	2005/06	2006/07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14
Vic					63,684	65,054	69,120	37,951	51,277	80,986	84,017	90,252	93,299	98,209	104,459
Qld	107,164	35,748	33	87,946	201,137	146,479	128,209	127,772	146,048	107,234	121,797	138,482	56,954	133,635	
WA								44,338	48,880	57,457	61,415	62,864	65,758	60,952	

K140 & 190. Tannery and wool scouring wastes

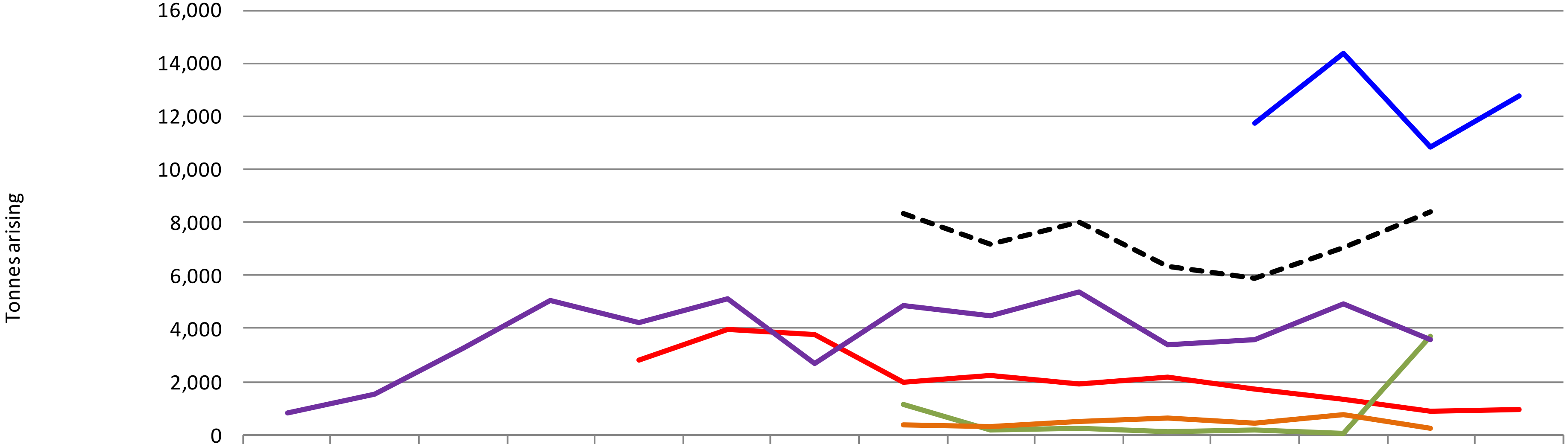
Figure 58: Historical arisings of tannery and wool scouring wastes



	1999-00	2000-01	2001-02	2002-03	2003-04	2004/05	2005/06	2006/07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14
Vic					622	311	107	33	78	271	2,793	1,856	979	982	996
Qld	81	19	7,049	12,031	11,284	5,597	6,605	16,833	17,404	12,323	12,579	7,428	9,134	6,149	

Other M. Other organic chemicals

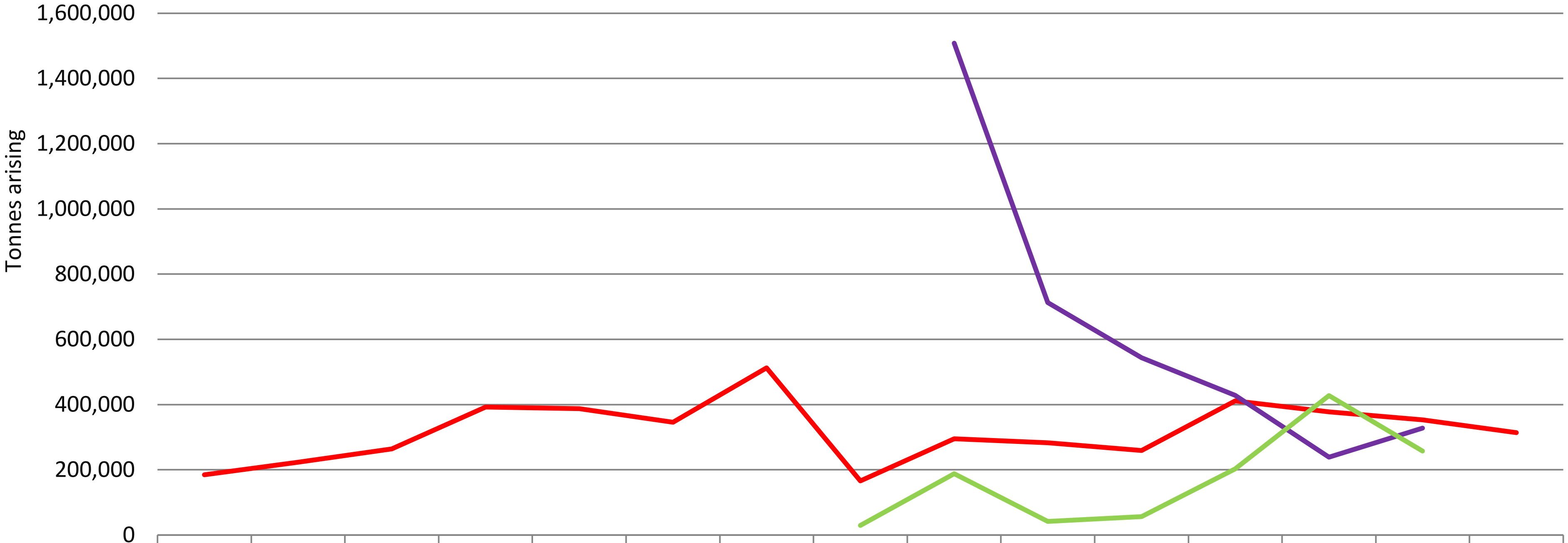
Figure 59: Historical arisings of other organic chemicals waste



	1999-00	2000-01	2001-02	2002-03	2003-04	2004/05	2005/06	2006/07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14
NSW												11,751	14,366	10,825	12,737
Vic					2,813	3,961	3,797	1,968	2,241	1,934	2,194	1,727	1,300	884	963
SA								1,114	153	232	136	157	71	3,674	
Qld	808	1,547	3,242	5,069	4,233	5,136	2,690	4,851	4,492	5,379	3,361	3,598	4,893	3,573	
WA								385	283	476	631	419	781	247	
Vic, SA, Qld, WA								8,318	7,168	8,022	6,322	5,902	7,046	8,377	

N120. Contaminated soils

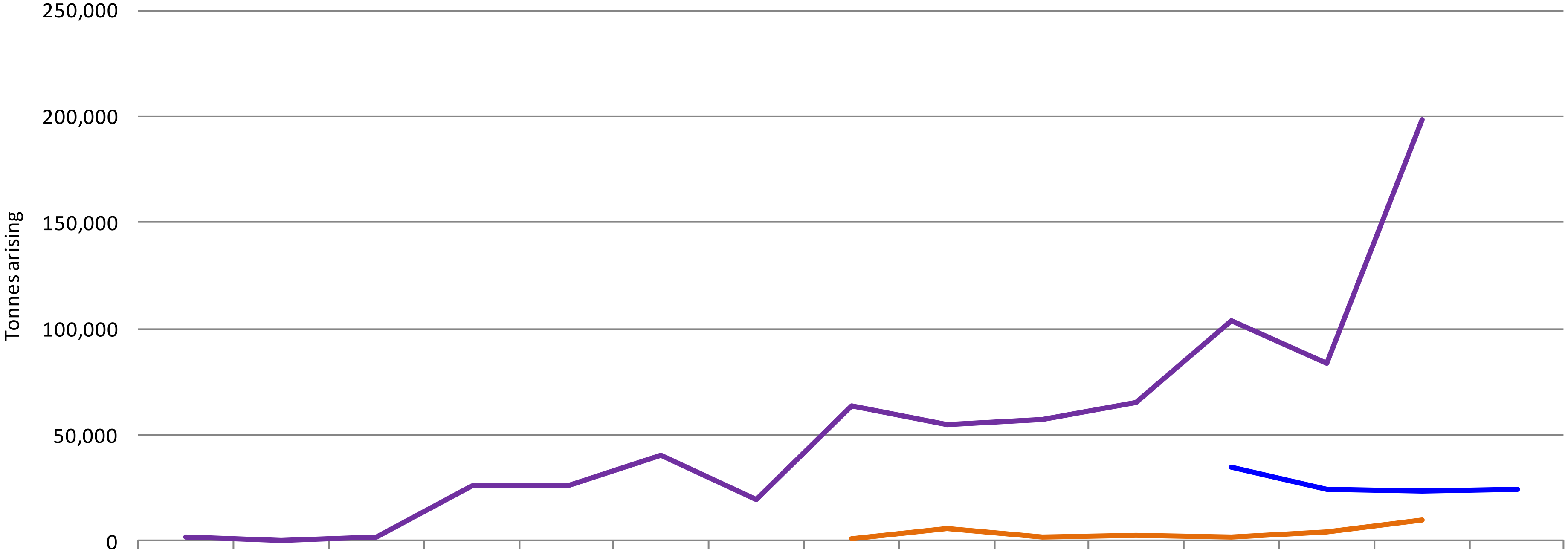
Figure 60: Historical arisings of contaminated soils waste



	1999-00	2000-01	2001-02	2002-03	2003-04	2004/05	2005/06	2006/07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14
Vic	185,214	223,506	264,088	392,439	387,133	345,507	512,835	166,205	294,850	282,756	259,257	411,371	377,783	353,134	314,335
Qld									1,508,0	712,729	543,803	428,076	238,564	327,585	
SA								29,854	188,351	41,507	56,466	202,655	427,946	257,835	

N205a. Contaminated biosolids

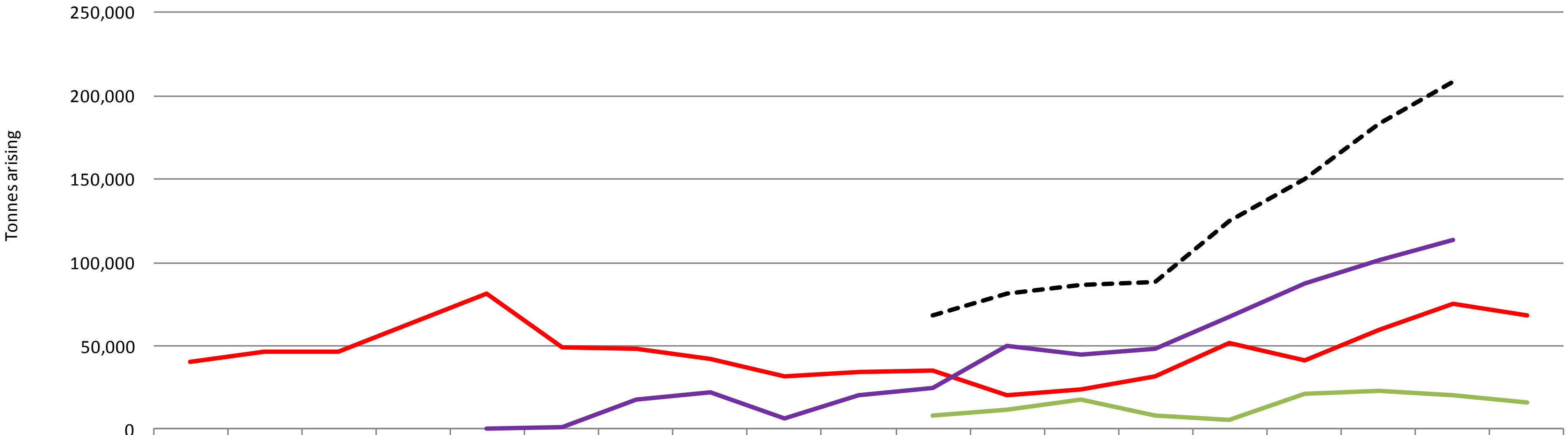
Figure 61: Historical arisings of contaminated biosolids waste



