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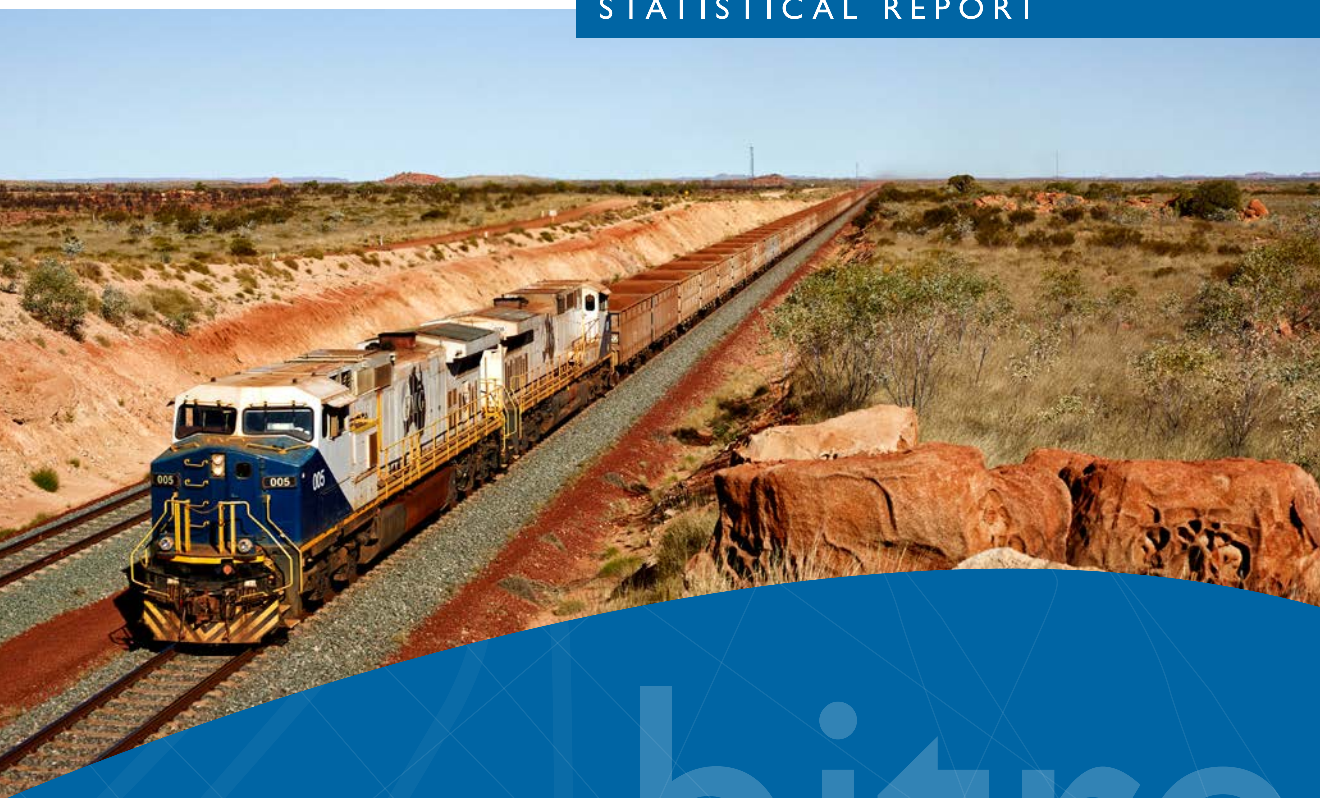
Bureau of Infrastructure, Transport and Regional Economics

AUSTRALASIAN RAILWAY ASSOCIATION

STATISTICAL REPORT



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Rail

Trainline 2

Bureau of Infrastructure, Transport and Regional Economics
and
Australasian Railway Association

Trainline 2

Statistical Report

Department of Infrastructure and Regional Development
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Cover photograph courtesy of Fortescue Metals Group. (Fortescue iron ore train outside of Port Hedland. Every Fortescue train is nearly 3 km long and carries more than 32,000 tonnes of iron ore.)

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Foreword

This statistical report is a further development of the previous rail freight performance publications series and *Trainline 1*. These publications are collaborations between the Australasian Railway Association (ARA) and the Bureau of Infrastructure, Transport and Regional Economics (BITRE).

TrainLine 2 provides an overview of freight, urban and non-urban passenger rail. The report analyses traffic levels; the provision of infrastructure and rolling stock; and railway performance.

We acknowledge the assistance of ARA members with providing data about the Australian railway industry.

This report was written by Jeremy Dornan with contributions from Peter Kain and John Ryan.

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November 2014

At a glance

Railway task

- In 2012–13 Australian railways carried over 1 billion tonnes of freight. The task was dominated by bulk movements, which accounted for 97 per cent.
- Intrastate bulk freight in Western Australia—principally iron-ore movements—accounted for 56 per cent of national rail freight tonnes. Bulk movements in Queensland and NSW—principally coal—were 22 per cent and 17 per cent, respectively.
- Australia's rail freight tonnage has grown by 57 per cent since 2007–08. The growth has been driven by the resources boom. The intrastate bulk task in Western Australia has increased by 83 per cent in the same period.
- Intermodal freight is recovering from the effects of the Global Financial Crisis. Intermodal tonnes decreased between financial years 2007–08 and 2009–10. Tonnages have since increased, by 67 per cent since 2009–10, to 28 million tonnes.
- Sydney has Australia's busiest urban heavy rail network, with over 300 million passengers in 2012–13. Melbourne's light rail system carried 183 million passengers in the same year.
- The experience of Transperth and V/Line show that network additions and enhancements, leading to greater network coverage and service improvements, can increase urban and non-urban patronage levels. Since 2003–04, both operators have more than doubled their patronage.

Railway networks

- Australia's operational heavy railway network is around 33 000 route-kilometres, with 10 per cent being electrified. There are 452 route kilometres of track under construction, including 75 route kilometres of passenger rail.
- Australia has approximately 291 route kilometres of operational light rail/tramway.
- Melbourne has Australia's largest heavy and light urban passenger rail networks at 462 route kilometres and 250 route kilometres, respectively.
- Iron ore, coal and grain rail networks and flows are reviewed. The principal iron ore railways are in Western Australia's Pilbara (2 295 route kilometres). The principal coal networks are Aurizon's central Queensland systems (1 912 route kilometres) and the NSW Hunter Valley Coal network (788 route kilometres). Grain flows run from agricultural hinterlands to ports and for domestic processing. There are approximately 5 400 route kilometres of operational railway that are largely or exclusively used for grain haulage.

Railway performance

- Scheduled freight train transit times on the North–South interstate corridor have continued to fall as investments in infrastructure are commissioned.
- Of the urban passenger rail systems, Perth provides the most consistent frequencies across its network, with a minimum of one train every 15 minutes on all lines. The highest train speeds (for all-stops services) are on Perth's Mandurah line, with an illustrative average speed of 84 km/h.
- The Victorian government's Regional Fast Rail Programme increased train speeds, enhanced rolling stock and increased service frequencies.

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CHAPTER 1
Australia's railway industry

Trainline is a compendium of Australia's railways, providing a broad range of data and analysis of the industry[1].

This compendium seeks to provide insights and understanding of the railway industry in a rapidly changing environment. Australia's railways continue to evolve in that setting, with a broad range of very rapid changes outside and within the industry. These changes include:

- **Logistics.** Interlinked chains of international and domestic production and distribution have revolutionised manufactured and processed goods. Logistics systems of bulk handling, too, has broadened, such as with containerised grain, ores in containers and barging of bulk commodities from rail heads to Cape-size vessels anchored in deep off-shore waters.
- **Commodity flows.** Australia produces around 40 per cent of the world's iron ore exports, with virtually all of this being conveyed by railway from the mine to the port. The East Turner River valley railway corridor in the Pilbara is the world's third-busiest. The last decade has seen a tripling of these exports, enabled by new and expanded railways. Over the same period, coal exports have risen by 45 per cent, again being enabled by the railway network.
- **Technology.** Where there is an appropriate business case, railway operations have embraced leading-edge technology, such as the world's heaviest wagon axle loads and pursuing the operation of remotely-controlled iron ore trains.
- **Regional passenger service.** Regional passenger services, specifically in Victoria, have been upgraded within the last decade leading to a doubling of traffic.
- **Urban patronage.** The introduction of frequent urban railway services with high average speeds, good bus, cycling, parking and amenity links has generated very strong patronage growth. Of the urban networks, Perth's patronage has grown at the fastest rate in the last decade.

In the following chapters, we present an overview and data on the railway transport task performed; characteristics of the railways and train operators' rolling stock that runs on that network; and aspects of railway performance, including safety, environment and reliability.

1 As a statistical report, the industry analysis does not consider operational, technical or regulatory aspects. Discussion of these aspects can be found in BTRE (2006). Note, also, that information about railway infrastructure investment levels will be provided in the BITRE's 2014 issue of the *Australian Infrastructure Statistics Yearbook (forthcoming).*

CHAPTER 2
Rail traffic

This chapter presents and profiles the principal tasks performed by Australia's railway industry. The review considers the major freight commodities moved and markets served. It also considers the passenger task—urban passenger movements, regional and long-distance patronage.

Overview

The railway industry performs vital freight and passenger traffic tasks. Railways excel in markets where large volumes need to be shifted, be it freight or passenger movements. In Australia's context, this means, specifically, the tasks of moving bulk commodities (for export) and serving urban travellers.

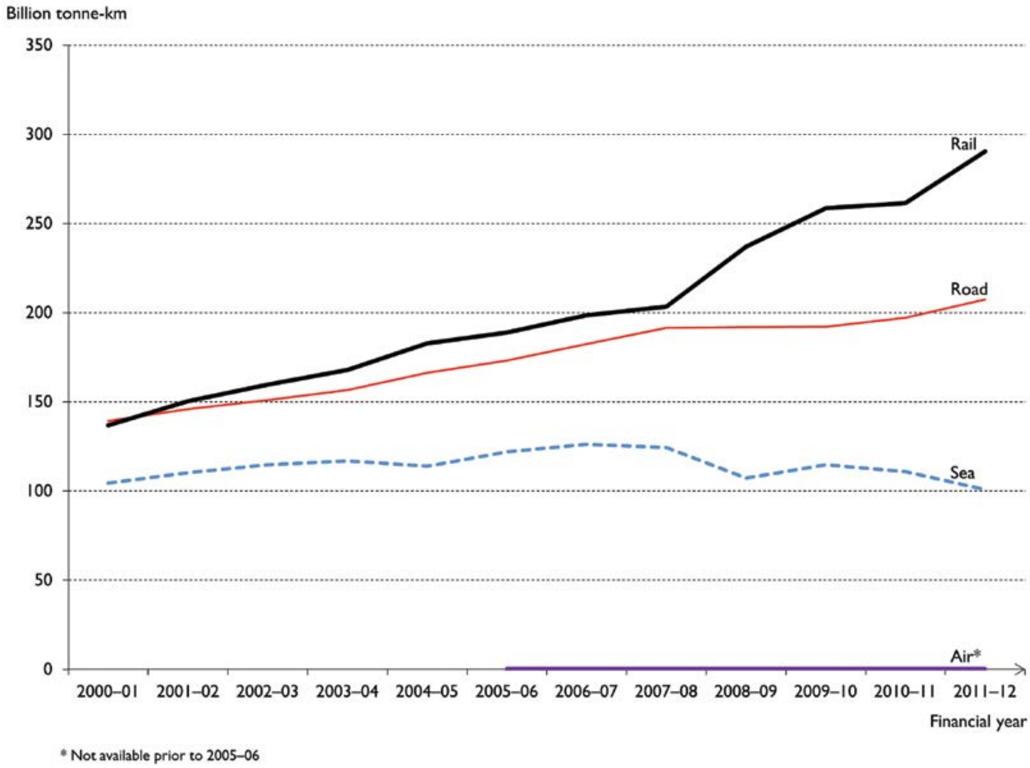
Weekday commuting to work is the key passenger rail task. The surge in rail patronage in Perth illustrates the growth in some commuter services (BITRE 2012, p. 55). Similarly, strategic investments in track and trains on regional Victorian railway corridors have brought exceptionally strong patronage growth. (BITRE 2014d, p. 68)

The role of rail in Australia's economic activity has increased dramatically in recent years—see Figure 1. Rail now accounts for almost one-half of the freight activity within Australia, up from about 36 per cent at the turn of the century. The current rail dominance is accounted for principally by the export task of moving iron ore and coal to ports. These two commodities account for over 80 per cent of the rail freight tonne-kilometres (BITRE 2014, p. 3).

Rail is also often central to moving other commodities, such as grains, sugar, and mineral sands, where it plays a key logistics role especially with flows to ports. Rail and road compete strongly for long-distance non-bulk freight. Rail's mode share of this freight is highest between the eastern states and Perth (the East–West Corridor)[2].

2 BITRE 2009 *(Road and rail freight: competitors or complements?)* assesses the circumstances for rail and road competition, particularly in non-bulk freight. See, also, *Freightline 1* (BITRE 2014, and other issues in the series) for contextual material on rail and road freight.

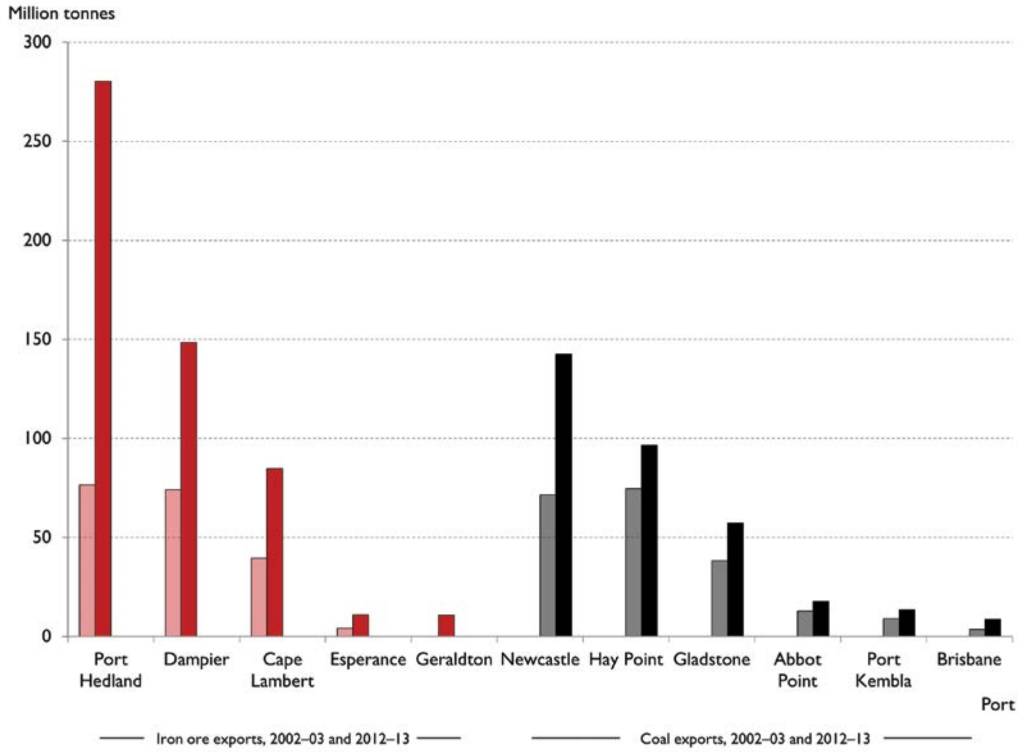
Figure 1 Estimated Australian freight volumes by transport mode



Source: Figure produced using data from BITRE 2014, (Table 1, p. 2).

As Figure 2 illustrates, the recovery of rail's freight market share has been driven by the extraordinary growth in these commodity exports in the last decade, with three times the volume of iron ore production in 2012 relative to 2002 and black coal production being up by 45 per cent in the decade to 2012–13.

Figure 2 Exports of iron ore and coal from major Australian ports



Source: BITRE 2013, p. 14.

This growth has been achieved through the expansion of ports, terminals, processing, mines and railways. The railways enable Port Hedland to be the world's largest bulk export port. In addition, Newcastle is the world's largest coal export port. Further, the East Turner River valley in the Pilbara has the third-busiest railway corridor in the world—it may take the mantle of the busiest corridor within the next few years[3]. The corridor also carries the world's heaviest rail wagon payloads; see Figure 3.

3 BHP Billiton and Fortescue have tracks through the East Turner River valley; Roy Hill's railway is being built along that same corridor, opening in 2015. Fortescue operate wagons with 40-tonne axle loads, the heaviest in the world. The 653 km Datong–Qinhuangduo railway in China is the busiet freight railway in the world (440 million tonnes), followed by the Union Pacific–BNSF joint railways from the Powder River coal basin in the USA (400 million tonnes in 2011). Unless there is very strong traffic growth on those railways, the additional logistics capacity being built in the Pilbara will, with current infrastructure expansion projections, result in the East Turner having the busiest railway corridor in the world.

Figure 3 **Fortescue's infrastructure allows wagons to carry the world's heaviest railway wagon payloads**

Source: Photograph courtesy of Fortescue Metals Group.

Rail's non-bulk freight performance is often seen as lacklustre, but there are strongly-performing areas. Rail accounts for the majority of intercapital origin–destination non-bulk freight on the East–West (Sydney/Melbourne – Perth) corridor. Rail also performs a key role in some regional freight flows, mainly between inland terminals and ports. For freight travelling between Brisbane and Melbourne, rail has roughly 30 per cent share of intercapital non-bulk freight (BITRE 2014, p. 3).

National rail freight task, tonnes

The total national rail freight task is presented, using data provided by above-rail train operators (Table 1). The freight task is measured in tonnes. The figures presented here are conventional net tonnes, excluding tare (non-payload) weight of the vehicle.

The largest rail freight flows in Australia are of bulk freight. The total rail freight task was 1.04 billion net tonnes in 2012–13, of which 1.01 billion tonnes (97 per cent) was bulk freight and 28 million tonnes was intermodal freight (See Box 1 for a definition of intermodal freight).

It is important to note tonnage data is not distance-weighted. The intermodal task would be a higher proportion of the total freight task were net tonne-kilometres measured.[4] This is because the largest intermodal flows travel comparatively long distances; reflecting the market in which intermodal rail is most competitive against road. National tonne-kilometres data are not available for 2012–13. However, data for the two largest freight train operators are presented in the next section (page 10).

Table 1 National rail freight task, thousand net tonnes

Year	Bulk	Intermodal	Total
2007–08	642 826	19 519	662 345
2008–09	705 039	17 481	722 520
2009–10	798 763	16 521	815 284
2010–11	-	-	-
2011–12	-	-	-
2012–13	1 012 997	27 559	1 040 556

Notes: The table excludes traffic data for some of the smaller train operators, such as Southern Shorthaul Railroad and Sydney Rail Services. Data for 2012–13 exclude El Zorro (which ceased operating in June 2013).
Data for 2010–11 and 2011–12 are not available.

Sources: BITRE 2012a; for 2012–13 data was provided by Asciano, Aurizon, Fortescue metals group, BHP Billiton, Rio Tinto, Freightliner, Genesee & Wyoming Australia, Qube, SCT Logistics, TasRail, Watco; BITRE estimates.

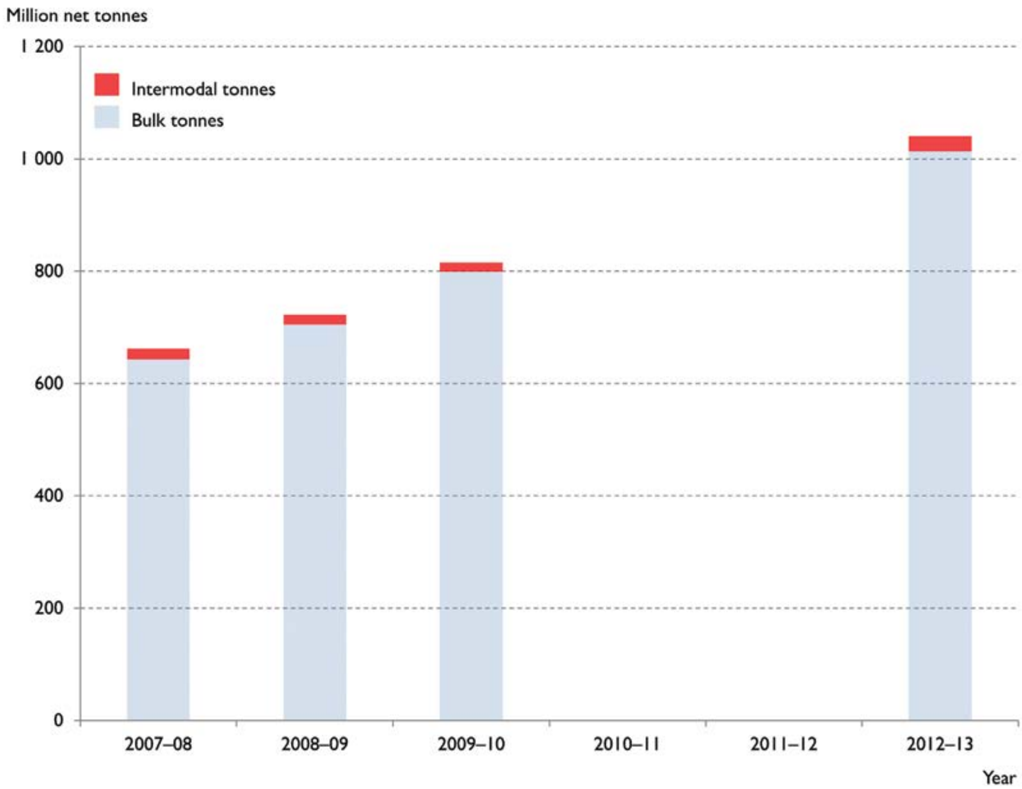
Bulk rail traffic is almost entirely intrastate. The biggest bulk haulage task is in Western Australia, dominated by rail's movement of iron ore in the Pilbara region; it represents 56 per cent of Australia's total rail freight task. Other sizeable intrastate bulk flows are recorded in Queensland (22 per cent of the total rail freight task) and NSW (17 per cent of the total rail freight task), where there are large coal movements. A matrix of the bulk freight task, by state of origin and destination, is presented in Appendix E.

The bulk and intermodal freight tasks have grown since 2007–08 (Figure 4). The growth in bulk freight has been driven by the resources boom. The intrastate bulk task in Western Australia, for example, has increased by 83 per cent since 2007–08.

The intermodal task is recovering from the effects of the Global Financial Crisis. The decline in intermodal traffic between 2007–08 and 2009–10 coincided with the economic slowdown (BITRE, 2012a, p. 15). The intermodal task has increased by 67 per cent since 2009–10.

4 In 2009–10, for example, the bulk task accounted for 98 per cent of net tonnes and 89 per cent of net tonne kilometres (Bitre 2012a, p.26).

Figure 4 National rail freight task, 2007–08 to 2012–13



Notes: The chart excludes traffic data for some of the smaller train operators, such as Southern Shorthaul Railroad and Sydney Rail Services. Data for 2012–13 exclude El Zorro (which ceased operating in June 2013).

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Source: BITRE 2012a; for 2012–13 data was provided by Asciano, Aurizon, Fortescue metals group, BHP Billiton, Rio Tinto, Freightliner, Genesee & Wyoming Australia, Qube, SCT Logistics, TasRail, Watco; BITRE estimates.

Trainline uses specific definitions for bulk and non-bulk freight. In principle, 'bulk' freight generally involves large quantities of homogenous product that is conveyed in wagons; non-bulk freight is generally perceived as any containerised or unitised freight, generally placed or lifted into transport holds. However, in practice the 'non-bulk' freight may not be containerised; conversely bulk commodities are often conveyed in containers. In this report, 'bulk' is used to refer to anything not considered 'intermodal'—so 'bulk' includes steel, which may—in other contexts—be classified as non-bulk. 'Intermodal' is defined by the classification of train as used for infrastructure charging. Box 1 provides more insight into these definitions.

Box 1 Defining 'intermodal' and other trains

Trainline provides statistics for 'intermodal', 'steel' and 'bulk' freight movements. The definition used here for intermodal freight is 'market-based'. Defining the traffic in terms of the market served (such as relatively high priority goods for which road freight is a strong competing mode) is argued to be clearer than when defined in terms of the type of goods (notably, non-bulk) conveyed or the type of wagon used. In particular, where data for 'intermodal' trains is reported, such trains are defined as trains with axle loads up to and including 21 tonnes and a maximum speed of 115 kph. In terms of ARTC infrastructure charges, this categorisation consists of the 'Express Freight' trains (with maximum train speed of 115 kph and axle load up to 20 tonnes) and 'Superfreighter' trains (with maximum train speed of 110 kph and axle load up to 21 tonnes).

These specifications reflect the competitive freight market for the conveyed traffic. Thus, the nature of the wagons themselves may not reflect the traditional perception of 'intermodal' as meaning 'more than one mode'; and may not reflect a situation where the goods can be readily transferred across modes.

As defined here, the 'intermodal' traffic can consist of wagons conveying containers on flat (or well) wagons as well as by louvre wagons. Further, the goods may be bulk goods (such as grains or hay) as well as non-bulk (such as palletised tinned dog food). However, the type of train operated is unambiguous. The defining feature of an 'intermodal' train is the infrastructure charge rather than the way the goods are conveyed. 'Container' can be used to define the 'intermodal' activity but it does not convey the market within which rail is competing. For instance, containers can be used to classify goods movements but the goods within the container may include 'bulk' items such as steel, grain or minerals.

Steel movements occur on timetable-defined 'steel' trains, which ARTC defines as 'Regular Freight' trains. It is possible, however, for such trains to convey other, low-priority, goods.

Finally, bulk-freight activity is also reported. Measuring 'bulk' freight can be ambiguous because the goods traditionally classified as bulk may be conveyed on intermodal trains (in louvre wagons or containers) and, on the definition used here, will be classified as 'intermodal'. Bulk freight can also be conveyed by containerised trains; when compiling data presented in this report, train operators have classified containerised bulk goods trains (such as ores, grains, steel and mineral sands) as 'bulk'.

National freight task, by operator

Some publicly-available data can be used to gain further insight into national rail freight activity. The railway industry is dominated by four major freight train operators: Aurizon, Asciano, SCT Logistics and Qube Holdings. The largest two operators, Aurizon and Asciano, provide quarterly train-operator traffic data[5] to the Australian Stock Exchange (ASX); that material forms the basis of the data that are presented in Table 2, with more detailed information being provided in Appendix C.

Table 2 ASX train operator traffic trends (billion net tonne-kilometres)

Period	Asciano				Aurizon					Two operators
	Coal	Other bulk	Intermodal (including steel)	Total	Coal	Iron ore	Bulk	Non-bulk — plus residual bulk from 2011–12	Total	Total
2007–08	12.7	2.8	25.9	41.4	42.8	-	13.6	4.8	61.2	102.6
2008–09	13.9	3.6	22.5	40.0	43.5	-	14.3	4.2	62.0	102.0
2009–10	18.1	3.4	22.2	43.7	45.3	-	15.2	3.7	64.2	107.9
2010–11	18.3	4.0	21.8	44.2	40.9	-	-	18.9	59.8	104.0
2011–12	20.0	5.6	23.0	48.6	41.9	6.7	-	14.3	62.9	111.5
2012–13	24.0	6.0	22.7	52.7	43.6	10.3	-	13.2	67.1	119.8
2013–14	29.2	5.1	21.5	55.8	49.2	12.2	-	12.5	73.9	129.7

Note: Data sources and (where published) a breakdown of information into quarters and half-years are presented in Appendix C.

The tonne-kilometre data present one perspective of each operator's performed traffic task; the measure is preferable to tonnes hauled (which can be unrepresentative of the task when short haulage lengths are involved).

Coal haulage dominates for both operators, representing just over one-half of Asciano's tonne-kilometres and two-thirds of Aurizon's tonne-kilometres. When comparing the coal operations, it should be noted that Asciano hauled 42 per cent of the 2013 (financial year) coal tonnage but just 35.5 per cent of the tonne-kilometres. Asciano dominates the coal haulage in the Hunter Valley, where the haulage length to the port (and power stations) is somewhat less than the average lengths in the Queensland coal fields. Asciano's average coal haulage length in 2013 was 174 km, compared with 225 km for Aurizon. In that context, Aurizon's average coal haul length in Queensland was 243 km but 153 km in NSW[6].

5 Aurizon's traffic data here refer to its own train haulages; the company also provides third-party access to its tracks (particularly Asciano trains), which the company reports through its Aurizon Network subsidiary.

6 Stock Exchange reports indicate the following data for 2013: Asciano coal ntk and tonnage were 24.0 billion and 0.1385 billion, respectively, implying an average haul length of 173.6 km. (That is, ntk is divided by tonnes.) Equivalent figures for Aurizon were 43.6 billion and 0.1937 billion, respectively, implying an average haul length of 225.1 km. The ntk for Aurizon's Queensland and NSW coal haulage were 37.8 billion and 5.8 billion, respectively; the tonnes hauled were 0.1558 billion and 0.0379 billion—the resulting average haul lengths are therefore 242.6 km and 153.0 km. Asciano's average haul length is raised to some extent by the company's 250 km coal haulage between the Leigh Creek (Telford) coal field and Stirling North, in South Australia.

Asciano's steel traffic is incorporated within the intermodal traffic; the traffic flows across the interstate network, connecting the steel-making facilities in Port Kembla (Bluescope) and Whyalla (Arrium) and the mainland capital cities and Hastings (metal processing). That traffic was 2.8 million tonnes in 2012–13 (Asciano 2013, p. 34); the tonne-kilometre figure is not provided.

The traffic flows inevitably reflect ongoing train competitiveness trends (particularly for intermodal traffic) and in prevailing economic activity. A dip in traffic in 2008–09, for example, reflects the downturn in international trade arising from the global financial crisis (Appendix C). Variations in individual commodity flows arise from international demand for commodities as well as train operators' winning or losing of major contracts. In the last few years, for example, the contract for grain haulage (for CBH) in Western Australia was transferred from Aurizon to Watco WA Rail (March 2012) while, in January 2012, Aurizon commenced hauling iron ore for Karara Mining on a 320 km route between Karara and Geraldton. Both companies have benefited from new coal haulage contracts.

Box 2 Further freight rail operator traffic data resources

There is a diverse range of sources for railway freight traffic data, although none of the sources covers the entire network. Data sources are train operator data, and track/infrastructure manager data.

Train operator data

The principal published train operator data are those presented above (Table 2; and also Table 34) for Asciano and for Aurizon; those data sources also provide financial information, including revenue by principal commodities hauled.

There is very limited information on the other freight train operators (Qube Holdings, SCT Logistics [and subsidiary, Specialised Bulk Rail], Queensland Rail, Freightliner Australia, Southern Shorthaul Railroad, Crawfords Freightlines, Glencore Rail, Genesee & Wyoming Australia, Watco and the Pilbara railways [BHP Billiton, Rio Tinto including its Weipa operations, Fortescue[7]]). TasRail provides limited information on tonnages of selected commodities that it transports, such as logs, minerals, newsprint and cement. (TasRail 2013, pp. 9, 37–38)

Genesee & Wyoming is required to file reports with the USA's Securities and Exchange Commission (SEC; see the references for the web link). The filings provide information on US Dollar-denominated revenue and costs for the Australian subsidiary; and insights into traffic trends.

Some one-off studies can provide data on traffic flows. For example, a Port of Brisbane study (Port of Brisbane, with the Queensland Transport and Logistics Council 2013, pp. 31–33) cites intrastate and interstate domestic container rail movements, by direction, whether containers are full or empty, and the origin and destination terminals of the containers.

(continued)

7 Fortescue (2014, p. 11) illustrates the mining traffic data that can be inferred as being essentially railed ore. The "ore shipped—Fortescue mined ore" tonnage will correspond to ore that has been mined at Fortescue mines; the third-party ore is ore that is shipped via Fortescue's berths at Port Hedland but will have been brought to the port by road.

Box 2 Further freight rail operator traffic data resources *(continued)*

Infrastructure manager data

Figure 50 illustrates the primary railway infrastructure managers. Below-rail data sources from these managers include:

- Aurizon Network's aggregated traffic data and train numbers for each of its five Queensland coal systems, together with other freight and passenger services operating over its network (Aurizon Network n.d.; Aurizon Network 2014e);
- ARTC's aggregated Hunter Valley network quarterly coal tonnage throughput (ARTC n.d.);
- ARTC's aggregated annual network tonnages are reported in the Corporation's annual reports; and
- disaggregated tonnage data for each of Brookfield's lines (Brookfield Rail n.d.(a) and Brookfield Rail n.d.(b); Brookfield Rail 2014 for selected 2013 grain line tonnages).

The Australasia Railway Corporation presents high-level annual traffic data for the Darwin line in their annual reports <http://www.aarail.com.au/about/publications/>

Note, also, that traffic data and projections can be provided to the infrastructure managers' economic regulators, which may then publish that material[8].

While explicit traffic data are not generally available for Pilbara railways or for east coast coal ports, the export iron ore and coal from those ports is generally moved to the ports by rail; discussion and data sources for each of those ports can be found in *Australia's bulk ports* (BITRE 2013). Further, the BITRE's *Freightline* series (being published a series of reports) presents freight flows by commodity. (BITRE 2014b)

Traffic activity

An informal data source for freight (and passenger) rail activity is the material collated by Graham Elliott, who records traffic activity (train lengths and characteristics) through Gheringhap station in Victoria, on the East–West Corridor. See the web site at http://ghaploop.railpage.org.au/ and the BITRE report on that data source (BTRE 2007).

Interstate network traffic

This section reviews traffic levels across the interstate network—the lines connecting mainland capital cities.

The traffic flows across the network are reported by line segment. Intermodal and total gross tonnes by line segment are shown in Table 3 and Table 4, with line segments ordered from North to South and East to West. The data are also shown in Figure 5, Figure 6, Figure 7 and Figure 8. There are two factors to note when reviewing the tonnages:

8 Aurizon's economic regulator is the Queensland Competition Authority (http://www.qca.org.au/Rail); ARTC's is the ACCC (https://www.accc.gov.au/regulated-infrastructure/rail); Brookfield Rail's is the Economic Regulation Authority [WA] (http://www.erawa.com.au/rail/rail-access).

- Where tonnage does not move along the entire length of a segment, the tonnage has been weighted by the proportion of the line segment travelled.
- Coal traffic is excluded. This is because that traffic is not in a form that is amenable to comparison with other commodities. In particular, while coal generally does not move on the interstate network, large coal volumes briefly traverse the network near Newcastle and in the NSW Southern Highlands. In those locations, coal tonnages are an order of magnitude higher than all other commodities carried.

Interstate intermodal traffic

Table 3 and Table 4 present intermodal, and total, tonnage levels on line segments of the interstate network.

Table 3 Gross tonnes by line segment, North–South corridor

Line segment, by direction of freight	Million gross tonnes					
	Intermodal			Total		
	2010–11	2011–12	2012–13	2010–11	2011–12	2012–13
Acacia Ridge to Casino	2.05	2.00	1.91	2.69	2.60	2.47
Casino to Acacia Ridge	2.25	2.30	2.25	3.60	3.71	3.57
Acacia Ridge – Casino	4.30	4.31	4.15	6.29	6.31	6.04
Casino to Maitland	2.06	2.00	1.91	3.17	3.22	2.91
Maitland to Casino	2.25	2.30	2.25	4.17	4.36	4.22
Casino–Maitland	4.31	4.30	4.16	7.34	7.58	7.13
Macarthur to Tahmoor	2.94	2.89	2.73	6.83	6.57	7.01
Tahmoor to Macarthur	3.26	3.28	3.26	7.56	8.06	7.99
Macarthur–Tahmoor	6.19	6.17	5.99	14.38	14.63	15.00
Tahmoor to Moss Vale	2.94	2.89	2.74	6.23	6.17	6.59
Moss Vale to Tahmoor	3.26	3.28	3.26	7.09	7.99	7.83
Tahmoor – Moss Vale	6.20	6.17	6.00	13.32	14.16	14.42
Moss Vale to Marulan	3.04	2.98	2.84	7.63	9.17	9.34
Marulan to Moss vale	3.35	3.40	3.37	10.78	15.77	14.76
Moss Vale – Marulan	6.39	6.38	6.20	18.40	24.93	24.09
Marulan to Goulburn	3.04	2.98	2.84	7.28	8.44	8.64
Goulburn to Marulan	3.35	3.40	3.37	9.63	13.48	12.62
Marulan–Goulburn	6.39	6.38	6.20	16.91	21.92	21.26
Goulburn to Cootamundra	3.04	2.98	2.84	6.03	6.71	6.95
Cootamundra to Goulburn	3.35	3.40	3.37	8.83	11.28	10.55
Goulburn–Cootamundra	6.39	6.38	6.20	14.87	17.99	17.50
Cootamundra to Junee	2.38	2.30	2.15	5.69	6.76	6.40
Junee to Cootamundra	2.46	2.49	2.39	6.31	7.98	8.23
Cootamundra–Junee	4.84	4.79	4.55	12.00	14.74	14.64
Junee to Albury	2.38	2.30	2.16	4.81	5.22	5.95
Albury to Junee	2.46	2.49	2.39	4.29	4.75	4.92
Junee–Albury	4.83	4.79	4.55	9.10	9.97	10.87
Albury to Tottenham	2.38	2.28	2.15	4.77	5.51	6.08
Tottenham to Albury	2.46	2.46	2.36	4.07	4.62	4.74
Albury–Tottenham	4.84	4.75	4.51	8.84	10.14	10.82

Source: Data provided by ARTC.

