Tyre supply chain fate analysis – method report

Final

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PREPARED FOR

TyreStewardship AUSTRALIA

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Abbreviations and glossary

ABS	Australian Bureau of Statistics
AHECC	Australian Harmonized Export Commodity Classification
ARTSA	Australian Road Transport Suppliers Association
BITRE	Bureau of Infrastructure and Transport Research Economics
EOLT	End-of-life tyres
EOLV	End-of-life vehicles
FCAI	Federal Chamber of Automotive Industries
GVM	Gross vehicle mass
MFA	Material flow analysis
TSA	Tyre Stewardship Australia

Model definitions

The following is a list of key definitions of tyre fates and circular economy metrics used throughout the model.

Table 1 Definitions of terms used in the model

Term	Definition
In use tyres	Tyres currently on a registered passenger vehicles, trucks or registered and unregistered off-the-road vehicles.
Used tyres	A tyre removed from a vehicle generates a 'used' tyre, which must then be managed responsibly. There are two pathways: • extend its life through **reuse** as a re-tread or second-hand tyre. • convert it to an **end-of-life tyre** if the owner decides they can't or won't extend its life by reusing it. 'Used tyres' is a collective term that refers to both used tyres that are reused and used tyres that have reached their end-of-life.
End-of-life tyres (EOLT)	A subsection of used tyres where it has been determined that their life cannot or will not be extended.
End-of-life management	The management processes applied to end-of-life tyres, including fates and additions to and removals from stocks.
Second-hand tyres (or 'seconds')	Used tyres directly reused, or allocated as suitable for direct reuse, on a different vehicle without processing.
Retreading	The application of a new layer of tread on used tyres.
Repurposing	The use of end-of-life tyres for a new application without reprocessing. Applications may include structural reinforcement, barriers, etc.
Stockpiling	The process of aggregating end-of-life tyres on a site not belonging to the original tyre owner for more than 12 months.
Retention onsite	Withholding of end-of-life tyres on the property of the person or business that owned that tyre for at least 12 months, with the possibility of subsequent application of a fate.
Fate	The final process of an end-of-life tyre before becoming a new product or unrecoverable. Includes reuse, recycling, energy recovery, burning, onsite burial and landfill.
Energy recovery	All processes through which tyres are processed to recover energy in usable form, for example process heat, steam or in electricity generation.
Burning	Incineration of end-of-life tyres in the open environment, regardless of whether the act is intentional.
Onsite burial	Burial of tyres on a site that is not a formal landfill, regardless of whether approved by a regulator, such that the tyres are no longer recoverable.
Environment	The world at large. Tyres or parts of tyres in the environment have no clear owner.
Unknown management	Processes applied to used tyres that cannot currently be accounted for due to lack of information.
High quality data	Numeric data obtained through primary and secondary sources.

Term	Definition
Moderate quality data	Estimates based on data collected through consultations or other information directly related to the data point.
Low quality	Estimates based on data indirectly related to the data point.
Recycled content (%)	Mass of secondary sourced material in consumed tyres divided by the total consumed mass.
Fossil carbon content (%)	Mass of fossil carbon in consumed tyres divided by the total consumed mass.
Hazardous content (%)	Mass of materials in consumed tyres that are derived from substances that, if they were presented as a waste, would be classified 'hazardous', divided by the consumed mass.
Tyre wear loss rate	One minus the mass of end-of-life tyres divided by mass of consumed tyres (lifespan adjusted).
Collection efficiency (%)	Mass of end-of-life tyres that are collected for recovery (not directed to landfill), divided by the total mass of end-of-life tyres.
Sorting efficiency (%)	Mass of materials recovered from sorting divided by the mass of materials sent to sorting.
Reprocessing efficiency (%)	Mass of materials recovered from reprocessing divided by the mass of materials sent to reprocessing.
Local material utilisation rate (%)	Mass of secondary material generated by the tyre recycling system that is used locally for manufacturing, divided by the total mass of material potentially available for local manufacturing.
Reuse rate (%)	Mass of tyres reused as a tyre through second-hand sale or retreading divided by the mass of material entering the waste system.
Recycling rate (%)	Mass of materials recycled back to local or overseas manufacturing divided by the mass of material entering the waste system.
Energy recovery rate (%)	Mass of post-consumer materials recovered back to local or overseas energy recovery (excluding residuals from energy recovery) divided by the mass of material entering the waste system.
Recovery rate (%)	The sum of the reuse rate, recycling rate and energy recovery rate.
Landfill rate (%)	Mass of materials sent to landfill divided by the mass of materials entering the waste system.
Stockpiles (t)	Mass of tyres in stockpiles (based on the definition of stockpiles in REC (2020, p. ii), as of 30 June each year.

1. Introduction

In January 2024, Tyre Stewardship Australia (TSA) engaged Blue Environment to review its materials flow analysis (MFA) for tyre flows in Australia, provide recommendations for ongoing updates to the model, and to present findings from the MFA.