	1999-00	2000-01	2001-02	2002-03	2003-04	2004/05	2005/06	2006/07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14
NSW												34,374	24,190	23,361	24,539
Qld	2,165	473	2,153	26,066	26,292	40,261	19,735	63,983	55,050	57,251	65,242	103,962	83,928	198,750	
WA								964	5,800	1,998	2,915	2,125	4,211	9,932	

N220. Asbestos

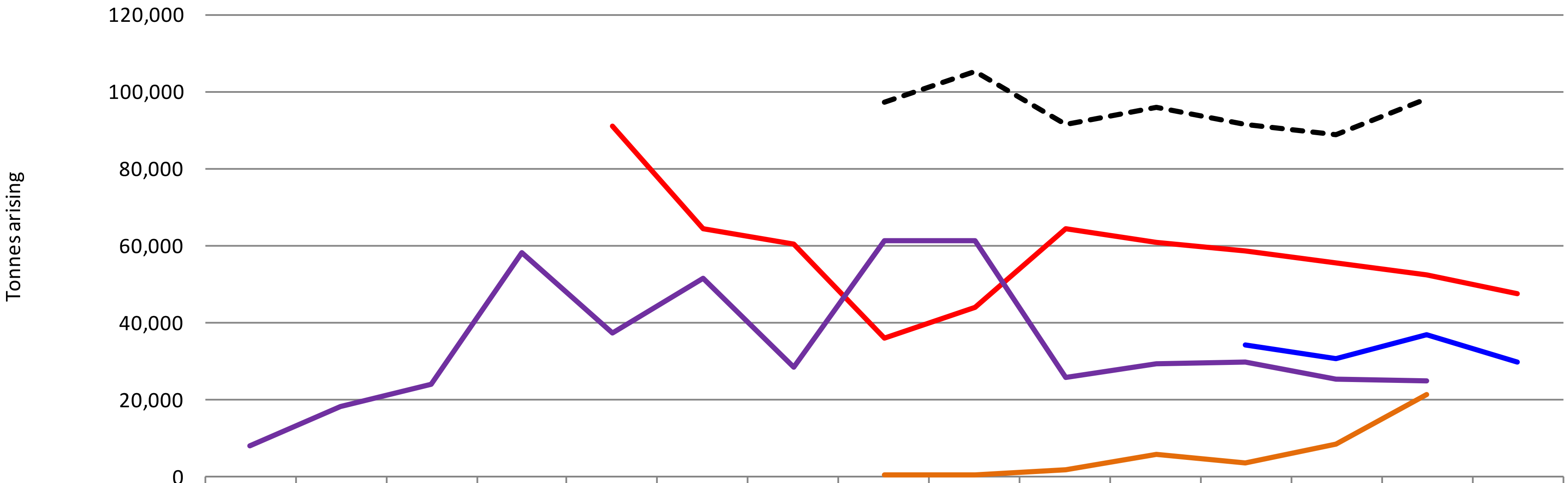
Figure 62: Historical arisings of asbestos waste



	1995-96	1996-97	1997-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04	2004/05	2005/06	2006/07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14
Vic	40,693	46,688	46,508	64,118	81,110	49,472	48,436	42,032	31,716	34,720	35,567	20,339	24,002	32,061	51,824	41,064	59,505	74,930	68,127
SA											7,798	11,757	17,602	7,798	5,916	21,085	22,828	20,129	15,991
Qld					538	1,100	17,418	21,761	6,281	20,087	24,874	49,646	44,674	48,314	67,472	87,779	101,048	113,408	
Vic, SA, Qld											68,239	81,742	86,278	88,172	125,212	149,928	183,381	208,467	

Other N. Other soil/sludges

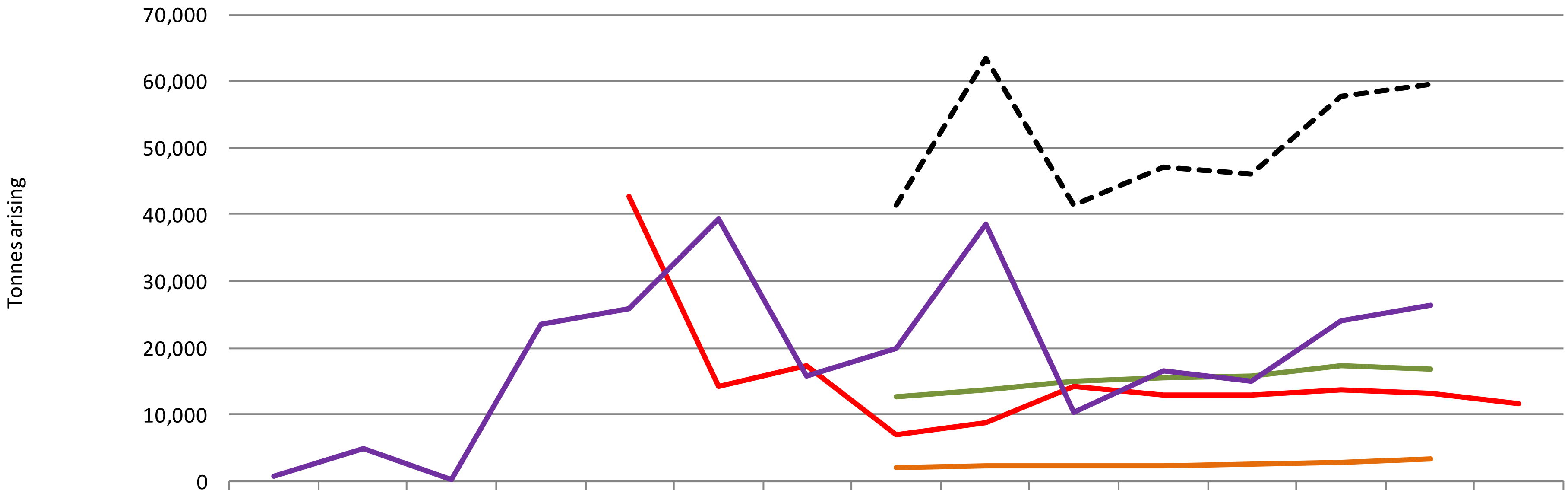
Figure 63: Historical arisings of other soil/sludge waste



	1999-00	2000-01	2001-02	2002-03	2003-04	2004/05	2005/06	2006/07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	
NSW												34,219	30,459	36,893	29,828
Vic					90,855	64,386	60,374	35,749	43,746	64,227	60,749	58,401	55,330	52,326	47,452
Qld	7,986	18,123	23,883	57,981	37,345	51,347	28,546	61,367	61,138	25,668	29,398	29,568	25,342	24,675	
WA								255	476	1,464	5,749	3,410	8,198	21,284	
Vic, Qld, WA								97,370	105,361	91,359	95,896	91,378	88,870	98,285	

R. Clinical & pharmaceutical

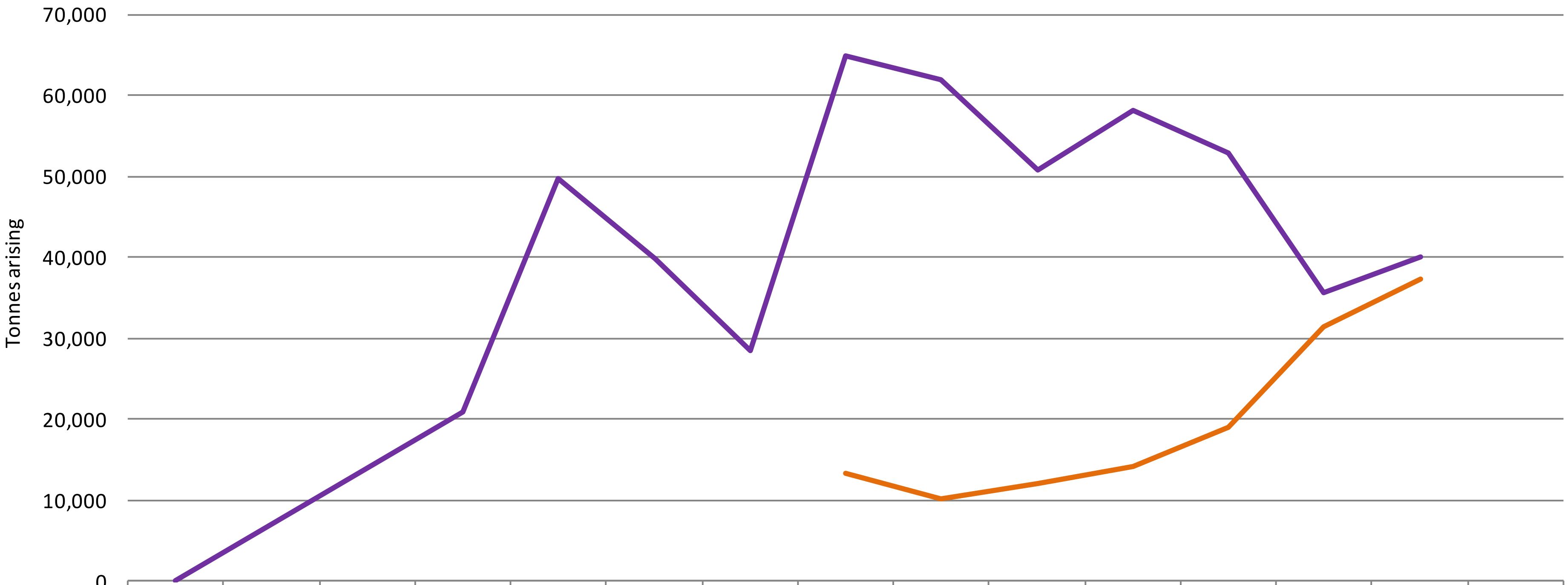
Figure 64: Historical arisings of clinical and pharmaceutical waste



	1999-00	2000-01	2001-02	2002-03	2003-04	2004/05	2005/06	2006/07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14
Vic					42,724	14,253	17,265	6,840	8,868	14,092	12,984	12,914	13,632	13,276	11,688
SA								12,691	13,800	14,841	15,369	15,641	17,374	16,772	
Qld	817	4,877	190	23,552	25,933	39,226	15,648	19,981	38,600	10,303	16,547	15,055	24,089	26,258	
WA								2,003	2,281	2,194	2,198	2,417	2,722	3,242	
Vic, SA, Qld, WA								41,515	63,548	41,430	47,098	46,026	57,818	59,548	