Table 4 Gross tonnes by line segment, East–West corridor

Line segment, by direction of freight	Million gross tonnes					
	Intermodal			Total		
	2010–11	2011–12	2012–13	2010–11	2011–12	2012–13
Cootamundra to Parkes	0.72	0.71	0.72	2.01	2.42	2.35
Parkes to Cootamundra	0.95	0.93	1.01	3.56	4.42	3.88
Cootamundra–Parkes	1.67	1.64	1.72	5.56	6.83	6.23
Parkes to Broken Hill	1.52	1.63	1.71	2.42	2.75	2.79
Broken Hill to Parkes	1.21	1.20	1.29	2.83	3.40	3.45
Parkes – Broken Hill	2.73	2.83	3.00	5.25	6.16	6.24
Broken Hill to Crystal Brook	1.52	1.62	1.71	3.63	4.53	4.37
Crystal Brook to Broken Hill	1.21	1.19	1.29	2.58	2.81	2.88
Broken Hill – Crystal Brook	2.73	2.82	3.01	6.21	7.34	7.24
Tottenham to Dimboola	4.29	4.28	4.13	6.12	7.21	7.72
Dimboola to Tottenham	3.89	3.66	3.44	6.37	8.53	9.46
Tottenham–Dimboola	8.18	7.94	7.57	12.49	15.74	17.17
Dimboola to Tailem Bend	4.16	4.29	4.15	5.90	6.49	5.90
Tailem Bend to Dimboola	3.59	3.68	3.46	4.70	4.99	4.57
Dimboola – Tailem Bend	7.75	7.97	7.61	10.60	11.48	10.46
Tailem Bend to Dry Creek	4.19	4.33	4.18	5.96	6.59	5.98
Dry Creek to Tailem Bend	3.62	3.71	3.48	4.73	5.03	4.61
Tailem Bend – Dry Creek	7.81	8.04	7.67	10.69	11.63	10.59
Dry Creek to Crystal Brook	4.66	5.01	5.10	6.80	7.71	7.85
Crystal Brook to Dry Creek	3.51	3.81	3.89	8.23	10.44	10.66
Dry Creek – Crystal Brook	8.17	8.82	8.99	15.04	18.16	18.51
Crystal Brook to Port Augusta	6.16	6.62	6.82	9.07	9.98	9.80
Port Augusta to Crystal Brook	4.71	5.00	5.18	8.91	10.92	10.81
Crystal Brook – Port Augusta	10.87	11.62	12.00	17.99	20.90	20.61
Port Augusta to Tarcoola	6.18	6.69	6.85	7.29	8.36	9.00
Tarcoola to Port Augusta	4.72	5.02	5.15	5.99	8.03	10.14
Port Augusta – Tarcoola	10.90	11.71	12.01	13.28	16.39	19.14
Tarcoola to Kalgoorlie	5.20	5.63	5.73	6.20	6.70	6.70
Kalgoorlie to Tarcoola	4.08	4.33	4.40	4.83	5.18	5.22
Tarcoola–Kalgoorlie	9.28	9.96	10.13	11.03	11.88	11.92
West Kalgoorlie to Koolyanobbing East	5.03	5.34	5.43		9.90	11.12
Koolyanobbing East to West Kalgoorlie	3.74	3.99	4.03		17.86	20.68
West Kalgoorlie – Koolyanobbing East	8.77	9.32	9.46		27.76	31.80
Koolyanobbing East to West Merredin	5.03	5.34	5.43		7.76	8.50
West Merredin to Koolyanobbing East	3.74	3.99	4.03		6.57	6.88
Koolyanobbing East – West Merredin	8.77	9.32	9.46		14.33	15.38
West Merredin to Avon	5.03	5.34	5.43		8.65	9.73
Avon to West Merredin	3.74	3.99	4.03		6.73	7.07
West Merredin – Avon	8.77	9.32	9.46		15.38	16.80

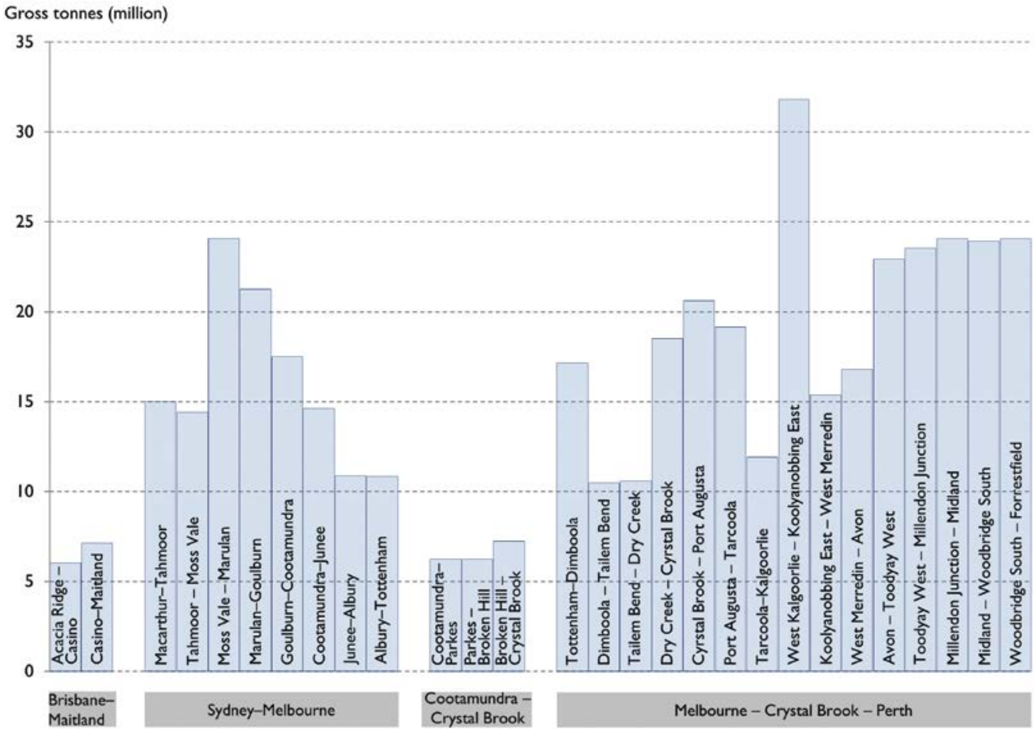
(continued)

Table 4 Gross tonnes by line segment, East–West corridor *(continued)*

Line segment, by direction of freight	Million gross tonnes					
	Intermodal			Total		
	2010–11	2011–12	2012–13	2010–11	2011–12	2012–13
Avon to Toodyay West	5.03	5.34	5.43		13.07	14.49
Toodyay West to Avon	3.74	3.99	4.03		8.03	8.42
Avon – Toodyay West	8.77	9.32	9.46		21.10	22.91
Toodyay West to Millendon Junction	5.03	5.34	5.43		13.30	14.94
Millendon Junction to Toodyay West	3.74	3.99	4.03		8.09	8.56
Toodyay West – Milledon Junction	8.77	9.32	9.46		21.39	23.51
Milledon Junction to Midland	5.03	5.34	5.43		13.60	15.38
Midland to Millendon Junction	3.74	3.99	4.03		8.17	8.69
Millendon Junction – Midland	8.77	9.32	9.46		21.78	24.07
Midland to Woodbridge South	5.03	5.34	5.44		13.53	15.31
Woodbridge South to Midland	3.75	3.99	4.04		8.10	8.61
Midland – Woodbridge South	8.79	9.33	9.48		21.62	23.92
Woodbridge South to Forrestfield	5.03	5.34	5.44		13.60	15.38
Forrestfield to Woodbridge South	3.76	4.01	4.05		8.19	8.68
Woodbridge South – Forrestfield	8.79	9.35	9.48		21.79	24.06

Note: Brookfield Rail data for "total freight" are not available for 2010–11.
Source: Data provided by ARTC and Brookfield Rail.

Figure 5 Gross tonnes on the interstate network, by line segment, 2012–13



Source: Data provided by ARTC and Brookfield Rail.

The variations in relatively consistent intermodal flows across the network are explained by specific flows:

- Intermodal traffic on North–South segments between Sydney (Macarthur) and Cootamundra include diverging/converging traffic at Cootamundra, from the East–West Corridor (via Broken Hill).
- Regional intermodal traffic (exports heading for the Port of Melbourne) joins the network at Junee from terminals in the Riverina (Griffith), as well as paper-based traffic from Junee destined for Melbourne.
- Intermodal rail traffic can originate/terminate in terminals in Parkes, for the East–West Corridor (via Broken Hill).
- Intermodal traffic flows between Melbourne and the-then terminal at Horsham (relocated subsequently to nearby Dooen).
- There is higher intermodal traffic to the west of Crystal Brook, where the separate Adelaide and via–Parkes flows merge.
- Intermodal flows fall to the west of Tarcoola, the junction with the Darwin line.

Further discussion on some of these intermodal flows can be found in the section on non-bulk rail freight, from page 32.

On the North–South corridor, intermodal traffic has been relatively stable, while East–West intermodal tonnages have grown on most segments. A decline in Melbourne–Adelaide land-bridging task (see page 74) has been off-set by increased traffic between Melbourne–Perth and Sydney–Perth.

"Other" traffic on the interstate network

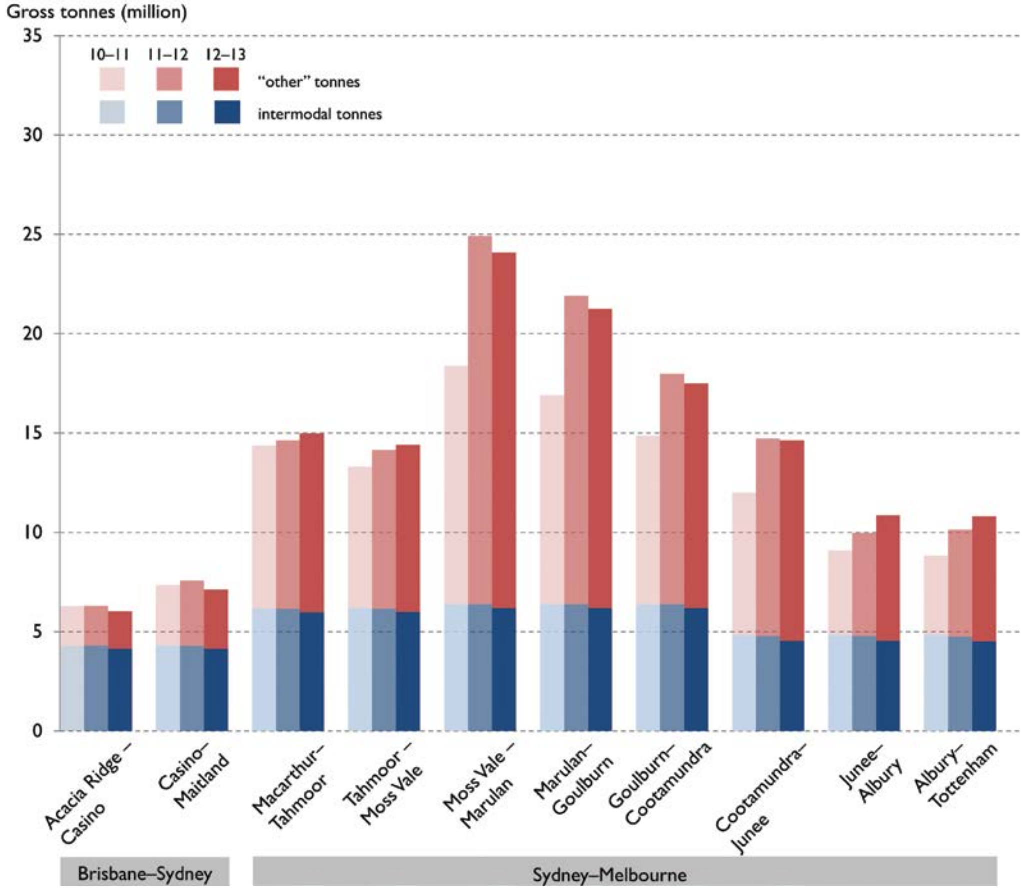
There are significant non-intermodal freight flows—classified as "other" in Figure 6, Figure 7 and Figure 8. An important part of this category is interstate steel traffic. Steel is moved along the length of the East–West corridor between New South Wales (Newcastle and Port Kembla) and South Australia and Western Australia (Port Augusta, Whyalla and Perth). There are also steel movements on the North–South corridor, primarily between Port Kembla and interstate capitals.

Other significant non-intermodal freight flows are as follows:

- Grain movements[9] generally join the network from a web of branch and secondary lines, connecting agricultural hinterlands to the port. Movements on the interstate network are heaviest close to Perth and in New South Wales. Good harvests in recent years have contributed to marked increases in tonnages on the interstate network between Moss Vale and Junee. See page 26 for more detail on grain movements.
- Aggregate, sand and limestone quarries in the southern New South Wales Tablelands are an important contributor to tonnages between Macarthur and Goulburn. The exhaustion of quarries in Western Sydney has resulted in expansion of mining activity in the Southern Tablelands.
- Iron Ore from the Yilgarn Region contributes a major proportion of tonnages hauled from the West Kalgoorlie – Koolyanobbing East line segment. Iron ore is railed in two directions. It moves westward from Koolyanobbing, via Kalgoorlie, to Esperance Port. This flow rose from 1.5 million tonnes per annum in 1995 to over 11 million tonnes in 2012–13 (Esperance Ports, 2014). Iron ore is also railed eastward from Mount Walton siding (serving Carina Mine) to Kwinana. The rate of iron ore production at Carina Mine reached an annual rate of 5 million tonnes per annum in 2014 (Polaris Metals, 2014).

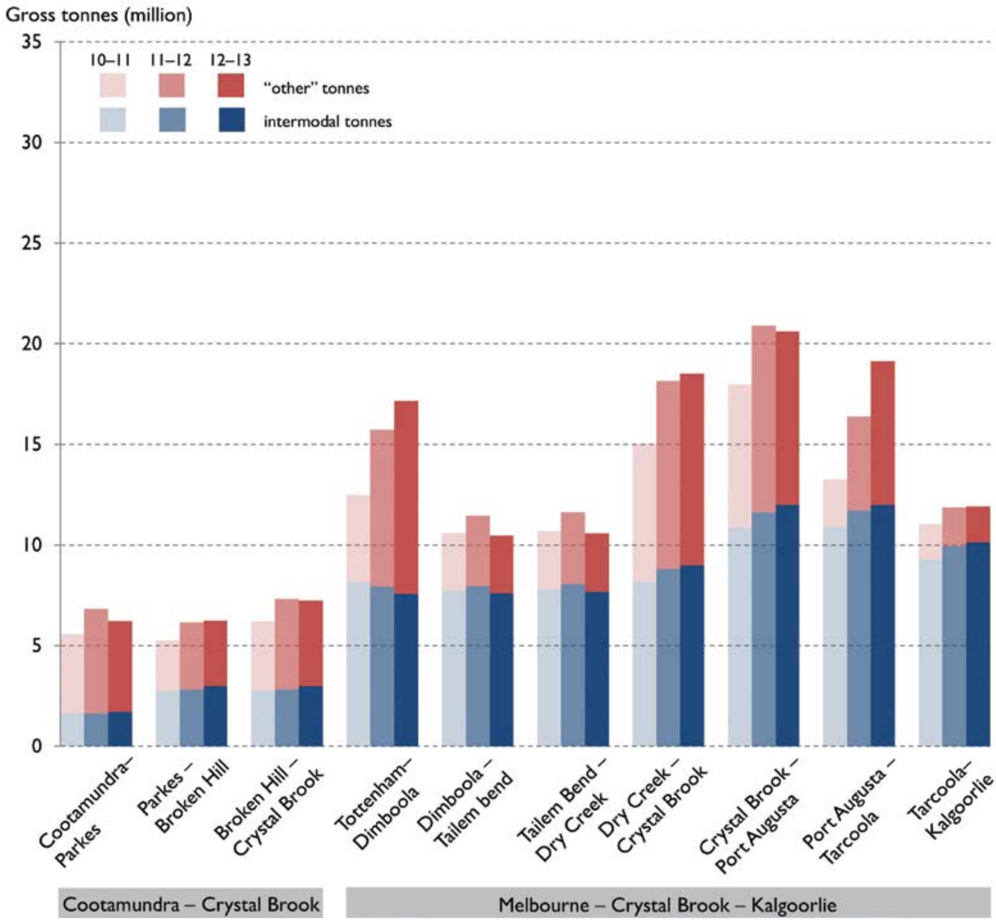
[9] Grain can also be transported in containers. When this is the case, grain is classified as intermodal. See further discussion of grain-in-boxes on p. 28.

Figure 6 Gross tonnage on the North–South corridor, by line segment, 2010–11 to 2012–13



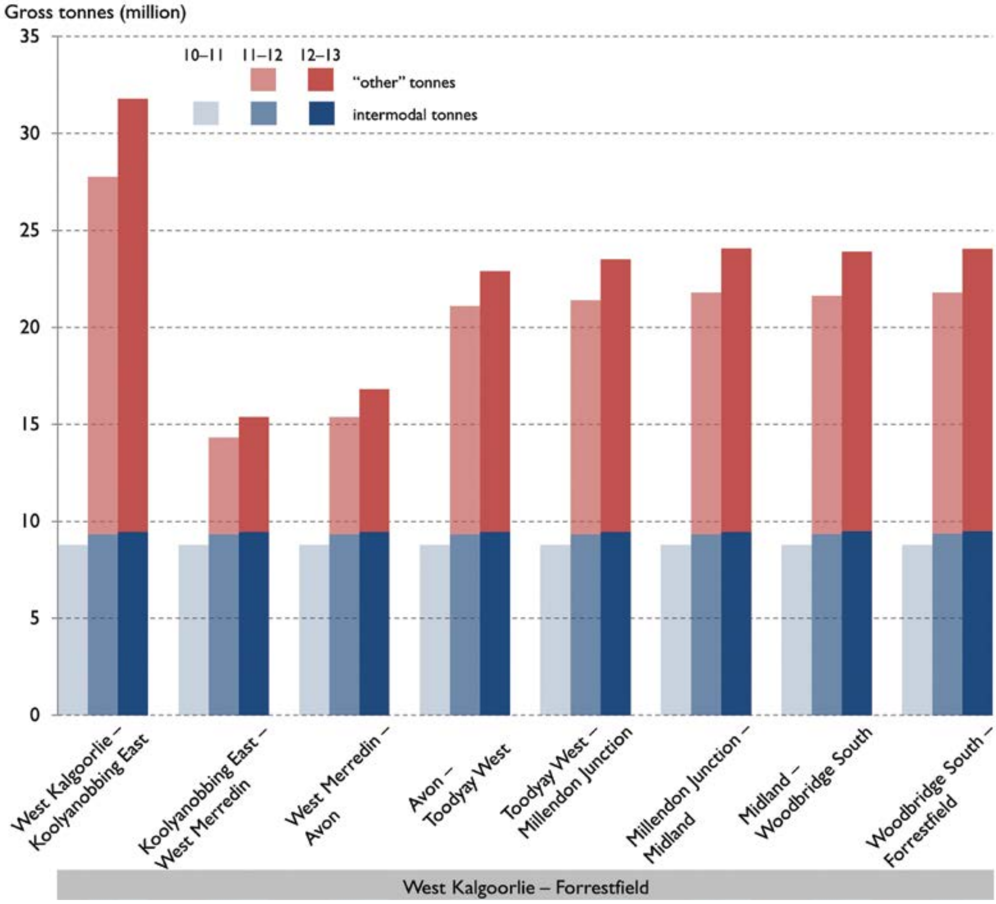
Source: Data provided by ARTC.

Figure 7 Gross tonnage on the East–West corridor, by line segment, 2010–11 to 2012–13



Source: Data provided by ARTC.

Figure 8 Gross tonnage on the East–West corridor, by line segment, 2010–11 to 2012–13



Note: Brookfield Rail data for "other freight" are not available for 2010–11.

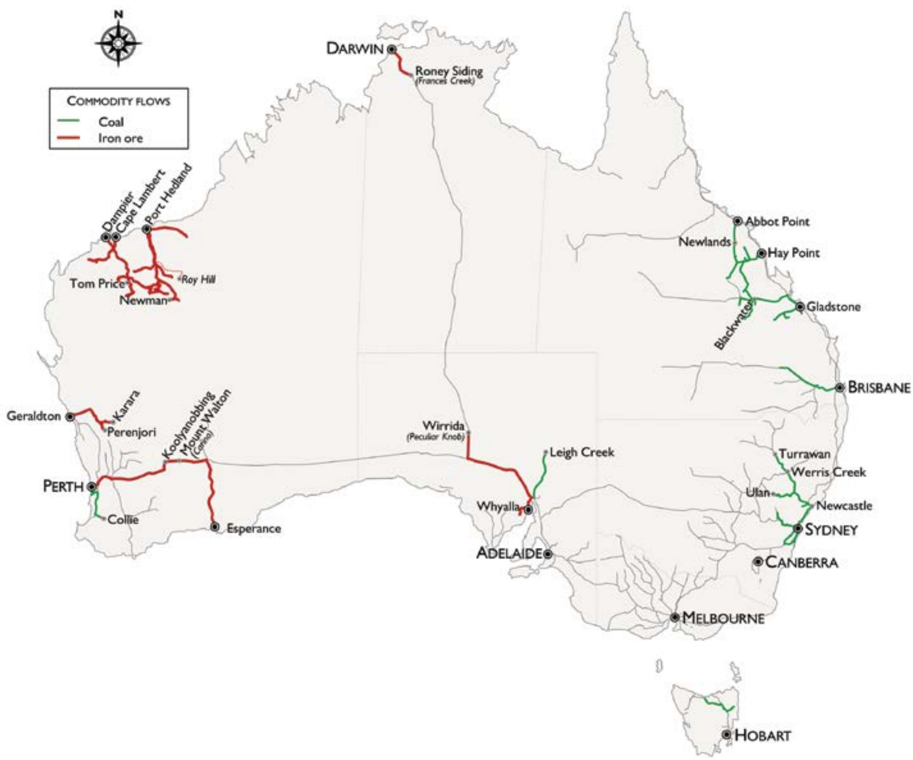
Source: Data provided by Brookfield Rail.

Rail freight traffic, by commodity

This section analyses rail freight traffic by commodity or market. Iron ore, coal, grain and non-bulk freight traffic are analysed.

Iron ore and coal are the rail industry's two largest bulk freight flows; these flows are illustrated in Figure 9.

Figure 9 Principal iron ore and coal flows, 2014



Iron ore traffic

The majority of Australia's iron ore is exported[10] and virtually all of this is shifted to port by rail[11]. The largest flows are in the Pilbara, with over 94 per cent of Australia's iron ore exports coming from the region (BITRE, 2014a). The integrated railways of the Pilbara, by infrastructure owner (Figure 10), are:

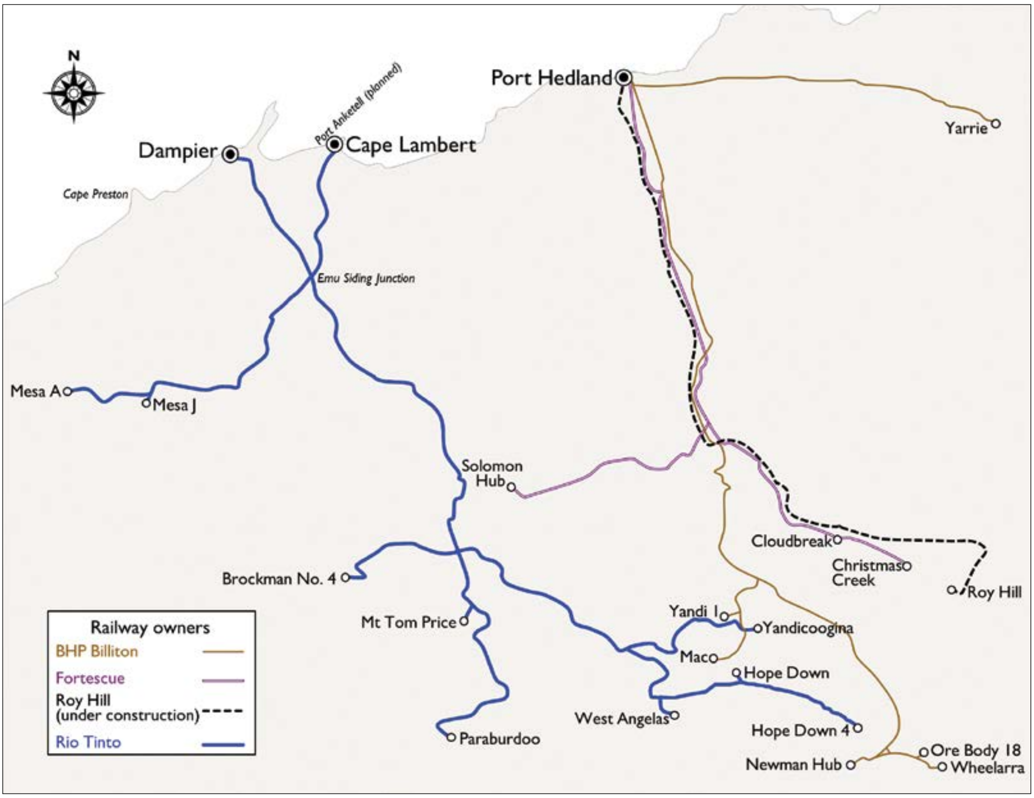
- **Rio Tinto:** the Robe River to Cape Lambert and the former Hamersley Iron's network to Port Dampier. As of 2012, trains on the Hamersley railway were approximately 2.4 kilometres long and had a capacity of 26 000 tonnes (BITRE 2013, p. 31).

10 There are two domestic manufacturers of steel, Arrium and BlueScope Steel, with a blast furnace in each of Whyalla and Port Kembla, respectively. Between them they used 6.5 million tonnes of iron ore in 2011–12. Arrium sources its iron ore mostly from the Middleback Ranges in South Australia. BlueScope Steel use iron ore from Mount Newman (Western Australia) and Savage River (Tasmania) (BITRE 2014a).

11 Rail has an estimated 86 per cent of the domestic iron ore freight task, with road having an estimated 2 per cent. Where iron ore is used in domestic manufacturing, coastal shipping is used to shift iron ore between ports (representing an estimated 12 per cent of the domestic iron ore freight task). See BITRE 2014a.

- **BHP Billiton:** the Goldsworthy line (to Yarrie) and the Newman line run to Port Hedland. Each train on the Newman line is able to carry approximately 37 000 tonnes while trains on the Goldsworthy line can carry up to 8 800 tonnes (BITRE 2013, p. 27).
- **Fortescue Metals Group:** the Fortescue Hamersley line from Solomon Hub and the Christmas Creek line run to Port Hedland. Trains on these lines are able to haul approximately 33 000 tonnes each (BITRE 2013, p. 27).
- **Roy Hill Holdings:** the 344 route kilometre railway from Roy Hill to Port Hedland is under construction, to be completed in 2015[12].

Figure 10 Pilbara iron ore railways, by infrastructure owner, 2014



The scale of the transport task for iron ore means that rail is generally the most cost effective means of transporting the commodity from mine to port. Tonnages exported, by principal port, provide a useful indicator of tonnages hauled by the iron ore railways. See Table 5, and Figure 2 (p. 5).

12 The Roy Hill Iron Ore Project is being developed by Roy Hill Holdings Pty Ltd, with Hancock Prospecting Pty Ltd holding a 70 per cent share and with the remaining 30 per cent equity being held by a consortia of Marunbeni Corporation, POSCO, and China Steel Corporation.

Table 5 Iron ore exports, million tonnes, 2012–13

Port Hedland	Dampier	Cape Lambert (Port Walcott)[a]	Esperance	Geraldton	Fremantle (Perth)	Port Adelaide	Darwin
280.2	148.4	84.8	11.0	10.7	3.5	1.8	1.7

Note: [a] Cape Lambert iron ore facilities lie within the administrative area of Port Walcott. The data for Port Walcott includes a small amount of mixed goods.

Sources: Ports Australia 2014 and BITRE 2014c.

Coal traffic

The scale of the coal logistics task makes railways the preferred cost-effective option for delivering coal from mine to port. The majority of Australia's coal is extracted in Queensland and NSW. The Queensland coal is predominantly metallurgical coal (used in steel-making) while the NSW coal is predominantly thermal coal (typically being used in power generation)[13].

Australia's principal coal haulage is on the Central Queensland Coal Network and on the Hunter Valley coal railways—see Figure 9. The Central Queensland Coal Network, using narrow gauge track, is managed by Aurizon and is divided into five coal systems. The standard-gauge Hunter Valley system is largely managed by ARTC, the systems are described below:

- **Newlands.** The Newlands system runs through the northern end of the Bowen Basin, carrying coal to the port at Abbot Point. The line services mines at Collinsville, Sonoma and Newlands (Aurizon 2014a, p. 24). Coal is also hauled from the Lake Vermont mine in the Goonyella system. The Newlands system is approximately 174 route kilometres. Trains from the Collinsville and Newlands mines have a maximum capacity of 4 600 tonnes.
- **Goonyella.** The Goonyella system services the Bowen Basin coal region. It primarily carries coal to the terminals at Hay Point and Dalrymple Bay. The Goonyella system is approximately 690 route kilometres and services 30 mines (Aurizon 2014b, p. 36). The maximum train load on the network is 10 000 tonnes, with a 2 100 metre maximum train length (BITRE 2013, p. 53).
- **Moura.** The Moura system is approximately 221 route kilometres of track and services five mines. It is single track with passing loops and transports coal to Gladstone power stations, Comalco refinery, Queensland Alumina Limited, Cement Australia and the R G Tanna and Barney Point coal terminals at the Port of Gladstone (Aurizon 2014c, p. 27). The average train payload from the Moura system, servicing the two coal terminals at the Port of Gladstone, is 4 200 tonnes (BITRE 2013, p. 63).
- **Blackwater.** The Blackwater system services the Bowen Basin coal region. Like the Moura system, it delivers coal to the two export terminals at the Port of Gladstone. It also services domestic users such as Stanwell and Gladstone power stations, Cement Australia and Comalco refinery (Aurizon 2014d, p. 36). The Blackwater system is approximately 727 route kilometres of (mostly) electrified lines that run west from Rockhampton.
- **Goonyella to Abbot Point (GAP).** This system corresponds to the 69 km railway, opened in 2011, that links the Newlands and Goonyella systems, enabling coal to be delivered to either Hay Point or (linked to capacity expansion [GAPE] through to and at) the port of Abbot Point.

13 Further overview of coal attributes is provided in BITRE 2013 (p. 9), while an issue of the BITRE *Freightline* series (forthcoming) will focus on coal movements.

- **Hunter Valley.** Coal is transported to three coal-loading terminals in Newcastle, the world's largest coal export port. Coal trains average between 6 000 and 7 000 tonnes each (BITRE 2013, p. 42).

Table 6 Annual coal traffic, by principal system, 2013–14

	Queensland					NSW
	Blackwater	Goonyella	Moura	Newlands	GAP	Hunter Valley
Net tonnes (m)	63.08	114.4	12.4	12.0	12.5	154.8
Net tonne-kilometres (b)	22.0	24.1	2.0	1.7	4.3	na

Note: Hunter Valley tonnages are also available through the web site of the Hunter Valley Coal Chain Coordinator <https://www.hvccc.com.au/DailyPlanning/Pages/SummaryPerformanceReports.aspx>.

Sources: ARTC n.d. (a) (p. 1, multiple issues); Aurizon 2014e, p. 10.

In addition to the main coal systems, other significant railway tonnages include haulages from:

- the West Moreton coal fields in southern Queensland (with 8.1 million tonnes hauled by Aurizon in 2013–14 (Aurizon 2014f, p. 45)), using Queensland Rail infrastructure;
- the Southern mine region at Wongawilli Colliery, NSW;
- the Metropolitan Colliery, near Helensburgh, NSW;
- the Tahmoor colliery, near Picton NSW;
- the Western coal region, near Lithgow, NSW;
- Fingal, in Tasmania, using TasRail infrastructure; and
- Leigh Creek in South Australia (with around 2.5 million tonnes hauled per annum).

Coal haulage is primarily undertaken by Aurizon and Asciano, with notable tasks also performed by Freightliner Australia and by Southern Shorthaul Railroad[14]. Aurizon is the main coal train operator in Queensland, with an estimated 79 per cent market share; it has also expanded its coal operations to NSW. It has approximately 30 per cent market share in the Hunter Valley[15] (Adamson 2014).

Asciano estimates that it undertakes around 72 per cent of the South Eastern Australia coal haulage (Asciano 2014, p. 27). In recent years it has won contracts to haul coal in Queensland and the company estimates that it has 30 per cent of the coal haulage market [measured by net-tonne-kilometres] in that State (Asciano 2014, p. 27). Asciano also hauls coal in South Australia, from Leigh Creek to power stations at Port Augusta. Table 7 shows the tonnes and net-tonne kilometres hauled by the two operators in 2012–13 and 2013–14.

14 Freightliner Australia operate coal trains in the Hunter Valley on behalf of Glencore; Southern Shorthaul Railroad operate coal trains in NSW on behalf of Centennial Coal.

15 Aurizon provides fact sheets of each coal system it operates in—see <http://www.aurizon.com.au/ourservices/coal>—and it cites an "almost 30 per cent" Hunter Valley market share for 2012–13. With Aurizon estimating a 56 per cent Hunter Valley share, this implies that the other operators had a 14 per cent share.

Table 7 Coal haulage by principal train operators

	Aurizon		Asciano	
	2012–13	2013–14	2012–13	2013–14
Tonnes (million)	193.7	210.4	138.5	159.0
Net tonne kilometres (billion)	43.6	49.2	24.0	29.2

Source: Asciano 2014, p. 28, Aurizon 2014, p. 16.

Approximately 90 per cent of coal extracted in Queensland and 73 per cent in NSW is exported. Coal extracted in South Australia and Tasmania is used domestically. Table 8 shows coal tonnages exported at principal ports.

Table 8 Coal exports, by principal ports, (million tonnes), 2012–13

Newcastle	Hay Point	Gladstone	Abbot Point	Port Kembla	Brisbane
142.6	96.5	57.3	17.7	13.5	8.6

Source: Ports Australia, 2013b.

Box 3 Further resources

BITRE (2013, *Australia's bulk ports*) includes a profile of the major coal ports as well as the landside logistics and production processes between the mine and the port facilities. Each port profile provides relevant material for additional landside traffic data and rail/terminal handling performances.

A forthcoming issue of the BITRE Freightline series will review the coal transport task.

Figure 11 Queensland coal train

Note: Pacific National coal train crossing the Bowen River on the Newlands line while on its way to the Abbot Point coal loader.

Source: Photograph courtesy of John Hoyle.

Grain traffic

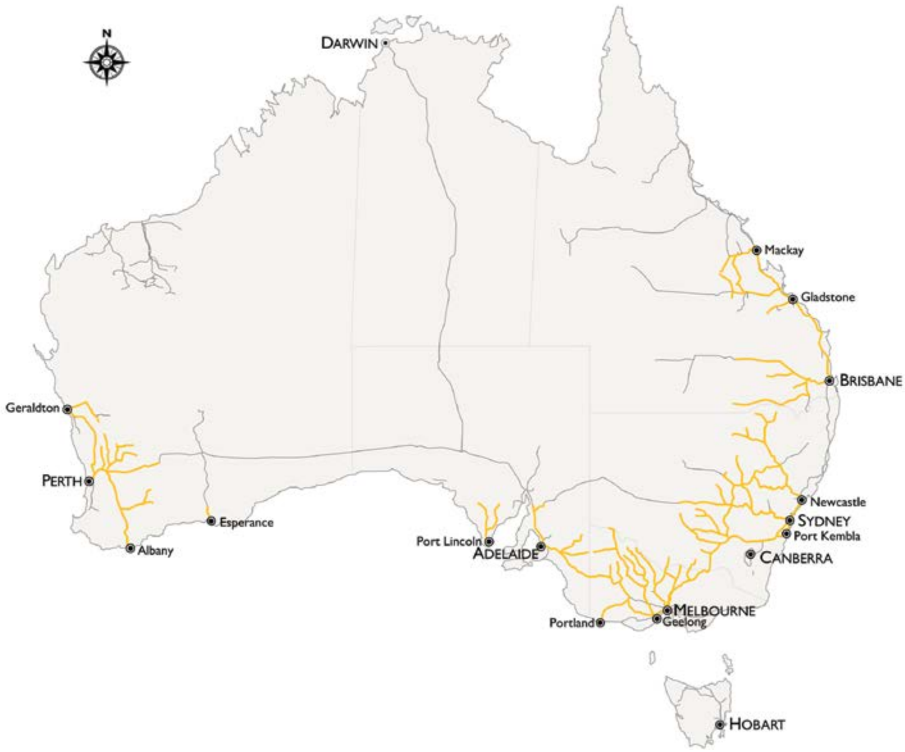
An important role for Australia's railways is hauling agricultural produce from rural areas to ports for export and, to a lesser extent, for domestic processing and consumption. (A forthcoming issue of BITRE's *Freightline* series—*Grain freight transport*—will provide a broader analysis of grain haulage.)

The "grain" harvest described here is cereal grains, however the broader logistics task includes pulses, chickpeas and oilseed. Illustrative volumes involved are 20 million tonnes of wheat (of which around 15 million are exported); 7.5 million tonnes of barley (with almost 5 million exported); 2 million tonnes of oilseeds (and around 1 million tonnes exported); and smaller volumes of sorghum, other pulses, oats, triticale and corn[16]. There is some discussion of non-cereal movements in the non-bulk rail freight section (from p. 32).

Grain flows from the hinterland are shown in Figure 12; the flows include use of a number of branch lines which, with no other commodities being moved, are dedicated to grain haulage. In mid-2014, there were 5 400 route-kilometres of *operational* railway track that was largely or exclusively provided for the haulage of grain.

16 Australian Export Grains Innovation Centre 2014, p. 10. The levels are averages of the 2006–07 to 2011–12 levels. Oilseed (Brassica) include plants commonly referred to as canola or rapeseed.

Figure 12 Australian grain railway flows



Notes: The railway network referred to here uses a broad definition that is based around cereals, such as soft and hard grains, but also including other agricultural food products such as pulses (or "legumes") and chickpeas (or "chick peas"). Traditional soft grains include barley, oats, rye and soft white wheat; hard grains include sorghum/millet, durum wheat, hard white wheat and spelt. Pulses include lentils. Also included here are rice and oilseed.

The map shows grain flows along the railway lines that are designated as operating in mid-2014; some railways—notably in south-west Western Australia and in central NSW—are not shown, having been classified as closed to traffic, but with some discussion on their re-opening.

As discussed in BITRE 2013 (pp. 109–10), eighteen major ports regularly export grain, of which fifteen have rail links with the grain-growing hinterland[17].

In principle, trains are ideally suited to conveying grains to ports for export, and to domestic processing centres; the haulage task is dominated by rail over long distances between the grain-growing hinterland and the coastal market or port. Road movements are common where the grain-growing hinterland is relatively close to the ports, as illustrated in Table 9. There is a range of other factors, however, that influence the mode-choice decision. For example, as discussed in the section on rail networks, the axle loads on some grain railways are relatively low, and this increases the costs of using rail or prevents the use of preferred wagons or containers. (See from p. 78 for further discussion on network limitations.) These factors can therefore make rail services uncompetitive with road haulage even over long distances.

17 These rail ports are, in decreasing order of 2011–12 grain exports, Fremantle, Melbourne, Pt Kembla, Pt Adelaide, Geraldton, Pt Lincoln, Brisbane, Albany, Esperance, Geelong, Sydney, Portland, Mackay, Gladstone. See BITRE (2013, p. 110). Note, also, the opening in 2014 of a bulk grain export facility at Bunbury and a new grain terminal in Newcastle (Newcastle Agri-Terminal).

Table 9 Rail market characteristics, by State

	Queensland	NSW	Victoria	SA	WA
Median bin distance to port (km)	303	412	273	130	207
Rail's mode share to port	46	85	53	50	60

Sources: Australian Export Grains Innovation Centre 2014 (p. 17). See also rail and road receivals at WA ports, presented in ACIL Tasman (2009, pp. 18–19).

For longer distances and prevailing access charges, rail can provide competitive haulage relative to road; CBH (2011, pp. 11–12) illustrates the relative rail and road charges in WA.

Transport efficiency and, thus, haulage costs, are a major grain handling cost. AEGIC (2014, p. 33) illustrates the rail transport costs for wheat, by State and grain handling company, within the overall export logistics supply chain; for a 200 km rail haul, these represent around one-third of the post-farm-gate prices through to the export vessel. As a major supply chain cost, therefore, the choice of mode can play a major role in the overall costs.

Grain traffic trends

Improvements in road haulage productivity—longer and heavier vehicles and upgraded roads—have eroded grain rail competitiveness, where there have been more modest productivity improvements.

Changes to the grain industry and logistics have brought new economics and new challenges to grain rail haulage: there has been a revolution in the industry structure, logistics, contractual and commercial environment of the grain industry.

One notable change has been the reduction in demand for bulk haulage, which is where rail has relative cost advantages. A second notable change has been underway in grain receival, storage and export marketing. Finally, there has been a change in the nature of the commercial setting between rail operators and grain handlers. These aspects are reviewed; Box 4 provides a list of additional resource material about grain railways, highlighting key inquiries and reports that review railway grain handling and infrastructure.

Grain conveyance—containerisation

Within the last decade, there has been a shift towards "non-bulk" handling of cereal grain transport. While still a modest change, there has been a trend to some shipping containers being used (to the port and onto container vessels) as an alternative to rail hopper wagons (to the port and then the dispensing of the grain onto bulk vessels)18.

The recent development of grain movement in boxes is exemplified by wheat export transport. In the 2002–03 financial year, the export of wheat in containers was negligible; in 2011–12, however, the volume had risen to 2.6 million tonnes, representing 11 per cent of exports. The uptake of exports of wheat in containers varied across the States, with 1.2 per cent of SA wheat exports being in boxes, 1.7 per cent in WA, 14.7 per cent in NSW, 15.7 per cent in

18 Fitzgerald (2014, p. 23–24) suggests that containerised complements bulk exports by allowing the demand requirements of both large- and small-scale overseas customers to be met as the container (a) caters for customers requiring smaller quantities (b) needs less infrastructure and storage at the destination port (c) allows the customer to purchase specific grades of grain for blending requirements (d) less financial risk and exposure and (e) allow just-in-time purchase and delivery relative to bulk handling.

Queensland and 33.7 per cent of Victorian exports. Victoria's tonnage was the highest tonnage of containerised wheat exports.[19]

This containerisation has implications for rail, which is less favoured for haulage than when grain is moved in bulk. In Queensland, all of the grain that is containerised at inland locations moves by road (Transport, Housing and Local Government Committee 2014, pp. 91, 93). As discussed in the network section, one impediment to using rail on some Queensland railways is that containerised grain would result in wagon weights that generate axle loads that exceed the technical limits on some of the State's rail lines. Similarly, in its 2011 report, the Grain Logistics Taskforce reported that rail is the mode used for approximately 22 per cent of containerised grain that goes through the Port of Melbourne[20]; this compares with an overall 53 per cent rail mode share for grain haulage to the port (Table 9).

Grain receival, storage and marketing

The haulage of grain forms one part of the grain supply chain logistics task. The mode choice also depends on the efficiency of the entire logistics flow, including the receival and storage components. Mode choice is heavily influenced by grain destination (domestic or export), size of shipment (with rail being better suited to larger loads than road) and distance to port. Increased on-farm storage is also more conducive to road haulage as farmers can wait for good spot prices before moving their grain.

Grain movements between the farm (whether directly harvested, or from on-farm storage) and the domestic processing plant or the export port commonly involves three key logistics stages. First, the grain may be transferred from the farm to a local receival centre (or simple grain silo). The grain may then be stored at that centre. Finally, the grain is transferred to the local processing plant (e.g., for milling) or to the port, for export.

Figure 13 Grain loading, Temora, NSW

Note: The photograph shows a Pacific National grain train loading at GrainCorp's Temora (NSW) sub-terminal.

Source: Photograph courtesy of John Hoyle.