TSA's original MFA was established in 2020 using data for 2018-19, culminating in a report titled *Used tyres supply chain and fate analysis* (REC et al 2020). Several amendments to the model were subsequently implemented, and it was updated annually by TSA to produce annual fact sheets. This is the first full update of the 'supply chain and fate' report and method.

Blue Environment reviewed an updated version of the MFA that incorporates data from 2018-19 to 2023-24. We found it produces high quality estimates of the generation and fate of different types of end-of-life tyre, and that it was based on robust theory, sound data, best available data and sensible assumptions. Several potential improvements were proposed, and some of those were incorporated into the model. Others may be incorporated later.

This document sets out a detailed method for the development of the material flow analysis (MFA) used to quantify the various elements of the supply chain analysis of tyres in Australia. The MFA covers the flow of whole tyres in the areas listed below. Each is allocated a separate MS Excel model and a chapter in this report:

- consumption
- tyres in use
- used tyre generation
- management of used tyres (fates)

This method report focuses on calculations made for the 2022-23 financial year but it is likely the method can be applied to previous years calculations with little difference in the assumptions and sources of data for earlier years.

1.1 Data sources

The MFA is developed using the best available data. Data sourced through Tyre Stewardship Australia (TSA) reporting is used in preference over other reporting sources. Where TSA reporting data is not available, alternative sources are used where available. These include:

- industry consultation
- data from the Australian Bureau of Statistics (ABS)
- state reporting
- audits
- industry body reports and reporting.

1.2 Data quality

TSA is a voluntary scheme with reprocessing carried out by members reported directly to TSA. Data from facilities involved with processing or disposal of tyres outside of TSA membership is not always readily available. In cases where data is not reported through TSA, data sources such as in Section 1.1 are used, in some cases in conjunction with assumptions to fill gaps resulting in an informed estimate rather than reported data.

For this MFA, model outputs have been classified as high, medium, low or unknown data quality based on the incoming data and assumptions used (see Table 2).

Table 2 Tyre supply chain fate analysis data classification and definitions

Data classification	Definition
High quality data	Numeric data obtained through primary and secondary sources.
Moderate quality data	Estimates based on data collected through consultations or other information directly related to the data point.
Low quality	Estimates based on data indirectly related to the data point.
Unknown management	Processes applied to post use tyres that cannot currently be accounted for due to lack of information.

There is a general high level of confidence in tyre derived product that goes into recycling, energy recovery and reuse. A significantly smaller proportion of reprocessed material and illegally dumped tyres make up flows with a medium level of confidence. Remaining flows largely make up flows with a low level of data confidence.

Table 3 Data classification of flows in tyre supply chain fate analysis

Data classification	Flow Classification
High quality data	TSA participant reported data: - majority of tyre derived product going into recycling, energy recovery and reuse. - a proportion of tyres going to landfill.
Moderate quality data	TSA consultations and information directly related to the data point: - a significantly smaller proportion of tyre derived product going into recycling, energy recovery and reuse. - illegally dumped tyres.
Low quality	Remaining flows: - stockpiled tyres. - tyres buried onsite. - remaining proportion of tyres going to landfill. - illegally exported tyres. - tyre wear.

1.3 Major data categories

Data from different external sources is not always in a format consistent with what is being used in the MFA. This data is either mapped or converted to data categories used in the MFA. There are a number of major data categories used for tracking tyres in the MFA, these are:

- mass
- tyre type (passenger, truck, OTR)
- financial year
- states and territories.

1.4 Assumptions

Data is not always comprehensive within specific jurisdictions, recovery fates, disposal fates, tyre characteristics and tyre types. In such cases, gap filling is used. The method used for gap filling is based on reports from similar datasets or information that could inform estimates for proportions/values.

The core data for the MFA is the consumption of loose tyres in Australia derived from ABS import and export data. This provides the basis for all 4 subsections for the MFA with end-of-life generation being derived from consumption under the assumption of one new tyre replacement on an existing vehicle equals one end-of-life tyre (EOLT) generated. This is added to the volume of tyres that are retread or sold as second-hand tyres to calculate used tyre generation, which provides the pool of tyres for distribution between different recovery, stocks, and disposal fates.

1.5 Exports and imports

There is essentially no domestic manufacturing for tyres. All new tyres are imported from overseas, which means visibility on tyre flows relies heavily on ABS imports data.

Many EOLT and used tyres are also exported from Australia back overseas. Some of these exports are reported to TSA though its members, but quantifying this flow of tyres also relies on ABS export data.

While ABS reporting is largely comprehensive, there are gaps in the data that need to be accounted for outside of reported data. Tyre exports are excluded from the ABS data if:

- they fall below the ABS minimum reporting value threshold of $2,000 per consignment
- the consignment was incorrectly coded by the exporter, which is apparently common.

Obvious gaps in the export data are filled as well as possible using assumptions and data from other sources.