T140. Tyres

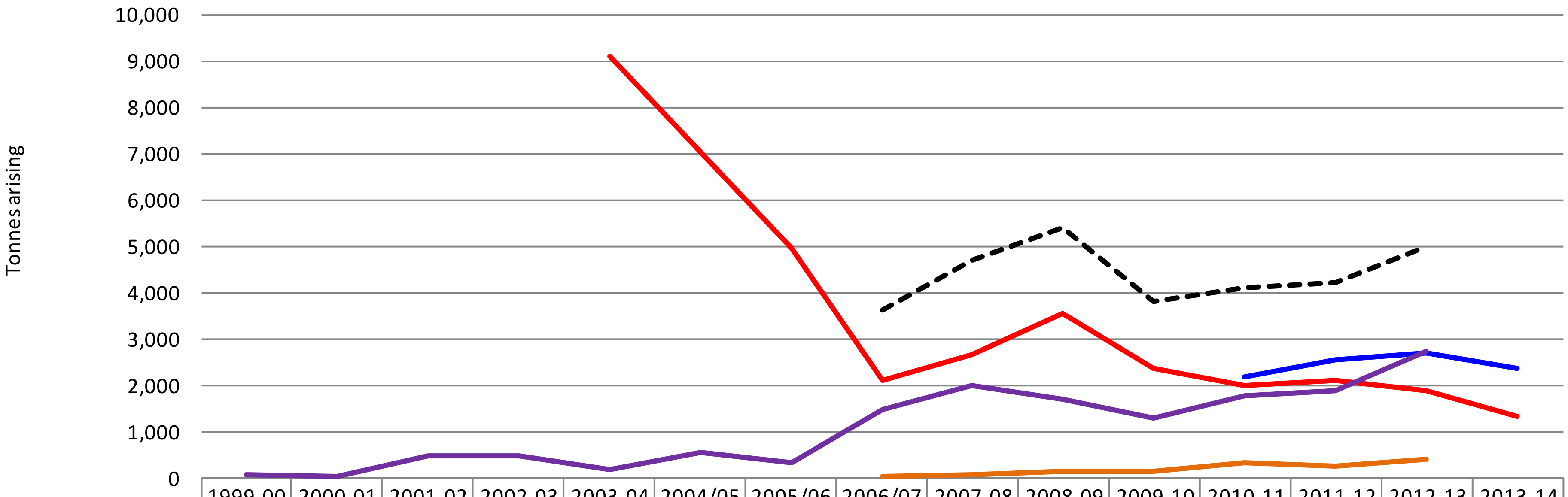
Figure 65: Historical arisings of tyre waste



	1999-00	2000-01	2001-02	2002-03	2003-04	2004/05	2005/06	2006/07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14
Qld	1			20,853	49,792	39,724	28,509	64,834	61,852	50,871	58,060	52,903	35,558	40,023	
WA								13,187	10,130	12,017	14,065	18,935	31,448	37,335	

Other T. Other miscellaneous

Figure 66: Historical arisings of other miscellaneous waste



	1999-00	2000-01	2001-02	2002-03	2003-04	2004/05	2005/06	2006/07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14
NSW												2,186	2,553	2,685	2,354
Vic					9,117	7,044	4,949	2,100	2,645	3,540	2,366	2,002	2,109	1,875	1,316
Qld	67	21	460	454	158	536	330	1,486	2,000	1,693	1,290	1,768	1,878	2,729	
WA								21	65	149	148	322	235	403	
Vic, Qld, WA								3,606	4,711	5,381	3,803	4,092	4,223	5,008	

A.5 'New Stockholm wastes' arising

Three 'new' potentially hazardous waste streams may emerge over the next five years should the Australian Government determine to ratify the recent listing of a number of new chemicals onto the Stockholm Convention on Persistent Organic Pollutants (POPs).

POPs are hazardous and environmentally persistent substances which can be transported between countries by the earth's oceans and atmosphere. POPs accumulate in living organisms and have been traced in the fatty tissues of humans and other animals. There is general international agreement that they require global action to reduce their impact on humans and the environment. The new listings of relevance to this project are POP-BDEs (a series of listed substances as described below), HBCD and PFOS. Both the POP-BDEs and HBCD are brominated flame retardant (BFR) chemicals.

In assessing the nature of any new waste streams arising from the (regulatory and management) actions that could be developed in response to a listing decision on these chemicals, consideration of their lifecycle flows as materials, articles and most importantly wastes needs to be considered. This informs the critical decision of what the hazardous wastes that contain these chemicals would look like, and therefore which ones need to be considered for this project.

POP-BDEs

POP-BDE uses

Polybrominated diphenyl ethers (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 (articles) including electrical and electronic equipment (EEE), 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 Persistent Organic Pollutants (POPs) 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.

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.

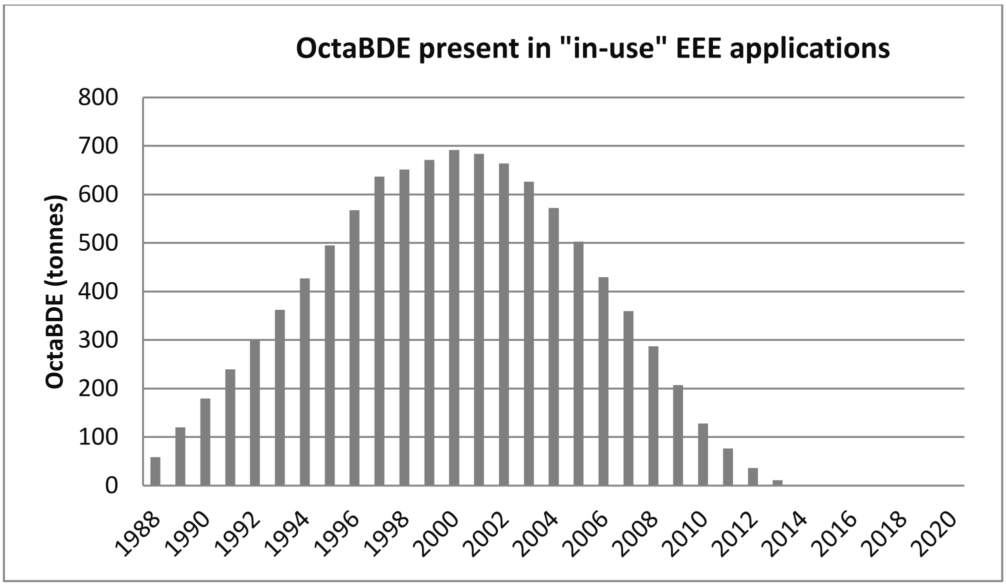
Global manufacture of articles containing POP-BDEs ceased prior to 2005, after a voluntary phase out of the use of these chemicals in manufacturing took hold, combined with international regulatory activity, such as bans on production and restriction of use in articles. In Australia, importation and manufacture of pentaBDE and octaBDE has been prohibited since early 2007, apart from comparatively insignificant laboratory use. Presently in Australia, most articles containing POP-BDEs are imported goods produced prior to 2005.

90 – 95% of pentaBDE use was as a flame retardant for the treatment of polyurethane (PUR) foam[41], with the vast majority of these foams used in car seat and furniture upholstery applications. Concentrations in the foam ranged between 3-5%. The major use of octaBDE (95%) has been as an additive to acrylonitrile butadiene styrene (ABS) polymers for the casing of electrical and electronic equipment (EEE) and typically added at concentrations between 10-18 % by weight[1]. Such items include cathode ray tube (CRT) televisions and monitors, office equipment such as printers and copying machines.

[41] Study on waste related issues of newly listed POPs and candidate POPs, ESWI, 2011.

A material flow study conducted by KMH Environmental in 2013[42] quantified historical article and PBDE flows throughout their lifecycle and identified potential environmental impact points. This study determined that all articles likely to contain either pentaBDE or octaBDE (at flame retarding levels) will have become waste by 2015, at the end of their useful lives, as shown for octaBDE in Figure 67. This is due to the combined effect of the phase-out of POP-BDE use in product manufacturing around the mid-2000's and the typical lifespan of the 'in-use' phase of these products.

Figure 67: OctaBDE in use for EEE applications



(Source: Latimer et al (KMH Environmental[43])

POP-BDE wastes (M160b)

There are a number of potential pathways for POP-BDEs to present as wastes throughout their lifecycle. Table 69 lists the potential POP-BDE containing waste types generated in Australia, and comments on the significance of each with respect to its likely inherent POP-BDE hazard and, consequently, its relevance as a hazardous waste for this study.

Critically, no Low POP Concentration Limit (LPCL) has been set for POP-BDEs, which is a level in materials that have become waste that above which would trigger management of that waste according to Stockholm Convention requirements. A level of 50mg/kg has been discussed, but levels as low as 10mg/kg have been recommended, transitioning from a start point setting of 200mg/kg[44]. Other similar POPs in Stockholm context have LPCLs of 50mg/kg, which also corresponds to Basel Convention triggers regarding organohalogen compound wastes.

Assumed waste generation scenarios for POP-BDEs are:

Low: 200mg/kg LPCL

Best: 50mg/kg LPCL

High: 10mg/kg LPCL

[42] KMH Environmental, 2013. "Reducing Releases of POP-BDEs to the Environment – Option Impact Analysis," Geoff Latimer (not yet published)

[43] KMH Environmental, 2013. "Reducing Releases of POP-BDEs to the Environment – Option Impact Analysis," Geoff Latimer (not yet published)

[44] Study on waste related issues of newly listed POPs and candidate POPs, ESWI, 2011.

Table 69: Potential POP-BDE Wastes

Potential POP-BDE Waste	Waste generation site	POP-BDE waste stream?
1. End of life article presenting for *Disposal*	Consumer disposal point	As described in Figure 67, at the time of writing and going forward, the likelihood of POP-BDEs being present in relevant end of life articles is very low. However, if a LPCL was set low enough, there is sufficient evidence that historical 'contamination' of recycled plastics in end of life products going forward could still render some over the LPCL. ***Consequently this is considered as a POP-BDE waste stream, noting that its practical relevance will be limited***.
2. End of life article presenting for *Recycling*	Consumer collection point	As described in Figure 67, at the time of writing and going forward, the likelihood of POP-BDEs being present in relevant end of life articles is very low. Moreover, there is currently a conditional recycling exemption in place for ABS plastics containing POP-BDEs. Consequently this is not considered as a POP-BDE waste stream.
3. Historical waste articles *in landfill*	Within landfill	While some of these historically landfilled items will undoubtedly contain POP-BDEs, while the articles themselves remain contained within a landfill they are deemed to be disposed of, thus no longer a waste. There is also no suggestion that such items would, could or should be extracted from landfill for treatment by other means. ***Consequently this is not considered a POP-BDE waste stream***.
4. *Landfill leachate* containing POP-BDEs	Landfill leachate collection pond discharge to sewer	ESWI[1] showed that the leaching rate for POP-BDEs was in the order of 10^{-5} - 10^{-6} of the original contamination in the waste. Limited monitoring data (various references[45]) confirms this, when compared to solids such as soils and biosolids (1,140 µg/kg dry weight[46]). While leachate volumes from landfills to sewer can be large (rainfall dependant) the actual concentration of POP-BDEs in leachate is many orders of magnitude lower than 50ppm. ***Consequently this is not considered as a POP-BDE waste stream***.
5. Emissions from in-use articles to *sewer*	Commercial trade waste and domestic discharge to sewer	Not a practical waste generation point to manage, since these inputs are distributed across property-based inputs to sewer. Additionally, the hydrophobic nature of POP-BDEs means that they will preferentially partition into the solid phase, which ultimately ends up at the Sewage Treatment Plant as sludge/ biosolids. ***Consequently this is not considered as a POP-BDE waste stream***.
6. *Biosolids* containing POP-BDEs - *produced*	Sewage Treatment Plant	One USA study[47] and one Australian study[4] correlated similar results for POP-BDEs in biosolids, in the range of 1.1 – 6.4 mg/kg, with the Australian measurements typically at the lower end of this range. While this is below a potential 50mg/kg limit, the likelihood of some biosolids stocks being potentially more contaminated than others and the fact that a limit as low as 10mg/kg could be set, means that there is some risk that biosolids could be considered hazardous waste with respect to POP-BDEs. ***Consequently this is considered as a POP-BDE waste stream***.
7. *Biosolids*	Sewage Treatment	One USA study[5] and one Australian study[4] correlated similar results

[45] Waara et al (2003), OSako et al (2004), Odusanya et al (2009), POPRC7 website, Keet et al (2010)

[46] Clarke, B., Porter, N., Symons, R., Marriott, P., Ades, P., Stevenson, G., Blackbeard, J. Polybrominated diphenyl ethers and polybrominated biphenyls in Australian sewage sludge. Chemosphere 2008, 73, 980–989.