19 Wheat Exports Australia (2012, pages 9, 12). See also Department of Transport [Victoria] (2011 p. 12) for levels of wheat and barley bulk- and container-exports through the Port of Melbourne. CBH has argued that its relatively low bulk freight rates make it more attractive to ship in bulk than in containers.(CBH 2011, p. 8),

20 See footnote 19.

Grain receival and storage is being rationalised with investment into fewer, larger facilities, with larger storage levels, higher handling speeds and improved rail siding capacity. The grain handling speed at receival centres (whether from road vehicles into the storage silos or from the silos to wagons) is a key factor that determines the pace of the overall grain logistics chain. For example, a recent Queensland government inquiry noted that old loading facilities required 12 hours to load a train whereas new "super depots" take just 2 hours to load and turn around a train. (Transport, Housing and Local Government Committee [Queensland] 2014, p. 97)

This consolidation of receival/storage centres can merit the investment in rapid grain-handling facilities[21]. The principal grain handlers (CBH, Glencore-Xstrata [Viterra] and GrainCorp) continue to invest in improved wagon-loading and train-capacity systems. For example, in 2014 GrainCorp announced its "Project Regeneration" investments, which include upgrading rail loading capacity. The investment focuses on primary grain-handling sites, to triple the wagon loading rates and expand track capacity to accommodate longer ("unit") trains[22].

Changes in the grain logistics management are working against rail haulage of grain; the deregulation of grain export marketing has triggered a dispersion of the logistics management and task. Traditionally, the grain receival centres were owned by a handful of State-based bulk grain handlers, whose receival, storage and transport decisions determined the logistics environment. However, with the end of the AWB "single-desk" wheat export system, other (and new) grain marketers began to undertake grain exports; there are now four main bulk handlers and more than 20 export grain marketers (Australian Export Grains Innovation Centre 2014, p. 3); the latter may undertake their own arrangements for transporting grain to the port. Further, to enable exporters to convey grain through the port, they are provided with access to the traditional bulk-handlers' port export facilities; this is formalised in regulations for access that is overseen by the ACCC. (As noted earlier—footnote 17—new exporter groups are constructing other port bulk-handling facilities.) Inevitably, with the deconsolidation of export market commerce, this has the effect of smaller parcels of grain being moved for a number of the new players. Those smaller grain parcels are therefore less suitable for rail haulage.

Impact on grain haulage arising from rail ownership and structural changes

The relationship between railway entities and their grain customers has changed within the last generation, influencing the mode choice. These changes include:

- **Railway industry restructuring, funding and ownership changes.** Some railways have been vertically separated, changing incentives for operating grain trains. Similarly, the privatisation of railways has shifted, or removed, the long-term funding of the upkeep of grain lines (which in all cases do not recover their long-run costs). In some cases (SA and WA especially) this has led to closure of a large number of grain railways.
- **Transfer of commercial risk.** Grain handlers and exporters now take the commercial risk on rail haulage instead of the train operators. Take-or-pay contracts with train operators are the standard form of agreement[23].

21 GrainCorp provides maps of its Victorian primary grain sites and receival and storage sites (http://www.graincorp.com.au/_literature_89200/South_Eastern_Victoria_Regional_Map ; http://www.graincorp.com.au/_literature_89199/North_Western_Victoria_Regional_Map).

22 Australian Export Grains Innovation Centre (2014, pp. 11–16; 19–21) discusses grain handling and storage operators, receival site efficiencies and receival-centre consolidations.

23 Such take-or-pay contracts include: GrainCorp, Emerald and Cargill contracting Asciano for a minimum of 13 trains and a maximum of 20 trains (Asciano 2014a, p. 60); CBH contracting Watco; Glencore–Viterra contracting Genesee & Wyoming Australia and also Aurizon; and Noble, Emerald and Cargill contracts with Qube Holdings.

By way of illustration, Qube offers a complete export logistics service, with bulk storage and handling, train operation, port storage and export loading (including container filling).

Box 4 Further reading on railway grain handling

There are a number of reports that consider grain networks, notably the wheat and barley flows. There is also some disaggregated data. The following are some core studies into grain railways and grain supply chains.

Overviews:

- A comprehensive overview of (essentially-cereal) grain flows can be found in the report *The cost of Australia's bulk grain export supply chains. An information paper*, and its *Postscript Version 2014.1*; both documents were published by the Australian Export Grains Innovation Centre.
- A review of trends in containerised grain exports can be found in the article "Container exports open market opportunities", written by Mark Fitzgerald.

Queensland reports:

- Transport, Housing and Local Government Committee (Queensland), Rail freight use by the agriculture and livestock industries, Report No. 45.
- Port of Brisbane 2013, *Import/export logistics chain study. Summary report.* This study presents a snapshot of railed grain through the Port of Brisbane, with rail heads at Thallon, The Gums, Meandarra, Miles, Talwood, Dalby West and Malu being cited. The railed tonnage of wheat (86 per cent by rail), sorghum (13 per cent by rail) and pulse (1 per cent by rail) are presented; maize and cottonseed do not move by rail. (p. 30).

NSW reports:

- *New South Wales Grain Freight Review* (by Department of Infrastructure, Transport, Regional Development and Local Government, 2009). The report assesses the case for retention and investment in grain railways.
- Independent Pricing and Regulatory Tribunal (IPART) 2012, *Review of access pricing on the NSW grain line network. Transport—Final report.* The report includes 2010–11 forecast volumes by grain branch line, which provides some indication of grain volumes by line (pp. 10–11).
- Grain Infrastructure Advisory Committee 2004, *Report on rail/road options for grain logistics,* NSW government. The report provides average tonnage on a number of NSW grain railway lines (p. 10).
- Pollard 2012a, 2012b, "Moving NSW wheat: the post deregulation experience", *Railway Digest,* presents a review of the logistics changes to wheat haulage in NSW.

Victorian reports:

- Department of Infrastructure (Victoria) 2007, *Victorian rail freight network review.*
- Department of Transport 2011, Grain logistics taskforce report, and *Victorian Government response to Grain Logistics Taskforce Report. November 2012.*

(continued)

Box 4 Further reading on railway grain handling *(continued)*

SA reports:

- Department of Transport and Urban Planning 2003, *Eyre Peninsula grain transport. Summary report.* The report considers the case for the retention (and joint-funding by interested parties) of grain railways on Eyre Peninsula.

WA reports:

- Strategic Design and Development 2009, *Report prepared for Freight and Logistics Council of WA on behalf of the Strategic Grain Network Committee.*
- Department of Infrastructure, Transport, Regional Development and Local Government 2009, *WA grain freight review.*
- Brookfield Rail, *Net tonnes per route section,* Web site, http://www.brookfieldrail.com/assets/br_files/Communications Material/Brookfield Rail Net Tonnes per Route Section.pdf The data do not report the commodities being transported but grain movements can be inferred where a branch railway is designated as part of the grain network.
- Economics and Industry Standing Committee, WA Parliament Legislative Assembly 2014, Inquiry into the management of Western Australia's freight rail network, *Ongoing.* This inquiry commenced in March 2014; the inquiry will consider a range of aspects of the lease of rail infrastructure.

National reports:

- House of Representatives Standing Committee on Transport and Regional Services 2007, *Inquiry into the integration of regional rail and road networks and their interface with ports.*

Non-bulk rail freight traffic

Australia's railways move a range of bulk freight commodities (coal, grain and iron ore especially) as well as moving steel products. Non-bulk rail freight movements are perceived as being based on containerised goods, although SCT Logistics, and Sadliers Logistics, (for example) typically use louvre wagons for their palletised traffic. (See Box 1 for further discussion of defining non-bulk rail freight.)

Apart from rail container movements between domestic intermodal terminals, rail services also undertake maritime tasks (for import, export and Bass Strait traffic) that can be classified as follows:

- **Landbridge** movements, from one port to another—container movements from around Hobart, to the Port of Burnie (for export or transfers to and from the mainland), and between Adelaide and the Port of Melbourne are the primary examples.
- **Regional** export movements, from inland terminals to the port. This traffic includes agricultural commodities, such as cotton, rice and other grains.
- **Urban** import and export movements. These are short-haul container movements, linking the port terminal with urban logistics centres (where boxes are de-stuffed, stored or distributed to local businesses around the terminals). Empty containers are also shifted by these local rail services.

The export maritime activities are generally based around single commodities and/or a single company's logistics-based hub.

The following discussion focuses on port rail flows to or from capital cities, while noting that other flows can operate. (Examples here are Mt Isa – Townsville; and [when container ships serve the port] Hobart – Bell Bay.)

Rail (and road) volumes of containers through the primary capital city ports are presented in the BITRE's regular *Waterline* series. (BITRE 2014e, tables 1.1–1.6, includes TEU[24] rail volumes through the ports for each of those cities.)

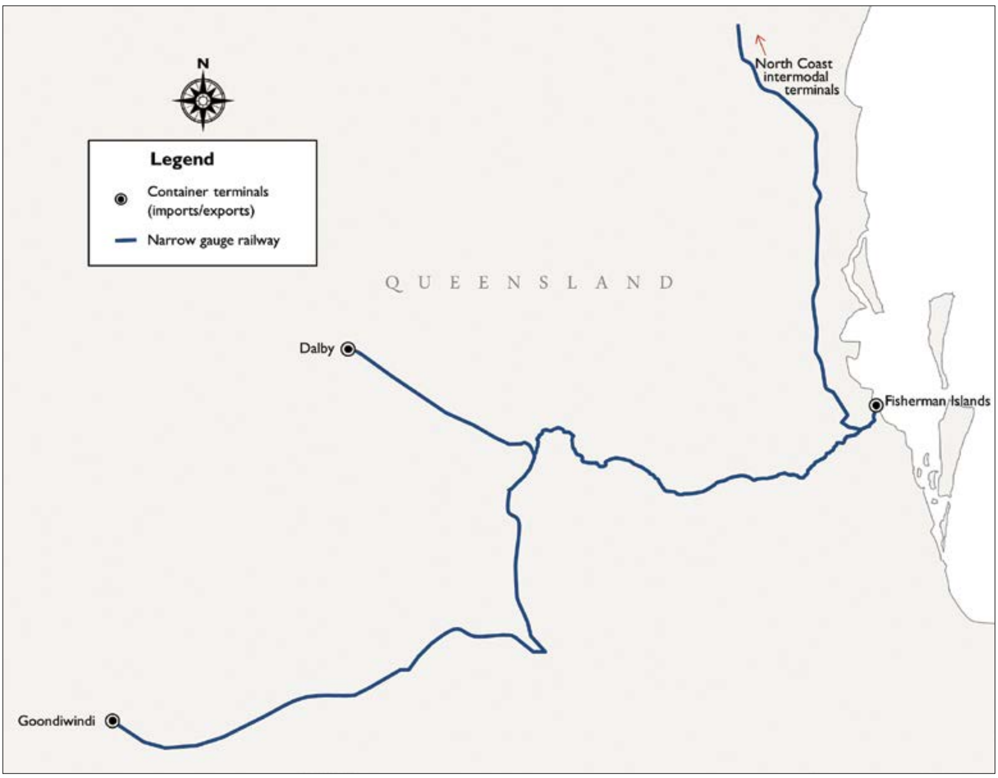
Landbridge and regional movements

The maps that follow present the long-distance maritime railway services linking with city ports (and between the environs of Hobart and the Port of Burnie).

Port of Brisbane—Fisherman Islands

Figure 14 presents the rail container flows between Queensland intermodal terminals and the Port of Brisbane (Fisherman Islands).

Figure 14 Rail container operations serving the Port of Brisbane (Fisherman Islands)



24 TEU: Twenty-foot equivalent unit.

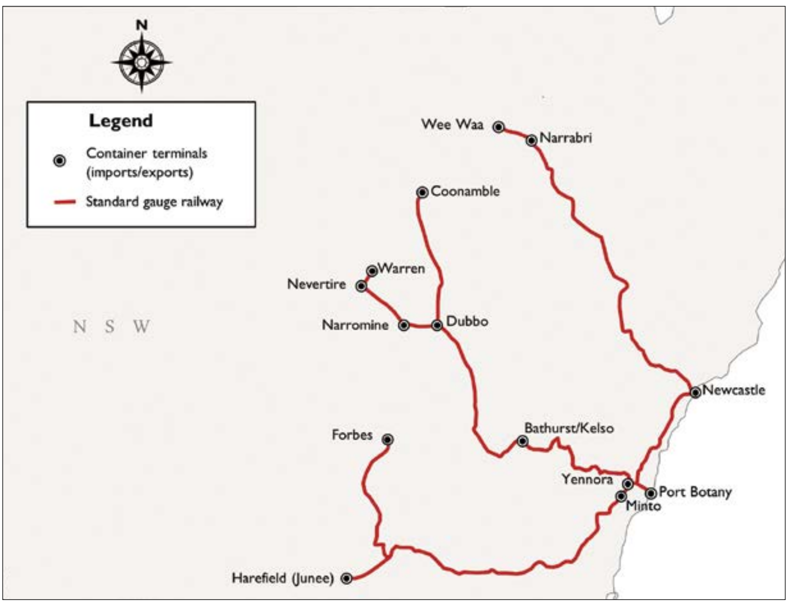
Exports form the main container traffic through the port. These include seasonal flows of cotton from Goondiwindi and from Dalby (on a less-regular basis). Refrigerated containers ("reefers") bring meat from Gladstone and beyond to Fisherman Islands. Although Fisherman Islands is equipped with dual narrow- and standard-gauge tracks, the container services operate exclusively from destinations on the narrow-gauge network.

A 2012 study of container movements at the Port of Brisbane found that 5 per cent of the container throughput (or 57 000 TEU [Twenty-foot equivalent units] were shifted between the port and hinterland by rail, with rail's share being 1 per cent of imports and 8 per cent of exports. Destinations of railed import containers were, in descending order of importance, Townsville, Mackay and Rockhampton; the equivalent origin sources of railed exports were Rockhampton, Goondiwindi, Gladstone and Townsville. (Port of Brisbane 2013, p 26) Movements of empty containers closely mirrored export and import flows (Ibid, p. 27).

Sydney Ports—Port Botany

Figure 15 illustrates the principal container train flows connecting with Port Botany.

Figure 15 Rail container operations serving Sydney Ports—Port Botany



Regional services are based on export container traffic, with train movements to the hinterland conveying empty boxes for filling.

Rail services convey a range of containerised commodities, primarily agricultural, to Port Botany. These commodities include:

- specialised grain, conveyed from Forbes, from Narrabri, Dubbo, Coonamble and Narromine;
- Qube's intermodal terminal at Harefield (near Junee)[25] ships containerised grain and cardboard (from Visy's plant at Tumut);
- chick peas from Narrabri;
- cotton from Warren, Nevertire, Wee Waa and Narrabri;
- logs from Bathurst/Kelso and Newcastle (Sandgate);
- refrigerated meat from Dubbo; and
- aluminium ingots from Newcastle (Bullock Island and Walsh Point).

Figure 16 Regional maritime intermodal train

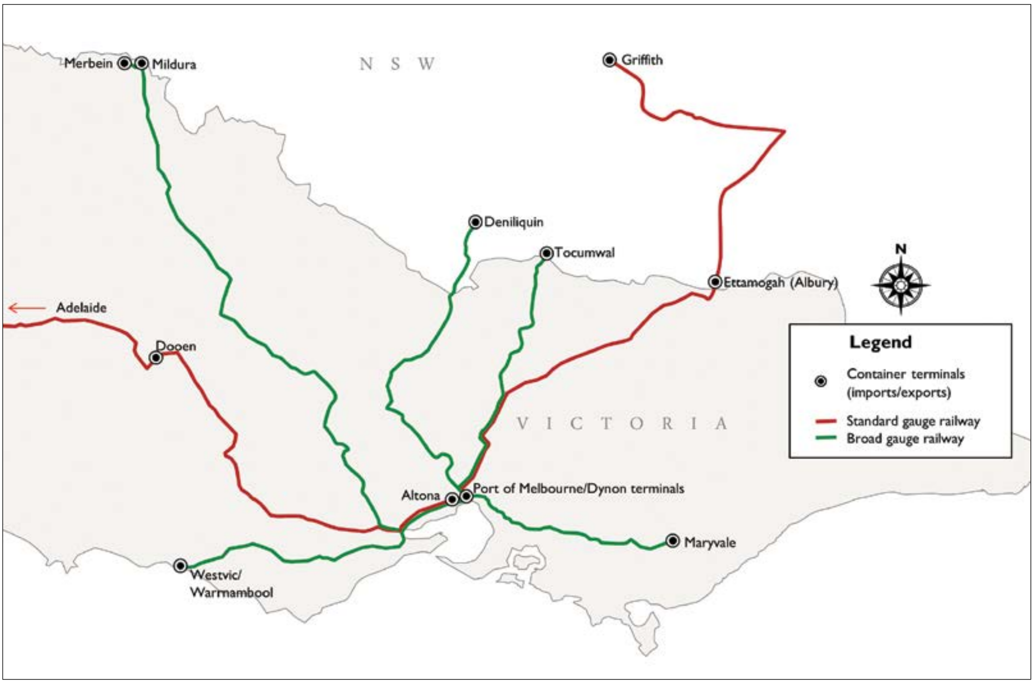
Note: The image shows a Qube Holdings intermodal train, enroute between Port Botany and Narrabri.
Source: Photograph courtesy of John Hoyle.

25 In April 2014, Wagga Wagga City Council called for expressions of interest in development of a Riverina Intermodal Freight & Logistics Hub at Bomen, in Wagga Wagga.

Port of Melbourne

The major regional container export flows through the Port of Melbourne are shown in Figure 17. Rail container flows through the Port that originate or are destined for Tasmania are not shown; it is possible that some of the Bass Strait traffic moves by rail along the North–South rail corridor.

Figure 17 Rail container operations serving the Port of Melbourne



The non-urban movements can be categorised into landbridge, western and eastern Victoria flows, and southern NSW flows.

Landbridging. There is a "landbridge" movement of containers between Adelaide and the Port of Melbourne. Some of the trains operate to the stevedore rail sidings at the dock (notably, to Patrick's Appleton Dock) while other train movements are to South Dynon intermodal terminal (with the containers then being conveyed to the stevedore container stacks by road vehicles). In recent years there has been a shift from hubbing Adelaide's container movements through Melbourne (for direct sailings to and from foreign-destination ports) to shipping through Adelaide with hubbing in Singapore (in particular). As a result, there are fewer landbridge trains serving the Port of Melbourne—train flows are discussed further at page 76.

Western Victoria. There are three logistics company-based hubs in Western Victoria:

- Wakefield Transport, at Merbein (Mildura), with logistics operations in a range of containerised agricultural and mining exports;
- Wimmera Container Line, at Dooen (near Horsham), especially with grain exports (for Wimmera Grain Company); and
- Westvic Container Export Services, at Warrnambool, with agricultural and other diverse export (and domestic) traffic.

Eastern Victoria. From Maryvale, in eastern Victoria, containerised paper is shifted to Qube's Victoria Dock in the Port of Melbourne.

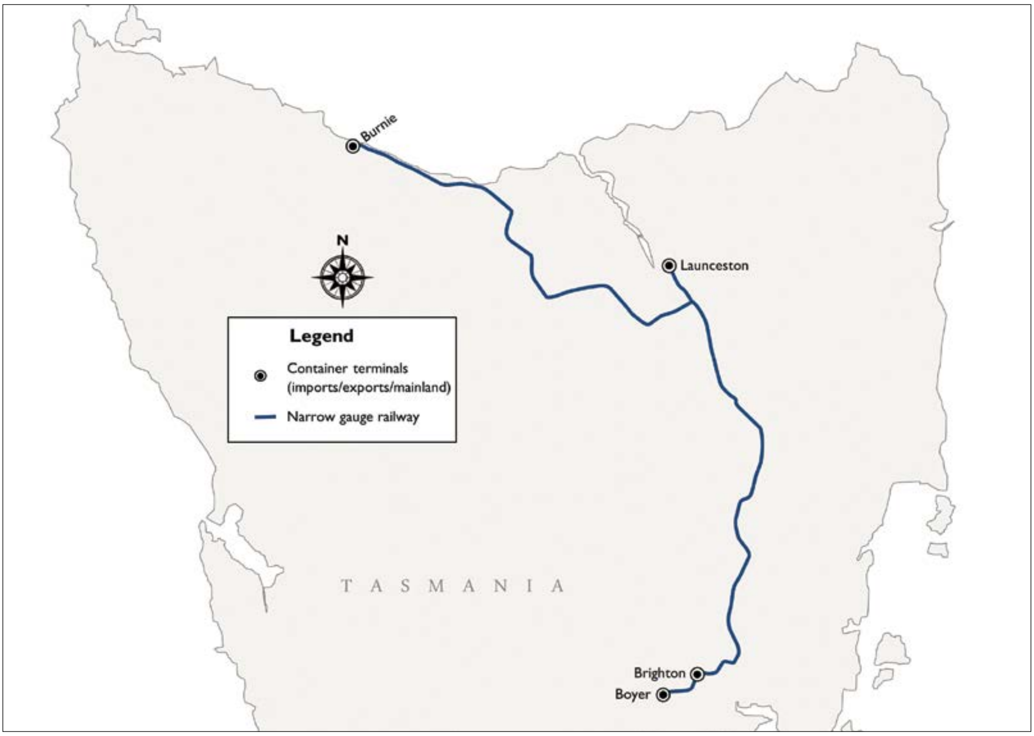
Southern NSW. From southern NSW to the Port of Melbourne there are a range of export flows, including:

- containerised rice from Deniliquin;
- containerised grains (such as wheat, barley, sorghum) from Tocumwal;
- containerised wine for export is undertaken from Griffith and Leeton; and
- inbound and outbound products through Ettamogah Rail Hub (near Albury), including products of the Mars Petcare company.

Tasmania—Port of Burnie

Maritime containers are landbridged between Hobart (Brighton Transport Hub) and Boyer (near Hobart) to the Port of Burnie.

Figure 18 Rail container operations serving the Port of Burnie

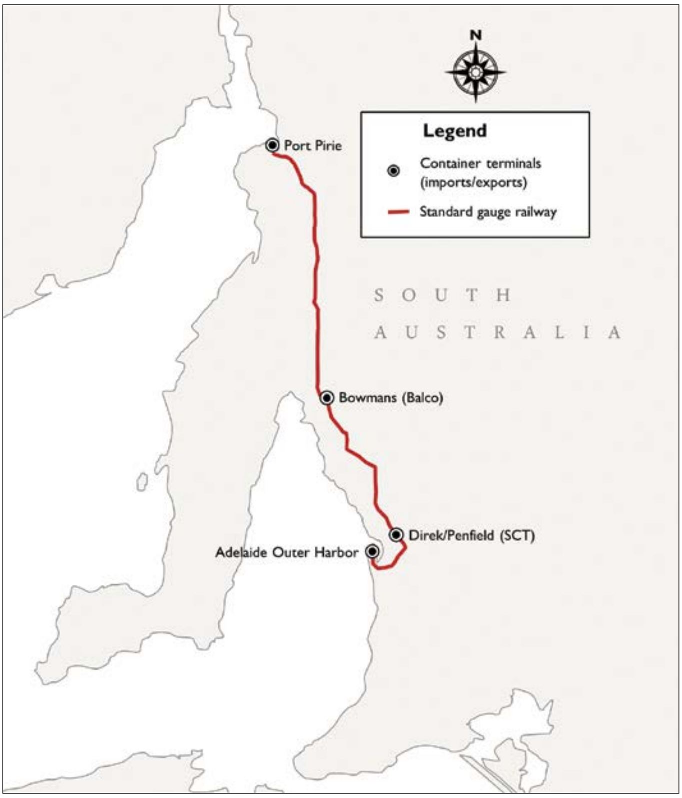


Commodities moved between the Hobart area and Burnie include paper (from Boyer) and haulage for the logistics company, Toll Group. Containers also move to Burnie from Launceston.

Port Adelaide—Outer Harbor

There are regional maritime container traffic flows to Outer Harbor (Port Adelaide)—see Figure 19. While purpose-built containers are also used for haulage of mineral sands (such as from Kanandah, near Broken Hill, to Port Flat), these movements lie outside this analysis.

Figure 19 Rail container operations serving Port Adelaide—Outer Harbor



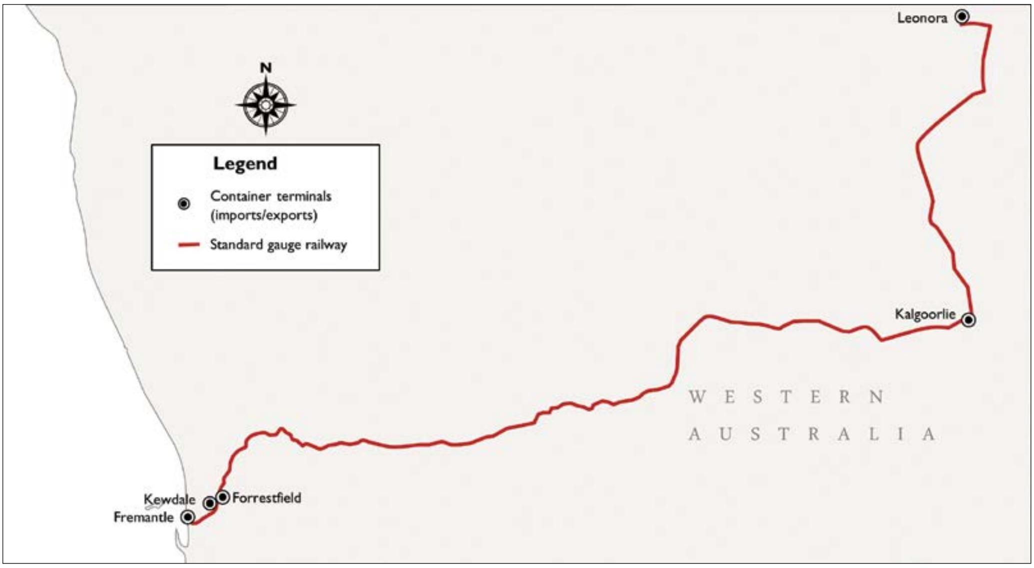
Regional trains operate between the Bowmans Intermodal Terminal (operated by Balco Australia) and Outer Harbor. The terminal is used for the export of agricultural products such as oaten hay, grain and pulses, seed, wine and pork bellies. The terminal also handles imported containerised tuna food (bait). More broadly, the facility is used as a consolidation point activity for a range of commodities, a task that would otherwise be undertaken at the port. The terminal is served by rail services that convey containers to both Outer Harbor and the Port of Melbourne (that is, the landbridging service discussed on page 74).

Some Bowmans container trains also serve the Nyrstar lead smelter at Port Pirie; containerised lead is collected for export through Outer Harbor.

Port of Fremantle—Inner Harbour

There is limited movement of regional containers to the Inner Harbour of the Port of Fremantle. These are shown in Figure 20.

Figure 20 Rail container operations serving the Port of Fremantle (Inner Harbour)



The primary regional container export flows are lead from Leonora and nickel products from a nickel smelter south of Kalgoorlie.

Short-haul (urban) maritime container movements

There are several flows of short-haul (urban) maritime container movements. These are:

- Yennora – Port Botany (approximately 40 km, Figure 15);
- Minto – Port Botany (approximately 55 km, Figure 15);
- Direk/Penfield – Outer Harbor, Port Adelaide (approximately 25 km, Figure 19); and
- Kewdale/Forrestfield – Fremantle (Inner Harbour) (approximately 24 km, Figure 20).

In addition, Salta Properties opened an intermodal terminal at Altona in Melbourne in May 2014. The terminal includes rail infrastructure. With shipping line Maersk as an anchor tenant, the intention is to operate shuttle trains between the terminal and the Port of Melbourne (Figure 17).

The Yennora and Minto operations handle both imports and exports. The urban terminals undertake a range of logistics activities for imported goods, including storage, consolidation and deconsolidation, and onwards road distribution to nearby warehouses. Exports include empty container transfers to the port.

The short-haul movement between the SCT Logistics terminal at Direk (or Penfield) involves the export of wine. The operation commenced in 2014.

The Western Australian Government subsidises the movement of containers by shuttle trains between intermodal facilities at Forrestfield/Kewdale and the Inner Harbour at Fremantle. Aurizon operates the train services on behalf of Intermodal Link Services (a part of the Intermodal Group); these operate between the Forrestfield Intermodal Terminal and the North Quay Rail Terminal at the port. Trains also operate between the Kewdale intermodal terminal and the North Quay Rail Terminal. Intermodal Link Services conveys the containers by road from that Rail Terminal to stevedore stacks at the wharf. Exports include grain that is containerised in grain-handling facilities in the Kewdale area.

Box 5 Further resources on non-bulk freight activity

There is a range of regular and one-off studies that can facilitate understanding port-rail freight flows. The ongoing and recent publications include:

- The BITRE's *Waterline* series presents quarterly data on rail traffic volumes through the mainland State capital city ports (where traffic is measured in TEU, Twenty-foot Equivalent Unit containers).
- Each *Waterline* issue also presents port maps, which show principal rail lines within port precincts and summarises each of the regional and short-haul rail services operating between the hinterland and the port. (BITRE 2014e, Appendix A)
- Fremantle Ports publish longer-run data on rail TEU volumes through the Port of Fremantle (2014, p. 5). Fremantle Ports (2012) analyses rail and road TEU movements between the hinterland and the port.
- Port of Brisbane provides survey data on rail and road container movements through the port. This is summarised (2013, pp. 10, 26).
- Port of Melbourne, *et. al.,* (2010), provides survey data on hinterland container freight task (presented in the number of TEU) through the Port of Melbourne. (for example, pp. 48, 74–75, 102).
- Rail TEU traffic volumes are reported by the Sydney Ports Corporation in its annual report, as part of its "Port Botany Landside Improvement Strategy" (See, for example, p. 28, of Sydney Ports Corporation 2013).
- Monthly and annual rail (and road) volumes through Port Botany are presented in chart format within the Transport for NSW web site (see relevant web window link in the references).

Urban rail passenger traffic

Each of the mainland State capitals operate urban passenger rail services. The suburban lines provide transport conduits through built-up areas, enabling the mass movement of passengers to and from major centres. At their broadest task, passenger services provide a role as an alternative to private cars and so help to de-congest roads. The services also provide essential services for those without cars.

Table 10 shows annual patronage figures for each capital, for both heavy rail and light rail traffic.

Table 10 Urban rail patronage, 2012–13[a]

	Brisbane[d]	Sydney[b]	Melbourne	Adelaide	Perth
Patronage – heavy rail	50	306	226	8	66
Patronage – light rail	–	4[c]	183	2	–

Notes: [a] Methodologies for calculating patronage vary between cities.

[b] Sydney's patronage data is for the former CityRail network which included the following non-urban lines: Hunter, Newcastle/Central Coast, Blue Mountains, Southern Highlands and South Coast.

[c] Sydney light rail data excludes the monorail.

[d] Brisbane does not include the seperately administered Airtrain line. Patronage for this line are included in BITRE 2014i.

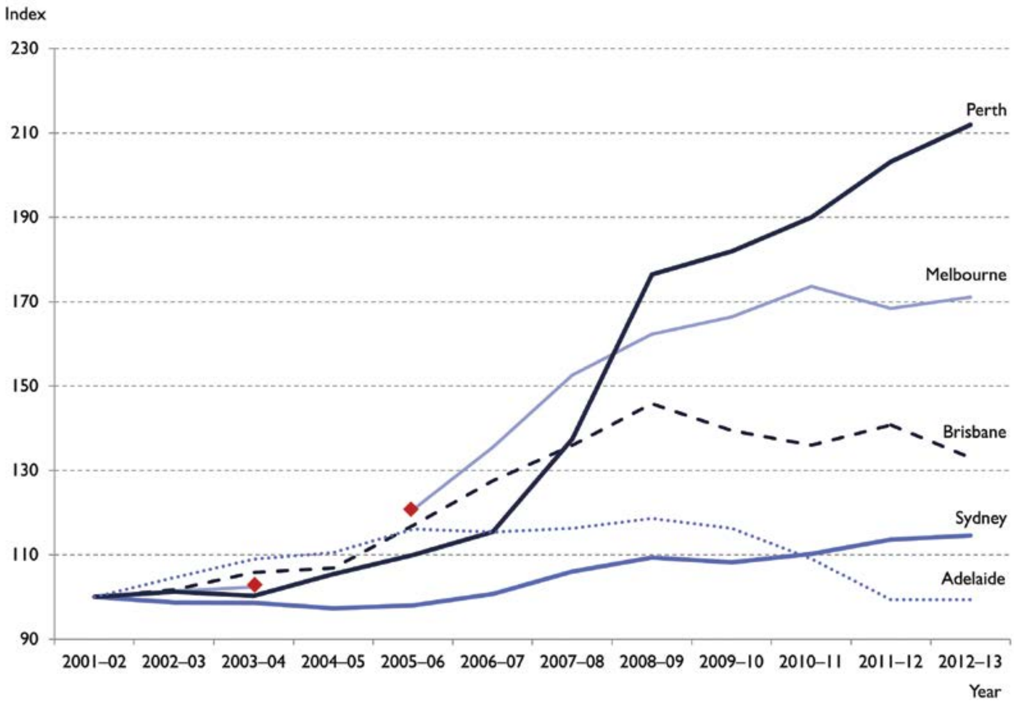
Patronage data are those reported by operators. For some cities, data differ to those reported in BITRE 2014i. This is because BITRE 2014i adjusts data where necessary to allow comparison across networks.

Sources: Public Transport Authority of Western Australia 2013; Public Transport Victoria 2013; Bureau of Transport Statistics NSW 2013; Department of Planning, Transport and Infrastructure 2013; Department of Transport and Main Roads 2013; Transport for NSW 2013.

As is evident, Sydney has the largest number of heavy rail patrons, with an average of over 800 000 users each day. In 2012–13, Sydney's heavy rail network attracted over 35 per cent more patrons than the second highest city, Melbourne.

As illustrated in Figure 21, urban passenger traffic in Perth has grown very strongly over the last decade, with strong growth also being recorded in Melbourne (growth that is mirrored in light rail/tram patronage (Figure 22)).

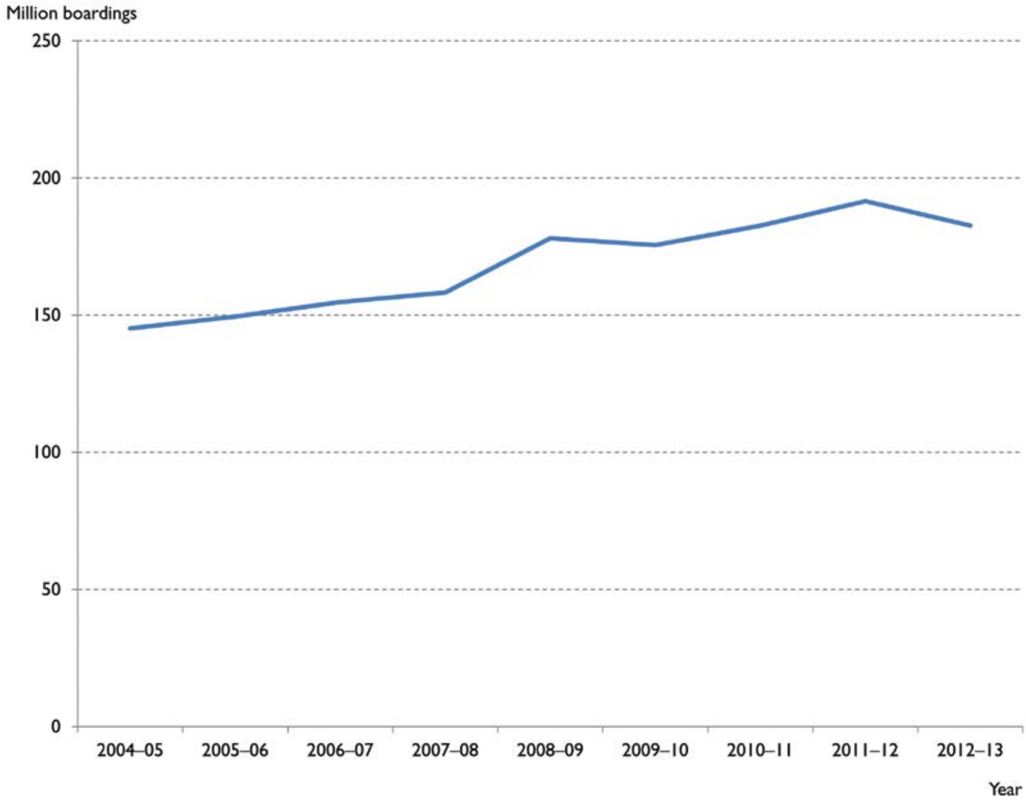
Figure 21 Index of heavy urban railway patronage in Australian cities



Note: There is a break in the Melbourne data between 2003–04 and 2004–05 due to a change in patronage measurement methodology. Brisbane also changed methodology in 2010–11. However, a revised time-series for this city was provided back to 2007–08. The index for 2007–08 (136) has been applied to the revised patronage level for that year.

Sources: Index based on patronage data from: BITRE 2012; Public Transport Victoria 2014; Bureau of Transport Statistics NSW 2013; Department of Transport and Main Roads 2013, TransLink 2012, TransLink 2011; Public Transport Authority of Western Australia 2013; Department of Planning, Transport and Infrastructure 2012; Department of Planning, Transport and Infrastructure 2013 .

Figure 22 Light rail patronage, Melbourne



Sources: Public Transport Victoria 2014.

Factors that explain patronage trends consist of national (external) factors and local, network-specific factors. National factors, such as economic activity (influencing employment activity and disposable income) and petrol prices will influence rail patronage in similar ways, encouraging similar patronage trends. Residents of each city will have faced similar petrol/diesel price fluctuations, impacting on everyday car operating costs: there were marked fuel increases in the 2006–2008 period. Other macroeconomic factors that influence car usage include mortgage interest rates, the costs of purchasing a car and disposable income. A significant macroeconomic influence over the past decade has been the resources boom. This has led to higher disposable incomes and—due to the higher Australian dollar—decreased the cost of imported goods, such as motor vehicles (Reserve Bank of Australia 2014, p. 18). To the extent that consumers prefer to drive if they can afford it, an increase in disposable income and decrease in the cost of motor vehicles encourages a degree of switching away from public transport.

However, peoples' propensity to switch to/from urban rail services in response to macroeconomic factors depends on the quality of those public transport substitutes. That is, switching to urban rail services depends on the network scale and service attributes of each city.

Divergent travel patterns across the systems can arise when strong local factors dominate; these include fare and network changes, local employment patterns and road infrastructure improvements and parking charges. Specific local factors that will have some bearing on the city travel trends include:

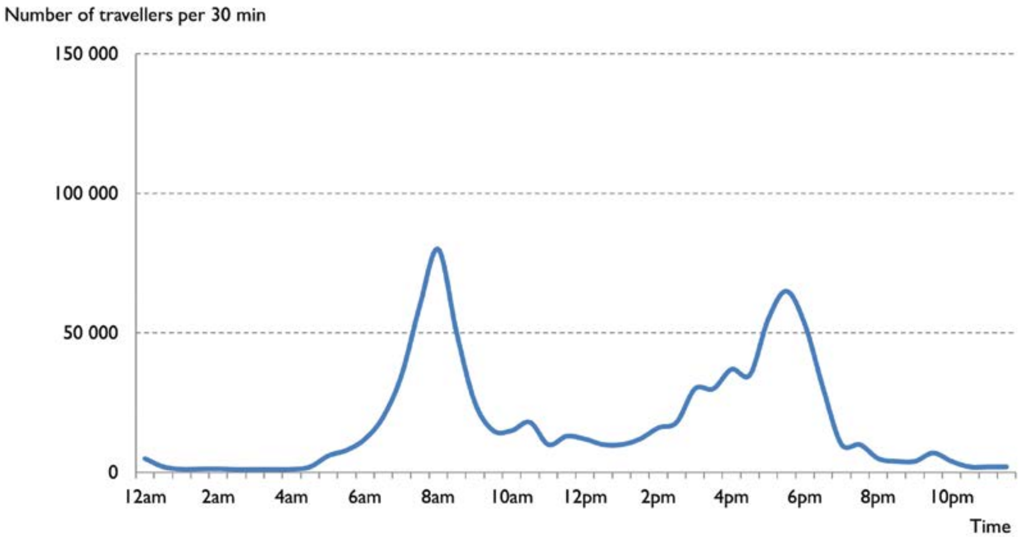
- **Brisbane**. Fares increased by 15 per cent per annum from January 2010. The annual fare increases were halved to 7.5 per cent for January 2013 and 2014 (TransLink, 2012a). The increases were accompanied by conditional discounts, such as cheaper off-peak travel, associated with the system's new electronic stored-value "go card".
- **Sydney** experienced strong population and employment growth between the census years 2001 and 2006. However, that growth was strongest in outer areas, where radially-focused public transport offers a weaker alternative to car transport (BITRE 2012, p. 18). The growth in these areas was accompanied by significant expansions in the road network, with the M5 East Freeway and Westlink M7 opening in 2001 and 2005, respectively (BITRE 2012b, p. 296).
- **Melbourne**. The strongest rate of patronage growth in Melbourne was between 2005–06 and 2008–09; Figure 21 shows the heavy rail trend and Figure 22 shows light rail. This corresponds with a rapid growth in employment in inner Melbourne[26]. Being serviced by relatively good heavy- and light-rail (and other public transport modes), strong inner Melbourne employment growth will encourage public transport patronage.
- **Adelaide** had a marked decline in patronage. This can be largely attributed to service disruptions caused by works associated with infrastructure enhancement and renewal works—the Rail Revitalisation Programme. The works required extended periods of line closures since 2008.
- **Perth**. Much of the surge in Perth's patronage in 200607 reflects the opening of the Mandurah line, with strong uptake of the services. The two new lines built from central Perth—to Butler and Mandurah—provide relatively high-frequency (a minimum of four trains per hour) as well as the highest average speed timetables (off-peak and peak) across the five urban systems.