2. Import and consumption

The consumption of tyres covers any new or reused (retread or second-hand) tyre that is fitted to a vehicle in Australia or imported into the country on a vehicle. Net imports make up all of Australia's new tyre consumption as there is no domestic tyre manufacturing.

Import/export data is used to determine the loose tyres coming into Australia. These are added to data on tyres imported on new vehicles and domestic reuse. A proportion of imported loose tyres are fitted on trucks and OTR vehicles assembled in Australia. These are subtracted to prevent double counting with tyres sold fitted to new vehicles. The formula below is a high-level representation of the calculation for consumption:

Consumption = new loose imports + domestic reused tyres + new tyres sold on vehicles - new loose imports fitted & sold on vehicles

2.1 New loose tyre imports

The net import of new loose tyres by state and tyre type is calculated from ABS import and export data (ABS 2023). Imports and exports are separated into passenger, truck and OTR tyre categories using Australian Harmonized Export Commodity Classification (AHECC) codes.

A small proportion of new loose truck tyres are fitted to new trucks assembled domestically. The proportion of net new imported tyres that are consumed this way is based on consultation and analysis of ARTSA-i (ARTSA-i 2023) truck data. These tyres must be subtracted from the total to avoid double counting with tyres sold on vehicles. The same assumption is applied to OTR tyres.

Table 4 New loose tyre imports – outputs, inputs and assumptions

Output	Input/assumptions
Net imports of new loose tyres by state and tyre type	ABS imports and exports data (ABS 2023) by tyre type and state.
New tyres fitted to vehicles assembled in Australia by state and tyre type	Assumption: based on Australian Road Transport Supplier Association (ARTSA-I) truck data.

2.2 Tyres imported on new vehicles

Tyres imported on new vehicles are approximated using vehicle sales data from VFACTS reports (VFACTS 2023a, 2023b, 2023c, 2023d, 2023e, 2023f, 2023g and 2023h). The reports give the number of new vehicles sold in each state. This data comes in as sales for passenger, SUV, light commercial and heavy commercial vehicles. Estimates of average tyre numbers and weights are used to convert and map to tonnes of passenger and truck tyres.

The average number of tyres on VFACTS heavy commercial and light commercial vehicles is calculated using VFACTS gross vehicle mass (GVM) subcategories for heavy commercial and light commercial vehicles. The number of tyres for each GVM range are estimated based on the types of vehicles expected in each subcategory. From this the weighted average number of tyres on heavy commercial and light commercial vehicles is calculated.

The average number of tyres on passenger vehicles and SUVs is based on the number of tyres that come with all car models sold in Australia, including spare tyres. These are categorised as either

vehicles with full sized spare tyre (5 tyres), space saver spare (4.5 tyres) or no spare tyre/puncture repair kit (4 tyres).

Tyres imported on new motorcycles are based on the reported new motorcycles sold in Australia by Federal Chamber of Automotive Industries (FCAI 2023), distributed between states based on BITRE registration data (BITRE 2024).

Tyres imported on new OTR vehicles are assumed to be 25% of the weight of loose OTR tyres imported. This is based on analysis of OTR vehicle imports.

Table 5 Tyres imported on new vehicles – outputs, inputs and assumptions

Output	Input/assumptions
Tyres imported on new vehicles by state and tyre type	VFACTS reports (VFACTS 2023a, 2023b,2023c, 2023d, 2023e, 2023f, 2023g and 2023h), number of vehicles sold in Australia by vehicle type and state.
	FCAI reports, number of vehicles sold in Australia by state.
	Assumption: the average number of tyres on SUVs and passenger vehicles based on the distribution of spare tyres on SUV/passenger vehicles in Australia.
	Assumption: the average number of tyres on light commercial vehicles based on the distribution of tyres by light commercial vehicle type.
	Assumption: the average number of tyres on heavy commercial vehicles based VFACTS reporting (VFACTS 2023a, 2023b,2023c, 2023d, 2023e, 2023f, 2023g and 2023h) on the distribution of tyres by heavy commercial vehicle type.
	Assumption: tyres imported on new OTR vehicles, based on OTR ABS import analysis (ABS 2023).

2.3 Reuse

Tyres retread for domestic reuse or sold second-hand are based on an annual industry survey of major retreading organisations, which is used to estimate percentage of EOLT generation that is retread for domestic reuse.

Table 6 Retreads output, inputs and assumptions

Output	Input/assumptions
Tyres retread for domestic use by tyre type and state	EOLT generation, see Section 4.
	Assumption: percentage of tyres retread proportional to EOLT generation.