[47] Davis, E. F., Klosterhaus,S. L. and Stapleton, H. M. 2011. Measurement of flame retardants and triclosan in municipal sewage sludge and biosolids. Environmental International 40 (2012) 1–7

	containing POP-BDEs - *stockpiled*	Plant	for POP-BDEs in biosolids, in the range of 1.1 – 6.4 mg/kg, with the Australian measurements typically at the lower end of this range. While this is below a potential 50mg/kg limit, the likelihood of some biosolids stocks being potentially more contaminated than others and the fact that a limit as low as 10mg/kg could be set, means that there is some risk that biosolids could be considered hazardous waste with respect to POP-BDEs. ***Consequently this is considered as a POP-BDE waste stream, although existing stockpiles' applicability under Stockholm is subject to policy interpretation by the Australian Government***.
8.	*Wastewater discharge* from Sewage Treatment Plant	Sewage Treatment Plant	A 2008 Chinese study[48] indicates that PBDE presence in STP effluent is strongly correlated to suspended solid concentrations, and that most of the PBDEs ended up in the sewage sludge, with <5% being discharged with the treated effluent. This study quotes STP effluent concentrations of PBDEs determined from its own and previous worldwide studies, as orders of magnitude below even a 10ppm limit. ***Consequently this is not considered as a POP-BDE waste stream***.

Table 69's analysis concludes that **biosolids** (whether historically stockpiled or recently produced) and **end of life WEEE articles destined for disposal (not recycling)**, subject to the likely concentrations of POP-BDEs being above a yet to be set threshold level, have the potential to be considered as a future hazardous waste, should Australia ratify the listing of the POP-BDEs.

Another material flow, post recycling ABS mixed plastic commodity destined for export has the potential to contain POP-BDEs. This is not included as a POP-BDE waste stream because:

- PACIA data[49] indicates that while recovered plastics were exported to China in significant quantities, ABS plastics relevant to POP-BDEs were not among these exports, since they were re-processed in a local recycling market.
- Even if they were, the quantities that could be reasonably deemed to contain levels of POP-BDEs above China's regulatory limits (1,000 mg/kg[50]) are likely to be very low, based on the lack of percentage-level POP-BDE containing articles hitting the waste stream from 2014 onwards.

Note that articles (products) in use are not yet wastes and therefore do not fall under the remit of the Stockholm Convention.

DecaBDE

While the production of commercial pentaBDE and OctaBDE (i.e. the declared POP-BDEs) has stopped, the production of decaBDE continues. The potential impact of decaBDE is currently under review as there is some evidence that commercial decaBDE can degrade in thermal processes, environmental processes and in biota to lower brominated PBDEs, including POP-BDEs (United Nations Environment Programme 2010).

Norway drafted a proposal to list commercial decaBDE on the Stockholm Convention, which was considered by the POPs Review Committee in 2013. Should decaBDE be added to the Convention at some

[48] Xianzhi Peng a, Caiming Tang, Yiyi Yu et al, Concentrations, transport, fate, and releases of polybrominated diphenyl ethers in sewage treatment plants in the Pearl River Delta, South China, Environment International 35 (2009) 303–309

[49] PACIA 2011, National Plastics Recycling Survey

[50] Levels set for PBDEs in the "China RoHS", officially known as the *Administrative Measure on the Control of Pollution Caused by Electronic Information Products*

future time there will be major consequences for the e-waste recycling industry, as decaBDE use for flame retardancy in ABS plastics has historically been much more prevalent than octaBDE.

It is noted that decaBDE is now considered along with pentaBDE and octaBDE to be included in the definition of PBDE, and therefore regulated, under Europe's RoHS Directive.

For the purposes of estimating potential new hazardous wastes for this project, decaBDE is noted as an emerging potential issue. It has not been considered in projections because the uncertainty of its listing combined with the likely long lead time (7-10 years before a ratification decision by Australia and longer still for any regulatory consequences to take effect).

There is also the question about the extent/ rate of possible debromination processes in biosolids in particular, and also in environmental media. This study's projections will not consider such debromination when projecting quantities of the lower BDEs (octa and penta) as this is a level of complexity we cannot model with any accuracy, in the context of the wide range of variables that already exist for these estimations/ projections.

HBCD

Although not a PBDE, another BFR known as Hexabromocyclododecane (HBCD), which has been historically used for flame retardancy in extruded and expanded polystyrene foams, was listed on the Convention in May 2013 with specific exemptions and allowed uses.

HBCD uses

HBCD has been on the world market since the 1960s but its use in the production of flame-retarded polystyrene materials only began in the 1980s (EC 2008). HBCD is used primarily as an additive flame retardant. The four main products in which HBCD is used are:

- expandable polystyrene (EPS)
- extruded polystyrene (XPS)
- high Impact Polystyrene (HIPS)
- polymer dispersion for textiles.

End-product uses include insulation and packing materials (EPS, XPS), electrical and electronic parts (HIPS) and textile coating agents (polymer dispersions). The main use (88%) of HBCD is for flame-retarded polystyrenes, predominantly EPS (see Table 70).

Table 70: Distribution of HBCD by use pattern

Form	Use	% use of total imported HBCD
Expandable and extruded polystyrene resin (EPS)	Domestic and industrial building insulation; Packaging for industrial products; beanbag fill; other (incl. automotive)	>88%
Other resins	Housing for electrical appliances	<5%
Textile coating additive	Blinds, public seating, garments	5%
Unspecified plastics in imported finished articles	Inkjet printers, projectors, scanners, ventilation units	<1%

Source: NICNAS Priority Existing Chemical Assessment Report No. 34, Table 4.2

Information provided for the application of imported EPS resin indicated that the majority is used in house insulation, exterior walls and sandwich panels.

HBCD Wastes (M160c)

The Priority Existing Chemical Assessment Report on HBCD (NICNAS) notes the following import quantities of HBCD (page 24):

Table 71: Quantity of HBCD imported into Australia

Product type	Concentration of HBCD (%)	Total quantity of HBCD (tonnes)							
		1998–99	2003–04	2004–05	2005–06	2006–07	2007–08	2008–09	2009–10
Technical grade	~99%	n.d.	12	41.5	51.7	32.0	43	30	0
Liquid dispersions	30%–60%	n.d.	<5	<5	<2	<1	2.0	0.38	0.69
Expandable polystyrene (EPS) resin and beads containing HBCD	0.5%–1%	n.d.	14.5	14.7	30.0	30.0	36	17.0	45.0
Finished articles Extruded polystyrene	<3%	n.d.	5.3	6.1	6.4	2.0	5.0	7.7	9.9
Inkjet printer, scanners, printers	<5 ppm	n.d.	n.d.	<1	<1	n.d.	n.d.	n.d.	n.d.
LCD digital audiovisual system	<1000 ppm	n.d.			n.d.	n.d.	n.d.	n.d.	n.d.
TOTAL	**-**	**36.0**	**37.0**	**68.3**	**91.1**	**65.0**	**86.0**	**55.0**	**60.5**

n.d. = no data

(Source: NICNAS Priority Existing Chemical Assessment Report No. 34, Table 4.1)

ACIL Allen Consulting is preparing for the Department a cost benefit analysis to support a decision RIS on HBCD. Extracts obtained from this working draft note:

- For the purpose of this study, and using NICNAS data from 1998-99 to 2009-10, we have estimated Australian imports of HBCD rising linearly from 5.3 tonnes in 1989 to a projected 112 tonnes in 2014.
- The HBCD content of EPS / XPS is small. Load factors of 0.5 - 1 per cent are common for EPS and are commonly around 2 per cent in XPS.

What is not available is the total quantity of either HBCD containing products or an estimate of the proportion of these that arises as waste.

As is the case with POP-BDEs, HBCD has no LPCL set, which would determine the level in waste below which the Stockholm Convention would not apply. Assuming similar chemical properties and hazards posed by the brominated nature of HBCD to those currently under consideration for POP-BDEs, the same range of possible LPCL-based waste arisings scenarios (for projection purposes) has been determined for HBCD:

Assumed waste generation scenarios for HBCD are:

Low: 200mg/kg LPCL

Best: 50mg/kg LPCL

High: 10mg/kg LPCL

Any of these levels would capture waste EPS/ XPS, which have HBCD present at levels above 5000 mg/kg.

HBCD has been detected in sludge in U.S. and European sludge. Representative concentration sets are shown below.

Table 72: Concentrations of HBCD in biosolids as reported in the literature

Location	HBCD Range µg/kg, dry weight	HBCD Mean µg/kg, dry weight
Sweden (n = 50), Law et al., 2006	3.8 – 650	45
England (n = 5), Morris et al., 2004	531 – 2,683	1,401
Ireland (n = 6), Morris et al., 2004	153 – 9,120	3,322

These levels are similar, although perhaps slightly higher than POP-BDE levels found in biosolids in Australia.

Qualitatively, the wastes considered as part of scenario projections with respect to HBCD are:

- End of life EPS building insulation panels/ materials from demolition or retrofitting of buildings
- Dependent on yet to be set LPCLs, biosolids with accumulated levels of HBCD above LCPLs.

PFOS

Perfluorooctanesulfonic acid or perfluorooctane sulfonate (PFOS), is a man-made fluorosurfactant and global pollutant. PFOS 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 on Persistent Organic Pollutants in May 2009.

PFOS uses

PFOS has been used in a range of applications including the following:

- hard chromium plating (referred to as hard metal plating in the Stockholm Convention)
- decorative chromium plating (referred to as decorative plating in the Stockholm Convention) and plastics etching
- fire-fighting foam concentrates (aqueous film forming foams, or AFFF).

Recent information provided by the Department shows 2013 use and stocks of PFOS:

Table 73: Summary of PFOS applications and estimates of PFOS use and stocks in 2013

Application sector	PFOS application	PFOS used in manufacturing process or incorporated into products?	PFOS use in 2013 (kg)	Stocks at end 2013 (kg)	Stockholm Convention: Acceptable purpose or Specific exemption
Surface finishing (metal plating)	Hard chromium plating (with closed loop recovery system)	Manufacturing process	162	81	Acceptable purpose
	Hard chromium plating (without closed loop recovery system)	Manufacturing process			Specific exemption
	Decorative chromium plating and plastics etching	Manufacturing process	30	15	Specific exemption
AFFF concentrates	Aqueous film forming foams	Products	4,200	37,700	Acceptable purpose
Totals	-	-	**4,392**	**37,796**	-

(Source: PFOS information summary supplied confidentially by the Department of the Environment)

These figures suggest that 96% of PFOS in use and 99.7% of PFOS in stocks in Australia is for the purpose of firefighting with Aqueous Film Forming Foams (AFFF). AFFF is no longer sold containing PFOS, which means that the use of PFOS in AFFF is due to its presence in existing AFFF stocks. AFFF stocks have continued to decline and are estimated to stand at 37,700 kg, down around 25% from the 50,200 kg estimated for 2010.

AFFF concentrates in Australia are estimated to contain on average 2.5% w/v of PFOS (Infotech Research, 2012a, as summarized by DoE).

PFOS wastes (M160a)

The Stockholm Convention allows the use of PFOS in AFFF applications, however any resultant firewater from firefighting using this foam is a potential new waste that should be managed/ destroyed as per Stockholm requirements. Due to the phasing down and current emphasis on destruction of AFFF stored concentrates that contain PFOS, this is expected to be a diminishing waste stream.