Commuting traffic

The railways are largely aligned to fulfil weekday commuting movements to and from city centres. The task is strongly skewed to morning and afternoon peak period travel, as is illustrated in Figure 23, showing Sydney's weekday patronage pattern. Sydney's rail task peaks at 8am at 80 000 passengers—more than five times the task performed two hours later.

26 Between 2006 and 2008, the City of Melbourne Local Government Area (LGA) gained 50 400 jobs. That employment growth represents 7 per cent per annum, compared with 3 per cent per annum growth experienced from 2002–2006 (BITRE 2011, p. 122).

Figure 23 Urban weekday patronage pattern, heavy rail, Sydney, 2011–12



Source: Bureau of Transport Statistics NSW 2012.

In each of the five cities, rail has a higher mode-share for the commuting task than at other periods, particularly for home–CBD movements. In Sydney, rail has the highest journey-to-work mode share for city-centre commuting, where around 46 per cent of workers use the train (Mees and Dodson 2011, p. 7). However, despite the relatively high employment density of city centres, the majority of jobs are located outside each centre. Thus, because rail offers poorer accessibility in non-CBD areas, its overall journey-to-work mode shares are relatively low (Table 11).

Table 11 Urban rail journey-to-work mode shares, 2011

	Brisbane	Sydney	Melbourne	Adelaide	Perth
Heavy rail (%)	7.6	16.0	11.7	2.5	7.7
Light rail (%)	–	0.1	3.6	0.5	–

Notes: Cities refer to greater metropolitan areas. For the 2011 census, ABS replaced its previous geographical definition system, the Australian Standard Geographical Classification, with the Australian Statistical Geography Standard. This led to some changes in the boundaries of greater metropolitan areas.

Mode shares defined as persons who caught a train/tram for all or part of their journey to work. Calculations exclude census respondents who did not specify travel mode, worked at home or did not go to work.

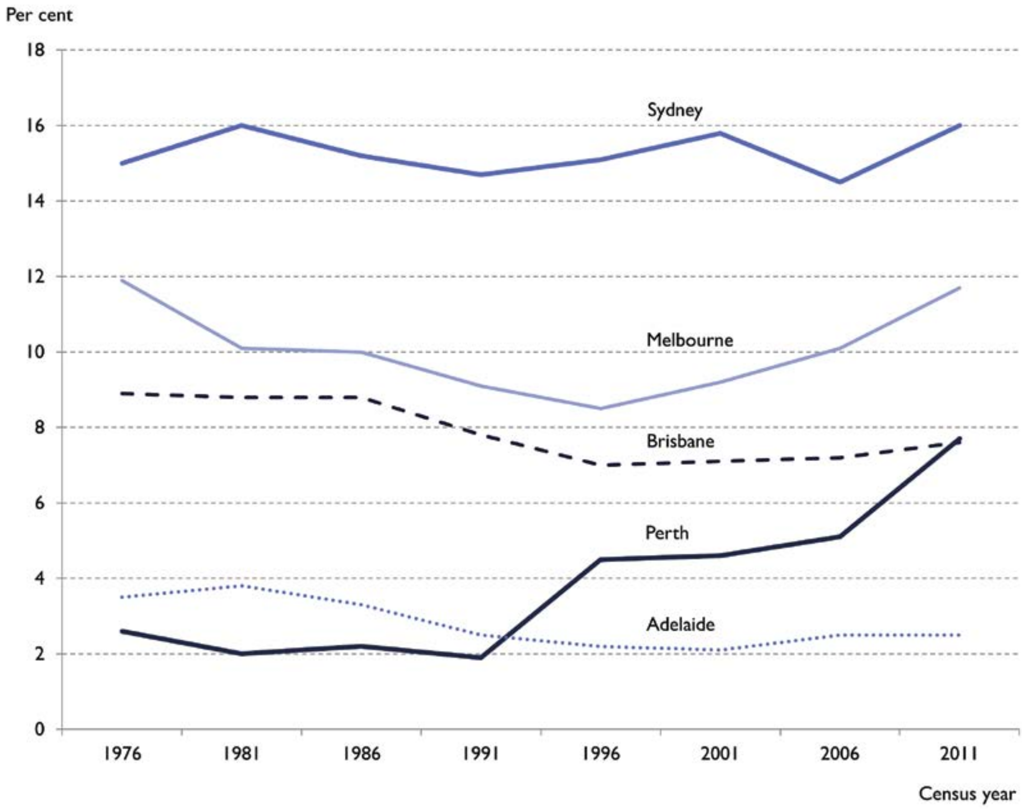
Tram/light rail census data includes respondents who: caught a tram/light rail; caught a train and tram/light rail; caught a bus and tram/light rail. The tram/light rail data is therefore an underestimate because it does not include all possibilities, for example, car and tram/light rail.

Source: ABS 2011.

Following long-term declines in urban rail patronage for all cities from the mid-1970s, ridership began to recover from the 1990s.[27] Figure 24 shows the journey-to-work mode share data for heavy rail, derived from the census, since 1976. The journey to work data from 2001 closely resembles total patronage trends over the last decade (Figure 21).

27 For an analysis of public transport mode share trends, see Mees & Groenhart, 2012.

Figure 24 Journey-to-work mode share, heavy urban rail



Note: Cities refer to greater metropolitan areas. For the 2011 census, ABS replaced its previous geographical definition system, the Australian Standard Geographical Classification, with the Australian Statistical Geography Standard. This led to some changes in the boundaries of greater metropolitan areas.

Sources: ABS 2011; Mees and Groenhart 2012.

Box 6 Further reading

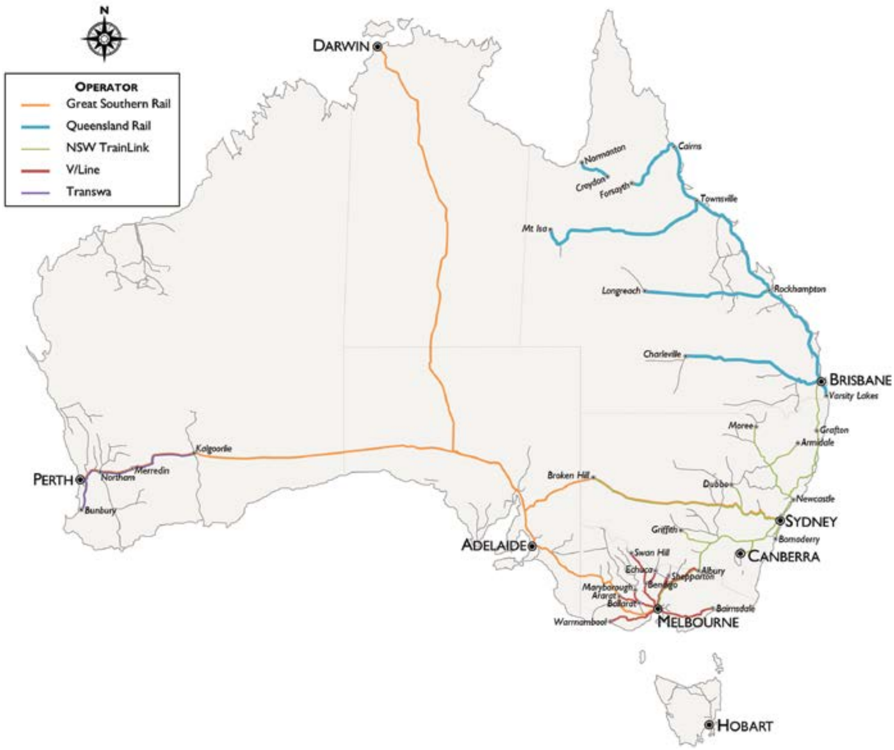
For further information on urban passenger trends, see BITRE information sheets: Urban transport: updated passenger trends—Information Sheet 59 (BITRE 2014h); and Long-term trends in urban passenger transport—Information Sheet 60 (BITRE 2014i).

BITRE 2012, *Understanding Australia's urban railways* presents an overview of Australia's passenger and freight railway systems.

Non-urban passenger traffic

Australia's railways provide a limited range of services in the inter-city, regional and long-distance passenger markets. The coverage of these services are presented in Figure 25.

Figure 25 Non-urban passenger services, by operator



Non-urban passenger traffic, broadly described as day-return (under four-hour) and long-distance (over four hours) travel, can be further classified by the primary travel markets served:

- "inter-city" or "regional" travel, such as Sydney–Canberra, Sydney–Wollongong/Bomaderry, Melbourne–Ballarat and Perth–Bunbury. Such services could include daily commuting or day-return business travel or away-day leisure travel.
- long-distance connections between cities (such as Brisbane–Sydney) and regional centres, such as Sydney–Moree and Perth–Kalgoorlie.
- heritage railway travel, for nostalgia and leisure purposes.
- tourist-focused services such as Cairns–Brisbane (Queensland Rail), and Adelaide–Darwin (Great Southern Rail).

The scale of an operator's passenger task is largely determined by the function of their railway. Table 12 shows the latest financial year patronage statistics, by operator. Railways with a large commuter task have higher patronage than those which cater largely to long-distance travel. For NSW TrainLink, for example, only a small percentage of patronage is from the former Countrylink regional network, with the majority of passengers using inter-city services on the Newcastle & Central Coast, Blue Mountains, Southern Highlands and South Coast lines.

Table 12 Non-urban rail patronage, by operator, 2012–13

	Queensland Rail[a]	NSW TrainLink[b]		V/Line	TransWA
		CountryLink	Total		
Patronage (thousands)	750	1 850	16 466	13 220	234

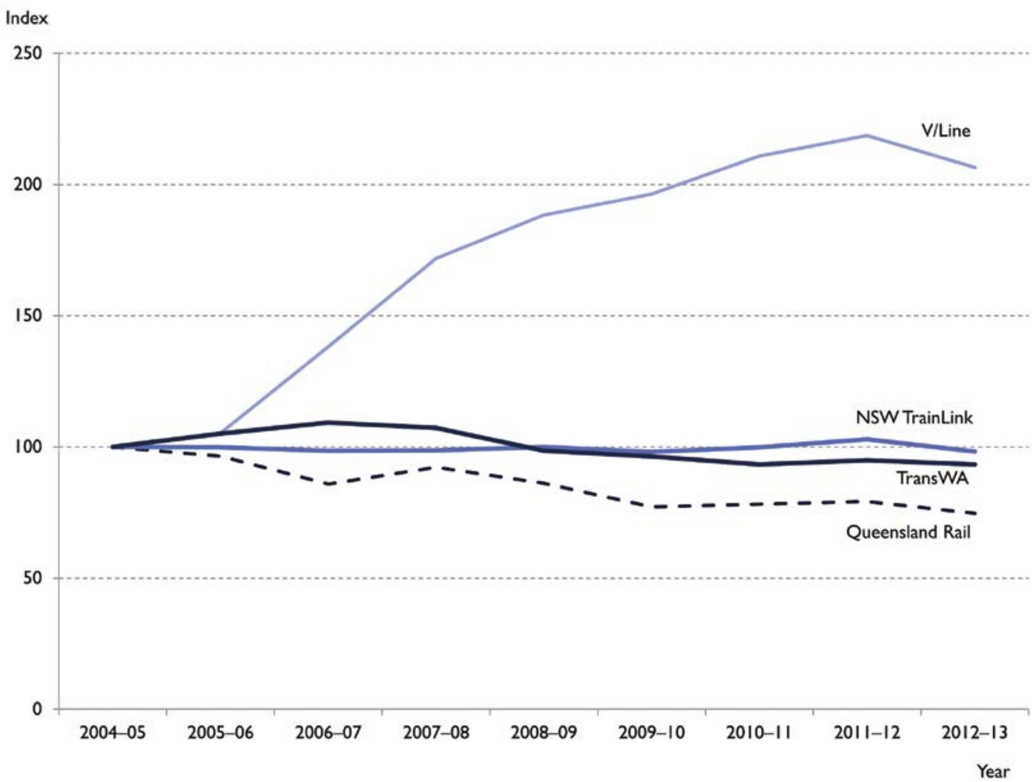
Notes: [a] Data exlude patronage on services delivered under the "TransLink" brand. Patronage data by line are not available for the Gold Coast and Sunshine Coast TransLink lines.

[b] "Total" data for NSW TrainLink are the combination of patronage on the former Countrylink network and CityRail (Central Coast & Newcastle, Blue Mountains, Southern Highlands, South Coast and Hunter lines). On 1 July 2013, NSW Countrylink was disbanded and became part of NSW TrainLink. The later was a combination of CountryLink's regional lines and the former CityRail's intercity lines. The NSW Bureau of Transport Statistics provides patronage by line.

Source: Public Transport Victoria 2013, p. 28; Bureau of Transport Statistics NSW 2013; Rail Corporation New South Wales 2013, p. 17; Public Transport Authority of Western Australia 2013, p. 29; Queensland Rail 2013, p. 7.

Much like urban patronage trends (page 41), non-urban patronage will be influenced by a range of broad, macroeconomic factors and local, network specific factors. Figure 26 shows patronage trends by operator.

Figure 26 Index of non-urban rail patronage, by operator



Notes: NSW Trainlink is the sum of CountryLink patronage and former CityRail inter-city lines.

Queensland Rail data exclude services under the TransLink brand on the Sunshine Coast and Gold Coast lines.

Source: Derived from Public Transport Victoria 2013, p. 28; Bureau of Transport Statistics NSW 2013; Rail Corporation New South Wales 2013, p. 17; Public Transport Authority of Western Australia 2013, p. 29; Queensland Rail 2013, p. 7; historical annual reports.

Some trends are of note:

- **Queensland Rail** non-urban rail travel has declined over the last decade. Queensland Rail notes a reduction in economic activity in 2012–13 (Queensland Rail 2013, p. 18). Long-distance and scenic railway services are vulnerable to reductions in discretionary spending because they are reliant on leisure travel and tourism. In addition, the decrease in 2012–13 patronage has been attributed to fewer Cairns Tilt Train services and disruptions caused by flooding in early 2013 (Department of Transport and Main Roads 2013, p. 74).
- **NSW TrainLink** patronage has remained relatively steady over the last decade. Patronage on the inter-city network[28] has decreased slightly, at an average annual rate of 0.3 per cent since 2004–05. Patronage on the long-distance, former CountryLink, network declined in the five years to 2007–08. Subsequently, patronage has grown with the exception of the latest financial year. Transport for NSW (2012, p. 229) note the quality of long-distance services, including on-time running and frequency, has made train travel uncompetitive with cars.[29]
- **V/line** patronage has grown strongly in the last decade, being more than twice the level it was in 2003–04. The growth follows substantial upgrades between 2000 and 2006 under the Regional Fast Rail programme; BITRE 2014d (pp. 61–70) reviews the upgrades. The upgrading provided a range of service enhancements, enabling an improvement in transit time and, notably, an increase in frequencies (see p. 99). Other factors having bearing on the patronage trend include a fare reduction (20 per cent in March 2007), central Melbourne employment growth, and strong population growth in the affected corridors (such as in the Melton/Bacchus Marsh area, which grew by 34 per cent between 2007 and 2012 (BITRE 2014d, p. 69). Such population growth could have been stimulated by the rail upgrades. The 2012–13 decline can be attributed to the transfer at the busy Sunbury Station of most V/Line patrons to Melbourne Metro services following completion of the Sunbury Electrification Project (BITRE, 2014d, p. 69).
- **TransWA** patronage has declined since 2006–07, arising from a fall in patronage on the Perth–Bunbury ("Australind") route, which accounts for almost half of TransWA's rail ridership[30]. The service was disrupted by track work in 2008–09 (Public Transport Authority of Western Australia 2009, p. 37). The service's competitiveness was reduced in 2009–10 when the Forrest Highway was opened; this "significantly" reduced road travel time between Perth and Bunbury (Public Transport Authority of Western Australia 2013, p. 39).

Traffic data are not available for Great Southern Rail services (Sydney–Perth *Indian Pacific;* Melbourne–Adelaide *The Overland*; Adelaide–Darwin *The Ghan*) although, with one or two services per week, relatively modest patronage levels can be assumed[31].

28 Blue Mountains, Central Coast & Newcastle, Southern highlands, South Coast and Hunter lines.

29 Transport for NSW is developing the Country Passenger Rail Services Strategy to improve service standards across the regional rail network.

30 The four services and their 2012–13 patronage are: Perth–Bunbury *Australind* (117 456), Perth–Kalgoorlie *Prospector* (95 303), Midland–Northam *AvonLink* (14 126), Perth–Merredin *MerredinLink (6 992).* (Public Transport Authority of Western Australia 2013, p. 39).

31 BTRE 2003, p. 198 provides historical traffic levels for the *Indian Pacific* ("approximately 110 thousand passengers in 2001") and *The Overland* ("approximately 80 thousand passengers in 2001").

CHAPTER 3

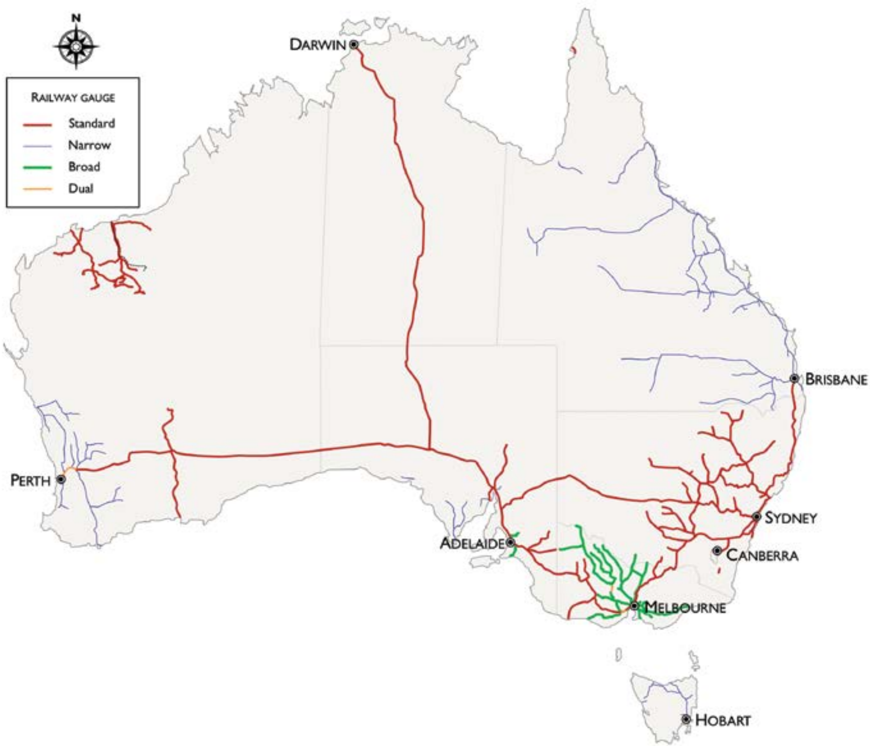
Infrastructure and rolling stock provision

This chapter analyses data on railway capital provision—railway network infrastructure and train operator rolling stock.

Railway network

In common with experiences in other countries, Australia's railway network was constructed with different gauges at different parts of the system. In particular, the network developed outwards from the State capitals, with cross-border links coming only after intrastate lines were well developed. While that legacy remains to this day (Figure 27), interstate trains operate uninterrupted across a common 1 435 mm 'standard' gauge.

Figure 27 Railway network, by track gauge, July 2014



Notes: The lines shown here are the railways that are open for traffic at July 2014. There is discussion amongst interested parties to re-open a number of grain lines in WA as well as the Demondrille–Greenthorpe/Blayney lines in NSW. Broad ("Irish") gauge is 1 600 mm; standard ("Stephenson") gauge is 1 435; narrow ("Cape") gauge is 1 067 mm.

Table 13 shows route kilometres of open and electrified railway in each jurisdiction. Queensland, Western Australia and New South Wales have similar-sized networks. Most of the network is single-tracked (89 per cent) although with notable exceptions, such as the Sydney–Melbourne line (of which around three-quarters is now double-track) and the East Turner River corridor through the Chichester Range in East Pilbara (with some BHP Billiton double track and some Fortescue double track).

Table 13 Route kilometres of open heavy railway in 2014, by jurisdiction, gauge and electrification

State or Territory									
	ACT	NT	NSW	Qld	SA	Tas	Vic	WA	Total
Route kilometres by gauge									
Broad			73		253		2 894		3 221
Narrow		3	8	7 583	561	667	16	2 963	11 801
Standard	6	1 690	7 071	67	3 114		1 222	4 211	17 381
Other			1	4			30		35
Dual				84	22		32	207	346
Total	6	1 693	7 153	7 739	3 950	667	4 196	7 381	32 784
Route kilometres by electrical system									
1 500V DC			629				375		1 004
25 kV AC				2 033	39			171	2 243
33 kV AC			8						8
Total			637	2 033	39		375	171	3 255

Notes: V denotes volts, kV denotes kilovolts, and Hz denotes hertz. DC denotes 'direct current' and AC denotes 'alternating current'.
Data may not add to totals due to rounding.
Does not include urban light rail and tramways; the extensive Queensland sugar tramways are excluded.

Source: BITRE rail database.

Queensland has the longest length of electrified railway, principally arising from the electrified line between Rockhampton and Brisbane and a number of the coal lines in Central Queensland. Elsewhere, overhead power systems have been installed on lines with relatively-intensive urban and selected intercity passenger services. Around 10 per cent of the network route-kilometres are electrified.

Appendix D provides an overview of the network in terms of infrastructure manager and of management structure (that is, whether the manager is vertically-integrated or vertically-separated).

New railways

Table 14 lists railways opened from 2009, with 554 route-kilometres of freight track and 69 route-kilometres of passenger (heavy- and light-rail) track.

Table 14 Railways opened from 2009

Traffic	Location	State	Length (km)	Project	Infrastructure builder
Iron ore	Mesa K – Waramboo (Mesa A)	WA	49	Mesa A	Rio Tinto
Iron ore	Cloudbreak – Christmas Creek	WA	50	Christmas Creek extension	Fortescue Metals Group
Iron ore	Brockman 2 – Brockman 4	WA	41	Brockman 4	Rio Tinto
Iron ore	Tilley Siding (Morawa) – Karara	WA	85	Karara Rail Spur	Karara Mining Ltd
Iron ore	Solomon Junction – Solomon	WA	130	Solomon extension	Fortescue Metals Group
Iron ore	Hope Downs 4 railway	WA	53	Hope Downs extension	Hope Downs Joint Venture (Hancock – Rio Tinto)
Coal	Dysart – Lake Vermont	Qld	18	Lake Vermont Spur Line	Aurizon
Coal	Cameby Downs Loop	Qld	7	Cameby Downs Loop	Aurizon
Coal	Goonyella–Newlands	Qld	69	Northern missing link	Aurizon
Coal	Middlemount Rail Spur	Qld	16	Middlemount Rail Spur	Aurizon
Intermodal	Sefton–Macarthur	NSW	36	Southern Sydney Freight Line	ARTC
Urban passenger	Darra–Springfield	Qld	10	Springfield branch	Queensland Rail
Urban passenger	Chatswood–Epping	NSW	15	Chatswood–Epping railway	Sydney Trains
Urban passenger	Epping – South Morang[a]	Vic	4	South Morang Extension (re-opening)	V/Line
Urban passenger	Noarlunga–Seaford	SA	6	Noarlunga Line extension	Department of Planning, Transport and Infrastructure
Urban passenger	Clarkson–Butler	WA	8	Joondalup Line extension	Transperth (Public Transport Authority)
Inter-urban passenger	Robina – Varsity Lakes	Qld	4	Varsity Lakes	Queensland Rail
Urban passenger light rail	Griffith University – Broadbeach	Qld	13	Gold Coast Light Rail	Queensland and Australian governments; Gold Coast City Council, GoldLinQ
Urban passenger light rail	Lilyfield – Dulwich Hill	NSW	6	Inner West Light Rail extension	Transport for NSW
Urban passenger light rail	North Terrace – Entertainment Centre	SA	3	Port Road Light Rail Extension	Department of Planning, Transport and Infrastructure

Notes: [a] The Epping – South Morang project was a line re–opening, using right-of-way from a railway that was closed in 1959.
A list of network additions since 1970 is at Appendix B.

Source: BITRE rail database.

Expansion of the mining industry has provided the source of much of the recent rail infrastructure expansion and subsequent rail freight task. Of the new railways, 408 route-kilometres have been constructed for iron ore exports, predominantly in the Pilbara region.

The development of iron ore mines in the Pilbara region of Western Australia has led to the construction of a network of railways linking mines with ports at Dampier, Cape Lambert (Port Walcott) and Port Hedland. BHP Billiton's network in the region began with the opening of the 208 kilometre Goldsworthy – Port Hedland Railway in 1965. Rio Tinto's line between Tom Price and Dampier opened in 1966. The third large mining company in the region is Fortescue Metals Group, which opened a railway between Cloudbreak Mine and Port Hedland in 2008. By early 2014, there were 2 295 route kilometres of railway in the Pilbara region. Enhancements to track and train specifications mean that trains in the region are amongst the longest and heaviest in the world.

Since 2009, 110 kilometres of railway have been constructed for coal haulage. Coal exports, centred on the Bowen, Galilee and Surat Basins and the Hunter Valley, rely on the railway network for moving coal to ports. New lines and additional capacity have enabled the substantial expansion of exports.

Beyond the projects in this list are a range of other significant infrastructure construction and renewal activities. For example the Goonyella–Newlands railway was part of the Goonyella to Abbot Point Expansion ("GAPE") project, enabling additional coal exports. Other notable projects include substantial Commonwealth investment in the interstate network, with new signalling, passing loops and passing lanes, re-railing, re-sleepering and re-ballasting. There have also been renewal and capacity-enhancing projects on urban passenger networks. Sydney's rail clearways programme enhanced the network's capacity and reliability through targeted works on key bottlenecks. Adelaide's urban passenger network has undergone extensive track renewal and the Seaford line has been electrified.

Table 15 lists railways that are being constructed in 2014, with 452 route-kilometres being built.

Table 15 Heavy Railways under construction, 2014

Traffic	Location	State	Length (km)	Project	Infrastructure builder
Iron ore	Roy Hill – Port Hedland	WA	344	Roy Hill mine, processing plant, railway and port berths	Roy Hill Holdings Pty Ltd
Coal	Maules Creek – junction with Werris Creek line	NSW	16	Maules Creek Mine spur and loop	Maules Creek Coal Joint Venture (majority partner, Whitehaven Coal)
Coal	Rail spur to Boggabri Coal Mine	NSW	17	Boggabri Coal Mine Expansion	Idemitsu Australia Resources
Urban passenger	Petrie – Kippa Ring	Qld	13	Moreton Bay Railway	Queensland Rail
Urban passenger	Glenfield–Leppington	NSW	12	South West Rail Link	Transport for NSW
Urban passenger	Epping– Cudgegong Road	NSW	23	North West Rail Link	Transport for NSW
Regional passenger	Deer Park – West Werribee	Vic	27	Regional Rail Link Project	V/Line

The Roy Hill Railway is pivotal to the development of iron ore mining at Roy Hill in the Pilbara Region—see the Pilbara railways map (Figure 10, p. 22); processed iron ore will be transported from the development site to Port Hedland. The operation will use Roy Hill's two new berths, SP1 and SP2, (under construction) at Stanley Point within the port. BITRE 2013 (p. 21) presents a map of the railway, berthing stockpile facilities at Port Hedland (inner harbour).

The two new coal spur lines that are under construction will be serving mines in the developing Gunnedah Basin.

The three urban passenger railways that are under construction will serve new developments in outer urban areas of Brisbane and Sydney. The new passenger railway being built for the Regional Rail Link Project will provide dedicated tracks for regional trains at the Melbourne end of the Geelong regional corridor.

Infrastructure activities extend beyond new railway construction, however, with a range of enhancement projects across the country. For example, the development of the Wiggins Island Coal Export Terminal (at the Port of Gladstone) involves a range of major railway infrastructure, including adding line capacity with additional tracks and passing loops; and enhancing train capabilities and efficiencies through extending overhead power for electric train operation (on the 107 km Bauhinia rail spur to the Rolleston coal mine).

Dedicated commodity networks

As discussed in Chapter 2, the primary railway traffic flows are iron ore, coal, grains, intermodal, and urban passengers. Major parts of the Australian railway network are dedicated to serving individual commodity flows; these are now considered.

Iron ore and coal networks

The iron ore and coal networks are illustrated in Figure 9 (p. 21). The iron ore railway networks in the Pilbara region were built by mining companies exclusively to serve the iron ore mines (as discussed on p. 55), as was the Karara (WA) spur line and the Middleback railways (near Whyalla) in SA. As bespoke developments, these lines were generally built to very high standards in order to accommodate the large traffic flows envisaged. On many of the lines there has been extensive capacity expansion (signalling, track and train capacity) since first built.

A considerable number of dedicated coal lines were developed in eastern Australia, generally being grafted onto the existing mixed-traffic network. While those standards are high—and include electrified systems—they are generally lower standards than the purpose-built iron ore lines.

Grain railways

Grain railways usually feed into secondary or main lines. (The map of grain haulage is shown on page 27.) By contrast with iron ore and many coal railways, the grain lines generally have a low technical and operational physical condition. With iron ore railways having exceptionally long and heavy trains that run a number of times a day, they are maintained to a much higher standard than grain branch lines. By way of illustration, while Fortescue railways have 40 tonne axle-load limits, some grain railways may be as low as 15 tonnes/axle.

The technical and operational diversity of the grain lines—mostly reflecting the varying importance (levels) of different branch traffic flows—has led to the classification of lines according to their technical standard (and, thus weight-bearing capability or train speed), or to their economic importance or to their viability. The respective categories across the States[32] are outlined here.

Queensland

In the first instance, the "network capabilities" of railways in Queensland are classified according to the maximum permitted axle loads on a given section of track. BITRE 2006 (p. 305) shows the prevailing axle loads that were current in 2005. Network information packs for access seekers provide details about track standards and permitted axle loads and train speeds[33]. Often the axle-load limits are 15 tonnes/axle. It has been noted that rail cannot be used to haul containerised grain for some flows as the loaded wagons would exceed axle load limits (Transport, Housing and Local Government Committee [Queensland] 2014, p. 24).

32 Most of SA's railways have been closed and the remaining four lines have not been classified.
33 An illustration of this information can be seen with the "Information pack" for South Western Queensland (Queensland Rail [Network Access], undated.

NSW

The NSW government's grain railways are categorised by class of track. Mainline tracks can be at the highest physical condition and technical standard of "Class 1". The grain railways are either Class 3 (45 per cent of the route-km) or, with the lowest standard, Class 5 (55 per cent of the route-km[34]). The axle limit on these two classes of line is 19 tonnes; this compares with 25 tonnes on Class 1 lines and 21 tonnes on Class 2 lines.

Victoria

Switchpoint, the 2007 review of the State's rail network, established a classification of different railways (Department of Infrastructure [Victoria] 2007). The classification attached descending priority for track rehabilitation (or upgrading)—from a high-priority Platinum, Gold, Silver, and then down to Bronze—to restore the railway infrastructure to the original track condition classification (which was generally Class 4 or [at a lower standard] Class 5). Note, however, that while these lines are of different operating standards, they are all suitable for 19 tonne axle load grain trains.

Western Australia

Grain railways in Western Australia are classified by their viability and competitiveness. Tier 1 lines are considered to be competitive with road transport at present and are perceived to remain competitive given probable future cost increases. Tier 2 railways are currently cost competitive with road, given prevailing rail access prices and train operating costs. Tier 3 lines are regarded as unviable as rail volumes are low and trains are uncompetitive with road; the lines are also typified by low (16-tonne) axle loads, with low-standard track structure. (Strategic Design and Development 2009, p. 8) In 2014 a parliamentary inquiry was undertaken to investigate aspects of the WA freight rail network, including the provision of Tier 3 railways—see the Economics and Industry Standing Committee of the WA Parliament Legislative Assembly (2014).

Urban heavy-rail passenger networks

The geographical reach of Australia's urban heavy rail networks is extensive, even if the network coverage is not dense (see Table 16). The networks are radial—reflecting the historical development of Australian cities—with lines branching from dense Central Business Districts (CBDs) into the surrounding, low density suburbs[35].

34 New South Wales Grain Freight Review 2009, p. 59.
35 Maps of these systems are provided in BITRE (2012).

Table 16 Network characteristics of heavy urban passenger railways, 2014

	Sydney	Melbourne	Brisbane	Adelaide	Perth
Operator	Sydney Trains	Metro Trains Melbourne	Queensland Rail	Adelaide Metro	Transperth
Ownership	Public	Private (government franchise)	Public	Public	Public
Dedicated metropolitan passenger lines (km)	178	232	90	93	175
Shared metropolitan freight/passenger lines (km)	156	171	140	30[b]	1
Total metropolitan route length (km)[a, e]	334[d]	403	230	123	176
Electrified metropolitan route length (km)	334	373	230	36	176
Metropolitan stations (number)	176	218	125	86	70
Average distance between stations (km)	1.9	1.8	1.8	1.4	2.5
Metropolitan passenger route length under construction (km)	34	27[c]	13	-	-
Passenger network gauge	Standard	Broad	Narrow	Broad	Narrow

Notes: [a] Metropolitan networks are defined by passenger operator boundaries with the exception of Queensland Rail. Brisbane's metropolitan network is defined here as being bounded by Caboolture, Shorncliffe, Domestic Airport, Doomben, Cleveland, Beenleigh, Rosewood, Springfield Central and Ferny Grove.

[b] Broad gauge freight services over this track ceased during 2014.

[c] In practical terms, this is Regional Rail Link trackage, being constructed for Regional Rail services.

[d] Junctions and crossovers are included in the calculation. The Bureau of Transport Statistics (2012, p. 6) exclude junctions and cross-overs and calculate total metropolitan route kilometres as 329 km.

[e] Does not include track dedicated to urban freight only.

Source: estimates derived from BITRE 2014f.

There are a number of characteristics and trends that make each system distinctive:

- **Network expansion.** Developments in Perth's system in recent years stand apart from experiences in the other cities, where small increments have been added to each city's systems. By contrast, Perth's system has expanded rapidly with more than two-thirds of the network built in the last 20 years. New lines from Perth – to Butler (40 km), and Mandurah (70 km), and the Thornlie branch (3 km) – have transformed long-distance urban movement within the city. (See Appendix B for dates of railway openings.)
- **Network form.** Perth's system is also distinctive relative to the other networks due to the nature of the new railways. Table 16 shows Perth's network is almost 45 per cent longer than Adelaide's, but has 16 fewer stations. This station spacing has resulted in significantly higher average speeds on Perth's Mandurah and, to a lesser extent, Butler services when compared to other lines (see Figure 40). With fewer stations, good station access is emphasised by bus interchanges, extensive park-and-ride facilities and encouragement of (nearby) Transit Oriented Development (TOD).
- **Shared network.** Brisbane, Melbourne, Adelaide and Perth systems use a different track gauge to the interstate network; this has limited operational interfaces between freight and urban passenger trains although the issue remains where intrastate freight services operate. Exceptions include the north coast intermodal freight and coal from the Toowoomba region into the Port of Brisbane; and steel products between Melbourne and Long Island. Sydney's network is unique in being a single, standard gauge throughout. It therefore shares

capacity with trains travelling on the interstate North–South and East–West (via Lithgow) corridors, as well as intrastate freight. The recently-opened Southern Sydney Freight Line provides southern access to Sydney freight yards, avoiding a curfew on their operating during passenger commuting periods.

- **Electrification**. Electrified services commenced in Sydney and Melbourne[36] from the early inter-war period. More advanced technology and electrical currents are used in the other cities due to more recent electrification: Perth and Brisbane electrified their networks relatively recently—Brisbane from the late 1970s and Perth in the early 1990s. In Adelaide the "Rail Revitalisation programme" includes track enhancements and the commencement of system electrification; electric train operation commenced on the Seaford and Tonsley lines in 2014[37].

There are lines under construction in Brisbane, Sydney and Melbourne—Brisbane's Moreton Bay Railway, Sydney's South West Rail Link and its North West Rail Link, and Melbourne's Regional Rail Link. See Table 15 for further details.

Urban light-rail passenger networks

The technological and operational differences between tramways, light rail and heavy rail are increasingly blurred.[38] This report will refer to Australia's light rail operations with an understanding that the networks, in particular in Melbourne, share characteristics with tramways. It should also be noted former heavy rail corridors form parts of the network in Melbourne, Sydney and Adelaide.

By route kilometre, Melbourne has the world's largest light rail network. Single route operations are on the Gold Coast and in Sydney and Adelaide (see Table 17).

Table 17 Network characteristics of light railways

	Gold Coast	Sydney	Melbourne	Adelaide
Total route length (km)	13	12.8	250	15
Segregated right of way	largely segregated	largely segregated	20% segregated	largely segregated
Routes (no.)	1	1	24	1
Number of stops (no.)	16	23	1 763	22

Sources: Currie and Burke 2013; Yarra Trams 2014b.

Operationally, Melbourne's network is distinct, with only a small proportion of the network being segregated from road traffic, and with close spacing between stops. In character some parts of the network share the close-stop and on-road feature of buses whereas in other parts it more closely resembles the limited-stop, segregated railway. These characteristics mean Melbourne's average speed is lower than other cities; see Table 32.

Sydney and Adelaide once had significant tramway systems but these were progressively closed from the middle of the 20th century. Adelaide's single remaining line runs between the

36 Only Melbourne's Frankston – Stony Point line remains un-electrified.
37 It is not intended to electrify the line between Goodwood Junction and Belair.
38 Tramways are generally considered to have short spacing between stations and operate on roads, often sharing a right-of-way way with traffic. Light rail is considered to largely have its own right-of-way with more widely spaced stations. Melbourne's extensive system, in particular, illustrates the flexibility of light rail and its consequent definitional blurring. Light rail vehicles operate on former heavy rail lines at St Kilda and Port Melbourne. The majority of the network, however, shares right-of-way with road traffic and has relatively short spacing between stations.

Adelaide Entertainment Centre and Glenelg, via the CBD. The majority of the route length is in a segregated light rail corridor between the edge of the CBD and Glenelg, using a former heavy-rail corridor.

Sydney's light rail line, between Central Railway Station and Dulwich Hill station, runs along a former freight rail corridor, with a small segment of on-road (largely segregated) operation between Haymarket and Central.

The Gold Coast light railway opened in July 2014. It runs between the Gold Coast University Hospital and Broadbeach. The line has been placed along roads but the space is generally not shared with road traffic. The line runs along a dense retail corridor (Currie and Burke 2013, p.12). Average station spacing is the highest of the cities.

Non-urban passenger network

By contrast with much of the urban rail systems, the non-urban passenger services are not stand-alone networks. Typically, the non-urban services share track with urban passenger and freight trains. (The coverage of the non-urban passenger operations services, by principal operator, has been presented in Figure 25.) Key network characteristics of the regional passenger services, including heritage railways, are presented in Table 18.

Table 18 Network coverage of non-urban passenger rail services

	Queensland Rail[a]	NSW TrainLink	V/Line	TransWA	Great Southern Rail	Heritage operators
Electrified route kilometres	728	449	–	–	–	1
Total route kilometres	4 617	4 275	1 628	836	7 243	555

Notes: [a] Queensland Rail route length includes the Gympie North – Brisbane and Brisbane – Varsity Lakes services.

Diesel services may run on electrified track. Where non-urban electrified and diesel services share electrfied track (such as Rockhampton–Brisbane), the route is defined as electrified. Where non-urban diesel services share track with electrfied urban trains (such as V/Line services on Melbourne's metropolitan network), the route is defined as not electrified.

Source: BITRE 2014f.

Train operator equipment stock

This section provides data on elements of train operators' rolling stock; wagons are not considered here.

Locomotives

Data on attributes of Australia's locomotives allow classification of the fleet. Data used here use the age of the locomotive since built new, or the age since rebuilt, whichever is the lower period.[39] The age of the fleet reflects a range of different underlying influences on rolling stock investment. Table 19, Figure 28 and Figure 29 illustrate a number of "spikes" in the age of the fleet.

A significant proportion of the fleet are under 5 years of age. This reflects the commodities boom, with a large number of electric and diesel-electric locomotives being purchased. Figure 29 shows approximately 50 per cent of Australia's fleet is aged 11 years or under.

The next age spike is for locomotives in the 16–20 age range. This reflects National Rail's Commonwealth-underpinned purchase of the NR-class locomotive; 120 of these high-horsepower locomotives were introduced from 1996–97.

The wholesale replacement of steam with large numbers of diesel-electric locomotives is reflected in the profile, with many locomotives aged around 41–50 years.