3. Tyres in use

Tyres in use covers any tyres currently fitted on a vehicle. Registration data is used to calculate the tyres fitted to trucks and passenger vehicles with estimates on the number of wheels on each different vehicle type. The number of OTR tyres is estimate based on average lifespan and the consumption of OTR tyres. The number of tyres in use is converted to tonnes using average tyre weights calculated from ABS import data (ABS 2023). This average weight is adjusted using tyre wear loss rate under the assumption that tyres in use are on average half-way through their life. The formula below is a high-level representation of the calculation of in use tyres:

Tyres in use = automotive tyres in use + trailer tyres in use + caravan tyres in use + OTR tyres in use

3.1 Tyre weights

Tyre weights are calculated from ABS import data (ABS 2023) for each year, with a weighted average being calculated for each tyre type over the 3 years prior to the focus year, using the total number of tyres imported and their recorded gross weights.

Table 7 Tyre weight – outputs, inputs and assumptions

Output	Input/assumptions
Average tyre weight by tyre type	ABS import data (ABS 2023) by tyre type and state.

3.2 Automotive tyres in use

The number of automotive tyres in use is calculated using the dataset of registered vehicles by state and vehicle type from Bureau of Infrastructure and Transport Research Economics (BITRE 2024). The number of vehicles is then converted to total number of tyres based on the average number of tyres on each vehicle type which is then converted to total weight by tyre type.

The number of tyres on passenger vehicles, campervans, light commercial vehicles, light rigid, non-freight and buses have estimated values based on the most likely wheel configuration as there is little variation for these types of vehicles.

The number of tyres on heavy rigid truck and articulated trucks is calculated using the distribution of registered heavy rigid trucks/articulated trucks in BITRE GVM weight ranges (BITRE 2024). Each weight range is assigned a number of tyres based on the most likely wheel configuration to find the weighted average number of tyres. The wheel configurations for articulated trucks also include the trailers.

BITRE vehicle types are mapped to the MFA tyre types.

Table 8 Automotive tyres in use – outputs, inputs and assumptions

Output	Input/assumptions
Automotive tyres in use by state and tyre type	BITRE vehicle registration data (BITRE 2024), by vehicle type and state.
	Assumption: the number of wheels on passenger vehicles, campervans, light commercial vehicles, light rigid, non-freight and buses.
	Assumption: the number of wheels on heavy rigid truck and articulated trucks based on BITRE GVM registration distribution (BTIRE 2024).

3.3 Trailer tyres in use

Trailer tyres in use is calculated from registered trailers by state and trailer type in the BITRE registration dataset (BITRE 2024). The number of trailers is then converted to total number of tyres based on the estimated number of tyres on each trailer type. This is then converted to total weight by tyre type using average tyre weights. Trailers that are already accounted for in use with articulated trucks are subtracted from the corresponding trailer type to avoid double counting.

Table 9 Trailer types in use – outputs, inputs and assumptions

Output	Input/assumptions
Trailer tyres in use by state and tyre type	BITRE vehicle registration data (BITRE 2024) by trailer type and state.
	Assumption: The number of wheels on each trailer type.

3.4 Caravan tyres in use

Caravan tyres in use is calculated from registered caravans by state and caravan weight class in the BITRE registration dataset (BITRE 2024). The number of caravans is then converted to total number of tyres based on the estimated number of tyres most likely for each caravan class. This is then converted to total weight by tyre type using average tyre weights.

Table 10 Caravan tyres in use – outputs, inputs and assumptions

Output	Input/assumptions
Caravan tyres in use by state and tyre type	BITRE vehicle registration data (BITRE 2024) by caravan weight class and state.
	Assumption: the number of wheels on each caravan weight class.

3.5 OTR tyres in use

BITRE reports registered OTR vehicles, but it is expected that a significant proportion of OTR vehicles are not required to be registered. Accordingly, an alternative method for estimating OTR tyres in use is used.

The number of tyres on OTR vehicles is estimated from the annual consumption of OTR tyres multiplied by the expected lifetime of an OTR tyre.

The expected lifetime of OTR tyres is estimated from expected tyre lifetimes for tyres in various sectors with OTR vehicles. This is paired with plant and equipment (OTR) registrations (BITRE 2024) and registered aircraft from BITRE (2023a) to calculate a weighted average for the lifespan of an OTR tyre.

Table 11 OTR tyres in use – outputs, inputs and assumptions

Output	Input/assumptions
Average lifespan of and OTR tyre	BITRE vehicle registration data (BITRE 2024) by vehicle type and state.
	BITRE aircraft registration data (BITRE 2023a) by vehicle type and state.
	Assumption: expected OTR tyre lifespan by tyre sector.
Consumption of OTR tyres	See Section 2.

4. Used tyre generation

4.1 Used tyre generation

Used tyre generation is a collective term that refers to both used tyres that are reused and used tyres that have reached their end-of-life (EOLT). Thus, used tyre generation is calculated by first determining EOLT generation, then adding tyres that are retread or sold as second-hand tyres.