Queensland drafted a policy for management of firefighting foam, specifically around the use of PFOS and other "fluorinated organic compounds" used as ingredients in these foams and their concentrates[51]. This policy was released as a draft in September 2013, and as of October 2014 it does not appear to have been finalised. It states that:

- *"Use of foams that contain the fluorinated organic compounds PFOS (perfluorooctanesulphonate) and PFOA (perfluorooctanoic acid) or any compound that degrades or converts to those compounds at a concentration of greater than 10mg/kg (in concentrate) are not to be used and must be withdrawn from service immediately and managed as a regulated waste."*
- *"All solid and liquid wastes that contain fluorinated organic compounds (e.g. concentrates, firewater, wash-water, run-off, soils, absorbents, etc.) are regarded as regulated wastes and must only be disposed of through a facility that is licensed to take regulated wastes."*

[51] http://www.amerex-aust.com.au/sites/default/files/web/Solberg/Policy-QLDFirefightingFoamsV3-0.pdf

- *"Notwithstanding that firefighting foams containing PFOS and PFOA must not be held or used, water contaminated by fluorinated organic compounds must not be released to the environment if the levels of fluorinated organics exceed the following levels:*

Compound(s)	***Water trigger value (µg/L)***
PFOS	*0.3*
PFOA	*0.3*
Total fluorinated organic compounds	*0.3 (total excluding PFOS & PFOA)"*

(Extract from Queensland DEHP draft policy on the Management of Firefighting Foam[11])

Provided in the following table is the change in estimated PFOS based AFFF concentrate and equivalent quantities of PFOS by industry sector between the end of 2010 and the end of 2013. PFOS in stocks has decreased by approximately 25% or around 12,500 kg of PFOS. A reasonable proportion of this has been reported as thermally destroyed

Table 74: AFFF concentrates and PFOS in stocks by industry sector

Industry sector	**Estimated stocks – end 2010**		**Estimated stocks – end 2013**	
	AFFF - PFOS based (L)	**Equivalent PFOS (kg)**	**AFFF - PFOS based (L)**	**Equivalent PFOS (kg)**
Fire-fighting authorities	~0	~0	~0	~0
Airports – mobile	~0	~0	~0	~0
Airports – hangers	425,100	10,600	319,300	8,000
Docks	340,100	8,500	255,400	6,400
Defence facilities	~0	~0	~0	~0
Petrochem., mining, & other industry	1,241,300	31,000	932,300	23,300
Total	**2,006,400**	**50,200**	**1,507,000**	**37,700**

(Source: PFOS information summary supplied confidentially by the Department of the Environment)

Like POP-BDEs and HBCD, another waste consideration for PFOS is biosolids. Figures recently presented to a biosolids conference in the USA [52] show levels of PFOS in biosolids up to 5.4 mg/kg. The author understands that some preliminary unpublished data indicates levels in biosolids in Australia are lower than this by an order of magnitude.

ESWI (2011)[53] have recommended lower PFOS LPCLs (than POP-BDEs) for consideration: 1mg/kg (the lowest of three options discussed), but with specific reference made to 0.5mg/kg as a biosolids-only level.

ESWI 2011[13] states of PFOS:

> *"It is oleophobic as well as hydrophobic and can therefore be used as a repellent for water, soil and dirt. The PFOS salt is more hydrophilic and disperses more easily in the water environment than the non-dissociated acid and sulfonamides, which are less hydrophilic and are more volatile and will be able to be transported long-range by air. "*

This means that unlike the POP-BDEs and HBCD, PFOS (and, in particular, its salts) could also be present in significant quantities in wastewaters.

[52] Hundal, L, Metropolitan Water Reclamation District of Greater Chicago, MWEA Biosolids Conference, Big Rapids, Michigan, March 2014 (http://www.mi-wea.org/docs/Dr.%20Hundal%20-%20Exposure%20Risks.pdf)

[53] Study on waste related issues of newly listed POPs and candidate POPs, ESWI, 2011.

Table 75 looks at the options for consideration as possible PFOS wastes for the purposes of arisings projection.

Based on discussion in the literature around possible LPCLs for PFOS[54], the following levels will be assumed for framing scenarios:

Assumed waste generation scenarios for PFOS are:

Low: 100mg/kg LPCL

Best: 10mg/kg LPCL

High: 1mg/kg LPCL

Table 75: Potential PFOS wastes

Potential PFOS Waste	Waste generation site	PFOS Waste stream?
1. AFFF stocks planned for thermal destruction	Airports, docks, other industrial facilities	Some AFFF concentrate stocks are currently being thermally destroyed. ***Consequently this will be considered as a POP-BDE waste stream, noting that its practical relevance will be limited***.
2. AFFF-containing firewaters and debris	At and downstream of a fire fighting site	The volumes of firewater and debris from firefighting scenes annually could be very high, and at 2.5% PFOS in the concentrates it is possible that diluted fire waters could be above yet to be set LPCLs. While fire waters and debris are tracked as hazardous waste presently, the volumes reported suggest it is has not been a compliance priority in the past. Also, fire waters are likely to be uncontained at the scene, resulting in uncaptured run-off to stormwater and directly into the environment. Those quantities that run off to sewer will ultimately be reflected primarily in biosolids concentrations. ***While there is difficulty in estimating fire water quantities, and they may directly entering waste infrastructure at present, this will be indirectly considered as a PFOS waste stream***.
3. Industrial mist dispersant waste	Industrial facilities conducting chrome plating and plastics etching	Since these uses make up <5% of PFOS imports used in Australia, ***this will not be considered as a POP-BDE waste stream***.
4. Biosolids containing PFOS	Sewage Treatment Plant	The fact that a limit as low as 1 or even 0.5mg/kg could be set means that there is some risk that biosolids could be considered hazardous waste with respect to PFOS. ***Consequently this will be considered as a PFOS waste stream***.
5. Wastewater discharge from Sewage Treatment Plant	Sewage Treatment Plant	ESWI[16] shows that PFOS's chemistry means it could partition to waste waters (as opposed to suspended solids in waste waters) more than the other Stockholm POPs considered in this paper. While leachate volumes from landfills to sewer can be large (rainfall dependant) actual concentrations of PFOS in leachate in Australia is unknown at present. Assuming the most stringent LCPL of 1 mg/kg could also be applied to waters (at 1mg/L), an international review[55]

[54] Study on waste related issues of newly listed POPs and candidate POPs, ESWI, 2011.

[55] Zareitalabad, et al, Perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS) in surface waters, sediments, soils and wastewater – A review on concentrations and distribution coefficients, Chemosphere 91 (2013) 725–732

			notes average concentrations of PFOS in WWTP effluent of 0.011 ug/L, compared to 69 ug/kg for sewage sludge, well below the lowest LPCL. ***Consequently this will not be considered as a PFOS waste stream.***
6.	Landfill leachate containing PFOS	Landfill leachate collection pond discharge to sewer	In a similar vein to WWTP discharge, landfill leachate is unlikely to contain PFOS at concentrations above the lowest predicted LCPL (1ppm). ***Consequently this will not be considered as a PFOS waste stream.***

Consequently, AFFF stocks, firewaters and biosolids, over a yet to be set LPCL, are potential hazardous waste streams worthy of consideration for 'new' waste projections.

Although WWTP effluent volumes are extremely large and could represent a large emission source of PFOS to the environment, likely concentrations of PFOS within these waste waters would be expected to be orders of magnitude less than LPCLs of 1mg/L.

Summary of arisings

Potential biosolids volumes above LPCLs

There is potentially 329,500t of biosolids produced in Australia in 2013[56] (dry weight). This corresponds to 1,464,000t wet weight. The table below partitions these biosolids according to estimates of POP concentrations as discussed throughout this section.

Table 76: Estimated baseline year arisings of POPs in biosolids under different LPCL settings

POP in biosolids	**Waste Arising Scenario**		
	High (assumed LPCL mg/kg)	**Best (assumed LPCL mg/kg)**	**Low (assumed LPCL mg/kg)**
PFOS	1	10	100
POP-BDEs	10	50	200
HBCD	10	50	200
Assumptions & assessment for 2013 biosolids volumes	• Estimate 5% of biosolids contain PFOS > 1 mg/kg[57] • Negligible biosolids contain POP-BDEs > 10mg/kg • Estimate 2% of biosolids contain HBCD > 10 mg/kg (based on the one result from limited international data in Table 4 very close to the limit (9mg/kg))	• Estimate 0.5% of biosolids contain PFOS > 10 mg/kg • Negligible biosolids contain POP-BDEs > 50mg/kg • Negligible biosolids contain HBCD > 50 mg/kg	• Negligible biosolids contain PFOS > 100mg/kg • Negligible biosolids contain POP-BDEs > 200mg/kg • Negligible biosolids contain HBCD > 200 mg/kg
M160a – PFOS	Estimated biosolids as hazardous waste M160a = 1,464,000 x 0.05 = **73,000 t** in 2013 (if LPCL was in place)	Estimated biosolids as hazardous waste M160a = 1,464,000 x 0.005 = **7,300 t** in 2013 (if LPCL was in place)	Estimated biosolids as hazardous waste M160a = **0 t** in 2013 (if LPCL was in place)
M160b – POP-BDEs	Estimated biosolids as hazardous waste M160b =	Estimated biosolids as	Estimated biosolids as

[56] Australian & New Zealand Biosolids Partnership - 2013 survey
[57] Estimate for European biosolids from p.242: *Study on waste related issues of newly listed POPs and candidate POPs, ESWI, 2011*

	1,464,000 x 0 = **0 t** in 2013 (if LPCL was in place)	hazardous waste M160b = **0 t** in 2013 (if LPCL was in place)	hazardous waste M160b = **0 t** in 2013 (if LPCL was in place)
M160c - HBCD	Estimated biosolids as hazardous waste M160c = 1,464,000 x 0.02 = **29,000 t** in 2013 (if LPCL was in place)	Estimated biosolids as hazardous waste M160c = **0 t** in 2013 (if LPCL was in place)	Estimated biosolids as hazardous waste M160c = **0 t** in 2013 (if LPCL was in place)

Potential other waste volumes above LPCLs

Non-biosolids wastes are explored in the table below as potential new Stockholm POP wastes over the forecast period (20 years).

Table 77: Estimated baseline year arisings of other POP-wastes, under different LPCL settings

	Waste Arising Scenario		
POP in waste	**High (assumed LPCL mg/kg)**	**Best (assumed LPCL mg/kg)**	**Low (assumed LPCL mg/kg)**
M160a - PFOS	**Fire Waters and AFFF concentrates containing PFOS** • 2012 waste tracking data for N140 Fire debris and fire wash waters = 2,668 t • This volume suggests that firefighting water/ debris is not fully captured in tracking systems and may not be well contained and recovered from fire scenes at all • End 2013 estimates of AFFF stocks in Australia are 1,507 tonnes • This has reduced 25% from 2010 estimates, which is approximately equivalent to a 10% reduction per year • 1,507 x 0.1 = **151 t** will be reduced from stocks in 2014 • A 'reasonable' proportion of this 151 t is thermally destroyed (as described in DoE briefing information) • On the basis that AFFF concentrates are still an allowable use under Stockholm and the concentrates are perfectly effective and functional in firefighting, we have assumed 'reasonable' to be 25% of 151 t = **38 t** of AFFF concentrate will be destroyed in 2014 • This leaves **113 t** of AFFF to be used in firefighting in 2014 • These concentrates are used in the field diluted at approximately 3% with water[58] • Estimate total working foam mixture consumed in firefighting in 2014 = 113 x 100/3 = **3,767 t** • Assume all of this volume becomes waste without further dilution, and all will be above any LCPLs to be set • Total estimate of PFOS wastes as fire waters and AFFF concentrates presenting for disposal in 2014 = 3,767 + 38 = **3,805tpa**		
	1	**10**	**100**
AFFF concentrates for destruction	38	38	38
Fire waters	3,767	3,767	3,767
M160b - POP-BDEs	**WEEE presenting for disposal (not recycling)** • Total WEEE in 2007/08 was 106,000 t and 10% recycled • Projected to grow to 181,000 t by 2027/28 and assume max. penetration of TV & Computers program is 80% • Assuming linear growth this equates to 3,750 t growth in WEEE per year		

[58] Chemguard Specialty Chemicals and Equipment Data Sheet, 2005 (http://www.chemguard.com/pdf/General-Foam-Information.pdf)