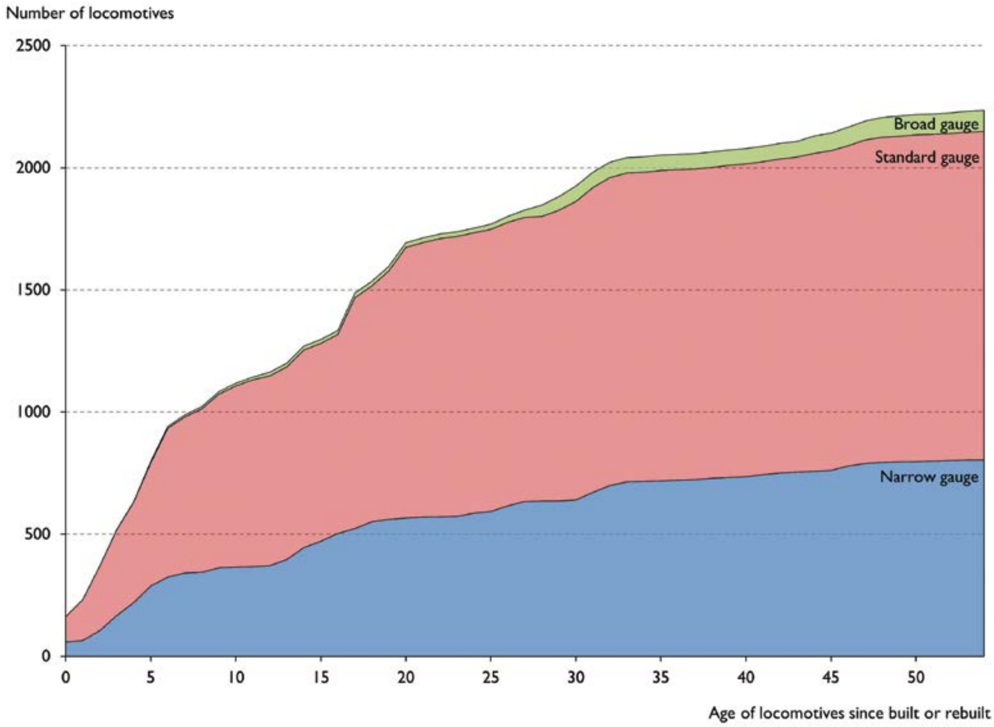
Table 19 Locomotive ages

Age range (years)	Narrow Gauge	Standard Gauge	Broad Gauge	Total
0–5	288	504	6	798
6–10	77	238	5	320
11–15	106	68	5	179
16–20	95	298	3	396
21–25	27	47	2	76
26–30	47	67	42	156
31–35	78	49	0	127
36–40	17	10	0	27
41–45	26	28	9	63
46–50	36	29	11	76
51+	7	7	3	17
Total	804	1345	86	2235

Source: Analysis of data from Cleverdon 2014.

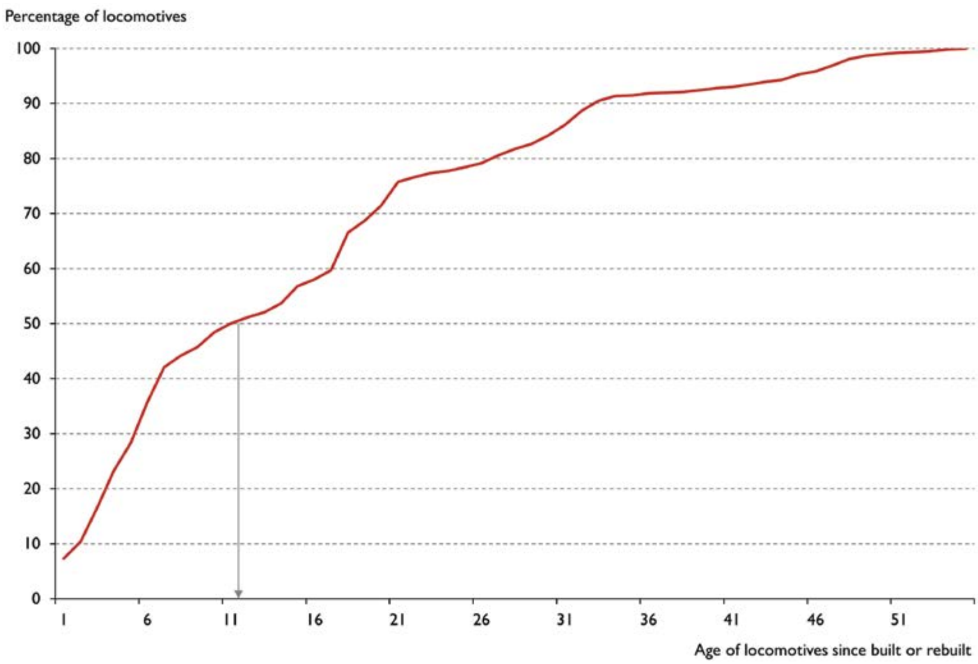
39 Rebuilt locomotives can attain the same (or better) performance and longevity characteristics as a new locomotive.

Figure 28 Cumulative locomotive age profile, by number of locomotives



Source: BITRE analysis of data from Cleverdon 2014.

Figure 29 Cumulative locomotive age profile, per cent



Source: BITRE analysis of data from Cleverdon 2014.

Box 7 Further resources

- *Railway Digest*, the monthly railway industry magazine, compiles a list of current and recently completed rolling stock contracts and deliveries—for locomotives, wagons, permanent-way vehicles and passenger stock. This list is published regularly in the magazine.

Urban passenger rolling stock

The levels of rolling stock required by different networks are a function of a range of factors, including:

- traffic levels;
- the size of the network and the length of individual lines;
- the range of different services on each part of the network (such as offering stopping, semi-fast, and express services on a given line); and
- the average speed of services (with faster operations requiring fewer train sets).

Heavy rail stock

Australian urban heavy rail rolling stock is generally modern, with the last of the 1970s stock in the process of being phased out. Operators are in the ongoing process of procuring additional or replacement stock. Most of the rolling stock is air-conditioned, with the remaining 24 of Sydney's non-air-conditioned S-Set trains used on low patronage lines and for stand-by services. (See Table 20.)

Most train services are provided by "multiple-unit" stock—permanently-coupled carriages. Sydney's fleet generally run as four car units, coupled into eight car trains. The new Waratah trains are 8 car units. Elsewhere, the standard stock is the three-car EMU, generally being paired as six-car trains. There are some exceptions. The characteristics of Adelaide's rolling stock, with large numbers of one and two-car units, enables the local provider, Adelaide Metro, to cater for comparatively modest traffic levels with a broad range of configurations. In addition, there are some two car operations in Perth.

Table 20 Heavy rail rolling stock

	Brisbane	Sydney	Melbourne	Adelaide	Perth
Vehicles (no.)	633	1 622[a]	1 278	120	240[b]
Air-conditioned vehicles (no.)	633	1 430	1 278	120	240[b]
Carriage format	Single-deck	Double-deck	Single-deck	Single-deck	Single-deck
Multiple-unit format	211 three-car	321 four-car 78 eight car	426 three-car	30 one-car; 20 two-car; 7 three-car; 29 units in various multiple-unit formations	48 two-car; 48 three-car
Common train formations	EMUs coupled as six-car	EMUs coupled as eight-car	EMUs coupled as six-car	Diverse DMU/DEMUs, up to four-car; EMUs normally three-car	EMUs coupled as six-car on new lines

Notes: [a] Sydney's S-set rollingstock is being progressively removed from service; 24 will be retained until at least 2019 for stand-by services.

[b] B-set rollingstock is being progressively introduced to service; 48 out of 68 three-car sets have been delivered as of July 2014.

Source: Sydney Trains 2014; VicSig 2014; Communication with Queensland Rail 2014; RailSA 2014; Public Transport Authority WA 2014; Government of Western Australia 2014.

Sydney is the only system to use double-deck carriages. Suburban single-deck trains were gradually replaced with double-deckers from 1964. The objective of this policy—facilitated by relatively generous height restrictions—was to increase the passenger-carrying capacity of the system. The Melbourne system experimented with operating a double-decker train in the 1990s but did not proceed with this format.

Light rail

Melbourne's light rail fleet is significantly larger and more varied than the other cities; see Table 21. Melbourne's older rolling stock, such as the Z and A classes—introduced between 1975–1984 and 1984–1986, respectively—are comparatively short and low capacity.

Over the past 30 years, there has been a progressive move towards longer, higher capacity vehicles, using vehicle articulation rather than the coupling of vehicles (as had been the practice with Adelaide's now-heritage H-class trams). Melbourne's E class—progressively introduced from 2013—is more than twice the length of the aforementioned Z and A classes. Similarly, rolling stock introduced in the last decade in other cities are all above 30 metres in length.

Table 21 Light rail rolling stock[a]

City	Vehicle type	Length (metres)	No. vehicles
Gold Coast	Flexity 2	43.5	14
Sydney	Variotram	28	7
	Urbos 3	33	3
Sydney total			10
Melbourne	A1 class	15	27
	A2 class	15	42
	B1 class	23.5	2
	B2 class	23.6	130
	C class (Citadis)	23	36
	C class (Bumblebee)	32.5	5
	D class (Combino)	20	38
	D2 Class (Combino)	29.9	21
	E Class	33.5	6
	Z1 class	16	29
	Z2 class	16	3
	Z3 class	16.6	114
	W6 class	14.2	5
	W7 class	14.2	2
	SW5 class	14.2	1
	SW6 class	14.2	11
Melbourne total			472
Adelaide[b]	100 Flexity Classic	30	15
	200 Citadis	32	6
Adelaide total			21

Notes: [a] Fleet numbers are based on rollingstock in service.
[b] Adelaide retains two heritage H class trams for tourist trips and special events.

Sources: Currie and Burke 2013; Yarra Trams 2014; VicSig 2014b; GoldlinQ 2014b; Transdev Sydney 2014b.

Non-urban passenger rolling stock

Much like urban rail rolling stock, and reflecting historical acquisitions, the composition of the non-urban passenger stock is a function of:

- traffic levels;
- service frequency;
- the size of the network and the length of individual lines;
- the range of different services on each part of the network (such as offering stopping, semi-fast, and express services on a given line); and
- the average speed of services (with faster operations requiring fewer train sets).

There are a wide range of non-urban passenger services in Australia. Thus, rolling stock, designed for individual markets and service types, vary considerably. Table 22 shows the number of individual vehicles/cars, by type and operator.

Table 22 Non-urban passenger rolling stock[a], by vehicle type and operator

	Queensland Rail	NSW TrainLink	V/Line	TransWA
Electric multiple unit cars (no.)	150	445	–	–
Diesel multiple unit cars (no.)	18	65	155	14
Locomotives (no.)	30	19	41	–
Carriages (no.)	122	60	133	–
Total cars/vehicles	320	589	329	14

Notes: [a] Rolling stock may also be used in urban operations. Electric multiple units in intercity operations, for example, often act as limited-stop urban trains once they enter the metropolitan network.

The above lists individual vehicles rather than sets.

Great Southern Rail's trains are hauled by Pacific National, which also supplies the locomotives used.

Sources: VicSig 2014c; Sydney Trains 2014; NSW TrainLink 2014; Public Transport Authority of Western Australia 2013 p. 38; communication with Queensland Rail.

Locomotive hauled trains are primarily used for long-distance routes—see the example at Figure 30. A number of Queensland Rail's long-distance services, running along the east coast and branching west into central Queensland, are locomotive hauled.

Figure 30 Long-distance passenger train operation in Queensland

Note: The image is of Queensland Rail's The Sunlander passes through cane fields between Home Hill and Ayr on his journey from Brisbane to Cairns.

Source: Photograph courtesy of John Hoyle.

Medium-distance regional/commuter services are generally operated with diesel multiple units (DMUs). High-performance "VLocity" DMUs that are capable of 160km/h are core components of Victoria's Regional Fast Rail services. TransWA use DMUs exclusively for their service on the Perth–Bunbury and Kalgoorlie–Perth corridors. NSW Trainlink use DMU's for the Sydney–Canberra service and numerous intrastate services. On board facilities, such as buffet, are provided depending on the length of the service. All DMUs are air-conditioned and generally seat two either side of a central aisle.[40]

NSW TrainLink and Queensland Rail have large electric fleets, largely used for intercity/commuter services. In the case of NSW, this fleet is used for Newcastle–Sydney, Sydney–Lithgow and Sydney–Kiama (via Wollongong) services. Much of Queensland Rail's EMUs are used on the Sunshine Coast and Gold Coast lines.

A unique passenger rolling stock for Australia is Queensland Rail's fleet of tilt train (fixed-formation) sets. Queensland Rail has a fleet of electric tilt trains, used on Rockhampton–Brisbane services, and diesel tilt trains used on the Cairns–Brisbane services. (BITRE 2014d, p. 60 and pp. 161–162, discusses the nature of the tilt-train services and the principles of tilt trains.)

40 NSW TrainLink's Hunter and Endeavour trains seat 5 across.

CHAPTER 4

Railway performance

In this chapter we present a diverse range of measures of railway performance and network activity.

Network indicators

Safety

A vital element of railway performance is the safe operation of the system. Table 23 shows the normalised[41] rate of train safety occurrences, by category of event. Collisions with infrastructure and running line derailments are the most common form of accident. These are followed by collisions with a person (not at a level crossing) and collisions with vehicles at level crossings.

41 Normalisation means, in this context, to transform measurements so that they can be compared in a meaningful way. In the context of the railway statistics cited here, the occurrences are reported relative to the level of railway activity that is undertaken. Clearly, the likelihood of any safety-related occurrence will rise, *cet. par.,* with the level of activity (usage) of the network. In this case, the occurrences are factored relative to the number of train kilometres operated.

Table 23 Normalised occurrence rate, per million train kilometres travelled

Year	Period	Running line derailments	Collisions with trains	Collisions with rolling stock	Collisions with person (not level crossings)	Collisions with vehicle (not level crossings)	Collisions with infrastructure	Collisions with vehicle (level crossings)	Collisions with person (level crossings)
2002	Jul-Dec	1.37	0.08	0.06	0.29	0.24	0.27	0.41	0.07
2003	Jan-Jun	1.09	0.12	0.00	0.19	0.07	0.39	0.34	0.03
	Jul-Dec	0.78	0.09	0.03	0.28	0.16	0.43	0.50	0.11
2004	Jan-Jun	0.99	0.06	0.02	0.20	0.16	0.40	0.30	0.03
	Jul-Dec	0.96	0.01	0.08	0.26	0.15	0.55	0.37	0.04
2005	Jan-Jun	0.80	0.14	0.04	0.21	0.10	0.43	0.40	0.04
	Jul-Dec	0.75	0.08	0.04	0.27	0.08	0.70	0.39	0.04
2006	Jan-Jun	0.60	0.05	0.07	0.27	0.05	0.51	0.40	0.06
	Jul-Dec	0.70	0.15	0.05	0.24	0.12	0.69	0.47	0.04
2007	Jan-Jun	0.75	0.07	0.01	0.25	0.06	0.58	0.35	0.06
	Jul-Dec	0.83	0.11	0.03	0.21	0.06	0.51	0.27	0.04
2008	Jan-Jun	0.83	0.11	0.08	0.21	0.08	0.88	0.34	0.04
	Jul-Dec	0.55	0.11	0.03	0.31	0.02	0.79	0.29	0.01
2009	Jan-Jun	0.92	0.11	0.01	0.23	0.04	0.63	0.29	0.07
	Jul-Dec	0.78	0.09	0.08	0.37	0.05	0.65	0.24	0.05
2010	Jan-Jun	0.69	0.13	0.06	0.28	0.07	0.75	0.24	0.07
	Jul-Dec	0.85	0.04	0,01	0.27	0.06	0.57	0.27	0.02
2011	Jan-Jun	0.91	0.06	0.05	0.33	0.06	0.51	0.24	0.03
	Jul-Dec	0.68	0.08	0.01	0.26	0.08	0.52	0.27	0.09
2012	Jan-Jun	0.78	0.06	0.01	0.23	0.03	0.73	0.22	0.04

Notes: Data excludes light rail and trams.
Occurences did not necessarily result in fatality or injury.
Source: ATSB 2012.

The ATSB (2012, p. 43) notes important differences in the collection and reporting of safety occurrences between jurisdictions. For a detailed description of these differences see (ATSB, 2012, pp. 43–45). Fatalities are presented in Table 24.

Table 24 Railway fatalities, by year (number)

Year	2002–03	2003–04	2004–05	2005–06	2006–07	2007–08	2008–09	2009–10	2010–11	2011–12
Fatalities	42	29	30	43	44	34	32	26	26	44

Notes: Data exclude light rail and trams.
Fatality data include collisions at level crossings.
Suicides are excluded from NSW data.
Source: ATSB 2012.

Environmental performance

The environmental impacts of transport are wide-ranging and may affect both the natural and built environment. Common environmental problems associated with transport include, among other issues: land-use and clearance, visual intrusion, localised noise and air pollution and the emission of greenhouse gases.

This section focuses on the rail industry's carbon dioxide equivalent emissions.[42] The measurement of the rail industry's emissions is complicated by the need to allocate upstream emissions—from power generation sources—to downstream energy uses, such as powering electric trains. Emissions data are therefore an approximation.

Table 25 shows the approximate carbon dioxide equivalent emissions of the rail industry since 2003–04. Emissions have increased by around 29 per cent in the last decade. The increase is a function of the scale of the transport task performed and the emissions intensity of the vehicles.

The commodities boom is likely to be the main cause of the higher level of emissions. The boom has increased the bulk freight task performed by rail in recent years. In addition, the passenger task has increased in some cities, in particular in Perth and Melbourne.

The emissions intensity of rolling stock also affects the industry's performance. While manufacturers have focused on maximising energy efficiency in rolling stock, changing requirements, such as higher performance and, for passenger rail, air-conditioning and on-board electronics, may increase emissions intensity.

Table 25 Rail industry's full fuel cycle carbon dioxide equivalent emissions, gigagrams by financial year

2003–04	2004–05	2005–06	2006–07	2007–08	2008–09	2009–10	2010–11	2011–12	2012–13
4330.3	4579.7	4581.9	4883.0	5037.6	5126.7	5197.5	5286.2	5436.4	5581.4[a]

Note: [a] preliminary/provisional estimate.

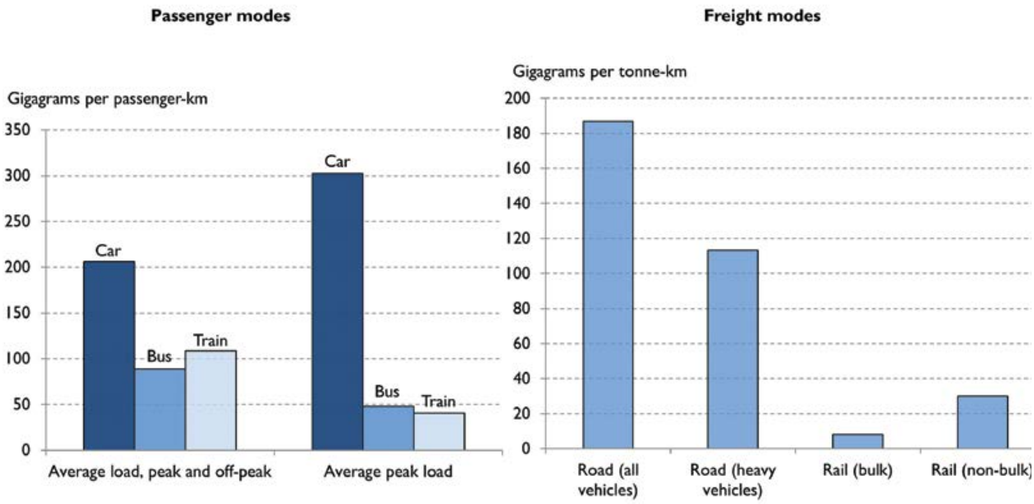
Source: BITRE estimates

The emissions intensity of freight rail is low relative to road freight vehicles. (Figure 31).

In regard to urban passenger transport, railways show a significant advantage in average emission intensity over cars, especially during peak period travel. Over the full day, the gap in average emissions intensity is not quite as substantial, however, since off-peak rail travel generally has much lower average occupancy levels.

42 "Carbon dioxide equivalent" is used to compare the emissions of greenhouse gases based on their global warming potential relative to carbon dioxide. For example, the warming potential, over a 100-year time period, of methane is roughly 21 times greater than carbon dioxide. This means emissions of one-million metric tonnes of methane is the equivalent of 21 million metric tonnes of carbon dioxide (OECD, 2014). Values in Table 9 include the estimated effects of three direcly warming gases: carbon dioxide (CO_2), methane (CH4) and nitrous oxide (N2O) – emitted from rail locomotives or electric power stations providing rail traction.

Figure 31 Emissions intensity of passenger and freight modes, 2007, carbon dioxide equivalent



Notes: "Average load (peak and off-peak)" is the national average occupancy, by mode, over the day, for all passenger travel (both urban and non-urban). For buses, if intensity estimates were restricted solely to urban use, then average values would be substantially higher.

"Road (all vehicles)" is the average across all rigid and articulated trucks as well as light commercial vehicles

"Road (heavy vehicles)" is the average across rigid and articulated trucks

"Rail (bulk)" is the average for private, dedicated bulk railways. Bulk traffic on railways shared by non-bulk trains would likely have a higher emissions intensity.

Source: BITRE estimates.

Interstate network indicators

In this section we consider a range of indicators of the interstate network, that is, the railway between the State capitals (and, additionally, including Darwin).

Access revenue yield indicator (ARTC)

The access revenue yield indicator is a composite measure that shows the impact of infrastructure improvements on ARTC's network and the resulting train operator uptake of the improved infrastructure capabilities.

Access revenue is the infrastructure manager's income derived from train operators using the railway. ARTC's access charge has two components: a flagfall charge, which is a reservation charge for booking a train path on a given line segment, invariant with tonnage; and a variable charge, which varies directly with the train operator's gross tonne kilometres. Thus, as tonnage on the train rises, the average access charge per tonne will decline.

This access charging regime provides an incentive for train operators to operate longer trains. In principle, operating longer trains enables infrastructure managers to achieve greater tonnage throughput, as there is a limit to the number of trains that can operate over the network.

However, to have longer trains requires trackage that can deal with the length. In recent years, interstate network infrastructure has been expanded to take longer trains. If train operators respond to the access charging structure by running longer trains, effective freight costs per tonne will fall.

The indicator presented here is an index of the maximum access yield for the interstate network managed by ARTC, based on ARTC data and analysis. The indicator measures the changes (relative to the base year) in the maximum access revenue yield per gross tonne kilometre. Changes in this composite indicator may reflect changes in:

- real access charges (higher charges will increase the indicator);
- train operators' use of existing capacity (heavier/longer trains will lower the indicator); or
- enhancements in rail infrastructure and train operators' uptake of those enhancements (more uptake of improvements, through heavier trains, will lower the indicator).

As shown in Table 26, since 2004–05, average yield has increased on all of the East–West corridor line segments. On the North–South corridor, Border loop – Newcastle and Albury–Tottenham have decreased.

Table 26 Index of real maximum access revenue yield, interstate network (2009–10 = 100)

	2004–05	2005–06	2006–07	2007–08	2008–09	2009–10	2010–11	2011–12	2012–13
North–South corridor									
Acacia Ridge – Border Loop						100.00	99.36	101.41	100.64
Border Loop – Newcastle	106.27	102.39	101.79	97.92	100.60	100.00	99.36	101.41	100.64
Macarthur–Albury	100.29	96.61	96.07	97.95	100.62	100.00	99.38	101.43	100.64
Albury–Tottenham	111.92	109.36	108.72	105.72	100.62	100.00	99.38	101.43	100.64
East–West corridor									
Melbourne–Adelaide	99.94	97.64	97.55	94.94	100.60	100.00	99.38	101.44	100.65
Adelaide–Kalgoorlie	94.95	92.77	92.68	90.23	100.60	100.00	99.36	101.42	100.64
Cootamundra–Parkes	97.51	93.94	93.41	97.98	100.60	100.00	99.38	101.44	100.66
Parkes – Broken Hill	99.88	96.23	95.68	97.91	100.60	100.00	99.37	101.43	100.65
Broken Hill – Crystal Brook	87.45	85.43	85.35	82.95	100.60	100.00	99.37	101.43	100.65

Source: Data provided by ARTC.

Interstate network utilisation

In this section we present indicators of freight train usage of the interstate network.

Train frequency on the interstate network

The number of scheduled weekly intermodal trains that originated and terminated in the given city pairs, are shown in Table 27. Note that these origins and destinations are those of trains, and not those of goods on the trains. For example, Brisbane–Melbourne trains will often dwell in Sydney where goods are loaded and unloaded.[43]

[43] Asciano/Pacific National trains dwell at Chullora. Aurizon trains dwell south of Sydney, at Glenlee Junction.

The number of scheduled intermodal trains have fallen on the North–South corridor since 2006. On the East–West corridor, the number of scheduled intermodal trains between Melbourne and Perth has increased, offset by fewer trains between Melbourne and Adelaide, between Adelaide and Perth.

The decline in Melbourne–Adelaide trains can be attributed to the reduction in land-bridge freight between Adelaide and the Port of Melbourne. These falls have arisen because a higher proportion of Adelaide's containers now leave by ship through the city's port and are transhipped at an overseas hub (notably Singapore) to vessels that deliver containers to their respective destination port. Previously, a higher proportion of containers were railed between Melbourne and Adelaide, with the Port of Melbourne as the hub for direct sailings to and from destination ports.

Table 27 Number of weekly intermodal services, by city pair

	2006	2007	2008	2009	2010	2011	2012	2013	2014
North–South corridor									
Brisbane to Sydney	4	1	1	1	1	1	2	2	2
Sydney to Brisbane	5	0	0	0	0	0	0	0	0
Sydney to Melbourne	4	6	3	0	2	2	3	2	2
Melbourne to Sydney	6	6	3	0	2	2	3	2	2
Brisbane to Melbourne	19	18	16	17	15	15	15	15	15
Melbourne to Brisbane	18	18	17	17	15	15	15	16	16
Brisbane to Adelaide		5	5	3	3	3	2	2	2
Adelaide to Brisbane		5	4	3	3	3	2	2	2
East–West corridor									
Melbourne to Adelaide	17	17	17	17	11	12	9	9	8
Adelaide to Melbourne	17	17	17	17	11	12	9	9	9
Melbourne to Perth	14	15	16	15	18	19	20	20	20
Perth to Melbourne	14	15	16	15	17	19	20	20	20
Sydney to Perth	8	8	8	7	7	7	8	9	10
Perth to Sydney	8	8	8	7	7	7	8	9	10
Adelaide to Perth	0	0	2	2	0	0	0	0	0
Perth to Adelaide	0	0	2	2	0	0	0	0	0
Central corridor									
Adelaide to Darwin			5	7	7	6	7	6	6
Darwin to Adelaide			5	6	6	6	7	6	6

Sources: Working timtables of infrastructure managers (ARTC, RailCorp, Brookfield Rail and Genesee & Wyoming Australia).

Weekly trains by interstate line segment

The number of scheduled weekly interstate intermodal and steel trains on each line segment is presented in Table 28. This is an indicator of the intensity of the usage of the interstate network. Note Table 28 differs from Table 27 because it measures all trains on a given line segment.

A train travelling from Melbourne to Perth, for example, will be counted on all line segments on that route.

The most intensive use of the network by interstate trains is on the Crystal Brook – Port Augusta and Port Augusta – Tarcoola segments. These segments are used by interstate intermodal trains travelling to and from Perth; intermodal trains between Adelaide and Darwin; and steel trains from Newcastle and Port Kembla to Port Augusta, Whyalla and Perth.

The Sydney–Cootamundra and Cootamundra–Melbourne line segments are the busiest on the North–South corridor. In addition to intermodal and steel trains, these segments are used extensively by passenger and bulk services.

On most line segments steel traffic is relatively stable. Steel trains travelling via Broken Hill are now split between the Lithgow and Cootamundra routes. Intermodal traffic has decreased on the North–South corridor substantially since 2006. Intermodal traffic levels have also decreased between Melbourne and Adelaide, largely due to the aforementioned decline in the land-bridging task. Additionally, the trend towards increased train sizes has likely contributed to the decreased number of trains.

Intermodal traffic on the Crystal Brook – Perth line segments has increased steadily. This is largely due to the growing number of Melbourne–Perth trains.

Table 28 Weekly interstate intermodal and steel trains, by line segment, four year intervals

	Intermodal			Steel		
Line segment	2006	2010	2014	2006	2010	2014
North–South corridor						
1. Brisbane–Sydney	50	37	37	11	12	10
2. Sydney–Melbourne						
Sydney–Cootamundra	61	49	53	23	19	20
Cootamundra–Melbourne	51	45	50	12	8	14
East–West corridor						
3. Sydney – Crystal Brook via Broken Hill						
Sydney–Parkes via Lithgow	6	9	6	0	0	4
Cootamundra–Parkes	10	9	14	11	11	6
Parkes – Crystal Brook	16	18	22	11	11	10
4. Melbourne – Crystal Brook						
Melbourne–Adelaide	66	63	61	12	8	8
Adelaide – Crystal Brook	38	47	52	13	10	8
5. Crystal Brook – Perth						
Crystal Brook – Port Augusta	54	65	74	13	21	18
Port Augusta – Tarcoola	54	65	74	6	6	6
Tarcoola–Perth	54	53	62	6	6	6

Sources: Working timetables of infrastructure managers (ARTC, RailCorp/Sydney Trains, Brookfield Rail and Genesee & Wyoming Australia).

Train flow patterns on the interstate network

Train flow indicators provide information about the flow of trains across the network. Flows are being improved by infrastructure investment and renewal such as new or improved signalling, additional long passing loops, and passing lanes.

Table 29 summarises three related indicators of train flow for the primary line segments: train dwell time; number of train stops; and average train speed. These indicators are now discussed.

Table 29 Scheduled intercapital intermodal train flow patterns

Line segment/ direction	Number of weekly intermodal services		Average speed		Average number of stops		Average scheduled transit time (mins)		Average dwell time (mins)		Percentage dwell time (per cent)		Dwell time per stop	
Year	2010	2014	2010	2014	2010	2014	2010	2014	2010	2014	2010	2014	2010	2014
North-South corridor														
Brisbane to Sydney	19	19	53	57	9	7	1 119	1 029	198	124	18%	12%	23	19
Sydney to Brisbane	18	18	51	55	8	7	1 150	1 061	162	156	14%	15%	19	23
Sydney to Melbourne	20	19	64	67	4	3	906	867	80	73	9%	8%	22	24
Melbourne to Sydney	20	20	68	71	4	3	850	809	54	36	6%	4%	14	14
Brisbane to Melbourne	18	17	56	58	13	11	2 108	2 016	397	317	19%	16%	31	30
Melbourne to Brisbane	18	18	57	59	13	10	2 044	1 992	345	313	17%	16%	28	31
East-West corridor														
Melbourne to Adelaide	32	30	63	65	6	5	786	772	102	84	13%	11%	18	18
Adelaide to Melbourne	31	31	59	57	6	6	850	869	148	167	17%	19%	24	27
Adelaide to Perth	18	20	66	65	14	14	2 429	2 460	378	366	16%	15%	27	26
Perth to Adelaide	17	20	59	58	18	18	2 698	2 770	668	680	25%	25%	37	37
Cootamundra to Crystal Brook	4	5	68	67	10	4	1 113	1 147	227	261	20%	23%	24	70
Crystal Brook to Cootamundra	6	9	65	63	10	5	1 164	1 209	251	323	22%	27%	26	72
Central corridor														
Tarcoola to Darwin	6	6	72	71	5	4	1 878	1 897	288	202	15%	11%	58	55
Darwin to Tarcoola	6	6	69	70	6	4	1 970	1 939	319	223	16%	11%	55	56

Note: The number of services excludes trains that do not run the entire line segment. Cootamundra to Crystal Brook, for example, excludes Sydney to Perth trains that run via Lithgow (5 trains).

Sources: Working timetables of infrastructure managers (ARTC, RailCorp/Sydney Trains, Brookfield Rail and Genesee & Wyoming Australia).

(a) Dwell time

The dwell time indicator shows the time trains are scheduled to spend 'dwelling' (stationary) in railway yards and passing loops. Reasons for dwelling may be:

- operational – such as changing train crews or refuelling;
- a function of the track capacity and traffic – trains may need to wait in passing loops and sidings for others to pass or overtake;
- trains may need to unload or load cargo at intermediate destinations.

North–South corridor

Compared with 2010–11, trains have fewer stops in 2013–14. This reflects ARTC's investment strategy on the corridor: new and extended passing loops between Brisbane and Sydney, additional passing lanes between Sydney and Melbourne, and upgraded signalling at pinch points along the corridor have improved track capacity and operational practices.

Two important factors should be considered in interpreting levels of, and changes in, dwell times:

- A significant factor that affects overall dwell time arises where trains stop to load and unload goods. An important new traffic flow on the corridor is the Ettamogah Rail Hub intermodal terminal (near Albury), which opened in June 2009. The terminal is served by four weekly Pacific National trains running between Brisbane and Melbourne (two trains per direction). Trains at Ettamogah dwell for between 40 and 45 minutes, which lengthens average corridor dwell times.
- Sydney is a major market served by the Brisbane–Melbourne and Brisbane–Adelaide trains; wagons are detached and attached and this process adds a number of hours to the transit time and, thus, to the average corridor dwell times. For example, Pacific National trains often remain at the company's Chullora Sydney Operations Yard (SOY) for periods ranging from a few minutes to almost 9 hours. Similarly, Aurizon trains travelling between Brisbane and Melbourne undertake shunting at Glenlee Junction (on the southern edge of Sydney) to attach and detach wagons (Aurizon uses a separate shuttle service between its Yennora yard and Glenlee Junction to transfer goods.)

Stops at intermediate destinations are an important revenue generating activity. They therefore play a role in improving the economic viability of rail services. It is important to keep this in mind when using dwell and travel time to assess the performance of the railways.

East–West corridor

Train flows on the East–West corridor are relatively stable. As with the North–South corridor, trains dwell at intermediate destinations and for operational reasons.

- Two significant operational dwell locations are at Cook and Spencer Junction (Port Augusta). Both locations are used for crew breaks and changes.
- Operators stop at intermediate destinations to attach and detach wagons and undertake shunting. Adelaide is the largest intermediate city on the corridor. Pacific National operates a terminal at Islington, SCT Logistics operate from their terminal in Direk and Aurizon use a terminal at Dry Creek. Another notable intermediate terminal is at Goobang Junction in Parkes, NSW.

- A significant change to train flows since 2010 is on the East–West corridor between Cootamundra and Crystal Brook. The number of stops have halved. This is a reflection of ARTC's investment in the corridor: existing loops have been extended to fit 1 800 metre trains and two new loops have been constructed. The signalling system has also been upgraded in sections, in particular between Cootamundra and Parkes.
- The overall transit time, however, has increased slightly because trains are dwelling for longer periods. Thus, a number of short dwells, mostly caused by network capacity constraints, have been eliminated. However, stops at intermediate terminals and sidings, such as Goobang Junction and Broken Hill, are now longer.

Central corridor

Dwell time on the central corridor has decreased, largely because there are fewer stops in 2014 than there were in 2010. Genesee & Wyoming Australia own the integrated Darwin–Tarcoola railway. Their Darwin–Adelaide trains generally include the following characteristics:

- Trains originate/terminate at the intermodal terminals at Berrimah (Darwin) and the Islington freight terminal (Adelaide).
- Trains stop at intermodal terminals in: Katherine, Tenant Creek and Alice Springs.
- Operational stops at Tarcoola and Spencer Junction are common.

(b) Average speed

Average train speed is an overall measure of physical railway performance—both train and infrastructure. As with other train pattern indicators, average speed is partly determined by train operator factors such as locomotive power and whether the operator picks up and drops off freight en route. Prevailing speeds also reflect a range of infrastructure-based factors, including the number of stops, track alignment and condition.

Table 29 shows that average scheduled speeds have increased on all North–South segments. In this case, the increase in speeds is driven by fewer stops, with "in motion" train speed remaining largely unchanged.

Speeds on the East–West corridor have decreased slightly. This reflects longer dwell times on most line segments, in particular Cootamundra – Crystal Brook.

Speeds on the Central corridor are stable. Dwell time makes up a smaller proportion of transit time in 2014 than it did in 2010.

Track indicators for the interstate network

The indicators presented in this section provide information on infrastructure quality and freight train flow patterns on the interstate network.

Scheduled intermodal transit time

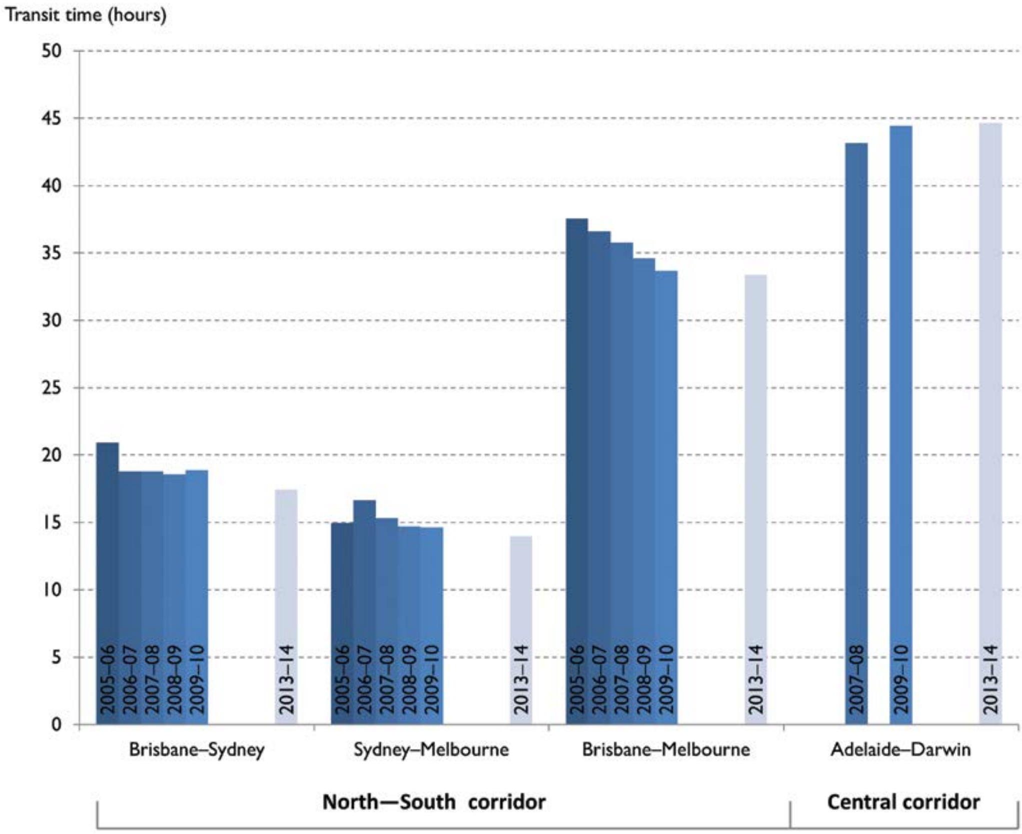
The scheduled intermodal transit time indicator is the average timetabled transit time of interstate intermodal trains. Figure 32 and Figure 33 present the average scheduled intermodal transit time for trains on seven city pairs, for the North–South, Central and East–West corridors respectively. These data are detailed in Table 29.

The scheduled transit time is influenced by a number of factors including: the line speed; the number of stops enroute; the number and type of other trains on the line (particularly when the route has single track); operator-dependent factors such as time spent in intermediate cities; and, for Sydney–Perth trains, the route used. As infrastructure enhancements are completed, a number of these factors are changing, resulting in lower transit times.

Continuing the trend of recent years, there have been further reductions in scheduled transit times for North–South corridor trains. The decline in transit time can be attributed, in particular, to fewer stops and lower dwell times. This has been achieved through improvements in signalling, the construction of passing lanes and lengthening of passing loops.

Transit times on the Central corridor are stable, with a small increase between 2007–08 and 2013–14.

Figure 32 Average scheduled transit times, North–South and Central corridors, 2005–06 to 2013–14



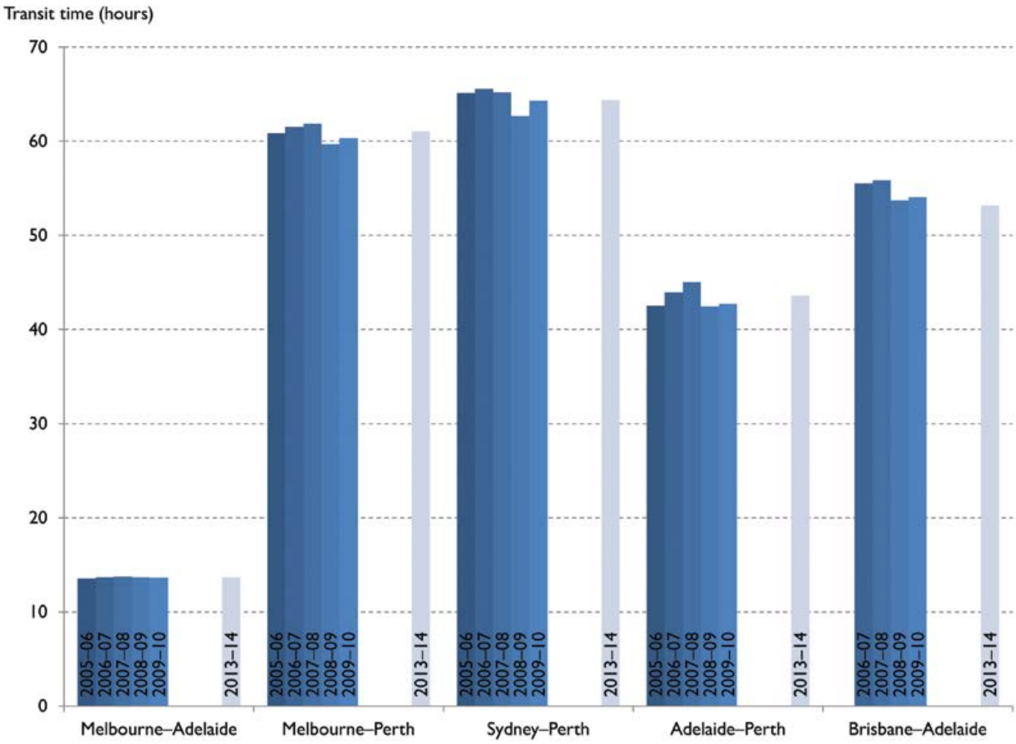
Notes: Calculations include all trains on a given line segment. The Sydney–Melbourne calculations, for example, include Brisbane–Melbourne trains.