EOLT generation is based on the consumption of tyres following a one on, one off methodology. Tyre wear is accounted for with an estimated reduction in weight from the original reported weight of new tyres. EOLT generated from end-of-life vehicles (EOLV) is added to this number and determined through the difference between annual changes in registrations and the number of new vehicles purchased. The formula below is a high-level representation of the calculation of EOLT generation:

End-of-life tyre generation = new tyres - tyres fitted on manufactured vehicles + tyres off EOLV - repaired/retread/second-hand tyres (export)

Using EOLT generation, used tyre generation is calculated with the addition of tyres that are retread or sold as second-hand tyres. Thus, the formula below is a high-level representation of the calculation of used tyre generation:

Used tyre generation = new tyres - tyres fitted on manufactured vehicles + tyres off EOLV + repaired/retread/second-hand tyres (domestic)

4.2 Used tyres generated through tyre replacement

The net import of new loose tyres by state and tyre type is based on ABS import and export data (ABS 2023) (see Section 2). It is assumed for every net loose new tyre being imported into Australia a tyre on a vehicle is being replaced (except for loose tyres that are fitted on new vehicles as described in 2.1).

4.3 Used tyres from end-of-life vehicles

The number of EOLV is calculated as the number of new vehicles sold minus the change in registrations. This is then converted to the number of EOLT off those vehicles. It is assumed that 50% of tyres off EOLV are EOLT, the remaining 50% are assumed to be second-hand tyres and considered to still be in use.

The number of new vehicles is calculated from VFACTS reports (VFACTS 2023a, 2023b,2023c, 2023d, 2023e, 2023f, 2023g and 2023h) (see Section 2.2).

The change in registrations is calculated from BITRE registration numbers (BITRE 2024), with the change being the number of registered vehicles in a given year minus the number of registered vehicles in the previous year.

Table 12 EOLT off EOLV outputs – inputs and assumptions

Output	Input/assumptions
Tyres off EOLV by state and tyre type	BITRE vehicle registration data (BITRE 2024) by vehicle type and state.
	VFACTS reports (VFACTS 2023a, 2023b,2023c, 2023d, 2023e, 2023f, 2023g and 2023h), number of vehicles imported into Australia by vehicle type and state

5. Management of used tyres (fates)

The fate of used tyres covers the management of tyres once they enter the waste stream including domestic and exported tyres for reuse, domestic and exported tyres for recycling, domestic and exported tyres for energy recovery, domestic disposal or domestic remaining in environment. They are distributed between different fates based on TSA reporting data and (for tyres not included in TSA reporting) estimates based on various sources of data for the proportion of tyres into each fate. Where possible, allocation of used tyre fates between jurisdictions is based on the jurisdiction of generation rather than the jurisdiction that the material is processed in.

Note: it is assumed that all material exported for energy recovery is recovered. This is consistent with Item 11 of the *Australian Standard for Waste and Resource Recovery Data and Reporting – second edition.* Exported tyres are allocated to energy recovery because they are exported primarily for that purpose. However, it is acknowledged that residuals such as ash would be disposed of or recycled. This tonnage is not quantified due to lack of data.

5.1 Fates of tyres managed by TSA participants and other known processors

TSA members involved in EOLT management report fates of material leaving accredited sites as part of their commitments as a TSA participant. The fates reported by TSA members are more granular than the MFA categories (Table 13) and are mapped to the MFA categories. Table 13 contains a list of all reported categories by TSA members.

The fates of tyres managed outside of TSA participant reporting are obtained through industry consultation with non-TSA members.

Table 13 TSA domestic and export fates

Domestic	Export
Retreader	Unknown use
Second-hand tyre dealer	Substitute fuel
Steel recycler/scrap dealer	For recycling - crumbing
Civil engineering product manufacturer	For recycling - pyrolysis
Asphalt and spray seal manufacturer	For recycling - other
Adhesive or sealant product manufacturer	Tyre derived material sales
Moulded and extruded product manufacturer	For reuse (second-hand tyres)
Steel manufacturer	For retreading
Recovered carbon black manufacturer	
Tyre pyrolysis oil refiner/processor	
Other manufacturer	
Unknown use	
Agriculture application	
Aquaculture application	
Civil engineering application	
Motor sport and racing application	
Mining application	
Roadworks application	
Rain infrastructure application	
Equestrian application	
Sports and recreational application	

Domestic	Export
Kiln/boiler/furnace application – fuel replacement Other market/finished product Landfill (disposal to cell) Landfill (monofil) Onsite burial Gas flaring Onsite energy use (gas)	

5.2 Reused tyres

Tyres reused domestically via retread and second-hand sale are estimated based on an annual industry survey of major retreading organisations, which is used to estimate percentage of EOLT generation that is retread for domestic reuse.

Tyres that are exported as retread or intended for retread are calculated from TSA members reporting and ABS waste exports data (DCCEEW 2024). Exports in ABS data are separated into passenger, truck and OTR tyre categories using Australian Harmonized Export Commodity Classification (AHECC) codes. From analysis of ABS data, it is expected that the ABS exports records are incomplete due to exports either falling below the reporting value threshold or being miscoded. To account for this, it is estimated that a percentage of these tyres are not reported with the additional exports being proportional to state and tyre type distribution of reported exports for retread.