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• At 2012/13 estimate of WEEE is 124,750 t with approx. 30% recycled
• UNEP Inventory Guidelines indicate polymer content of average WEEE items is 30% of the weight of the article
• Estimate of ABS polymer casings at 2012/13 = 0.3 x 124,750 = 37,425t
• Assuming 30% recycling then 70% goes to landfill = 0.7 x 37,425 = **26,198t ABS polymer casings to landfill**
• Latimer (2013)[59] found that the amount of WEEE presenting in Australia from 2014/15 onwards with POP-BDEs at flame retarding levels will be negligible
• Bentley (2013)[60] analysed 18 brand new TVs and computer equipment in Australia (amongst other EEE) and found 10 above 50ppm for octaBDE and 5 above 200ppm for octaBDE. Levels identified were too low for flame retardancy and are assumed to be due to contamination of 'clean' plastics with POP-BDE containing recyclate plastics, thereby maintaining a lower but significant level of POP-BDEs in new products.
• Latimer (2) (2013)[61] tested 124 WEEE samples in New Zealand for Br, and analysed 15 representative high positives for POP-BDEs, finding no detectable levels of POP-BDEs
• In the largest study conducted in recent years, Sindiku analysed 383 samples of CRT TVs and monitors aged from the mid '80s – 2004 (highest anticipated usage period for POP-BDEs). Only 2% of these results were positive for octaBDE, at average concentrations around 50,000 mg/kg

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<tr><td></td><td>10</td><td>50</td><td>200</td></tr>
<tr><td>WEEE presenting for disposal</td><td>

• Assume contaminated recyclate causes **10%** of plastics in WEEE to be > 10mg/kg
• Estimated WEEE presenting for landfill that should be diverted & treated as hazardous POP-BDE waste = 26,198 x 0.1 = **2,620t** (if LPCL was in place)

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• Assume contaminated recyclate causes **2%** of plastics in WEEE to be > 50mg/kg
• Estimated WEEE presenting for landfill that should be diverted & treated as hazardous POP-BDE waste = 26,198 x 0.02 = **524t** (if LPCL was in place)

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• Assume contaminated recyclate causes **0.5%** of plastics in WEEE to be > 200mg/kg
• Estimated WEEE presenting for landfill that should be diverted & treated as hazardous POP-BDE waste = 26,198 x 0.005 = **131t** (if LPCL was in place)

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<tr><td>M160c - HBCD</td><td colspan="3">

End of Life EPS

• EPS building panels represent the major use article type, with HBCD present at ~ 0.5%
• 112 t of HBCD are estimated to be imported into Australia in 2014, rising from ~36t in 1998/99
• NICNAS estimates the life span of building insulation EPS to be 20 years
• Assume the 36t import level in 1998/99 was the same in 1994 (20 years ago)
• Estimated quantities of end of life EPS building materials containing HBCD becoming waste in 2014 (at the end of their 20 year usable life) can calculated as follows:
• 36 x (100/0.5) = **7,200tpa**
• Following the same logic, this would be expected to increase to **22,400tpa** by 2034 (the end of the projection period), based on the import figures projected for 2014
• LPCLs are not relevant in distinguishing arisings scenarios for EPS end of life articles because the articles themselves will always be above any likely limit to be set. Other factors such as differing rates of building growth are better primary factors in projection scenarios

</td></tr>
<tr><td></td><td>10</td><td>50</td><td>200</td></tr>
</table>

[59] KMH Environmental, 2013. "Reducing Releases of POP-BDEs to the Environment – Option Impact Analysis," Geoff Latimer (not yet published)
[60] Entox Innovations, 2013. "Testing of Articles for Persistent Organic Pollutants (Draft)," Christie Bentley (not yet published)
[61] Latimer (ENVIRON Australia), BRF Research: A Pilot Study of E-waste Plastic Sorting in New Zealand, for the Ministry for the Environment, New Zealand, 2013

End of Life EPS	7,200tpa	7,200tpa	7,200tpa

All 'new' Stockholm POPs waste

The total 'new' Stockholm POPs waste presenting to waste infrastructure in the baseline year (2013) is estimated below.

Table 78: Estimated baseline year arisings of all 'new' POP-wastes, under different LPCL settings

POP Waste	POP Waste stream	Waste Arising Scenario (tpa base year 2013)		
		High (assumed LPCL mg/kg)	Best (assumed LPCL mg/kg)	Low (assumed LPCL mg/kg)
PFOS (M160a)		**1**	**10**	**100**
	Biosolids	73,000	7,300	Neg.[1]
	AFFF conc. for destruction[2]	38	38	38
	Fire waters[2]	3,767	3,767	3,767
	Total	77,000	11,000	3,800
POP-BDEs (M160b)		**10**	**50**	**200**
	Biosolids	Neg.[1]	Neg.[1]	Neg.[1]
	WEEE (for disposal)	2,620	524	131
	Total	2,620	524	131
HBCD (M160c)		**10**	**50**	**200**
	Biosolids	29,000[3]	Neg.[1]	Neg.[1]
	End of Life EPS[3]	7,200	7,200	7,200
	Total	36,000	7,200	7,200
TOTAL POP WASTE (as M160)[3]		**87,000 t**	**19,000 t**	**11,000 t**

Notes:
1. Neg. = Negligible
2. Scenarios do not vary based on estimates of possible LCPL settings. Other causal factors will be used.
3. Assume the HBCD-containing biosolids are a subset of the PFOS-containing biosolids

Projections

Biosolids (relevant waste stream for PFOS and HBCD)
Causal factors:
Best

- Population growth
- Existing historical national biosolids generation information (good data for 2010 and 2013)
- Biosolids concentrations of POP-BDEs, HBCD and PFOS reporting in literature
- Likely LPCL's to be set for POP-BDEs, HBCD and PFOS, below which the Stockholm Convention will not apply
- Estimated time for LPCL to come into effect – minimum 2 years from now
- Assuming that Australia ratifies the Stockholm Convention's new POPs

- See 'biosolids' N205a projection

WEEE for disposal (relevant waste stream for POP-BDEs)
Causal factors:

- National TV and Computers Recycling Scheme RIS projections for recycling

End of Life EPS (relevant waste stream for HBCD)
Causal factors:

- ACIL Allen Consulting CBA and Decision RIS – summary information provided in confidence by DoE
- Limited projections of HBCD imports (AAC CBA and RIS)
- Construction activity data

AFFF Concentrates (for destruction) – relevant waste stream for PFOS
Causal factors:

- Previous reports – summary information provided in confidence by DoE
  - Provides historical and limited projections about national stocks of AFFF concentrates, and their likely rate of decline, including the fact that PFOS-containing concentrates are no longer manufactured – only historical stocks
- Rate of change in bushfires/ other fires due to warmer climate scenarios, mitigated by rapidly declining stocks of AFFF containing PFOS

Firewaters – relevant waste stream for PFOS
Causal factors:
Difficult to quantify due to unknown wash-down volumes of fire waters, but tracking data exists for fire waters and debris (N140) and potential volumes and changes in volumes can be deduced from modelled changes in stocks.

A.6 Contaminated biosolids arising

The Australia and New Zealand Biosolids Partnership produces data on the quantities of biosolids produced. Data on dry weights from ANZBP (2013) were used, and previous more detailed data from 2010 (reported in BE & REC 2013) were applied to this data set to estimate wet weight and end fates of these materials. Melbourne Water (2010) data were used to estimate the size of the large Victorian stockpiles.

The quantities of biosolids to be classified under each scenario as contaminated, and therefore hazardous, were based on the assumptions set out below.

Best estimate

- Biosolids are contaminated when contaminant levels fall into the Victorian C3 classification; that is, they exceed the EPA Vic (2004) limits for classification as C2 biosolids (see below). C3 biosolids cannot be applied to land in Victoria.
- Biosolids exceed this level if they are stockpiled. This covers the some quantity of biosolids produced in Victoria (Western Treatment Plant only), WA and NT.
- For other jurisdictions, the proportion of biosolids that are contaminated can be estimated with reference to the Victorian proportion, multiplied a factor that represents the degree to which those states are ‘industrialised’ relative to Victoria, namely: NSW 1; Qld 0.5; ACT, NT, SA and Tas 0.25.
- Stockpiled biosolids do not enter the waste stream during the projection period.
- The quantities of contaminated biosolids produced grow annually by 1% until 2024, then decline annually by 1% as wastewater quality improves.

High estimate

- The quantity of biosolids that is contaminated is equal to the highest of the following estimates:
  - all biosolids except those are used for agriculture, landscaping or land rehabilitation
  - the best estimate.
- Stockpiles are contaminated. They start to enter the waste stream in 2016 and are fully treated over 15 years.
- The quantities of contaminated biosolids produced grow in proportion to population growth.

Low estimate

- The proportion of biosolids that is contaminated is equal to half the ‘best estimate’ proportion.
- Stockpiled biosolids do not enter the waste stream during the projection period.
- Reducing contaminant levels result in an annual net reduction in contaminated biosolids of -2%.

Table 79: Upper limits for classification of biosolids as C2 in Victoria (see EPA Vic 2004)

Contaminant	**C2 threshold** (mg/kg dry)	**Contaminant**	**C2 threshold** (mg/kg dry)
Arsenic	60	Nickel	270
Cadmium	10	Selenium	50
Chromium	3000	Zinc	2500
Copper	2000	DDT & derivatives	1
Lead	500	Organochlorine pesticides	0.5
Mercury	5	PCBs	1

A.7 Waste lithium-ion batteries arising

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, represent a safety hazard due to risks of causing explosions and or fire (ABRI 2014).

Following Lewis (2014), lithium-ion batteries are considered in three categories:

- handheld (< 1 kg)
- automotive
- large and industrial.

Note that the large increases in waste lithium-ion battery waste of all types and in all scenarios is contingent on the expected decline in costs as production ramps up and economies of scale are achieved.

Handheld batteries

The projections follow the large increases in consumption and waste proposed in a recent national study by NC & SRU (2014) to 2020. After that year and until 2034:

- best estimate – the rate of increase declines by 50% as other technologies become competitive
- high estimate – the rate of increase continues as before
- low estimate – the rate of increase is proportional to population growth.

Automotive batteries

The projections are founded on: Baylis (2012) best, high and low estimates of future global sales of electric vehicles to 2010; OICA (2014) data on the proportions of vehicles sold in Australia; and Battery University (2014) data on the average weights of batteries. For each scenario, it is assumed that after 2020 growth in the sale of automotive lithium-ion batteries increases at half the Baylis (2012) estimate as alternative technologies become competitive and the rate of increase of electric vehicle sales declines.

Large and industrial batteries

Baylis 2012 provides estimates of global projections of the amounts of grid storage from lithium-ion batteries. These projections are supported by a separate analysis of the expected future storage market by MHC (2012), which extend to 2030. This suggests average annual growth of 12% (low estimate), 14% (high estimate) and 10% (low estimate). The quantity of grid storage (in MW) is converted to tonnes of material using a Ragone chart given at electronicdesign.com.