For 2005–06 to 2009–10, BITRE calculated average scheduled transit times from infrastructure managers (ARTC, RailCorp and Brookfield Rail) working timetables that were current for the last week of June each year. In 2013–14, ARTC timetables effective from 6 April 2014 to 21 June 2014 were used. For the Central corridor, ARTC timetables were used in conjunction with Genesee & Wyoming Australia's timetable, effective as of 30 April.

Sources: Working timtables of infrastructure managers (ARTC, RailCorp/Sydney Trains, and Genesee & Wyoming Australia).

Transit times on the East–West corridor are relatively unchanged since 2005–06. The discussion from page 76 includes a more detailed discussion of train flow patterns by corridor.

Figure 33 Average scheduled transit times, East–West corridors, 2005–06 to 2013–14



Notes: Calculations include all trains on a given line segment. The Melbourne–Adelaide calculations therefore include Melbourne–Perth trains.

For 2005–06 to 2009–10, BITRE calculated average scheduled transit times from infrastructure managers (ARTC, RailCorp and Brookfield Rail) working timetables that were current for the last week of June each year. In 2013–14, ARTC timetables effective from 6 April 2014 to 21 June 2014 were used. Brookfield Rail provided their timetable used in the week beginning 6 April 2014.

Sources: Working timtables of infrastructure managers (ARTC, RailCorp/Sydney Trains, Brookfield Rail).

Train reliability on the interstate network

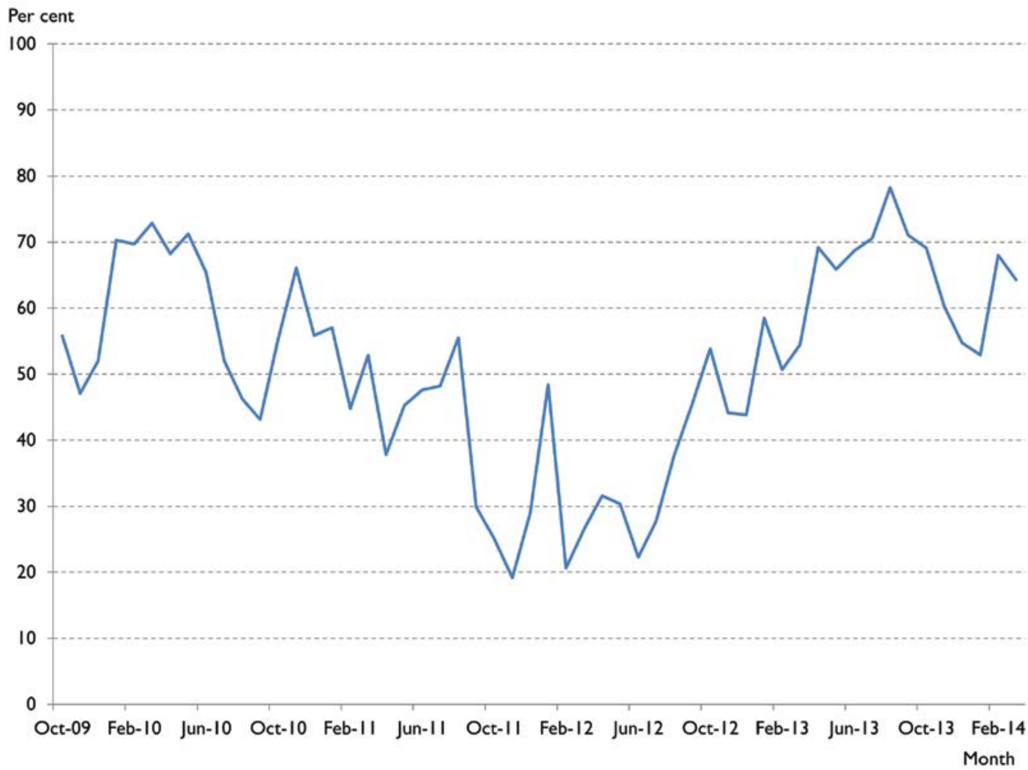
The ARTC publish performance indicators relating to key service quality areas including reliability. Reliability on the North–South and East–West corridors is examined here. Detailed information regarding reliability by city pair is available on the ARTC website.

Reliability can be affected by train and track issues. Problems for train operators include mechanical issues with rolling stock and delays at terminals. The former can cause significant delays across the network. The later may result in a train entering the network late. This will require the infrastructure manager to allocate a train path without compromising its obligations to other operators.

Railway infrastructure issues can also impact reliability. Problems with the quality of track and ballast can result in speed restrictions and track closures. Signalling failures can also cause delays. Infrastructure maintenance and renewal, as well as weather conditions, are important aspects in infrastructure reliability.

Figure 34 and Figure 35 show the percentage of intermodal trains that left the ARTC network within 30 minutes of schedule. The data are collected monthly and subject to significant variation due to the impact of individual events.

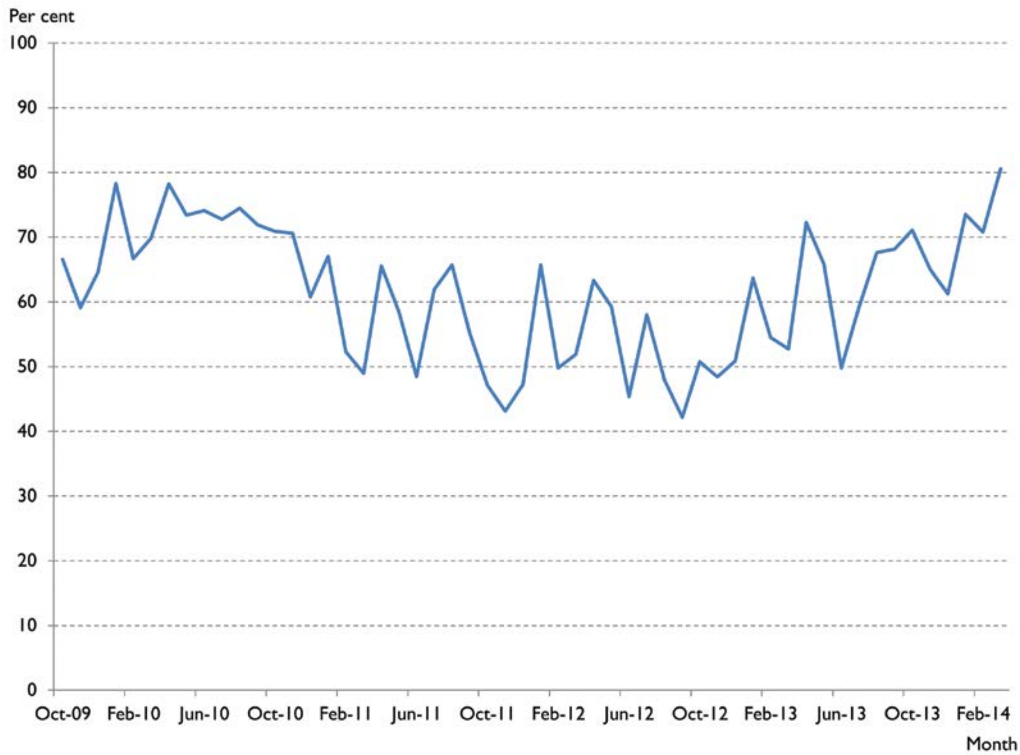
Figure 34 North–South corridor, percentage of intermodal trains exiting the network within 30 minutes of schedule



Source: Adapted from ARTC 2014.

Reliability on the North–South corridor (Brisbane – Islington Junction, Botany/Macarthur/Unanderra–Melbourne) decreased from early 2011 to mid-2012. During this period, the track between Sydney and Melbourne was subject to temporary speed restrictions and increased maintenance activity due to reported rough-riding and mud holes (ATSB 2013, p.5). In December 2011, the ARTC embarked on the "Ballast Rehabilitation Programme", to replace fouled ballast and improve drainage on the corridor. Temporary speed restrictions have been progressively removed and reliability improved from mid-2012.

Figure 35 East-West corridor, percentage of intermodal trains exiting the network within 30 minutes of schedule



Source: Adapted from ARTC (2014)

Reliability on the ARTC's East–West corridor (Cootamundra/Parkes–Kalgoorlie and Melbourne–Kalgoorlie) has remained relatively stable. There was a small decline from August 2011 to early 2013. During this period, high track utilisation, due to the commencement of iron ore services, meant unhealthy trains44 on the Crystal Brook – Tarcoola section had limited opportunity to recover. Reliability has since improved due to the installation of Centralised Train Control signalling (CTC).

Permitted train lengths on the interstate network

The permitted train length is an important component of overall track capacity. On Australia's mostly single track this is often determined by the length of passing loops. Since the mid-1990s in particular, infrastructure managers have invested in longer passing loops across the interstate network. Permitted train length can also be constrained by track alignment and gradient.

Permitted train lengths on the interstate network are as follows:

- 1 500 metres on Brisbane–Sydney;
- 1 800 metres *restricted*, on Melbourne–Adelaide; and

[44] ARTC defines a "healthy" service as one which: (a)presents to the network within tolerance (on time within tolerance), is configured to operate to its schedule and operates in a way that it is able to maintain its schedule; (b) or is running late only due to causes within the network, but only when the root cause is outside the rail operator's control; (c) or is running within tolerance, regardless of previous delays (ARTC 2014).

- 1 800 metres on Sydney–Melbourne, Cootamundra – Crystal Brook, Adelaide–Kalgoorlie, Tarcoola–Darwin.

The 'unrestricted' train length is the length up to which operators can operate any scheduled service without reference to the track manager; the length is shorter than the prevailing standard loop length on the line segment. The 'restricted' train length is the maximum train length permitted on the line segment (under restricted access terms, trains that exceed the prevailing loop length can be operated by ensuring trains that have to be passed can be accommodated within the prevailing loop length).

Since 2007–08 passing loops have been constructed on the Cootamundra–Parkes section and additional passing lanes added between Junee and Melbourne to allow unrestricted movement of 1 800 metre trains.

Double stacking capability on the interstate network

As with train length, the ability to double-stack containers on wagons is an important component of track capacity. In the Australian context, double-stacking capability refers to the ability to stack one hi-cube (9 feet 6 inch, or 2.896 metres high) container on top of another and to convey them within a low-floor (well) wagon. The top of the stack must be no higher than 6.5 metres above the top of the rail, and mass limits must not be exceeded.

Double-stacking is permitted west of Parkes and west of Adelaide.

There are more restricted clearances on the North–South corridor, where loading clearances are restricted to single-stacking of hi-cube containers. The increasingly prevalent higher maxicube (10 feet 6 inch, or 3.20 metre) containers must be conveyed within the specialised low-floor well wagons.

The central corridor line accepts double-stacked containers and road freight vehicles (for the transport of oil) piggybacked on rail flat wagons.

Track quality of the interstate network

The maintenance and standards of railway infrastructure are important to the operating performance of trains. The permitted track speed and the smoothness of the ride of the wagons are strongly influenced by the quality of the infrastructure, the maintenance regime and the underlying economic life of the infrastructure.

Figures 36 to 39 illustrate engineers' physical measures of average track condition by line segment. These indicators use a 'track quality index' (TQI). In reading the index, the interpretation is that the lower the number the higher the track quality.

The composition of the index varies between infrastructure managers, reflecting both differences in priority and different operational environments across the network. Therefore these index numbers should not be used to compare track conditions across line segments managed by different infrastructure managers. However, relative changes in TQIs can meaningfully be compared. Box 8 provides details of how these indices are calculated for each track manager.

Box 8 Calculating track quality indices

For safety, maintenance, planning and regulatory reasons, infrastructure managers regularly measure the condition of their track. In essence, managers measure the extent to which the railway track deviated from the 'designated' (or 'true') alignment. Infrastructure managers can report a global indicator of track condition on a given line segment. ARTC (2006) published a 'track quality index' (TQI) as part of their Access Undertaking agreement with the Australian Competition and Consumer Commission. The TQI is a statistical measure calculated from the standard deviations of a number of different track geometry parameters. The TQI for a given line segment is taken as the average of the individual TQI sample readings. The parameters that are measured include rail placement, vertical and horizontal alignment, and twist.

On a regular basis on the intercapital city network, infrastructure managers operate a train with a 'track geometry measuring car'. The carriage is equipped with instruments that measure and record a range of different geometric parameters. There is a variety of track geometry measuring cars in Australia and hence a number of different means of measuring and analysing the parameters that make up the TQI. Further, track quality is reported as a composite measure of the different geometric parameters; this composite measure can differ between systems depending on the parameters used.

The following are the track quality measurements and indicators for the national network:

The ARTC's and Genesee & Wyoming Australia's TQIs, standardised across both networks, consists of:

- gauge;
- twist (short), measured over 2 metres;
- vertical irregularities ('top'), deviation over a 20 metre inertial reading (average of left and right rail); and
- horizontal line irregularities ('versine'), 5/10 metre chord emulation (average of left and right rail).

These are based on average of Standard Deviations over 100 metre sections.

The charts are indicative of trends in track condition for a given line segment. In normal operating conditions, the track condition should not deteriorate appreciably between one year and the next.

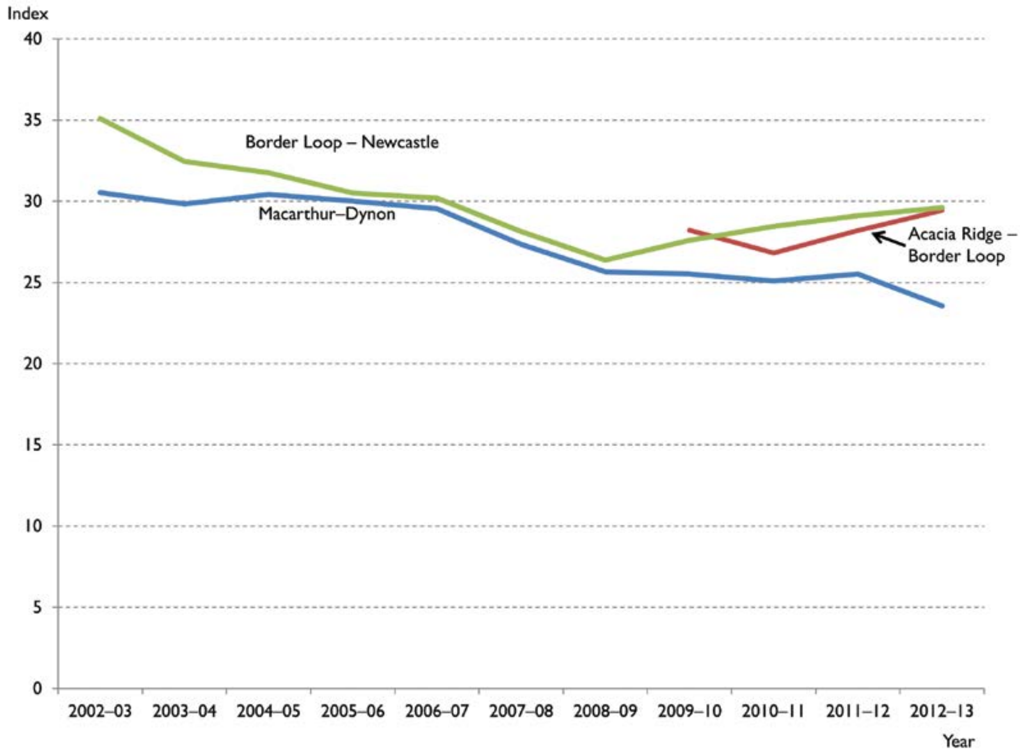
The speed of decline in track quality is influenced by a range of factors, including the quality of renewal material and work, the level and type of track usage, climatic and local geographical factors, and the skill and timeliness of ongoing maintenance work.

The TQI values for most ARTC line segments have been trending down—that is, the track quality has been improving. Genesee & Wyoming Australia's TQI has remained relatively stable.

Investment has been undertaken to upgrade ARTC's interstate track. In particular, near-life-expired timber sleepers have been replaced with concrete sleepers on the North–South corridor and the Cootamundra–Parkes line.

This investment is particularly evident in the Cootamundra – Crystal Brook line segment TQI, which has decreased substantially since 2010–11 (Figure 37). From 2011–12, the ARTC's "Ballast rehabilitation programme" has resulted in a decrease of the Macarthur–Dynon TQI (Figure 36).

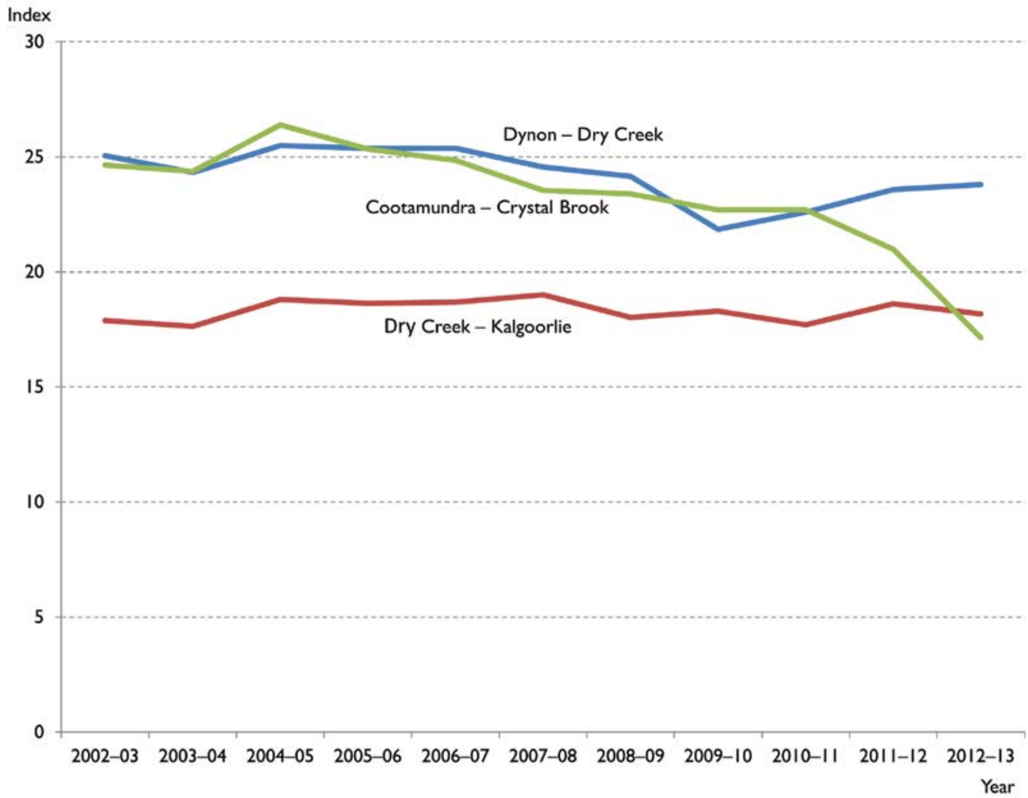
Figure 36 ARTC track quality index, North–South corridor



Note: Lower indices indicate higher track quality.

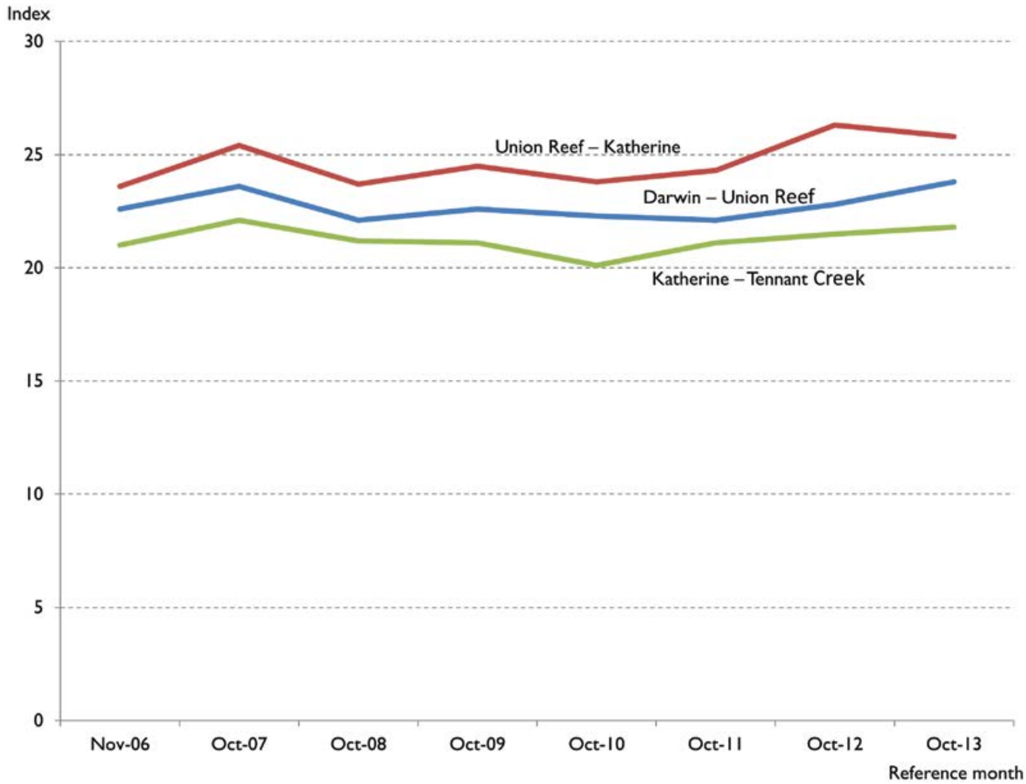
Source: Track quality indices provided by ARTC.

Figure 37 ARTC track quality index, East–West corridor



Note: Lower indices indicate higher track quality.
Source: Track quality indices provided by ARTC.

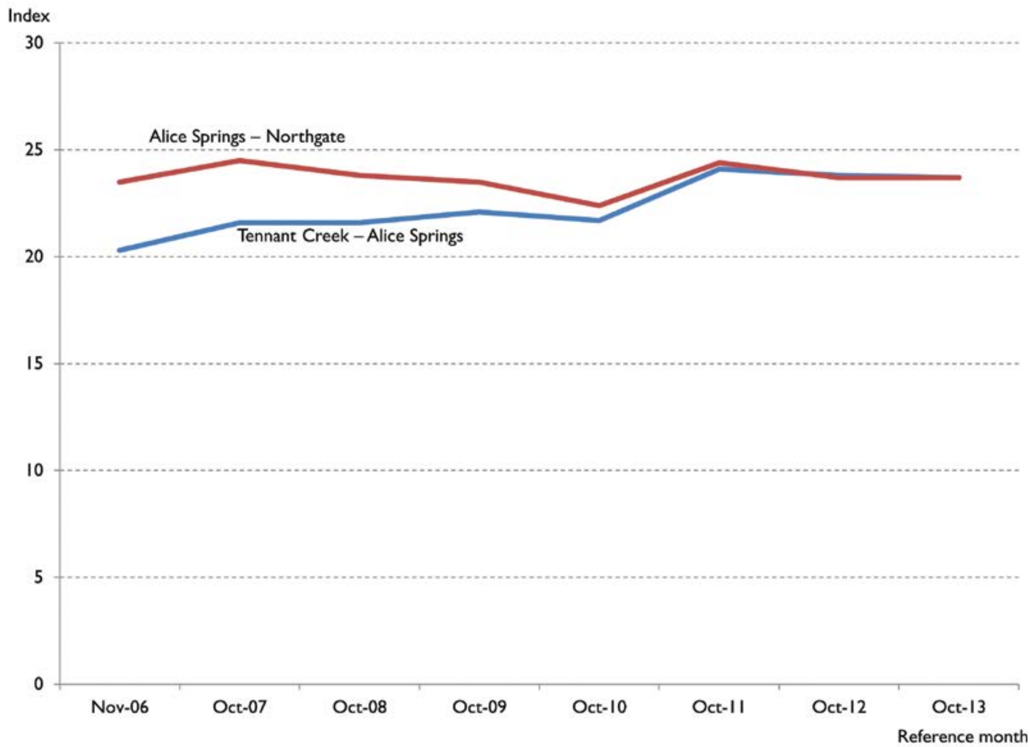
Figure 38 Genesee & Wyoming Australia track quality index, Darwin – Tennant Creek



Note: Lower indices indicate higher track quality.

Source: Track quality indices provided by Genesee & Wyoming Australia.

Figure 39 Genesee & Wyoming Australia Track Quality Index, Tennant Creek – Northgate[a]



Notes: a Northgate is the start of GWA track and is located just to the north of Tarcoola, where the railway meets the ARTC trackage.

Lower indices indicate higher track quality.

Source: Track quality indices provided by Genesee & Wyoming Australia.

Passenger train indicators

(a) Punctuality

Punctuality—often called reliability—is an important element in railway's competitiveness. It can be an important determinant of the uptake of a service. The International Transport Forum (2010, p. 5) notes that punctuality not only worsens the transport "experience" but can affect the commercial (work) and personal activities that depend on reliable transport services.

Urban rail punctuality

For infrequent services, in particular, customers rely on timetables when planning their trip. The punctuality of a service therefore becomes an important element in perceived journey time. Punctuality, in accordance with published timetables, becomes less significant for frequent "turn up and go" services.[45]

Real-time information at railway stations, light rail stops, online and through smart phone applications are playing an increasingly important role in helping customers plan their trips.

Measures of punctuality are largely determined by the definitions of "on time". The punctuality of operators are presented in Table 30. In 2012–13 the majority of operators met their punctuality targets. Perth's on-time performance fell below their target. The Public Transit Authority of Western Australia (2013) attributed this to track and infrastructure works, poor weather conditions and high passenger numbers.

Table 30 Urban rail punctuality, on time performance, 2012–13

	Sydney[a]	Melbourne	Perth	Brisbane	Adelaide[b]
Heavy rail punctuality (%)[c]	94.7	92.1	93	95.04	91.67
Heavy rail target (%)	92	89	95	94.2	–
Heavy rail measure	Arriving within 5 minutes of schedule at peak times	Arriving no later than 4 minutes 59 seconds late.	Arriving within 4 minutes of schedule	Arriving within 4 minutes of schedule	Departing 1 minute early to 5 minutes 59 seconds late
Light rail punctuality (%)	–	81.7 (average over route)	–	–	89.96
Light rail target (%)	–	82	–	–	–
Light rail measure	–	Arriving no earlier than 59 seconds before and no later than 4 minutes 59 seconds after scheduled time.	–	–	Departing 1 minute early to 5 minutes 59 seconds late

Notes: [a] Sydney and Gold Coast light rail opeartors do not publish timetables.
[b] Adelaide's data are for the fourth quarter 2012–13.
[c] Sydney heavy rail is "suburban lines". It does not include inter-city services.

Sources: Public Transport Victoria 2014; Public Transport Authority WA 2013; Rail Commissioner SA 2013; Sydney Trains 2013; Queensland Rail 2013.

45 The light rail operators in Sydney and the Gold Coast, for example, do not publish timetables.

Non-urban rail punctuality

Table 31 shows punctuality results and targets by operator. Punctuality targets are generally higher for markets which are likely to have a higher value-of-time. For example, trains which service commuter corridors, such as NSW TrainLink's intercity services and V/line have targets of 92 per cent. In contrast, QR Travel, which includes numerous long-distance services, have a punctuality target of only 60 per cent.

The punctuality results indicate long-distance services are generally less punctual than shorter distance. This difference is recognised in the punctuality targets and measurement.

Table 31 Non-urban rail punctuality, on time performance, 2012–13

	Service type	Punctuality 2012–13 (%)	Punctuality target (%)	Measurement
Queensland Rail	QR Travel Network	64.5	60	Arriving within 10 minutes
NSW TrainLink	Intercity	91.4	92	Arriving within 6 minutes
	Regional and interstate	73.8	78	Arriving within 10 minutes
V/Line	All	83.8	92	Arriving within 6 minutes on short services, 11 minutes on long services
TransWA	Australind	94	90	Arriving within 10 minutes
	Prospector	77	90	Arriving within 15 minutes
	MerridinLink	84	95	Arriving within 10 minutes
	AvonLink	99	95	Arriving within 10 mintes

Note: For intercity Queensland Rail services on the TransLink network, see Chapter 3 – Urban passenger rail – Reliability

Sources: Public Transport Victoria 2014; Rail Corporation New South Wales 2013, p. 17; Queensland Rail 2013, p. 10; Public Transport Authority of Western Australia 2013, pp. 108–109.

(b) Service attributes

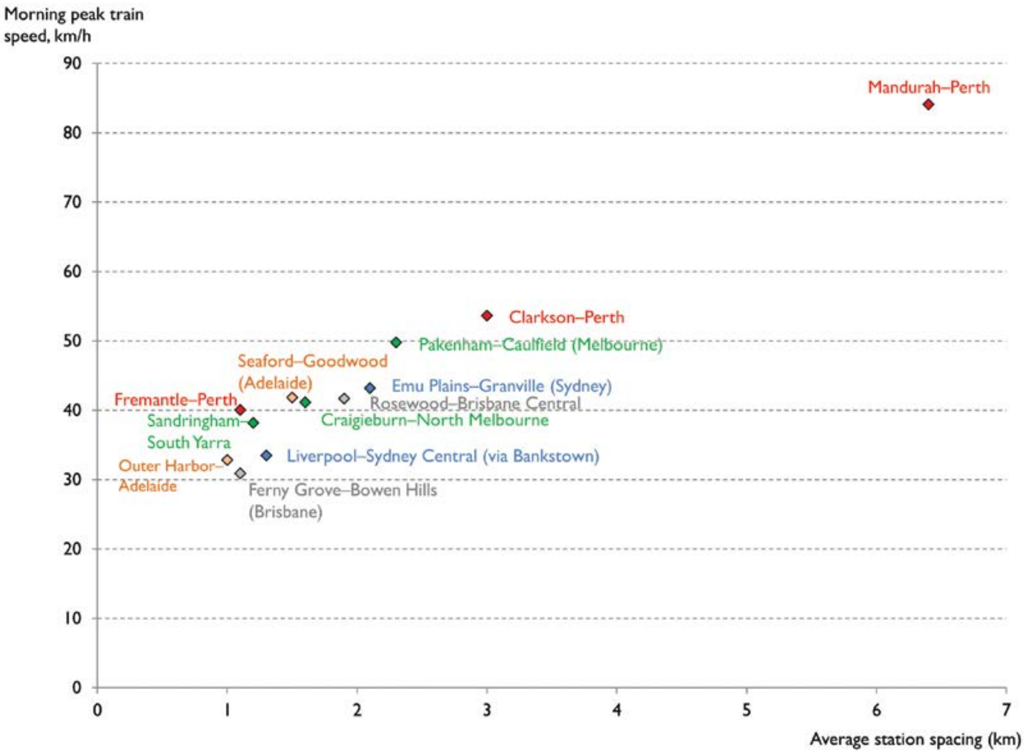
Train speeds

Australia's older passenger lines are characterised by relatively short station spacing. Mees and Dodson (2011) have observed that Australian lines were often built as a way of supporting urban expansion with consequent short distances between stations.[46] A consequence, however, of this spacing is the regular stops provide one reason for relatively slow speeds on older lines.

In contrast, newer lines, such as the Mandurah–Perth and, to a lesser extent, Clarkson–Butler have wider station spacing, allowing for higher average speeds. In addition to speed, wider station spacing allows for simpler train schedules because there is little need for express services. Figure 40 shows stopping services; express services are a common way of overcoming short station spacing.

46 Mees and Dodson cite Davison as observing the role of urban railways in urban development (Mees & Dodson 2011, p. 5).

Figure 40 Station spacing and illustrative train speeds



Source: Derived from operator timetables, August 2014.

Wide station spacing will reduce the capacity for patrons to access the railway by walking. Integration of the railway with other modes of transport, such as the provision of park and ride facilities and bus/train interchanges therefore becomes crucial.

Average scheduled light rail speeds are generally correlated with stop spacing (see Table 32). The reader should be cautious in comparing Melbourne with other networks due to the wide variation in speeds that exist in that city. Currie and Burke (2013) conducted an analysis of station spacing and average speed by line on Melbourne's network. Station spacing varies from 100 metres on the East Brunswick – St Kilda Beach line to 317 metres on the Bundoora RMIT – Water Front City Docklands line.

Table 32 Light rail station spacing and speeds

	Gold Coast	Sydney	Melbourne	Adelaide
Average station spacing (metres)	813	557	254	517
Indicative scheduled speed (km/h)	23	20	16	18

Note: Sydney and Adelaide average speeds derived from scheduled transit time and route kilometres.

Sources: Currie and Burke 2013; Yarra Trams 2014b; GoldlinQ 2014; NSW Transport 2014; Adelaide Metro 2014.

Speeds are largely determined by the function and operating environment of a light railway. A line designed to operate in a dense pedestrian zone will likely have lower speeds than vehicles operating in a segregated corridor. Sometimes a single line will have a mix of functions—

Sydney's light rail, for example, operates largely on a segregated former goods line. However, between Haymarket and Central Station, it travels "on-road" (albeit largely separated from vehicles) past significant pedestrian activity near Paddy's Market and George Street.

Frequency

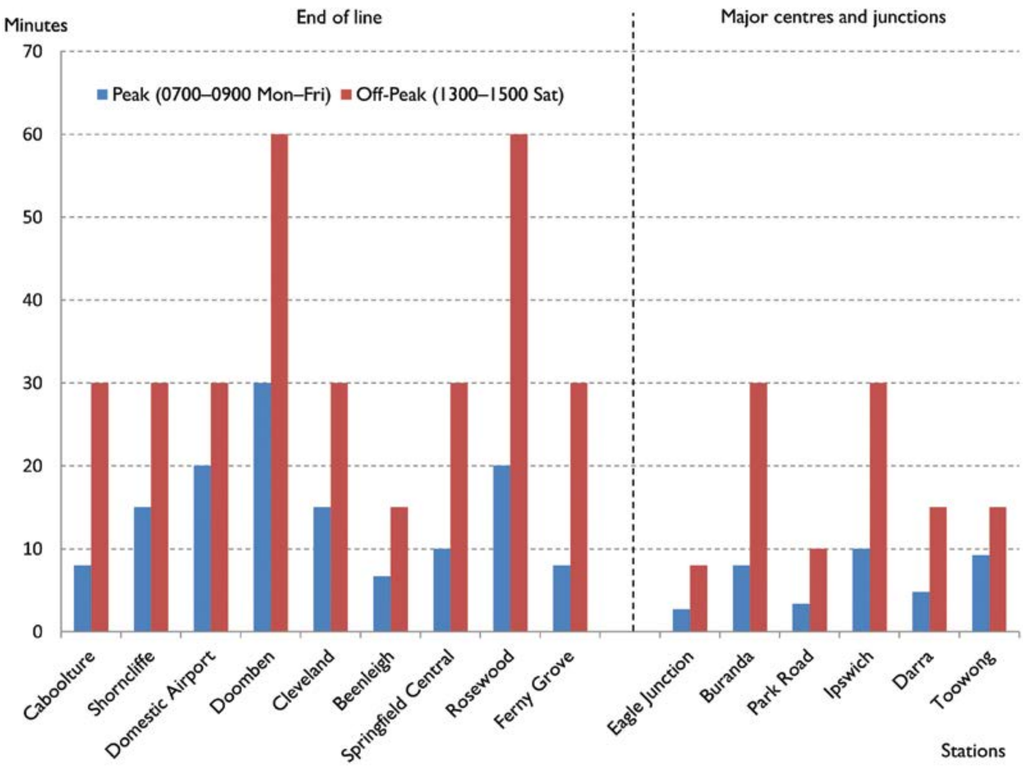
Service frequency is an important component of rail service quality and, therefore, competitiveness. Frequency is closely connected to travel time. It determines how long a passenger waits for a train and how closely the train departure (or arrival) is to the passenger's preferred time. Passenger's perception of service frequency are therefore closely related to their perception of journey time.

Frequency is also important in integrating a service with other rail services and modes. Services may have coordinated arrival and departure times to allow passengers to change. However, the scale of large urban networks can mean coordination becomes unfeasible. In these cases, frequency becomes crucial in reducing a passenger's waiting time when changing services.

Brisbane heavy rail

Queensland Rail operates all-stops and express trains. Figure 41 illustrates average time between trains for services arriving at Brisbane Central in the peak and off-peak, from stations that are at the end of lines or at major centres and junctions.

Figure 41 Average time between trains for services arriving at Brisbane Central



Source: Derived from TransLink timetables, August 2014.

Railway stations located at junctions generally have high train frequencies due to service densification. The relatively low peak time-intervals for Beenleigh to Brisbane trains reflect the station's dual role as an urban and inter-urban station.

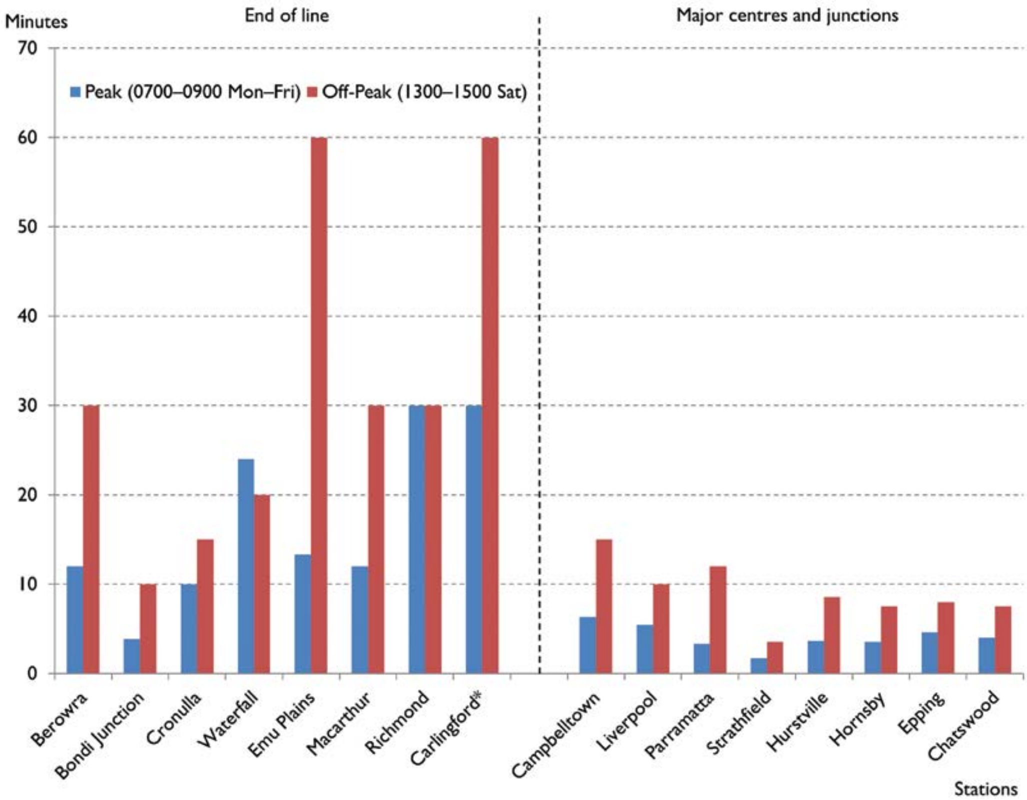
The system, in general, is geared towards the commuter task, with significantly higher frequencies in the peak periods. All the selected centres and junctions and many of the smaller stations have peak frequencies of a train every ten minutes. In the off-peak, thirty minute train intervals are common.

Sydney heavy rail

Frequencies on the Sydney Trains network depend on the time of day, service demand and capacity constraints on different parts of the network. As a general rule, the average time between trains in the peak period is close to 10 minutes or less; see Figure 42.

Off-peak service frequencies vary significantly across the network. Major centres and junctions retain "turn-up-and-go" frequencies of under15 minutes. However, average waiting time is significantly higher at smaller stations and on the Carlingford line.

Figure 42 Average time between trains for services arriving at Sydney Central



Source: Derived from Sydney Trains timetables August 2014.