Tyres exported for direct reuse as second-hand tyres are based on TSA reported export of second-hand tyres from QLD. The ratio 'seconds exports' / 'retread exports' is estimated using the ratio 'TSA-reported Qld seconds exports' / 'ABS-reported Qld retread exports'. It is assumed no OTR tyres are exported for reuse as second-hand tyres. The highest value of TSA reported data, ABS reported data and estimates based on QLD data is used to get the most likely representative value.

Table 14 Reused tyres – outputs, inputs and assumptions

Output	Input/assumptions
Tyres retread for domestic use by tyre type and state	EOLT generation, see Section 4.
	Assumption: percentage of tyres retread proportional to EOLT generation.
Tyres retread for export by tyre type and state	ABS waste export data (DCCEEW 2024), tyres exported for retread.
	Assumption: the proportion of tyres export for retread that are not reported in ABS data.
Tyres export for reuse as second-hand tyres by tyre type and state	ABS waste export data (DCCEEW 2024), tyres exported for retread.
	The ratio of seconds exports to retread exports based on QLD reported data.

5.3 Domestic dispersed dumping

Domestic dispersed dumping is primarily based on Blue Environment's *Stockpiling and illegal dumping of tyres: cost to local governments and others* report (BE 2024). The report contains information from a survey with state and local governments on the incidence of, and financial costs for, illegal dumping. This includes estimates of the tonnes of tyres retrieved from dumping in each

state and the fate of those tyres (recycle, storage or landfill). Reports from survey participants indicate that number of tyres being dumped vs cleaned up is for the most part at a net zero with a slight increase indicated by some. This provides the basis for estimates of the proportion of dumped tyres that are recovered. It is assumed that almost all dumped EOLT are recovered in urban areas but the proportion declines with region remoteness.

The reported numbers represent the net change in dumped tyres remaining in the environment in a given year rather than the total dumped tyres. This avoids double counting of any dumped tyres that are cleaned up and either recovered, landfilled or stockpiled. It is expected that these tyres would already be reported in their respective streams.

Different distributions of dumped tyres by type are assumed by region types (urban, fringe, regional and rural). Based on images of dumped tyres, it is clear a majority are passenger tyres, with truck tyres making up a much smaller proportion, likely due to the more valuable nature of truck tyres. OTR tyres are estimated to make up the smallest proportion of these tyres due to lower generation rates and often larger size of the tyres.

Table 15 Domestic dispersed dumping – outputs, inputs and assumptions

Output	Input/assumptions
Tyres dumped by state and tyre type	(BE, 2024) tyres dumped by state and region type.
	Assumption: distribution of tyre type of dumped tyres, based on images, tyre value and generation factors.
Fates of recovered tyres by state, and tyre type	(BE, 2024) Fates of recovered tyres by state and recovery fates.
	Assumption: proportion of tyres recovered by region type.

5.4 Onsite retention

Onsite retention of OTR tyres is a category to cover tyres that do not leave the premises of the owner at the time the tyre becomes a used tyre. Quantities are assumed from a range of sources, but primarily the *Tipping the balance* report (TSA 2023). A small proportion of tyres from construction, industrial and aviation are expected to be retained on work/business sites. A small proportion of mining tyres at mines without a void are expected to be retained onsite in storage for burial or temporary uses such as in walls or to set road boundaries. Most tyres from the agriculture sector are expected to be retained onsite, due to high disposal costs at landfills and transfer stations and large amounts of space for storage incentivising this approach.

Estimates of onsite retention of passenger and truck tyres are based on the distribution of tyres by state and region type. A higher proportion of these tyres are expected to be retained in remote and rural areas due to lesser access to collection points for tyres as well as greater space for storage. Truck tyres are expected to be retained in higher proportions compared to passenger tyres due to higher disposal costs.

Flows of old tyres out of stocks from retention on site are expected to be minimal as there is little incentive for these tyres to be collected or sent to a landfill/transfer station.

Table 16 Onsite retention – outputs, inputs and assumptions

Output	Input/assumptions
OTR tyres remaining in onsite retention stocks	Assumption: proportion of tyres to onsite burial.
	(TSA, 2023) proportion of tyres to onsite burial (reallocated to onsite retention) for construction, industry and aviation sectors.
Truck and passenger tyres remaining in onsite retention stocks	Distribution of vehicles by remoteness area analysis, based on BITRE database of registered vehicles by postcode (BITRE 2023b).
	Assumption: truck and passenger tyres are only retained onsite in rural and remote areas.
	Assumption: the proportion of EoL truck and passenger tyres generated in rural and remote areas that are retained onsite.