A.8 National projected arisings scenarios of hazardous waste by waste group

Table 80: Best estimate scenario for all groups

Hazardous waste groups		2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
A	Plating & heat treatment	6,270	6,483	6,703	6,931	7,167	7,411	7,664	7,925	8,196	8,476	8,766
B	Acids	43,304	42,004	40,744	39,522	38,336	37,186	36,071	36,071	36,071	36,071	36,071
C	Alkalis	300,047	313,094	327,237	342,561	359,153	377,108	396,530	417,529	440,224	464,744	491,227
D120	Mercury; mercury compounds	1,510	1,525	1,540	1,556	1,571	1,587	1,603	1,619	1,635	1,651	1,635
D220	Lead; lead compounds	165,387	167,867	170,386	172,941	175,535	178,168	180,841	183,554	186,307	189,101	191,938
D300	Non-toxic salts	85,110	91,760	99,113	107,237	116,209	126,114	137,043	149,099	162,393	177,049	193,202
Other D	Other inorganic chemicals	200,247	196,242	192,317	188,471	184,702	181,008	177,387	173,840	170,363	166,956	163,617
E	Reactive chemicals	113	113	113	113	113	113	113	113	113	113	113
F	Paints, resins, inks, organic sludges	44,900	45,573	46,257	46,951	47,655	48,370	49,096	49,832	50,579	51,338	52,108
G	Organic solvents	31,202	32,075	32,973	33,897	34,846	35,821	36,824	37,855	38,915	40,005	41,125
H	Pesticides	3,733	3,838	3,945	4,056	4,169	4,286	4,406	4,530	4,656	4,787	4,921
J	Oils	669,037	703,665	740,960	781,126	824,386	870,976	921,153	975,195	1,033,397	1,096,081	1,163,592
K100	Animal effluent and residues (+ food processing waste)	293,354	299,808	306,404	313,145	320,034	327,075	334,271	341,624	349,140	356,821	364,671
K110	Grease trap waste	537,039	552,076	567,535	583,426	599,762	616,555	633,818	651,565	669,809	688,564	707,844
K140 & 190	Tannery & wool scouring wastes	6,893	6,610	6,339	6,079	5,830	5,591	5,362	5,142	4,931	4,729	4,535
M160a	PFOS	3,805	3,425	10,603	10,407	10,245	10,111	10,004	9,922	9,861	9,821	9,799
M160b	POP-BDEs	0	0	379	322	274	233	198	168	143	121	103
M160c	HBCD	0	0	7,609	7,974	8,357	8,758	9,178	9,619	10,081	10,564	11,072
M160d	HCB	0	0	0	0	0	0	0	0	0	0	0
Other M	Other organic chemicals	21,634	21,116	20,619	20,142	19,682	19,298	18,921	18,551	18,189	17,834	17,486
N120	Contaminated soils	1,360,347	1,360,347	1,360,347	1,360,347	1,360,347	1,360,347	1,360,347	1,360,347	1,360,347	1,360,347	1,360,347
N205a	Contaminated biosolids	269,319	272,012	267,212	269,846	272,507	275,193	277,906	280,645	283,411	286,204	283,133
N205b	Other industrial treatment residues	242,782	249,580	256,568	263,752	271,137	278,729	286,533	294,556	302,804	311,282	319,998
N220	Asbestos	854,769	898,703	923,307	948,599	974,600	1,001,329	1,008,806	1,037,052	1,066,090	1,095,940	1,126,627
Other N	Other soil/sludges	103,864	102,826	101,797	115,779	114,772	113,774	112,786	111,808	110,840	109,882	108,933
R	Clinical & pharmaceutical	71,353	72,726	74,126	75,608	77,120	78,663	80,236	81,841	83,478	85,231	87,021
T140	Tyres	411,138	417,305	423,565	429,918	436,367	442,913	449,556	456,300	463,144	470,091	477,143
Other T	Other miscellaneous	7,002	6,961	6,940	6,939	6,953	6,980	7,020	7,070	7,129	7,196	7,270
	Lithium-ion batteries	8,190	9,705	11,504	13,642	16,182	19,202	22,792	24,989	27,400	30,046	32,950
	Total (millions of tonnes)	**5.73**	**5.87**	**6.00**	**6.14**	**6.27**	**6.41**	**6.57**	**6.73**	**6.90**	**7.08**	**7.27**

Table 80 cont.

Hazardous waste groups		2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
A	Plating & heat treatment	9,066	9,377	9,698	10,031	10,375	10,732	11,101	11,483	11,878	12,287
B	Acids	36,071	36,071	36,071	36,071	36,071	36,071	36,071	36,071	36,071	36,071
C	Alkalis	519,822	550,690	584,003	619,947	658,724	700,548	745,653	794,288	846,725	903,252
D120	Mercury; mercury compounds	1,618	1,602	1,586	1,570	1,555	1,539	1,524	1,508	1,493	1,478
D220	Lead; lead compounds	194,817	197,739	200,705	203,716	206,772	209,873	213,021	216,217	219,460	222,752
D300	Non-toxic salts	211,002	230,612	252,213	276,004	302,202	331,047	362,805	397,766	436,249	478,606
Other D	Other inorganic chemicals	160,344	157,137	153,995	150,915	147,896	144,938	142,040	139,199	136,415	133,687
E	Reactive chemicals	113	113	113	113	113	113	113	113	113	113
F	Paints, resins, inks, organic sludges	52,890	53,683	54,488	55,306	56,135	56,977	57,832	58,700	59,580	60,474
G	Organic solvents	42,277	43,460	44,677	45,928	47,214	48,536	49,895	51,292	52,729	54,205
H	Pesticides	5,059	5,200	5,346	5,495	5,649	5,808	5,970	6,137	6,309	6,486
J	Oils	1,236,301	1,314,608	1,398,946	1,489,777	1,587,602	1,692,960	1,806,430	1,928,638	2,060,256	2,202,008
K100	Animal effluent and residues (+ food processing waste)	372,694	380,893	389,273	397,837	406,589	415,534	424,676	434,019	443,567	453,326
K110	Grease trap waste	727,663	748,038	768,983	790,514	812,649	835,403	858,794	882,840	907,560	932,972
K140 & 190	Tannery & wool scouring wastes	4,349	4,171	4,000	3,836	3,679	3,528	3,383	3,244	3,111	2,984
M160a	PFOS	9,793	9,803	9,826	9,862	9,910	9,969	10,037	10,115	10,201	10,295
M160b	POP-BDEs	88	75	63	54	46	39	33	28	24	20
M160c	HBCD	11,603	12,160	12,744	13,355	13,996	14,668	15,372	16,110	16,883	17,694
M160d	HCB	0	0	0	0	0	0	0	0	0	0
Other M	Other organic chemicals	17,146	16,812	16,484	16,164	15,849	15,541	15,239	14,943	14,653	14,369
N120	Contaminated soils	1,360,347	1,360,347	1,360,347	1,360,347	1,360,347	1,360,347	1,360,347	1,360,347	1,360,347	1,360,347
N205a	Contaminated biosolids	280,090	277,074	274,085	271,123	268,187	265,277	262,392	259,533	256,699	253,890
N205b	Other industrial treatment residues	328,958	338,169	347,638	357,372	367,378	377,665	388,239	399,110	410,285	421,773
N220	Asbestos	1,158,172	1,190,601	1,223,938	1,258,208	1,293,438	1,329,654	1,366,885	1,405,157	1,444,502	1,484,948
Other N	Other soil/sludges	107,994	107,064	106,143	105,232	104,329	103,436	102,552	101,676	100,809	99,951
R	Clinical & pharmaceutical	88,848	90,714	92,619	94,564	96,550	98,577	100,647	102,761	104,919	107,122
T140	Tyres	484,300	491,564	498,938	506,422	514,018	521,729	529,555	537,498	545,560	553,744
Other T	Other miscellaneous	7,350	7,436	7,527	7,622	7,721	7,824	7,931	8,040	8,153	8,269
	Lithium-ion batteries	36,138	39,637	43,478	47,695	52,326	57,411	62,995	69,128	75,864	83,263
	Total (millions of tonnes)	**7.46**	**7.67**	**7.90**	**8.13**	**8.39**	**8.65**	**8.94**	**9.24**	**9.57**	**9.91**

Table 81: High estimate scenario for all groups

Hazardous waste groups		2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
A	Plating & heat treatment	6,475	6,921	7,397	7,906	8,451	9,034	9,657	10,323	11,036	11,799	12,614
B	Acids	43,812	43,812	43,812	43,812	43,812	43,812	43,812	43,812	43,812	43,812	43,812
C	Alkalis	307,428	329,293	353,096	379,024	407,282	438,095	471,713	508,406	548,476	592,251	640,094
D120	Mercury; mercury compounds	1,521	1,582	1,645	1,711	1,780	1,887	2,000	2,120	2,247	2,382	2,382
D220	Lead; lead compounds	165,763	171,565	177,569	183,784	190,217	196,874	203,765	210,897	218,278	225,918	233,825
D300	Non-toxic salts	86,214	94,663	104,126	114,725	126,596	139,891	154,782	171,459	190,138	211,058	234,489
Other D	Other inorganic chemicals	202,574	202,574	202,574	292,574	292,574	292,574	292,574	292,574	292,574	292,574	292,574
E	Reactive chemicals	114	116	119	121	123	126	128	131	134	136	139
F	Paints, resins, inks, organic sludges	45,217	46,935	48,718	50,570	52,491	54,486	56,556	58,706	60,936	63,252	65,656
G	Organic solvents	31,562	33,077	34,665	36,329	38,073	39,900	41,815	43,822	45,926	48,130	50,441
H	Pesticides	3,777	3,958	4,148	4,347	4,556	4,775	5,004	5,244	5,496	5,760	6,036
J	Oils	678,720	729,040	784,041	844,185	909,977	981,976	1,060,795	1,147,108	1,241,658	1,345,259	1,458,808
K100	Animal effluent and residues (+ food processing waste)	296,083	308,518	321,476	334,978	349,047	363,707	378,983	394,900	411,486	428,768	446,777
K110	Grease trap waste	541,388	567,374	594,608	623,150	653,061	684,408	717,259	751,688	787,769	825,582	865,210
K140 & 190	Tannery & wool scouring wastes	7,016	6,869	6,724	6,583	6,445	6,310	6,177	6,047	5,920	5,796	5,674
M160a	PFOS	3,805	4,521	80,765	82,275	83,874	85,559	87,327	89,177	91,106	93,113	95,198
M160b	POP-BDEs	0	0	2,415	2,318	2,225	2,136	2,051	1,969	1,890	1,814	1,742
M160c	HBCD	0	0	38,376	39,359	40,367	41,402	42,462	43,551	44,667	45,811	46,985
M160d	HCB	0	0	0	1,997	3,594	3,394	3,194	2,995	2,795	2,595	2,396
Other M	Other organic chemicals	21,807	21,955	22,110	22,272	22,440	22,686	22,937	23,191	23,448	23,710	23,976
N120	Contaminated soils	2,040,520	2,040,520	2,040,520	2,040,520	2,040,520	2,040,520	2,040,520	2,040,520	2,040,520	2,040,520	2,040,520
N205a	Contaminated biosolids	486,375	493,670	1,519,896	1,524,733	1,529,616	1,534,544	1,539,519	1,544,539	1,549,604	1,554,716	1,559,873
N205b	Other industrial treatment residues	247,774	262,145	277,349	293,435	310,454	328,461	347,512	367,667	388,992	411,553	435,424
N220	Asbestos	1,278,892	1,332,825	1,357,429	1,382,721	1,408,722	1,435,451	1,432,928	1,461,175	1,490,212	1,520,063	1,550,749
Other N	Other soil/sludges	104,578	105,624	106,680	122,747	123,824	167,662	168,762	169,872	170,993	172,125	173,269
R	Clinical & pharmaceutical	71,957	74,781	77,716	80,824	84,057	87,420	90,917	94,553	98,335	102,367	106,564
T140	Tyres	414,859	429,379	444,407	459,961	476,060	492,722	509,967	527,816	546,290	565,410	585,199
Other T	Other miscellaneous	7,069	7,241	7,423	7,614	7,816	8,028	8,251	8,484	8,728	8,984	9,250
	Lithium-ion batteries	8,190	9,896	11,968	14,488	17,554	21,288	25,838	29,279	33,191	37,639	42,699
	Total (millions of tonnes)	**7.10**	**7.32**	**8.66**	**8.98**	**9.22**	**9.51**	**9.77**	**10.05**	**10.36**	**10.68**	**11.03**

Table 81 cont.