Figure 42 includes a number of stations listed in the NSW government's Transport Master Plan as being "Regional Cities" (Parramatta and Liverpool) and "Major Centres" (Hornsby, Chatswood, Bondi Junction Hurstville, Campbelltown, Macarthur).[47] The locations are significant transport interchanges as well as destinations in their own right. Frequencies through these locations provide an important indicator of the value of the network in providing transport services other than radial-based commuting.

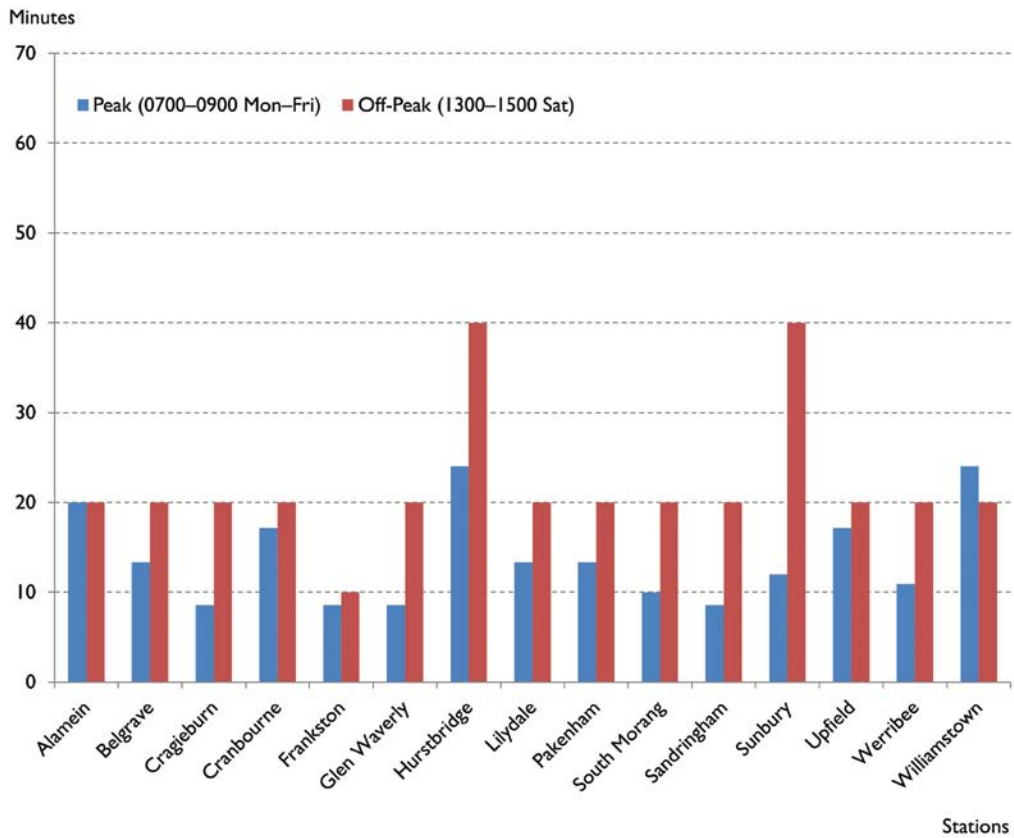
Melbourne heavy rail

Melbourne's services are configured around express and all-station services. Figure 43 illustrates the average time between trains arriving at Melbourne's Flinders Street station, from stations at the end of each line.

Peak frequencies vary considerably across services, with smaller branch lines generally running fewer trains. Hurstbridge and Williamstown have the highest average peak time, at 24 minutes.

For most lines, the peak average time between trains is much better than the off-peak, with service frequency being primarily geared to the commuter task. Most of the off-peak services are based on an average 20 minute train interval.

Figure 43 Average time between trains for services arriving at Flinders Street



Source: Derived from Melbourne Metro timetables, August 2014.

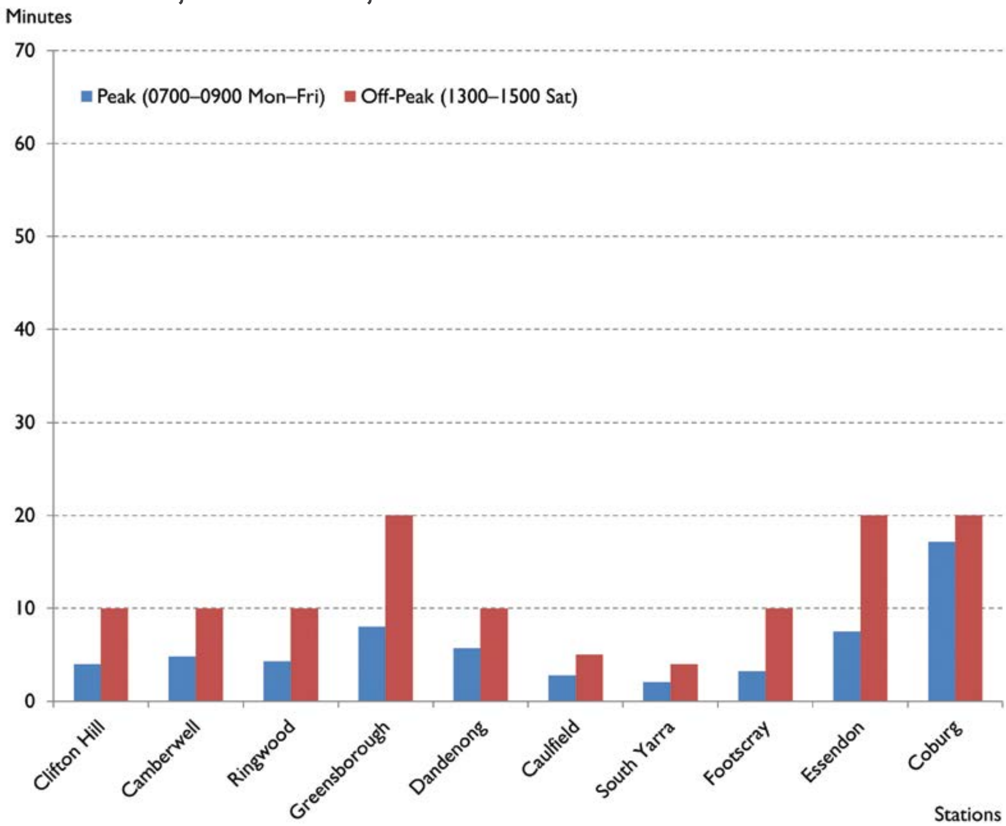
The pattern of high-frequency peak services and lower off-peak frequencies is repeated for major centres and junctions (see Figure 44). The structure of the network into branch lines

47 The full list of "Regional Cities" is: Paramatta, Liverpool, Penrith. Major centres are: Hornsby, Dee Why, Brookvale, Chatswood, Bondi Junction, Burwood, Bankstown, Kogarah, Hurstville, Cambelltown, Macarthur, Blacktown, Castle Hill.

means that stations closer to the city loop will generally have higher frequencies. Although the network is designed as a radial system, centred on the city loop, the densification of services at junctions provides high frequencies at some centres outside the CBD.

South Yarra station has the lowest average time, with 2 minutes in the peak period and 4 in the off-peak. The station is located close to the City loop, at the junction of the Sandringham and Pakenham lines.

Figure 44 Average time between trains arriving at Flinders Street Station from major centres and junctions



Source: Derived from Melbourne Metro timetables, August 2014.

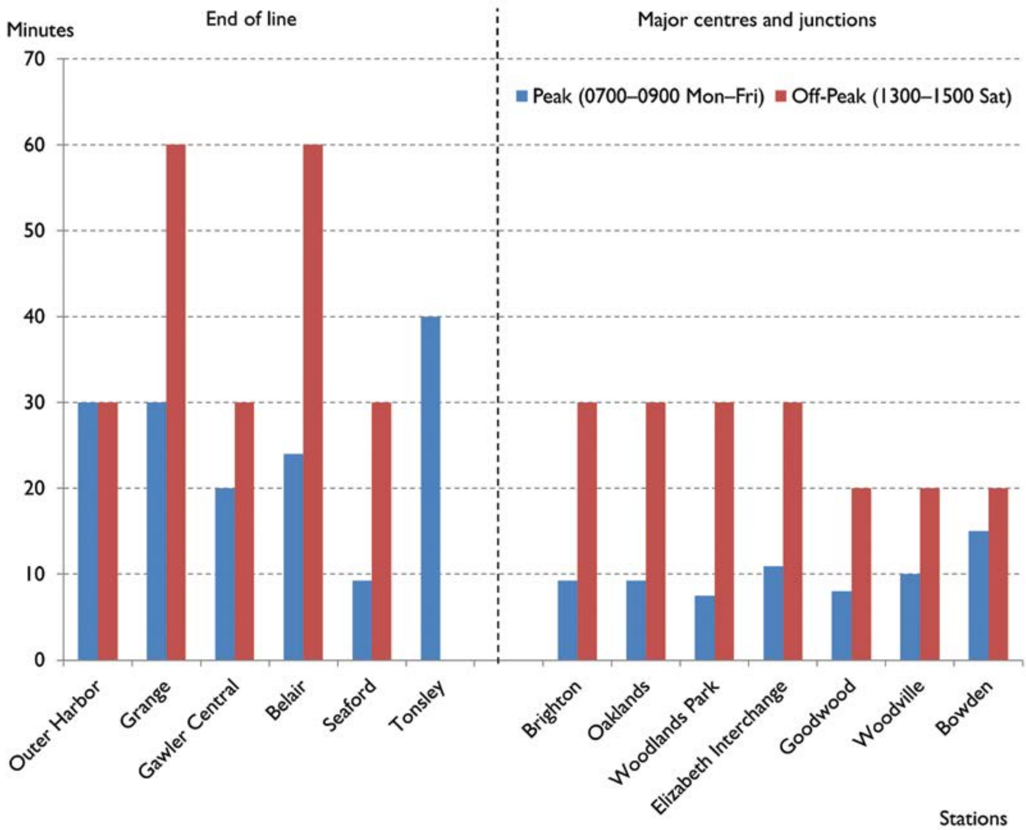
Adelaide heavy rail

Adelaide Metro runs express and all-stops services on a radial network. Figure 45 compares train frequencies from the end of railway lines to major centres and junctions.

While average time is relatively consistent across the network, this time is comparatively long. Current service patterns are strongly geared to the peak-period commuting task to Adelaide Railway Station. In most cases, average time between trains in the peak is less than one-half those in the off-peak. Indeed, the Tonsley line does not have services on the weekend.

Adelaide's lower service levels reflect the relatively modest ridership in comparison to the other networks. Infrastructure enhancement, as part of the Rail Revitalisation Programme, includes electrification, the acquisition of new rolling stock and track renewal. The works should enable higher speeds and increased frequencies.

Figure 45 Average time between trains for services arriving at Adelaide Railway Station



Note: The Tonsley line does not run services on the weekend.
Source: Derived from Adelaide Metro timetables, August 2014.

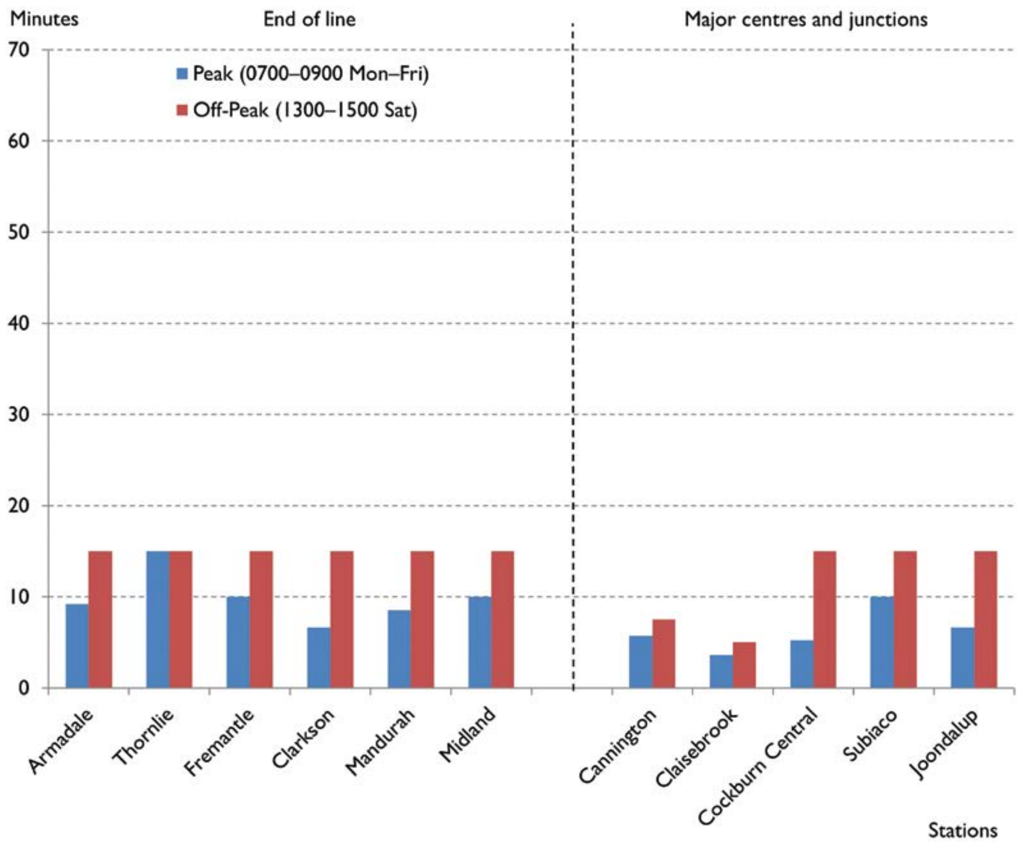
Perth heavy rail

Transperth runs all-station trains but relatively few express trains. With Transperth's focus on keeping train dwell times low and with relatively long distances between stations, average line speeds are relatively high; see Figure 40. As a consequence, there is little need to provide express services when compared with Sydney and Melbourne—two networks spread over large areas but with closer average station spacing.

Figure 46 compares train frequencies from stations located at the end of lines with stations at major centres and junctions. There are two notable aspects of the services. First, service standards are relatively consistent both across and within lines. The difference in service levels between major centres and junctions and stations located at the end of lines is less significant than in Brisbane, Sydney and Melbourne. Part of the reason for this is the aforementioned lack of express services. In addition, the low number of railway junctions—with only two junctions outside the city centre—reduces the service densification seen in other cities when operations merge.

The second notable aspect is, except at the extreme ends of operating hours, the maximum time between trains is 15 minutes in the off-peak. In the peak, all selected stations except for Thornlie record average train intervals of 10 minutes or below. The consistent and high service frequencies on the network allow for easier integration with Transperth's bus network—in turn broadening the catchment area of the railways.

Figure 46 Average time between trains for services arriving at Perth Central



Note: The Butler extension had not opened at the time of writing.

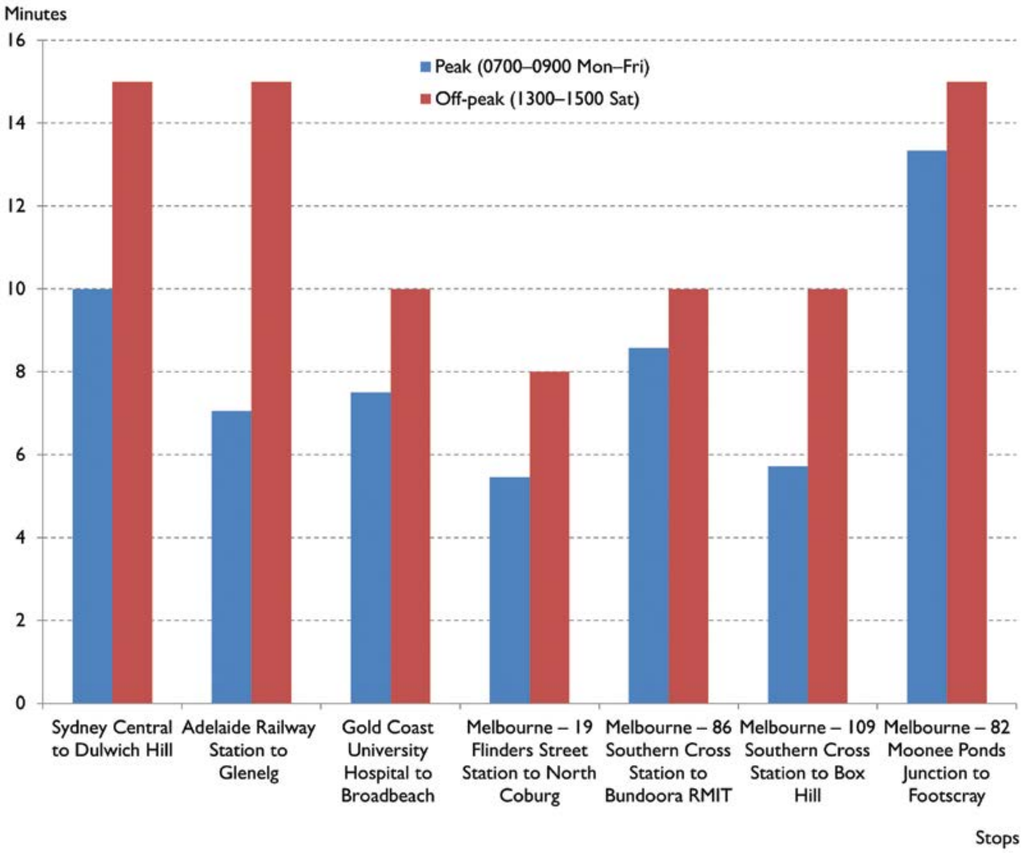
Source: Derived from Transperth timetables, August 2014.

Light rail

Light rail frequencies in Australia vary across networks (see Figure 47). In the off-peak, average waiting times are 15 minutes or less. In the peak, waiting time is generally less than 10 minutes. Care should be taken when comparing the single-line Sydney, Gold Coast and Adelaide operations with Melbourne. This is because Melbourne light rail routes share track, meaning a customer may be able to take more than one tram to his/her destination, thus increasing frequency.

The selected routes for Melbourne provide an indicator of transit time across the network's 24 routes. Route 19 and Route 82 have the shortest and longest peak hour intervals on the network, respectively.

Figure 47 Average time between trams, by route and direction



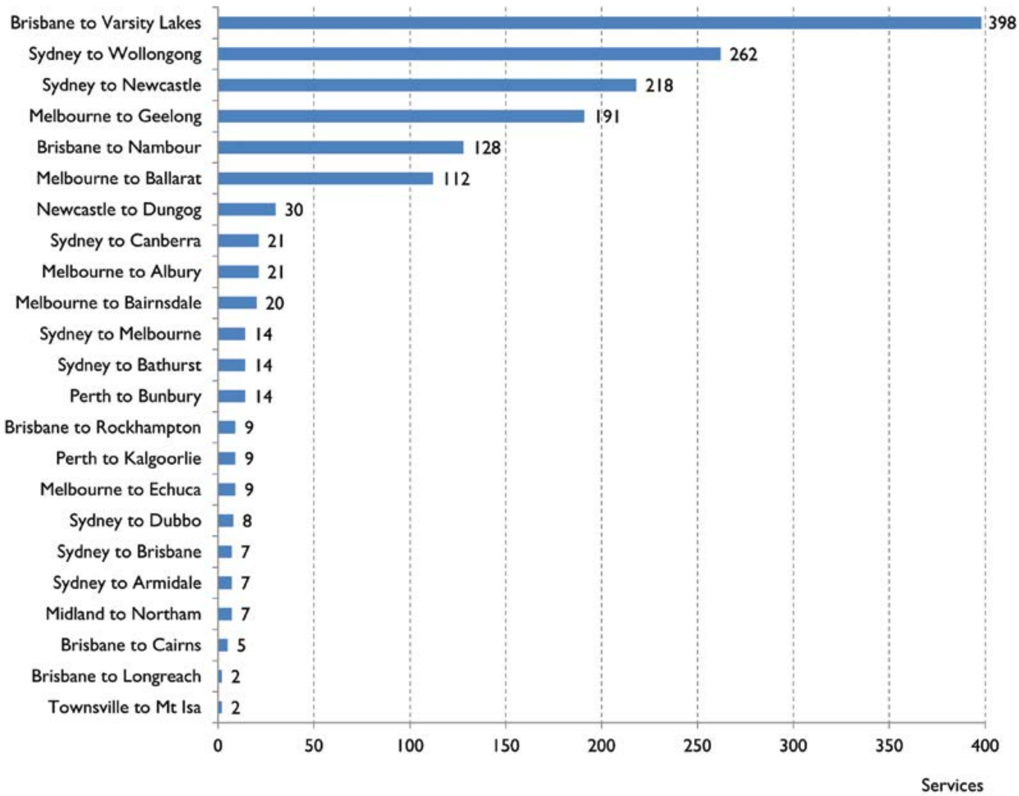
Note: Sydney and Gold Coast operations do not use timetables. Service frequencies are on their website.
Sources: Transdev Sydney 2014; GoldlinQ 2014; Yarra Trams timetables; Adelaide Metro timetables.

Non-urban rail

Frequencies are important for non-urban services because it determines how closely a train departure and arrival is to the passenger's preferred time. Service frequencies can also determine the amount of time a passenger spends waiting for a train and, therefore, is closely aligned with perceptions of travel time.

Figure 48 shows services per week on selected non-urban routes. Frequencies align with the function of each railway, the distance of the corridor and the size of the populations they serve. Railways that serve inter-city and regional centre – capital city commuter markets generally have the highest service frequency.

Figure 48 Non-urban passenger rail services per week



Note: Does not include return services.
Source: Operator timetables as of August 2014.

An analysis of Census 2011 data by Bernard Salt (2013) found Sunshine Coast – Brisbane, Brisbane – Gold Coast, Newcastle–Sydney (via the Central Coast), Sydney–Wollongong, Melbourne–Geelong and Perth–Mandurah are among Australia's largest inter-city commuter corridors.

Victoria, in particular, has important regional centre – capital city services. An increase in frequency was one of the central upgrades in Victoria's Regional Fast Rail project. The programme increased weekly services between Melbourne and: Geelong (+13%), Ballarat (+83%), Bendigo (+71%) and Traralgon (+59%) (BITRE, 2014d, p. 65).

Long-distance trains, in general, have lower service frequencies.

Transit times—non-urban

Transit times are important in determining the competitiveness of rail services. Customers consider the comparative door-to-door transit time, rather than the top speed of a service, when choosing their mode of transport. For non-urban services the importance of transit time varies according to the travel market. For tourist travellers, for example, the overall comfort is likely to be of more value than a low transit time, which is of particular importance for regional/commuter travellers.

Table 33 shows key characteristics of selected regional/commuter and long-distance services. The speed shown is an average over the length of the service, including stops.

Table 33 Key characteristics of selected non-urban passenger services[a]

	Operator	Track gauge	Route length (km)	Electrified	Indicative transit time	Indicative average speed (km/h)	Stopping stations (no.)
Regional/commuter – 3 hour 59 minutes or less							
Brisbane to Nambour	QR (TransLink)	Narrow	105	Yes	1h53m	56	23
Brisbane to Varsity Lakes			89	Yes	1h33m	58	12
Newcastle to Dungog	NSW TrainLink	Standard	84	No	1h26m	59	17
Sydney to Newcastle			168	Yes	2h36m	65	17
Sydney to Wollongong			82	Yes	1h28m	56	7
Sydney to Bathurst			238	No	3h43m	65	6
Melbourne to Ballarat	V/line	Broad	118	No	1h27m	81	8
Melbourne to Ecucha			250	No	3h21m	75	4
Melbourne to Bairnsdale			275	No	3h48m	72	15
Melbourne to Geelong			73	No	56m	78	8
Melbourne to Albury		Standard	305	No	3h50m	80	10
Midland to Northam	TransWA	Narrow	107	No	1h20m	89	1
Perth to Bunbury			181	No	2h25m	75	11
Long-distance – 4 hours or more							
Townsville to Mount Isa	QR Travel	Narrow	977	No	20h55m	47	8
Brisbane to Longreach			1 325	No	24h50m	53	23
Brisbane to Cairns			1681	No	24h55m	67	25
Brisbane to Rockhampton			639	Yes	7h25m	86	11
Sydney to Canberra	NSW TrainLink	Standard	330	No	4h18m	77	9
Sydney to Dubbo			462	No	6h27m	72	14
Sydney to Armadale			579	No	8h6m	71	19
Sydney to Brisbane			988	No	14h17m	69	21
Sydney to Melbourne			951	No	10h58m	86	17
Perth to Kalgoorlie	TransWA	Standard	655	No	6h50m	87	15
Adelaide to Darwin[b]	GSR	Standard	2 971	No	53h10m	56	2

Notes: [a] Data are derived from selected services, they are not averages across all services on that route.
[b] Three day Ghan, four day services are also available.

Sources: Operator timetables as of July 2014; BITRE 2014f.

Average train speeds are a function of:

- The quality of **the track**, including condition, curves, level crossings and capacity;
- The standard of **rolling stock,** influenced by its power, propulsion, in-cab signalling and the existence of a tilting mechanism;
- **Railway procedures**, including crew changes, loading and unloading passengers/luggage and right-of-way priority relative to other trains.
- The **station spacing and stopping pattern**, determined largely by the function and policy objective of the service.

The Brisbane–Nambour; Brisbane – Varsity Lakes; Sydney–Newcastle; and Sydney–Wollongong services have similar, relatively low, average train speeds; see Table 33. These services are medium-distance, inter-city, commuter railways. The services stop at a large number of stations relative to distance travelled. This is because they function as limited-stop and stopping commuter trains in the peri-urban coastal regions and metropolitan areas of Brisbane and Sydney, respectively. In addition, the alignments of the Newcastle–Sydney and Sydney–Wollongong services are circuitous due to the mountainous terrain in which they operate.

V/Line's medium-distance regional services are relatively fast. The Victorian Government's Regional Fast Rail Project (largely completed by 2006), included a number of measures that improved average speed:

- upgraded track condition;
- improved alignment;
- the upgrade or elimination of level crossings;
- improved signalling and communications;
- and enhanced rolling stock.

It is important to note there is a wide dispersion of transit times across individual V/Line services—caused by different stopping patterns—largely to cater for different segments of the market. For more information on V/line's Regional Fast Rail Project, see BITRE, Improving regional passenger rail services, 2014d.

Long-distance trains in Australia generally have uncompetitive transit times, from origin to destination point, compared with air travel.[48] Long-distance services may provide a competitive travel time with road. However, if a traveller decides to drive a long distance, thus ignoring the faster travel times offered by air, they are likely choosing their mode of travel for a reason not embodied in their value-of-time (Swan, 1990, p. 5). A car driver, for example, may need his/her car upon arrival at the destination.

Long-distance rail patronage is largely made-up of travellers who place a lower importance on transit time relative to other factors. For example, railway tourism is one of the key markets for long-distance train travel, especially Great Southern Rail's transcontinental services. In addition, railways can provide a social service to those who do not have access to other modes of transport.

48 Long-distance trains can provide services for centres along their route, thus acting as medium-distance services along numerous route segments. For example, the Sydney–Melbourne and Sydney–Canberra trains serve regional centres such as Goulburn and Moss Vale.

APPENDIX A

Significant railway events

Date	Event	Description
30 July 1991	National Rail Corporation (Agreement) Act	Agreement between Federal Government and states of Queensland, NSW, Victoria and WA for National Rail Corporation to take over operation of interstate rail services from states.
3 April 1993	Commencement of National Rail third-party access	National Rail began third-party access freight operations on interstate track.
1995	Port of Brisbane	Connection of Port of Brisbane to standard gauge network, opening in 1997.
1995	Trans Australia Railway	Traffic on Trans Australia Railway disrupted for six weeks due to flooding
June 1995	Melbourne–Adelaide gauge standardisation	Completion of standardisation of Melbourne–Adelaide broad gauge with new standard gauge line via North Geelong – Cressy – Ararat (bypassing former main line through Ballarat).
July 1995	First private train on national network	SCT commenced first private train service on national network, Melbourne–Perth.
June 1996	TNT (Toll) trains commenced	TNT (later Toll) began operating freight trains between Melbourne and Perth.
1 July 1996	Vertical separation in NSW	State Rail Authority split, with Rail Access Corporation managing infrastructure, Rail Services Australia undertaking track maintenance, FreightCorp operating freight trains and residual State Rail Authority operating passenger trains.
1 July 1996	National Rail Safety agreement	Inter-governmental Agreement to legislate terms for national safety and accreditation processes.
26 October 1996	NR class locomotives enter service	The first of 120 of National Rail's new 4000 hp locomotives entered service.
May 1997	Patrick Rail operations	Patrick Corporation commences land bridging container train service between Port Adelaide and the Port of Melbourne.
30 October 1997	Privatisation of AN's passenger business	Great Southern Railway consortium purchased Australian National Railways' passenger business ("Pax Rail") for $16 million, effective from 7 November 1998.
14 November 1997	Privatisation of AN's Tasmanian network	Australian Transport Network purchased Australian National Railways' Tasmanian operations ("Tasrail") for $22 million, effective from 14 November 1997.
31 October 1997	Privatisation of AN's SA intrastate network	Genesee & Wyoming purchased Australian National Railways' SA intrastate network ("SA Rail") for $57.4 million, effective from 31 October 1997.
1 July 1998	Vertical separation of Commonwealth railway infrastructure	ARTC commenced management of Australian National's infrastructure (assets of AN's Track Access Unit) following incorporation of ARTC on 25 February 1998.

(continued)

Date	Event	Description
February 1999	V/Line freight service sold and track leased	V/Line freight business sold and intrastate country track leased for 45 years to Rail America for $163 million trading as Freight Australia.
August 1999	Victorian franchising	Victorian passenger rail and tram services franchised to National Express, Connex and Yarra Trams.
1 July 1999	Lease of Victorian interstate rail network	The Australian Rail Track Corporation is given 15 year lease of Victorian interstate rail network from SA border through Melbourne to Albury.
2 December 1999	Glenbrook accident	Train collision at Glenbrook, NSW.
November 2000	NSW rail industry restructure	Merger of Rail Services Australia and Rail Access Corporation in NSW into Rail Infrastructure Corporation.
18 December 2000	Privatisation of Westrail	Consortium of Wesfarmers and Genesee & Wyoming purchased Westrail for $585 million.
May 2001	Opening of intermodal terminal	Bowports, in conjunction with FreightCorp, developed an intermodal terminal at Minto, with port shuttle trains commencing in May 2001.
30 January 2002	Sale of National Rail and FreightCorp	Consortium of Patrick Corporation and Toll Holdings purchased National Rail Corporation and FreightCorp for $1.2 billion, forming Pacific National.
17 December 2002	National Express abandons franchises	National Express walked away from its V/Line Passenger and Melbourne passenger contracts.
31 January 2003	Waterfall accident	Passenger train derailment at Waterfall, NSW
27 March 2003	Bridge closure	Temporary closure, until 23 April, of Menangle Rail Bridge, on Sydney–Melbourne railway line. Interstate trains had to move along alternative circuitous routes.
May 2003	Freight competition between Sydney and Melbourne	Freight Australia commenced a daily freight service between Sydney and Melbourne.
1 January 2004	NSW RailCorp	Creation of Rail Corporation New South Wales (RailCorp) as the merged entity of the State Rail Authority of New South Wales and the metropolitan functions of the Rail Infrastructure Corporation.
16 January 2004	Darwin line opened	First freight train arrived in Darwin.
February 2004	Takeover of ATN-Tasrail	Pacific National purchased ATN-Tasrail.
April 2004	QRN commences North–South intermodal service	QR National commences intermodal freight service between Brisbane, Sydney and Melbourne.
1 September 2004	Takeover of Freight Australia	Pacific National purchased Freight Australia business and track lease for $285 million.
5 September 2004	ARTC lease in NSW	ARTC commences 60 year lease of interstate rail network in NSW and management contract of country rail network.
1 July 2005	QRN operating in Hunter Valley	QR National commences operating in Hunter Valley (Mount Arthur–Port Waratah).
September 2005	Tasmanian rail freight	Pacific National announced that it intended to withdraw most of its rail freight services in Tasmania leaving only two bulk haul operations.
14 February 2006	Sale of WA and SA rail freight operations and track	In a complex sale worth $970 million, Queensland Rail purchased ARG's WA freight business; Babcock & Brown purchases ARG's WestNet infrastructure; and Genesee & Wyoming takes full control of ARG's SA operations.
11 March 2006	Toll takeover of Patrick	ACCC approves Toll takeover of Patrick.

(continued)

Date	Event	Description
March 2006	South Maitland Railway	30 km of the South Maitland Railway reopens to service the Austar Coal Mine in the Hunter Valley.
17 August 2006	Linfox buys FCL	Linfox buys FCL, a major rail-based freight forwarding company.
September 2006	Victorian regional fast trains commence	The start of the first Regional Fast Train service begins. Faster services are introduced from Geelong, Ararat/Ballarat, Bendigo and the Latrobe Valley.
October 2006	End of Sydney–Perth coastal shipping service	Boomerang coastal shipping service, operating between Sydney and Perth since June, ended after financial failure.
20 October 2006	SCT commence Parkes service	SCT Logistics commenced freight service between Parkes and Perth.
November 2006	Sandgate Flyover	Opening of main line flyover of coal lines, to enable unimpeded movement of coal trains, between Hunter Valley and Kooragang Island
18 December 2006	Pacific National wins 7-year steel contract	PN wins a contract extension, with Bluescope and OnesSteel for 7 years, to shift steel products around the country.
1 January 2007	Tasmanian government takes back rail infrastructure	Tasmanian government resumes financial responsibility for the State's commercial railways; day-to-day infrastructure management remains with Pacific National.
3 January 2007	North–South Corridor upgrading	On this date the new Wagga Wagga bridge was opened The construction is a first major milestone in the $1.8 billion North–South Corridor upgrade.
15 February 2007	ACCC approval of SCT acquisition	ACCC approved SCT Logistics' purchase of train assets (including 9 locomotives) from Pacific National, as part of Toll's takeover of Patrick
18 February 2007	CRT ceases Melbourne port shuttle	CRT ceased its Altona North–Port of Melbourne shuttle.
15 March 2007	Tasrail funding	Australian Government announced $78 funding of remedial work on AusLink section of Tasmanian railway system with $40 million more from the Tasmanian Government and commitment by Pacific National to spend $38 million on locomotive and wagon upgrades.
18 April 2007	ACCC approves Toll restructuring, formation of Asciano	ACCC approves Toll Holdings restructure, with new company Asciano, which will include the Pacific National and Patrick Portlink assets.
18 April 2007	Toll restructuring	Toll announces split of Toll Holdings, with Asciano Ltd controlling the Patrick and Pacific National assets.
4 May 2007	Re-acquisition of Victorian track lease	Victorian government bought back leased intrastate track from Pacific National giving control of the network to V/Line Passenger, the State's regional rail operator.
November 2007	Asciano announces end of rail services in southern Australia	Asciano announces end of grain and intrastate intermodal services in Tasmania, Victoria and NSW, to take effect from early 2008.
16 November 2007	QRN commences Melbourne–Perth service	QRN commences new thrice-weekly Melbourne–Perth service, incorporating the weekday P&O Melbourne–Adelaide train.
23 December 2007	Opening of Mandurah railway in Perth	Opening of 70km Perth–Mandurah passenger railway.

(continued)

Date	Event	Description
18 January 2008	Rail competition begins in Victoria	El Zorro begins broad gauge grain train competition in Victoria, the first in that State.
March 2008	Opening of Lang Hancock Railway	Opening of 58km Lang Hancock Railway in the Pilbara, linking Hope Down iron ore deposits with Pilbara Rail network.
March 2008	Pacific National begins withdrawal from Victoria	Pacific National begins withdrawal of freight services in Victoria, following earlier (Nov. 2007) announcement of closure of operations. El Zorro announces it will take over Warrnambool–Melbourne container operation.
15 May 2008	Opening of Fortescue railway	Opening of Fortescue Metals Group's 260 km Cloudbreak railway in the Pilbara.
13 June 2008	Cessation of Tasmanian train operations	Pacific National announced cessation of its Tasmanian train operations, later indicating it would sell the business.
25 July 2008	Extension of double-stacking network	Commencement of standard double-stacking operations between Parkes and Perth following ARTC investment.
5 August 2008	Pacific National wins Queensland coal haulage contracts	Asciano announces it has signed 10-year contracts with Rio Tinto and Xstrata for coal haulage in Queensland from early 2010.
May–September 2008	Grain contracts awarded	GrainCorp, AWB, ABB sign contracts with train operators for grain haulage.
15 September 2008	New Portland freight traffic	Commencement of movement of mineral sands between Portland and Melbourne
24 September 2008	Investment in Tasmanian tracks	Announcement by Tasmanian government of upgrading of its railway tracks.
2 October 2008	Additional east–west train service	Pacific National adds a third "Express" freight train to its Melbourne–Perth service.
27 October 2008	Pilbara railway access decision	The Treasurer, Mr Swan, announces that Fortescue Metals Group has the right to use Pilbara railways built by BHP-Billiton and Rio Tinto.
November 2008	Closure of grain lines	NSW Government announces closure of 5 grain railways in the west of State.
November 2008	Construction of Southern Sydney Freight Line	Construction of the 36 km Southern Sydney Freight Line commenced.
6 November 2008	Darwin railway operator in administration	FreightLink placed in administration.
26 November 2008	Suspension of railway construction	Suspension of work on Fortescue's Cloudbreak–Christmas Creek railway.
1 December 2008	Gauge conversion	End of Albury-Wodonga–Seymour broad gauge services marked the commencement of conversion of railway to standard gauge.
12 December 2008	Infrastructure investment announcement	Australian Government announces $1.2 billion funding for ARTC for rail projects on interstate and Hunter Valley networks.
23 February 2009	Chatswood–Epping	Opening of Sydney's Chatswood–Epping passenger line.
3 March 2009	Extra Parkes–Perth service	SCT Logistics commenced second freight service between Parkes and Perth.
23 March 2009 8 April 2009	Grade separation in Melbourne	Opening of Melbourne's Footscray Road rail underpass, as part of Dynon Port Rail Link; opening of Tottenham–Dynon rail link.
5 May 2009	PN coal contract in Queensland	Asciano wins 9-year coal-haulage contract with Macarthur Coal (3.7 million tonnes pa).

(continued)

Date	Event	Description
15 May 2009–23 June 2009	Temporary mainline closure in Tasmania	Following a derailment, Tasmanian railway was closed to enable significant track renewal task to be brought forward and expedited.
29 May 2009	GrainCorp trains	GrainCorp commences train operations in NSW, taking grain trains from NSW government.
2 June 2009	QR above-rail privatisation	Queensland Premier announced plan to part-privatise QR, namely, the freight businesses (but not passenger services); and to explore the sale or lease of the regional intrastate infrastructure to ARTC.
23 June 2009	Announcement that Tasmanian railways will be nationalised	Asciano agrees the transfer of Tasmanian train operations to Tasmanian government, effective from 30 November 2009.
30 June 2009	New train operator	Freightliner Australia, a subsidiary of a major UK freight operator, commenced operating in Australia.
June 2009	GrainCorp trains	GrainCorp takes over 18 48-class locomotives and 180 wagons from NSW government; grain trains to be run by Pacific National.
22 July 2009	Asciano contract	Asciano signed 10-year contract with Xstrata Coal for moving coal in Hunter Valley.
22 Aug 2009	Mildura railway	Completion of upgrade of Mildura railway.
October 2009	ARTC lease	ARTC commenced lease of the Benalla–Oaklands railway, from V/Line.
30 Nov 2009	Formation of TasRail	Tasmanian government took control of railways, from Asciano, establishing TasRail on 1 December.
Dec 2009	Track upgrade	Completion of concrete sleepering of the Cootamundra–Parkes line.
17 Jan 2010	ARTC track	ARTC commenced a 60-year lease of the Brisbane–NSW border standard gauge track.
22 Feb 2010	Rio Tinto line opens	Opening of 49-kilometre Rio Tinto railway in Pilbara, between Pannawonica and Mesa A.
May 2010	Goonyella-Newlands	Commencement of construction of 69 km Northern Missing Link railway linking the Goonyella and Newlands coal systems in Queensland
May 2010	Asciano wins contract from Toll	Toll and Asciano signed a five-year contract for intermodal and car transport.
May 2010	Interstate track re-railing	Commonwealth announced programme to re-rail interstate track, Cootamundra–Parkes, Broken Hill–Whyalla, Albury–Melbourne–Geelong, Kalgoorlie–Koolyanobbing.
9 June 2010	Freightlink sold	Genesee & Wyoming Australia buys Freightlink, the Darwin line operator. The transaction is expected to take 3 months for completion.
30 June 2010	Camellia closed	Asciano closed its Patrick-subsidiary Camellia intermodal terminal in Sydney, along with its Dubbo and Port Botany services.
1 July 2010	QR split	QR split into passenger train and non-coal intrastate infrastructure (Queensland Rail); and freight train and coal infrastructure network (QR National).
October 2010	SBR	Commencement of Specialised Bulk Rail services between siding west of Cairn Hill and Outer Harbour (Adelaide). SBR is a subsidiary of SCT Logistics. The service is for IMX Resources.
22 November 2010	QR National float	QR National was floated, while leaving around 25–40 percent of the shares with the Government.
January 2011	Widespread flooding	Severe flooding in eastern Australia, especially in Queensland, where train services and coal exports were severely disrupted.
January 2011	New Fortescue line	Fortescue commenced commissioning of new 50 km railway between Cloudbreak and Christmas Creek, WA.
February 2011	Cyclone Yasi disruption	Cyclone Yasi crossed the north Queensland coast around Cairns, causing disruption to freight, notably coal exports.