5.5 Stockpiles

Stockpiles occur for a range of reasons, including: lack of funding to shift tyres from rural waste facilities; failing recycling operations; and illegal activity. Stockpile clearances occur periodically, often due to enforcement by regulators. In any year it is assumed there are flows into and flows out of stockpiles. Currently net flows are assumed to be zero as, in general, there is a lack of information to confidently claim or quantify a significant increase in the size and number of stockpiles.

Table 17 Stockpiles – outputs, inputs and assumptions

Output	Input/assumptions
Tyre remaining in stockpiles	Net flows of old tyres from stockpiles to fates are small or zero and can reasonably be ignored in this model iteration.

5.6 Onsite burial

Onsite burial is commonplace with OTR tyres from the mining sector and to a lesser extent with agricultural tyres. It is expected a majority of tyres from the mining sector will be buried as it is a legal means of disposal in all states and is the most cost-effective option. Small proportions of tyres are expected to be buried on farms for disposal.

Table 18 Onsite burial – outputs, inputs and assumptions

Output	Input/assumptions
Onsite burial of OTR tyres	Assumption: proportion of OTR tyres from the mining sector buried onsite.
	Assumption: proportion of OTR tyres from the agriculture sector buried onsite.

5.7 Burning

A small proportion of agricultural EOLTs are expected to be burned in piles of waste material (primarily vegetation with the addition of other combustible items). The proportion of agricultural OTR EOLT generated in each state is based on estimates from TSA's *Tipping the balance* report (TSA 2023). Other OTR sectors are unlikely to have the means to burn tyres.

Similarly, it is expected a small amount of passenger and truck tyres are burned in waste piles. A higher proportion of these tyres are expected to be burned in remote and rural areas, the distribution of tyres between states and remoteness area is based on the BITRE distribution of registered vehicles by postcode (BITRE 2023b).

Table 19 Burning – outputs, inputs and assumptions

Output	Input/assumptions
Burning passenger tyres	Distribution of vehicles by remoteness area analysis, based on BITRE database of registered vehicles by postcode (BITRE 2023b).
	Assumption: proportion of EoL passenger tyres in rural and remote areas burned.
Burning truck tyres	Distribution of vehicles by remoteness area analysis, based on BITRE database of registered vehicles by postcode (BITRE 2023b).
	Assumption: proportion of EoL truck tyres in rural and remote areas burned.
Burning OTR tyres	(TSA, 2023) Distribution of OTR tyres by state and sector.
	Assumption: only tyres from OTR agricultural and forestry sector are burned.

5.8 Landfill (not reported by TSA members)

5.8.1 ACT

The quantity of tyres landfilled that is not reported through TSA in ACT is estimated using a landfill audit from 2022, noting that the ACT has a single operating landfill. The total tonnes of waste to landfill in 2022-23 in the ACT and the percentage of tyres in the audited waste are used to estimate the quantity of tyres landfilled.

Table 20 Landfill ACT – outputs, inputs and assumptions

Output	Input/assumptions
Tyres landfilled in ACT (not reported by TSA)	APC audit 2022, percentage of tyres in audited waste.
	Total waste to landfill 2022-23.

5.8.2 NSW

Tyres landfilled not reported through TSA in NSW are estimated based on reported percentages of tyres landfilled from total generation of EOLT by region type (metro, regional and rural) from NSW EPA WasteLocate data.

The distribution of tyres by type is based on state specific distribution of registered vehicles by remoteness. This is calculated through data analysis of registered vehicles by postcode from BITRE (2023b).

Table 21 Landfill NSW – outputs, inputs and assumptions

Output	Input/assumptions
Tyres landfilled in NSW (not reported by TSA)	NSW EPA WasteLocate data, proportion of tracked tyres to landfill by region type.
	Distribution of vehicles by remoteness area analysis, based on BITRE database of registered vehicles by postcode.

5.8.3 NT

The quantity of tyres landfilled that is not reported through TSA in NT regional areas are assumed to have the same proportion of EOLT generated that are landfilled in NSW metro areas (based on WasteLocate data). This is because Darwin is considered regional. Landfill rate for rural NT is assumed to lower as due to remoteness, it is likely a large proportion of rural NT does not have easy access to a landfill or transfer station.

The distribution of tyres by tyre type is based on state specific distribution of registered vehicles by remoteness. This is calculated through data analysis of registered vehicles by postcode from BITRE (2023b).

Table 22 Landfill NT – outputs, inputs and assumptions

Output	Input/assumptions
Tyres landfilled in NT (not reported by TSA)	Assumption: NT has the same distribution of tyres landfilled in regional areas as NSW for metro areas.
	Assumption: proportion of tyres diverted from landfill in rural areas in NT.
	Distribution of vehicles by remoteness area analysis, based on BITRE database of registered vehicles by postcode (BITRE 2023b).

5.8.4 Qld

The quantity of tyres landfilled that is not reported through TSA in QLD are assumed to have the same proportion of EOLT generated that are landfilled as NSW in metro, regional and rural areas (based on NSW WasteLocate data). This is because access to tyre collection/recovery services in these areas is expected to be similar.