Hazardous waste groups		2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
A	Plating & heat treatment	13,487	14,420	15,418	16,486	17,628	18,850	20,157	21,555	23,051	24,651
B	Acids	43,812	43,812	43,812	43,812	43,812	43,812	43,812	43,812	43,812	43,812
C	Alkalis	692,402	749,613	812,209	880,718	955,722	1,037,860	1,127,837	1,226,424	1,334,472	1,452,916
D120	Mercury; mercury compounds	2,382	2,382	2,382	2,382	2,382	2,382	2,382	2,382	2,382	2,382
D220	Lead; lead compounds	242,009	250,479	259,246	268,320	277,711	287,431	297,491	307,903	318,679	329,833
D300	Non-toxic salts	260,732	290,123	323,042	359,910	401,203	447,451	499,249	557,263	622,238	695,011
Other D	Other inorganic chemicals	292,574	292,574	202,574	202,574	202,574	202,574	202,574	202,574	202,574	202,574
E	Reactive chemicals	142	145	147	150	153	156	160	163	166	169
F	Paints, resins, inks, organic sludges	68,151	70,740	73,428	76,219	79,115	82,121	85,242	88,481	91,843	95,333
G	Organic solvents	52,862	55,399	58,058	60,845	63,766	66,826	70,034	73,396	76,919	80,611
H	Pesticides	6,326	6,629	6,948	7,281	7,631	7,997	8,381	8,783	9,205	9,647
J	Oils	1,583,294	1,719,800	1,869,520	2,033,766	2,213,984	2,411,760	2,628,841	2,867,148	3,128,794	3,416,104
K100	Animal effluent and residues (+ food processing waste)	465,541	485,094	505,468	526,697	548,819	571,869	595,888	620,915	646,993	674,167
K110	Grease trap waste	906,740	950,263	995,876	1,043,678	1,093,774	1,146,276	1,201,297	1,258,959	1,319,389	1,382,720
K140 & 190	Tannery & wool scouring wastes	5,555	5,438	5,324	5,212	5,103	4,996	4,891	4,788	4,688	4,589
M160a	PFOS	97,359	99,596	101,908	104,296	106,760	109,300	111,916	114,609	117,380	120,230
M160b	POP-BDEs	1,672	1,605	1,541	1,479	1,420	1,363	1,309	1,257	1,206	1,158
M160c	HBCD	48,189	49,425	50,692	51,991	53,324	54,691	56,093	57,531	59,006	60,520
M160d	HCB	2,196	1,997	0	0	0	0	0	0	0	0
Other M	Other organic chemicals	24,245	24,519	24,797	25,080	25,367	25,659	25,955	26,257	26,564	26,876
N120	Contaminated soils	2,040,520	2,040,520	2,040,520	2,040,520	2,040,520	2,040,520	2,040,520	2,040,520	2,040,520	2,040,520
N205a	Contaminated biosolids	1,565,076	1,570,324	1,575,617	1,580,956	1,586,339	1,591,767	471,256	476,772	482,333	487,937
N205b	Other industrial treatment residues	460,678	487,397	515,667	545,575	577,219	610,697	646,118	683,592	723,241	765,189
N220	Asbestos	1,582,295	1,614,723	1,648,060	1,682,331	1,717,560	1,753,777	1,791,007	1,829,280	1,868,624	1,909,070
Other N	Other soil/sludges	174,424	175,591	176,769	177,960	179,162	180,376	181,602	182,841	184,092	185,355
R	Clinical & pharmaceutical	110,933	115,482	120,216	125,145	130,276	135,617	141,178	146,966	152,992	159,264
T140	Tyres	605,681	626,880	648,821	671,530	695,033	719,359	744,537	770,596	797,566	825,481
Other T	Other miscellaneous	9,529	9,819	10,122	10,438	10,766	11,108	11,464	11,833	12,218	12,617
	Lithium-ion batteries	48,458	55,014	62,483	70,993	80,695	91,759	104,383	118,793	135,249	154,049
	Total (millions of tonnes)	**11.41**	**11.81**	**12.15**	**12.61**	**13.12**	**13.66**	**13.11**	**13.74**	**14.42**	**15.16**

Table 82: Low estimate scenario for all groups

Hazardous waste groups		2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
A	Plating & heat treatment	6,064	6,059	6,053	6,048	6,042	6,037	6,032	6,028	6,023	6,019	6,014
B	Acids	42,117	37,905	34,114	30,703	27,633	24,869	22,382	22,159	21,937	21,718	21,501
C	Alkalis	289,323	290,319	291,632	293,257	295,191	297,431	299,973	302,816	305,957	309,396	313,130
D120	Mercury; mercury compounds	1,506	1,506	1,506	1,506	1,506	1,506	1,506	1,506	1,506	1,506	1,461
D220	Lead; lead compounds	165,105	165,105	165,105	165,105	165,105	165,105	165,105	165,105	165,105	165,105	165,105
D300	Non-toxic salts	81,905	83,164	84,499	85,912	87,402	88,971	90,618	92,346	94,154	96,044	98,017
Other D	Other inorganic chemicals	197,920	190,003	182,403	175,107	168,103	161,379	154,924	148,727	142,778	137,066	131,584
E	Reactive chemicals	112	110	108	105	103	101	99	97	95	93	92
F	Paints, resins, inks, organic sludges	44,625	44,401	44,179	43,959	43,739	43,520	43,302	43,086	42,871	42,656	42,443
G	Organic solvents	30,841	31,088	31,336	31,587	31,840	32,094	32,351	32,610	32,871	33,134	33,399
H	Pesticides	3,690	3,719	3,749	3,779	3,809	3,840	3,870	3,901	3,933	3,964	3,996
J	Oils	648,497	656,132	664,190	672,681	681,611	690,990	700,825	711,126	721,902	733,162	744,917
K100	Animal effluent and residues (+ food processing waste)	290,626	291,207	291,790	292,373	292,958	293,544	294,131	294,719	295,309	295,899	296,491
K110	Grease trap waste	532,691	536,952	541,248	545,578	549,943	554,342	558,777	563,247	567,753	572,295	576,874
K140 & 190	Tannery & wool scouring wastes	6,770	6,357	5,969	5,605	5,263	4,942	4,641	4,358	4,092	3,842	3,608
M160a	PFOS	3,805	2,543	2,289	2,060	1,854	1,669	1,502	1,351	1,216	1,095	985
M160b	POP-BDEs	0	0	74	55	41	31	23	17	13	10	7
M160c	HBCD	0	0	7,316	7,374	7,433	7,493	7,553	7,613	7,674	7,735	7,797
M160d	HCB	0	0	0	0	0	0	0	0	0	0	0
Other M	Other organic chemicals	21,461	20,287	19,190	18,162	17,198	16,338	15,521	14,745	14,008	13,308	12,642
N120	Contaminated soils	680,173	680,173	680,173	680,173	680,173	680,173	680,173	680,173	680,173	680,173	680,173
N205a	Contaminated biosolids	130,660	128,047	125,486	122,976	120,516	118,106	115,744	113,429	111,161	108,937	106,759
N205b	Other industrial treatment residues	237,790	237,315	236,840	236,366	235,894	235,422	234,951	234,481	234,012	233,544	233,077
N220	Asbestos	430,647	464,581	489,184	514,477	540,478	567,206	584,684	612,930	641,968	671,818	702,505
Other N	Other soil/sludges	103,151	100,056	97,054	94,143	91,318	88,579	85,922	83,344	80,844	78,418	76,066
R	Clinical & pharmaceutical	70,749	70,695	70,642	70,642	70,642	70,642	70,642	70,642	70,642	70,713	70,783
T140	Tyres	407,418	405,381	403,354	401,337	399,330	397,334	395,347	393,370	391,404	389,447	387,499
Other T	Other miscellaneous	6,935	6,727	6,555	6,412	6,291	6,188	6,101	6,025	5,958	5,899	5,847
	Lithium-ion batteries	8,190	9,143	10,218	11,432	12,805	14,359	16,120	16,682	17,270	17,888	18,536
	Total (millions of tonnes)	**4.43**	**4.46**	**4.49**	**4.51**	**4.53**	**4.56**	**4.59**	**4.63**	**4.66**	**4.70**	**4.74**

Table 82 cont.

Hazardous waste groups		2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
A	Plating & heat treatment	6,010	6,006	6,002	5,998	5,994	5,991	5,987	5,984	5,980	5,977
B	Acids	21,286	21,073	20,862	20,653	20,447	20,242	20,040	19,839	19,641	19,445
C	Alkalis	317,159	321,483	326,102	331,015	336,225	341,731	347,535	353,640	360,046	366,757
D120	Mercury; mercury compounds	1,417	1,374	1,333	1,293	1,254	1,217	1,180	1,145	1,111	1,077
D220	Lead; lead compounds	165,105	165,105	165,105	165,105	165,105	165,105	165,105	165,105	165,105	165,105
D300	Non-toxic salts	100,074	102,216	104,444	106,760	109,165	111,661	114,249	116,931	119,709	122,585
Other D	Other inorganic chemicals	126,320	121,268	116,417	111,760	107,290	102,998	98,878	94,923	91,126	87,481
E	Reactive chemicals	90	88	86	84	83	81	79	78	76	75
F	Paints, resins, inks, organic sludges	42,231	42,020	41,809	41,600	41,392	41,185	40,979	40,775	40,571	40,368
G	Organic solvents	33,666	33,936	34,207	34,481	34,756	35,035	35,315	35,597	35,882	36,169
H	Pesticides	4,028	4,060	4,092	4,125	4,158	4,191	4,225	4,259	4,293	4,327
J	Oils	757,176	769,950	783,251	797,089	811,477	826,426	841,949	858,059	874,769	892,094
K100	Animal effluent and residues (+ food processing waste)	297,084	297,678	298,274	298,870	299,468	300,067	300,667	301,268	301,871	302,475
K110	Grease trap waste	581,489	586,140	590,830	595,556	600,321	605,123	609,964	614,844	619,763	624,721
K140 & 190	Tannery & wool scouring wastes	3,388	3,181	2,987	2,805	2,634	2,473	2,322	2,181	2,048	1,923
M160a	PFOS	887	798	718	646	582	524	471	424	382	344
M160b	POP-BDEs	6	4	3	2	2	1	1	1	1	0
M160c	HBCD	7,860	7,922	7,986	8,050	8,114	8,179	8,244	8,310	8,377	8,444
M160d	HCB	0	0	0	0	0	0	0	0	0	0
Other M	Other organic chemicals	12,010	11,410	10,839	10,297	9,782	9,293	8,829	8,387	7,968	7,569
N120	Contaminated soils	680,173	680,173	680,173	680,173	680,173	680,173	680,173	680,173	680,173	680,173
N205a	Contaminated biosolids	104,623	102,531	100,480	98,471	96,501	94,571	92,680	90,826	89,010	87,230
N205b	Other industrial treatment residues	232,611	232,146	231,681	231,218	230,756	230,294	229,834	229,374	228,915	228,457
N220	Asbestos	734,050	766,479	799,816	834,086	869,316	905,532	942,762	981,035	1,020,380	1,060,826
Other N	Other soil/sludges	73,784	71,570	69,423	67,340	65,320	63,361	61,460	59,616	57,828	56,093
R	Clinical & pharmaceutical	70,854	70,925	70,996	71,067	71,138	71,209	71,280	71,352	71,423	71,494
T140	Tyres	385,562	383,634	381,716	379,807	377,908	376,019	374,139	372,268	370,407	368,555
Other T	Other miscellaneous	5,799	5,755	5,714	5,676	5,640	5,606	5,573	5,541	5,510	5,480
	Lithium-ion batteries	19,216	19,932	20,685	21,477	22,311	23,191	24,119	25,099	26,134	27,228
	Total (millions of tonnes)	**4.78**	**4.83**	**4.88**	**4.92**	**4.98**	**5.03**	**5.09**	**5.15**	**5.21**	**5.27**