(continued)

Date	Event	Description
Late February 2011	Trans Australia Railway	Flooding cut the Trans Australia Railway for a number of days.
26 June 2011	V/Line services to Albury-Wodonga	Resumption of V/Line passenger services to Albury-Wodonga, following conversion of broad gauge track between Albury and Seymour.
20 July 2011	Roy Hill Holdings	Roy Hill Holdings received permission to build 342 km Roy Hill–Port Hedland railway.
19 December 2011	Northern Missing Link	Opening of 69 km "Northern Missing Link", Newlands – North Goonyella, Queensland.
27 December 2011 to 29 February 2012	Darwin Line cut	The Darwin line was broken near Katherine after flood waters washed away part of the track/bridge work. Goods between Darwin and Katherine were conveyed by road during this period.
15 January 2012	NSW regional rail	John Holland took over management of NSW's Country Regional Network from ARTC, under contract from NSW Government.
15 January 2012	Karara railway	QR National commenced contract with Karara Mining to haul iron ore over new railway, to Geraldton.
30 January–27 February 2012	Port Botany works	DP World's Port Botany rail yards were closed to enable expansion of the rail facilities.
April 2012	South Morang	Opening of Epping – South Morang railway in Melbourne.
7 June 2012	Sale of Independent Railways	Qube announced that it was purchasing Independent Railways of Australia, including the Macarthur Intermodal Shipping Terminal at Minto, Sydney
5 August 2012	ARTC lease in Sydney	Enfield West – Port Botany section (19 km) of Metropolitan Freight Network leased by NSW to ARTC until 2064.
14 September 2012	Trans Australian Railway	Centenary of the commencement of construction of the Trans Australian Railway.
14 November 2012	MidWest Rail Upgrade	Formal completion of $550 million upgrade of the Morawa–Mullewa–Geraldton Port railway, including installing dual-gauge sleepers.
1 December 2012	Aurizon	QR National changed its name to Aurizon.
1 December 2012	Fortescue Hamersley Line	First train on the Fortescue Hamersley Line in the Pilbara, serving the Firetail iron ore deposits at Solomon.
December 2012	Geraldton upgrade	Completion of substantial track upgrade and capacity expansion of tracks into Geraldton.
21 January 2013	Southern Sydney Freight Line	Formal opening of the Southern Sydney Freight Line.
29 January–February 2013	Queensland coal disruptions	Queensland's Blackwater and Moura coal systems disrupted by Cyclone Oswald.
21 April 2013	Hope Down 4	Opening of Hope Down 4 railway in the Pilbara.
June 2013	El Zorro	South-east Australian train operator, El Zorro, ceased operations.
1 July 2013	Sydney Trains/NSW Trains	Establishment of Sydney Trains and NSW Trains, from CityRail and RailCorp.
October 2013	Roy Hill Railway	Commencement of construction of Roy Hill Railway.
1 December 2013	Springfield Railway	Opening of the Springfield urban railway in Brisbane.
2 December 2013	Enfield Staging Facility	First train to use the Enfield Staging Facility in Sydney.
23 February 2014	Seaford Railway and Adelaide electrification	Opening of the Seaford urban railway extension from Noarlunga, coinciding with first public operation of electric trains in the city on the Adelaide–Seaford line.
2 May 2014	Tonsley Railway electrification	The Tonsley railway electrification was commissioned.

(continued)

Date	Event	Description
22 June 2014	Hobart/Brighton Hub	Intermodal freight services shifted from Hobart to Brighton Hub (to the north of the city), leading to closure of the Hobart–Bridgewater Junction line.
27 July 2014	Regional Rail Link	V/Line regional passenger services commenced using new dedicated tracks between Sunshine and Melbourne Southern Cross railway stations, as part of the Regional Rail Link project.

APPENDIX B

Significant network route additions from 1970

Opened	Route additions	Jurisdiction	Gauge	Route km	Project/ market
1970	Midland–Forrestfield Forrestfield – Kenwick Junction	WA	Narrow	8.0 10.0	Urban freight
	Kenwick Junction – Kenwick	WA	Narrow	1.0	Urban freight
	Bunbury Power House – Bunbury Inner Harbour	WA	Narrow	1.5	Urban freight
	Broken Hill – SA/NSW border SA/NSW border – Peterborough Peterborough – Port Pirie	SA/NSW	Standard	48.7 253.8 114.4	Interstate standardisation
	Blackwater–Laleham	Qld	Narrow	41.1	Coal
1971	Hay Point – Yukan Yukan–Goonyella Goonyella Mine Balloon Loop	Qld	Narrow	30.2 196.9 5.1	Coal
1972	Shay Gap – Goldsworthy	WA	Standard	65.0	Iron ore
	Tom Price – Paraburdoo	WA	Standard	110.0	Iron ore
	Kooragang Junction Triangle Loop	NSW	Standard	0.9	Coal
	Coppabella – Peak Downs Peak Downs Mine Balloon Loop	Qld	Narrow	42.6 5.6	Coal
	Cape Lambert – Pannawonica (Mesa J)	WA	Standard	203	Iron ore
	Spencer Junction – Whyalla	SA	Standard	74.0	Steel
	East Swanson Dock	Vic	Broad	1.4	Urban freight
1973	Longreach Junction – Coldwater Creek Longreach Junction – Longreach	Tas	Narrow	27.0 2.8	Mixed freight
	Redmine–Kambala	WA	Standard	8.0	Mixed freight
	Taurus–Koorilgah	Qld	Narrow	5.9	Coal
	Cockburn South–Kwinana	WA	Narrow	12.0	Urban freight
	West Kalgoorlie–Kambalda	WA	Standard	54.0	Gauge standardisation

(continued)

Opened	Route additions	Jurisdiction	Gauge	Route km	Project/ market
1974	Leonora–Kalgoorlie Kambalda–Esperance	WA	Standard	259.0 332.3	Gauge standardisation
	Bell Bay Wharf – Longreach Junction	Tas	Narrow	17.8	Freight
	Coldwater Creek Junction – East Tamar Junction	Tas	Narrow	12.5	Freight
	Peak Downs – Saraji Saraji Mine Balloon Loop	Qld	Narrow	21.1 5.5	Coal
	Cobarra Balloon Loop Junction – Greenvale	Qld	Narrow	216.5	Nickel ore
1975	Callemondah Yard – Powerhouse Loop – Fork at Callemondah	Qld	Narrow	3.6	Coal
	Boorgoon Mine Balloon Loop	Qld	Narrow	4.2	Coal
	Box Flat – Swanbank Powerhouse	Qld	Narrow	4.6	Coal
1975–1988	Bottom Points – Clarence	NSW	Narrow	7.0	Heritage passenger
1976	Pt Stanvac – Christie Downs	SA	Broad	2.9	Urban passenger
	Pinjarra East – Pinjarra South	WA	Narrow	1.1	Passenger and freight
	Dongara–Eneabba – South Mine	WA	Narrow	93.5	Mineral sands
	Osborne Power Station – Container Terminal	SA	Broad	4.2	Port–intermodal
	Flynn – Phosphate Hill	Qld	Narrow	66.1	Phosphate
1978	Kenwick Junction – Canning Vale	WA	Narrow	5.0	Urban freight
	Picton Junction – Picton East – Point V	WA	Narrow	5.1	Freight
	Christie Downs – Noarlunga Centre	SA	Broad	1.3	Urban passenger
	Whittingham Junction – Mount Thorley Balloon Loop	NSW	Standard	14.8	Coal
	Roma Street – South Brisbane	Qld	Narrow	1.8	Urban passenger
1979	Norwich Park Mine Balloon Loop	Qld	Narrow	5.4	Coal
	Bondi Junction – Erskineville Junction	NSW	Standard	10.1	Urban passenger
	Saraji – Norwich Park	Qld	Narrow	43.2	Coal
	Port Botany – Botany ANL (now Patrick) Terminal – Port Botany	NSW	Standard	0.8 1.4	Port–intermodal
1980	Alice Springs–Kulgera Kulgera – SA/NT border SA/NT border – Tarcoola	NT/SA	Standard	256.0 15.7 562.5	Interstate
	Vales Point Balloon Loop – Vales Point Junction	NSW	Standard	2.7	Coal
	Golding – Callemondah Yard	Qld	Narrow	8.5	Coal
	Fork at Gladstone	Qld	Narrow	0.5	Port
	Fisherman Islands – Ampol Refinery Junction	Qld	Narrow	3.0	Port
	Fisherman Islands Balloon Loop	Qld	Narrow	1.7	Port
	Gregory Mine – Burngrove Gregory Mine balloon loop and fork	Qld	Narrow	61.1 7.6	Coal

(continued)

Opened	Route additions	Jurisdiction	Gauge	Route km	Project/ market
1981	Tahmoor Colliery Junction – Tahmoor Colliery Balloon Loop	NSW	Standard	1.3	Coal
	Kwinana CBH	WA	Narrow	8.0	Grain/port
	Boonal (Yarrabee)	Qld	Narrow	3.5	Coal
	Inner Harbour Balloon Loop	NSW	Standard	2.0	Port
1982	Container Terminal – Outer Harbor	SA	Broad	1.3	Port
	Dry Creek North Junction – Dry Creek East Junction	SA	Broad	0.5	Port
	Lota–Thornside	Qld	Narrow	1.9	Re-opening/ urban passenger
	Elura Mine – Elura (CSA) Junction	NSW	Standard	33.6	Ore
	Glanville – Grand Junction Road Container Terminal – Glanville Container Terminal – Outer Harbor Dry Creek North – Dry Creek East Junction Cavan – Dry Creek East Junction Dry Creek – Gillman Junction Gillman Junction – Port Adelaide Junction Port Adelaide Flat – Gillman Junction	SA	Standard	2.7 10.9 1.3 0.5 1.1 4.7 2.4 3.1	Interstate standardisation
	Saxonvale Junction – Saxonvale Balloon Loop (Bulga Mine)	NSW	Standard	8.0	Coal
	Ulan Junction – Ulan Balloon Loop Sandy Hollow – Ulan	NSW	Standard	2.0 105.2	Coal
	German Creek – Gregory Mine Junction	Qld	Narrow	36.1	Coal
	Snowtown–Kadina Kadina–Wallaroo	SA	Standard	74.4 9.9	Gauge conversion (dual gauge)
	Crystal Brook East Fork	SA	Standard	1.2	Interstate standardisation
	Crystal Brook – Salisbury–Islington	SA	Standard	189.1	Interstate standardisation

(continued)

Opened	Route additions	Jurisdiction	Gauge	Route km	Project/ market
1983	Hamilton–Worsley Worsley North – Worsley East	WA	Narrow	11.0 1.0	Alumina/rural freight
	Norwich Park – German Creek Fork at German Creek	Qld	Narrow	21.7 1.3	Coal
	Oaky Creek Mine Balloon Loop Fork at Oaky Creek Mine balloon Loop	Qld	Narrow	6.1 0.5	Coal
	Riverside Mine Balloon Loop Riverside–Goonyella	Qld	Narrow	7.4 5.2	Coal
	Teralba Colliery Junction – Teralba Colliery Balloon Loop	NSW	Standard	3	Coal
	Watonga – Blair Athol Mine Blair Athol Balloon loop	Qld	Narrow	108.2 6.9	Coal
	Drayton Junction – Drayton Balloon Loop	NSW	Standard	8.0	Coal
	Curragh–Saggitarius	Qld	Narrow	14.0	
	Moss Vale Triangle Loop	NSW	Standard	0.4	Mainline/rural freight
	Abbot Point – Kaili	Qld	Narrow	16.0	Coal
	Annandale – Boundary Hill Mine	Qld	Narrow	5.6	Coal
	Torrens Bridge Junction – Mile End Junction Mile End Junction – Mile End Goods Yard	SA	Standard	0.9 2.3	Interstate standardisation
1984	Collinsville – Newlands Mine	Qld	Narrow	75.6	Coal
	Canning Vale – Cockburn South	WA	Narrow	13.0	Urban freight
	Cockburn North – Cockburn East	WA	Narrow	1.0	Urban freight
	Kooragang Island Balloon Loop	NSW	Standard	5.0	Coal
1981–1985	Flagstaff – Flinders Street (City Loop)	Vic	Broad	3.0	Urban passenger
1985	Altona – Laverton Junction	Vic	Broad	4.6	Freight/ passenger
	Ulan–Gulgong	NSW	Standard	23.8	Coal
1986	Blair Athol Mine – Claremont	Qld	Narrow	22.0	Coal
	Fork at Rocklands	Qld	Narrow	0.8	Coal
	Roma Street – South Brisbane	Qld	Standard	1.8	Interstate passenger
	Melbourne Yard – Webb Dock	Vic	Broad	7.8	Port
1987	Wellington Point – Cleveland	Qld	Narrow	4.4	Urban passenger
	East Hills – Glenfield	NSW	Standard	8.3	Urban passenger
1987–1988	Blue Cow – Perisher – Bullocks Flat	NSW	Standard	8.5	Rural passenger
1989	Hellyer Mine – Moory Junction	Tas	Narrow	11.5	Zinc ore
1989	Jimblebar – Jimblebar Junction	WA	Standard	32.0	Iron ore
1990	Glenlee Triangle Fork	NSW	Standard	0.3	Mainline Freight
	Mount McLaren Balloon Loop	Qld	Narrow	1.0	Coal
	Yarrowlea–Ebenezer	Qld	Narrow	8.4	Coal

(continued)

Opened	Route additions	Jurisdiction	Gauge	Route km	Project/ market
1991	Camberwell Balloon Loop – Camberwell junction	NSW	Standard	4.0	Coal
	Rosella – Brockman 2	WA	Standard	44.0	Iron ore
	Thornton Junction – Bloomfield Colliery Balloon Loop	NSW	Standard	7.5	Coal
1992	Gidgy Junction – Yandicoogina	WA	Standard	32.0	Iron ore
	Stanwell Power House Balloon Loop	Qld	Narrow	5.1	Coal
	Eraring Junction – Eraring Balloon Loop	NSW	Standard	1.8	Coal
	Gordonstone Junction – Gordonstone Balloon Loop	Qld	Narrow	12.8	Coal
	Joondalup–Perth	WA	Narrow	26	Urban passenger
1993	Currambine–Joondalup	WA	Narrow	3.0	Urban passenger
	Shay Gap – Yarrie	WA	Standard	32.0	Iron ore
	Riverside – North Goonyella	Qld	Narrow	18.8	Coal
	Point "V" – Bowen Junction	Qld	Narrow	0.9	Coal
	Mackay – Point "X"	Qld	Narrow	4.3	Coal
	Gunnedah Junction – Gunnedah Balloon Loop	NSW	Standard	2.0	Coal
1994	Marandoo–Rosella	WA	Standard	59.0	Iron ore
	Moura Mine Balloon Loop	Qld	Narrow	5.6	Coal
	Owanyilla Balloon Loop	Qld	Narrow	0.2	Coal
1995	Apamurra–Monarto	SA	Standard	34.4	Gauge conversion
	Fork at Blackwater	Qld	Narrow	0.6	Coal
	Tottenham Junction – VIC/SA border (via Cressy) VIC/SA border – Goodwood – Mile End Goods	SA/Vic	Standard/ dual	520 309.0	Interstate standardisation
	Hopetoun–Murtoa	Vic	Standard	111.3	Gauge conversion
	Rainbow–Dimboola	Vic	Standard	64.0	Gauge conversion
	Yaapeet–Rainbow	Vic	Standard	17.0	Gauge conversion
	Maroona–Portland	Vic	Standard	171.0	Gauge conversion
	Dartbrook Junction – Dartbrook Balloon Loop	NSW	Standard	4.0	Coal
	Stratford Balloon Loop – Stratford Junction	NSW	Standard	3.2	Coal

(continued)

Opened	Route additions	Jurisdiction	Gauge	Route km	Project/ market
1996	Islington Workshops – Kilburn Junction	SA	Standard	0.3	Interstate standardisation
	Fork at Coppabella	Qld	Narrow	1.4	Coal
	Ewington Branch	WA	Narrow	3.0	Coal
	Burton Mine Balloon Loop	Qld	Narrow	5.0	Coal
	Beenleigh–Helensvale	Qld	Narrow	28.0	Urban passenger
	Maryborough–Ararat	Vic	Standard	81	Gauge conversion
	Dunolly–Maryborough	Vic	Standard	15	Gauge conversion (dual)
	Loxton–Tookayerta Tookayerta – Tailem Bend	SA	Standard	8.1 151.2	Gauge conversion
	Granville Triangle Loop	NSW	Standard	0.9	Urban passenger
	Mount Owen Balloon Loop – Glennies Creek Junction	NSW	Standard	6.5	Coal
	Liddell Junction – Ravensworth Washery Balloon Loop	NSW	Standard	3.0	Coal
1997	Mackenzie – Ensham Mine Balloon Loop	Qld	Narrow	14.9	Coal
	South Walker Branch	Qld	Narrow	2.3	Coal
	Aldoga – East End	Qld	Narrow	11.9	Coal
	Fishermans Landing – Mount Miller	Qld	Narrow	8.3	Coal/port
	Fisherman Islands – Dutton Park	Qld	Narrow/ Standard	20.4	Urban freight (dual gauge)
	Helensvale–Nerang	Qld	Narrow	7.7	Urban passenger
1998	Arriga Junction – Arriga Junction Fork – Arriga	Qld	Narrow	4.1	Rural freight
	Nerang–Robina	Qld	Narrow	9.5	Urban passenger
	Moranbah North Balloon Loop	Qld	Narrow	7.3	Coal
	Pinnaroo – Tailem Bend	SA	Standard	144.5	Gauge conversion
	Olympic Park Flemington – Goods Junction	NSW	Standard	3.9	Urban passenger
1999	Macarthur Junction – Macarthur Balloon Loop	Qld	Narrow	5.1	Coal
	Yandi–Marandoo	WA	Standard	147.0	Iron ore
	Parkes Y-Link	NSW	Standard	0.4	Rural freight
	Mount Thorley Junction – Wambo Balloon Loop	NSW	Standard	16.0	Coal
2000	Sydney Central – Turrella (Airport line)	NSW	Standard	7.3	Urban passenger
2001	Brisbane Airport – Eagle Junction	Qld	Narrow	8.5	Urban passenger
2002	Mindi–South Walker	Qld	Narrow	8.7	Coal
2003	Hail Creek – South Walker	Qld	Narrow	46.7	Coal

(continued)

Opened	Route additions	Jurisdiction	Gauge	Route km	Project/ market
2004	Darwin – Alice Springs	NT	Standard	1 418	Interstate
	Mt Millar – Comalco Balloon Loop	Qld	Narrow	2.4	Coal
	Clarkson–Currambine	WA	Narrow	4.0	Urban passenger
2005	Beckenham–Thornlie	WA	Narrow	3.0	Urban passenger
2006	South Maitland Railway	NSW	Standard	30.0	Coal (re-opened line)
	Kinrola–Rolleston	Qld	Narrow	110.0	Coal
2007	Hancock Junction – Hope Downs	WA	Standard	58.0	Iron ore
	Perth–Mandurah	WA	Narrow	70.0	Urban passenger
2008	Port Hedland – Cloudbreak Mine	WA	Standard	260.0	Iron ore
	Port River Rail Bridge	SA	Standard	0.3	Port
2009	Lake Vermont – Dysart	Qld	Narrow	18.0	Coal
	Chatswood–Epping	NSW	Standard	15	Urban passenger
	Robina – Varsity Lakes	Qld	Narrow	4.1	Urban passenger
	Oaklands–Benalla	NSW	Standard	125	Gauge conversion
2010	Cameby Downs Loop	Qld	Narrow	7.0	Coal
	Brooklyn Triangle	Vic	Standard	0.5	Interstate
	Mesa K – Warramboo (Mesa A)	WA	Standard	49.0	Iron ore
	Darra–Richlands	Qld	Narrow	4.5	Urban passenger
2011	Cloudbreak Mine – Christmas Creek	WA	Standard	50.0	Iron ore
	Newlands – North Goonyella	Qld	Narrow	69.0	Coal
	Middlemount Rail Spur	Qld	Narrow	16.5	Coal
2012	Brockman 2 – Brockman 4	WA	Standard	41.0	Iron ore
	Tilley Siding (Morawa) – Karara	WA	Narrow	85.0	Iron ore
	Solomon Junction – Solomon	WA	Standard	130.0	Iron ore
	South Morang – Epping	Vic	Broad	3.5	Urban passenger (re-opened line)
2012–13	Sefton – Macarthur (Southern Sydney Freight Line)	NSW	Standard	36	Interstate freight
2013	Hope Downs 4 railway	WA	Standard	53.0	Iron ore
	Richlands–Springfield	Qld	Narrow	9.5	Urban passenger
2014	Noarlunga–Seaford	SA	Broad	5.7	Urban passenger
	Clarkson–Butler	WA	Narrow	8.0	Urban passenger

Note: Does not include light rail/tramways

Sources: Quinlan and Newland 2000; BITRE 2014f.

APPENDIX C
Train operator traffic

Table 34 ASX train operator traffic trends (billion net tonne-kilometres)

Period	Asciano				Aurizon				
	Coal	Other bulk	Intermodal (including steel)	Total	Coal	Iron ore	Bulk	Non-bulk—plus residual bulk from 2011–12	Total
Sep-07	3.0	0.7	6.7	10.4	–	–	–	–	–
Dec-07	3.1	0.6	6.7	10.5	–	–	–	–	–
1HY-08	6.2	1.4	13.4	21.0	–	–	–	–	–
Mar-08	3.1	0.7	6.0	9.8	–	–	–	–	–
Jun-08	3.4	0.7	6.5	10.6	–	–	–	–	–
2HY-08	6.5	1.4	12.5	20.4	–	–	–	–	–
Full year 2007–08	12.7	2.8	25.9	41.4	42.8	–	13.6	4.8	61.2
Sep-08	3.4	0.8	6.7	10.8	–	–	–	–	–
Dec-08	3.5	0.8	5.9	10.2	–	–	–	–	–
1HY-09	6.9	1.6	12.6	21.1	–	–	–	–	–
Mar-09	3.3	1.0	4.8	9.1	–	–	–	–	–
Jun-09	3.7	1.1	5.1	9.8	–	–	–	–	–
2HY-09	7.0	2.0	9.9	18.9	–	–	–	–	–
Full year 2008–09	13.9	3.6	22.5	40.0	43.5	–	14.3	4.2	62.0
Sep-09	4.2	0.9	5.7	10.8	–	–	–	–	–
Dec-09	4.2	0.8	5.9	10.9	–	–	–	–	–
1HY-10	8.4	1.7	11.6	21.7	–	–	–	–	–
Mar-10	4.4	0.8	5.3	10.5	–	–	–	–	–
Jun-10	5.2	0.9	5.4	11.5	–	–	–	–	–
2HY-10	9.7	1.7	10.7	22.0	–	–	–	–	–
Full year 2009–10	18.1	3.4	22.2	43.7	45.3	–	15.2	3.7	64.2
Sep-10	5.3	0.9	5.7	11.9	–	–	–	–	–
Dec-10	4.2	0.8	5.6	10.6	–	–	–	–	–
1HY-11	9.6	1.6	11.3	22.5	22.6	–	–	10	32.6
Mar-11	4.1	1.2	5.0	10.3	–	–	–	–	–
Jun-11	4.6	1.2	5.5	11.4	–	–	–	–	–
2HY-11	8.7	2.4	10.5	21.6	18.3	–	–	8.9	27.2
Full year 2010–11	18.3	4.0	21.8	44.2	40.9	–	–	18.9	59.8

(continued)

Period	Asciano				Aurizon				
	Coal	Other bulk	Intermodal (including steel)	Total	Coal	Iron ore	Bulk	Non-bulk —plus residual bulk from 2011–12	Total
Sep-11	4.9	1.3	5.8	12.0	–	–	–	–	–
Dec-11	4.8	1.4	5.9	12.0	–	–	–	–	–
1HY-12	9.6	2.7	11.7	24.0	22	–	9.9	–	31.9
Mar-12	4.7	1.4	5.6	11.8	–	–	–	–	–
Jun-12	5.7	1.6	5.7	12.9	–	–	–	–	–
2HY-12	10.3	3.0	11.3	24.6	19.9	–	–	11.1	31.0
Full year 2011–12	20.0	5.6	23.0	48.6	41.9	6.7	–	14.3	62.9
Sep-12	5.3	1.6	5.8	12.7	–	–	–	–	–
Dec-12	6.1	1.3	6.0	13.4	–	–	–	–	–
1HY-13	11.5	2.9	11.7	26.1	21.9	4.8	–	6.8	33.5
Mar-13	6.0	1.5	5.4	12.9	–	–	–	–	–
Jun-13	6.6	1.6	5.5	13.7	–	–	–	–	–
2HY-13	12.6	3.1	10.9	26.6	–	–	–	–	–
Full year 2012–13	24.0	6.0	22.7	52.7	43.6	10.3	–	13.2	67.1
Sep-13	7.1	1.3	5.6	14.0	12.4	3	–	3.3	18.7
Dec-13	7.4	1.2	5.6	14.3	13.1	3.1	–	3.3	19.5
1HY-14	14.5	2.5	11.2	28.2	25.5	6.1	–	6.6	38.2
Mar-14	7.3	1.4	5.1	13.8	11.4	3	–	3	17.4
Jun-14	7.4	1.3	5.1	13.8	12.3	3.1	–	2.9	18.3
2HY-14	14.7	2.7	10.2	27.6	23.7	6.1	–	5.9	35.7
Full year 2013–14	29.2	5.1	21.5	55.8	49.2	12.2	–	12.5	73.9

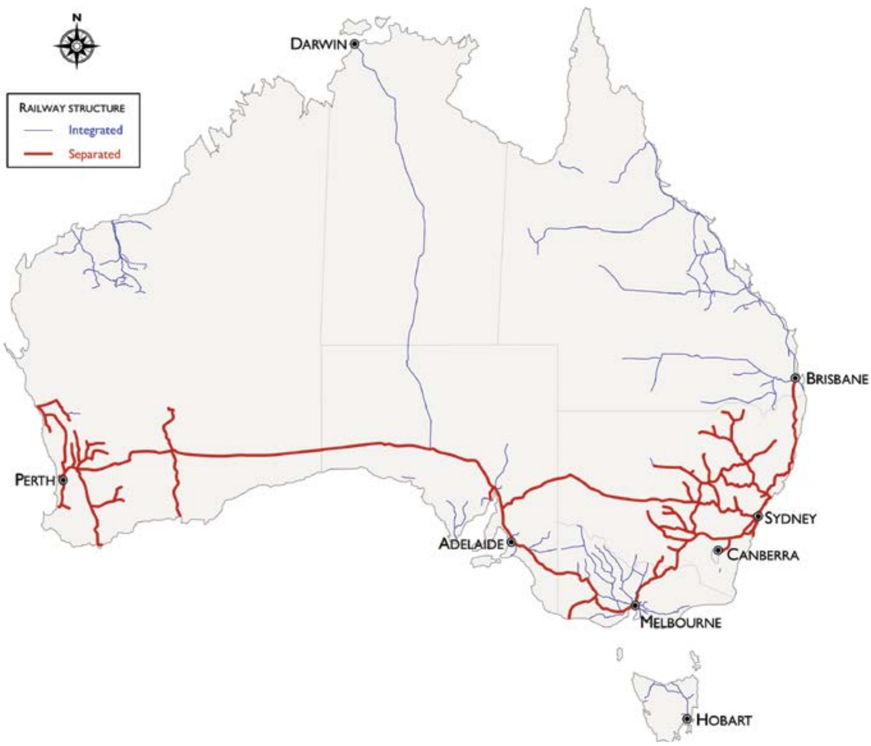
Sources: QR National 2010, pp. 98–99; Asciano web site (Australian Stock Exchange [ASX] Announcements); Aurizon web site (Australian Stock Exchange [ASX] Announcements); Asciano 2013, pp. 30, 34.

APPENDIX D
Industry structure

This Appendix provides an overview of the Australian railway industry, its structure and its key players.

The industry structure consists of both vertically-separated and vertically-integrated railways (Figure 49). With vertically-separated railways, the manager of the railway infrastructure does not operate revenue-earning trains; the "open access" manager sells track access to train operators. Integrated railways manage the network's infrastructure and access and also operate trains on the track. Integrated railway owners may provide "third-party access" to (other) train operators.

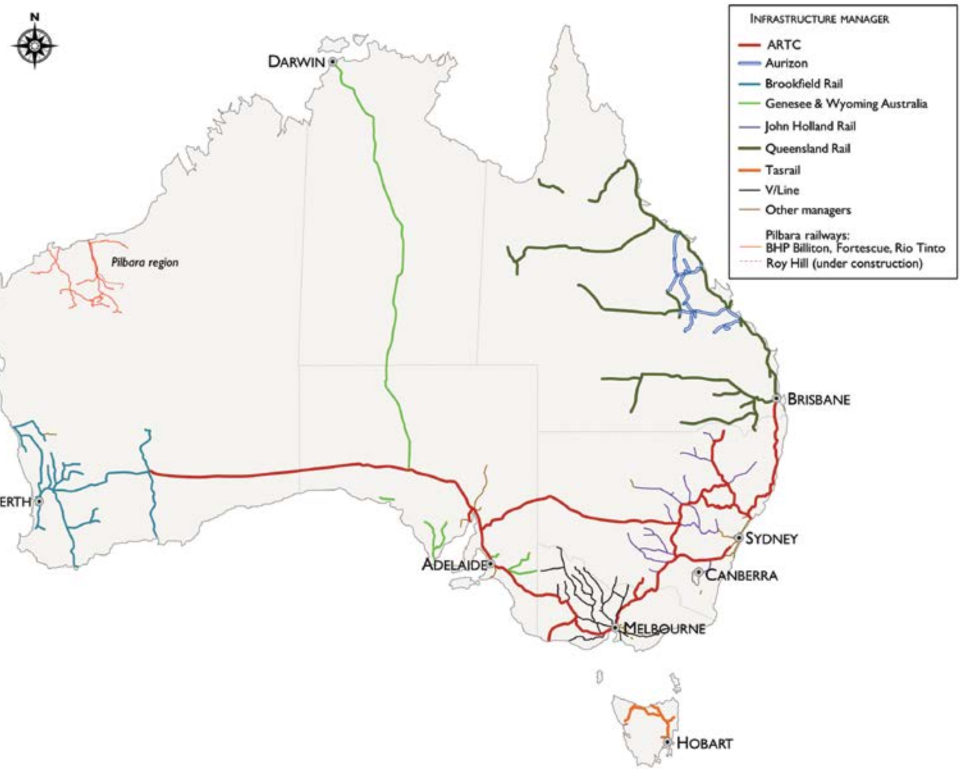
Figure 49 Australian rail industry structure



Infrastructure management

Australia's infrastructure managers are diverse in structure and operation. Figure 50 presents Australia's railway system by network manager.

Figure 50 Australian railways, by network manager, 2014



Note: The lines shown here are the railways that are open for traffic at July 2014. There is discussion amongst interested parties to re-open a number of grain lines in WA as well as the Demondrille–Greenthorpe/Blayney lines in NSW.

The pattern of the network management can be described thus, by traffic type:

- **Interstate.** The interstate network is managed by the Australian Rail Track Corporation (ARTC) and Brookfield Rail infrastructure managers. The Tarcoola–Darwin line is owned (or long-leased) as an integrated railway company, by Genesee & Wyoming Australia.
- **Iron ore – Pilbara.** The heavily-trafficked Pilbara iron-ore lines have integrated infrastructure management and train operation, with lines owned by BHP Billiton, Rio Tinto, and Fortescue Metals Group.
- **Coal.** Coal railways in Queensland have an integrated structure, with Aurizon managing infrastructure and operating trains in Central Queensland and with Queensland Rail elsewhere. Third-party access is provided to these lines. Coal railways in NSW have a vertically-separated structure, with the ARTC managing the Hunter Valley coal network and with some coal trains also operating over the infrastructure managed by John Holland Rail or RailCorp/Transport for NSW.

- **Grain.** Grain railways are integrated in Queensland (Queensland Rail), Victoria[49] (V/Line) and South Australia (Genesee & Wyoming) and separated in NSW (ARTC, John Holland Rail and RailCorp/Transport for NSW) and WA (Brookfield Rail).
- **Mixed.** Tasmania's network of mixed bulk and non-bulk traffic is vertically-integrated, with TasRail managing the system and operating the trains.
- **Passenger.** Urban systems have integrated management structures.

Table 35 lists the infrastructure managers by type and primary network usage.

49 Also in Victoria, the ARTC manages the Portland and Yarrawonga–Benalla (Victoria)–Oaklands (NSW) lines.

Table 35 Principal infrastructure managers of Australian railways, 2014

Infrastructure manager	Structure	Primary usage
Interstate		
Australian Rail Track Corporation (ARTC)	Separated	Intermodal, grain, ores, steel
Brookfield Rail	Separated	Intermodal, grain, ores, steel
Genesee & Wyoming Australia (GWA)	Integrated	Intermodal, ores
Intrastate		
Aurizon	Integrated	Coal
Queensland Rail	Integrated (mostly)	Passenger, grain, coal, cattle, ores, intermodal
John Holland	Separated	Grain, ores, cotton
ARTC (NSW regional and Hunter Valley)	Separated	Coal, grain, cotton
V/Line	Integrated (passenger); Separated (freight)	Passenger, grains, mineral sands, intermodal
ARTC (Portland, Benalla–Yarrawonga)	Separated	Grain, mineral sands
Tasrail	Integrated	Intermodal, coal, ores
GWA (intra-state South Australia)	Integrated	Grain, gypsum, ores
Asciano (Pacific National, Patrick)	Integrated	Coal
Brookfield Rail (intra-state Western Australia)	Separated	Grain, ores
BHP Billiton	Integrated	Iron ore
Rio Tinto	Integrated	Iron ore
Fortescue Metals Group	Integrated	Iron ore
Urban		
Queensland Rail (Brisbane, Gold Coast)	Integrated	Passenger
Airtrain CityLink Limited	Integrated	Passenger
Sydney Trains (Sydney urban, Newcastle, Lithgow, Bomaderry)	Integrated (passenger), Separated (freight)	Passenger
MTM (Metro Trains Melbourne)	Integrated	Passenger
Adelaide Metro (Department of Planning, Transport and Infrastructure)	Integrated	Passenger
Transperth	Integrated	Passenger

Note: There are a number of other, smaller, infrastructure managers, including heritage railways, totalling approximately 555 route-kilometres.

Above rail operators

Train operation is undertaken by a diverse range of organisations.

- **Heavy rail urban passenger** operators are largely integrated organisations, that is, they manage the tracks on which their trains run. Most are publically-owned entities, with the exception of Metro Trains Melbourne, a private joint venture that operates trains on behalf of the Victorian government under a franchise agreement.
- **Non-urban passenger services** are largely government operated with a few important exceptions including Great Southern Rail, which operates the long-distance *The Ghan, Indian Pacific* and *The Overland* passenger trains.
- **Heritage passenger railways.** Around 40 heritage volunteer-based organisations manage and operate railways, totalling approximately 500 route-kilometres.
- **National rail freight operators.** Two large national rail freight train operators are Aurizon and Asciano (operating under the subsidiary names Pacific National and Patrick); see p. 10 for further details of their traffic. The companies' core activity is coal haulage in Queensland and NSW, with other important ancillary bulk-haulage activities. Both companies operate intermodal services on the open access interstate network.
- **Regional rail freight operators.** Genesee & Wyoming Australia is a major train operator in SA and the Northern Territory; other significant players include Southern Shorthaul Railroad and Freightliner Australia. TasRail provides the rail freight services in Tasmania while Watco WA Rail is contracted by CBH to provide grain haulage in WA[50].
- **Logistics companies**—notably, SCT Logistics, and Qube Holdings—operate intermodal services for their own logistics chains; they also operate a limited number of bulk services. SCT Logistics has a diverse portfolio of rail and road activities, including intercity intermodal operations. Qube Holdings also has a diverse intermodal and bulk portfolio, with a primary focus on local and regional port-based operations. (Other logistics companies—such as Toll, Sadliers Logistics and Ettamogah Rail Hub—use rail freight operators to undertake their rail haulage.)
- Mining companies, such as Rio Tinto, BHP Billiton, Fortescue Metals Group and Karara Mining operate trains on their own railways.

A list of significant above-rail operators is at Table 36.

50 Freightliner Australia is a subsidiary of Freightliner Limited (headquartered in London). Genesee & Wymoning Australia is a subsidiary of Genesee & Wyoming, headquartered in Connecticut. Watco WA Rail is a subsidiary of Kansas-headquartered Watco Companies (a transport-based operation).

Table 36 Principal train operators in Australia, 2014

Train operator	Infrastructure network used	Primary tasks
Freight		
Aurizon	Aurizon, Queensland Rail, ARTC, Brookfield, NSW TrainLink, Sydney Trains	Coal, iron ore, intermodal, cattle, grain, mixed bulk
Asciano (Pacific National, Patrick)	Aurizon, Queensland Rail, ARTC, V/Line, John Holland, Sydney Trains, NSW TrainLink, Brookfield, GWA	Coal, ores, intermodal, steel, grain, mixed bulk
Genesee & Wyoming Australia (GWA)	GWA, ARTC	Intermodal, ores
SCT Logistics/Specialised Bulk Rail	ARTC, Brookfield Rail, GWA, V/Line	Intermodal, grain, iron ore
Qube Holdings	ARTC, Brookfield Rail, V/Line, Sydney Trains, NSW TrainLink, John Holland	Intermodal, grain, mixed bulk
Watco	Brookfield	Grain
Southern Shorthaul Railroad	ARTC, Sydney Trains, NSW TrainLink, John Holland	Coal, grain, intermodal
Freightliner Australia	ARTC, Sydney Trains, NSW TrainLink, John Holland	Coal, grain, cotton
TasRail	TasRail	Intermodal, coal, ores
Rio Tinto	Rio Tinto	Iron ore
BHP Billiton	BHP Billiton	Iron ore
Fortescue Metals Group	Fortescue Metals Group	Iron ore
Non-urban passenger		
Queensland Rail	Queensland Rail	Passenger
NSW Trainlink	NSW Trainlink, Sydney Trains, ARTC, John Holland	
V/Line	V/Line	
TransWA	TransPerth, Brookfield Rail	
Great Southern Railway	Sydney Trains, NSW TrainLink, John Holland, ARTC, Brookfield Rail, GWA	
Heavy urban rail passenger		
Queensland Rail	Queensland Rail, AirTrain CityLink Limited	Passenger
Sydney Trains	Sydney Trains	
MTM Melbourne	MTM Melbourne	
Adelaide Metro (Department of Planning, Transport and Infrastructure)	Adelaide Metro (Department of Planning, Transport and Infrastructure)	
Transperth	Transperth	
Light urban rail passenger		
GoldLinQ	GoldLinQ	Passenger
Transdev	Transport for NSW	
Yarra trams	Yarra trams (Keolis Downer EDI Rail)	
Adelaide Metro (Department of Planning, Transport and Infrastructure)	Adelaide Metro (Department of Planning, Transport and Infrastructure)	

APPENDIX E

Bulk rail freight task

Table 37 Bulk rail freight, by origin and destination (thousand net tonnes), 2012–13

Origin	Destination								
	QLD	NSW	ACT	Vic	Tas	SA	NT	WA	Total
Qld	224 226	-	-	-	-	-	-	-	**224 226**
NSW	574	173 022	-	915	-	343	-	217	**175 071**
ACT	-	-	-	-	-	-	-	-	**-**
Vic	83	38	-	2 550	-	105	-	155	**2 931**
Tas	-	-	-	-	1 654	-	-	-	**1 654**
SA	79	741	-	121	-	21 123	5	63	**22 132**
NT	-	-	-	-	-	-	2 356	-	**2 356**
WA	-	-	-	-	-	-	-	584 629	**584 629**
Total	224 962	173 801	-	3 586	1 654	21 571	2 361	585 064	1 012 997

Note: Sub-totals are rounded to the nearest 1 000 tonnes, thereby excluding some flows. Sub-totals do not add to total due to rounding.

The table excludes traffic data for some of the smaller train operators, such as Southern Shorthaul Railroad and Sydney Rail Services. Data for 2012–13 exclude El Zorro (which ceased operating in June 2013).

The data used to compile this matrix are provided by train operators. The operators typically use billing information and goods dispatch records to compile their data. A deficiency in this data arises when goods are trans-shipped. For example, interstate tonnages originating in Tasmania will be recorded as intrastate.

Sources: Data provided by Asciano, Aurizon, Fortescue Metals Group, BHP Billiton, Rio Tinto, Freightliner Australia, Genesee & Wyoming Australia, Qube, SCT Logistics, TasRail, Watco.

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