The distribution of tyres by tyre type is based on state specific distribution of registered vehicles by remoteness. This is calculated through data analysis of registered vehicles by postcode from BITRE (2023b).

Table 23 Landfill QLD – outputs, inputs and assumptions

Output	Input/assumptions
Tyres landfilled in Qld (not reported by TSA)	Assumption: QLD has the same distribution of tyres landfilled by region type as NSW for metro, regional and rural areas.
	Distribution of vehicles by remoteness area analysis, based on BITRE database of registered vehicles by postcode (BITRE 2023b).

5.8.5 SA

The quantity of tyres landfilled that is not reported through TSA in SA are assumed to have the same proportion of EOLT generated that are landfilled as NSW in metro and regional areas (based on NSW WasteLocate data). This is because access to tyre collection/recovery services in these areas is expected to be similar. The proportion of tyres landfilled in rural areas is assumed to be lower in SA due to whole tyre disposal bans and overall good recovery rates across all waste materials.

The distribution of tyres by tyre type is based on state specific distribution of registered vehicles by remoteness. This is calculated through data analysis of registered vehicles by postcode from BITRE (2023b).

Table 24 Landfill SA – outputs, inputs and assumptions

Output	Input/assumptions
Tyres landfilled in SA (not reported by TSA)	Assumption: SA has the same distribution of tyres landfilled by region type as NSW for metro and regional areas.
	Assumption: proportion of tyres diverted from landfill in rural areas in SA.
	Distribution of vehicles by remoteness area analysis, based on BITRE database of registered vehicles by postcode (BITRE 2023b).

5.8.6 Tas

The quantity of tyres landfilled that is not reported through TSA in TAS are assumed to have the same proportion of EOLT generated that are landfilled as NSW in metro and regional areas (based on NSW WasteLocate data). This is because access to tyre collection/recovery services in these areas is expected to be similar. The proportion of tyres landfilled in rural areas is assumed to be lower in TAS with a larger proportion recovered due to a higher population density in TAS rural areas and smaller distances between regional centres, meaning better access to tyre collection services.

Table 25 Landfill TAS – outputs, inputs and assumptions

Output	Input/assumptions
Tyres landfilled in TAS (not reported by TSA)	Assumption: TAS has the same distribution of tyres landfilled by region type as NSW for metro and regional areas.
	Assumption: Proportion of tyres diverted from landfill in rural areas in TAS.
	Distribution of vehicles by remoteness area analysis, based on BITRE database of registered vehicles by postcode (BITRE 2023b).

5.8.7 Vic

The quantity of tyres landfilled that is not reported through TSA in VIC are assumed to have the same proportion of EOLT generated that are landfilled as NSW in metro and regional areas (based on NSW WasteLocate data). This is because access to tyre collection and recovery services in these areas are expected to be similar. The proportions of tyres landfilled in rural areas is estimated to be 50% of the proportion landfilled in NSW based on WasteLocate data, due to a higher population density in VIC rural areas and smaller distances between regional centres meaning better access to tyre collection services.

The distribution of tyres by tyre type is based on state specific distribution of registered vehicles by remoteness. This is calculated through data analysis of registered vehicles by postcode from BITRE (2023b).

Table 26 Landfill VIC – outputs, inputs and assumptions

Output	Input/assumptions
Tyres landfilled in VIC (not reported by TSA)	Assumption: VIC has the same distribution of tyres landfilled by region type as NSW for metro and regional areas.
	Assumption: proportion of tyres diverted from landfill in rural areas in NSW compared to VIC.
	Distribution of vehicles by remoteness area analysis, based on BITRE database of registered vehicles by postcode (BITRE 2023b).

5.8.8 WA

The quantity of tyres landfilled that is not reported through TSA in WA are assumed to have the same proportion of EOLT generated that are landfilled as NSW in metro and regional areas (based on NSW WasteLocate data). This is because access to tyre collection/recovery services in these areas is expected to be similar. The proportion of tyres landfilled in rural WA is expected to be slightly lower than NSW due to tyre landfill exclusion zones WA has in some regional/rural towns and councils.

The distribution of tyres by tyre type is based on state specific distribution of registered vehicles by remoteness. This is calculated through data analysis of registered vehicles by postcode from BITRE (2023b).

Table 27 Landfill WA – outputs, inputs and assumptions

Output	Input/assumptions
Tyres landfilled in WA (not reported by TSA)	Assumption: WA has the same distribution of tyres landfilled by region type as NSW for metro and regional areas.
	Assumption: proportion of tyres diverted from landfill in rural areas in NSW compared to WA.
	Distribution of vehicles by remoteness area analysis, based on BITRE database of registered vehicles by postcode (BITRE 2023b).

5.9 Illegal export

After the allocation of EOLT generation to all known fates, the remaining tyres are allocated to Illegal exports. This number is also checked against, and supported by, numbers provided through industry consultation.

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