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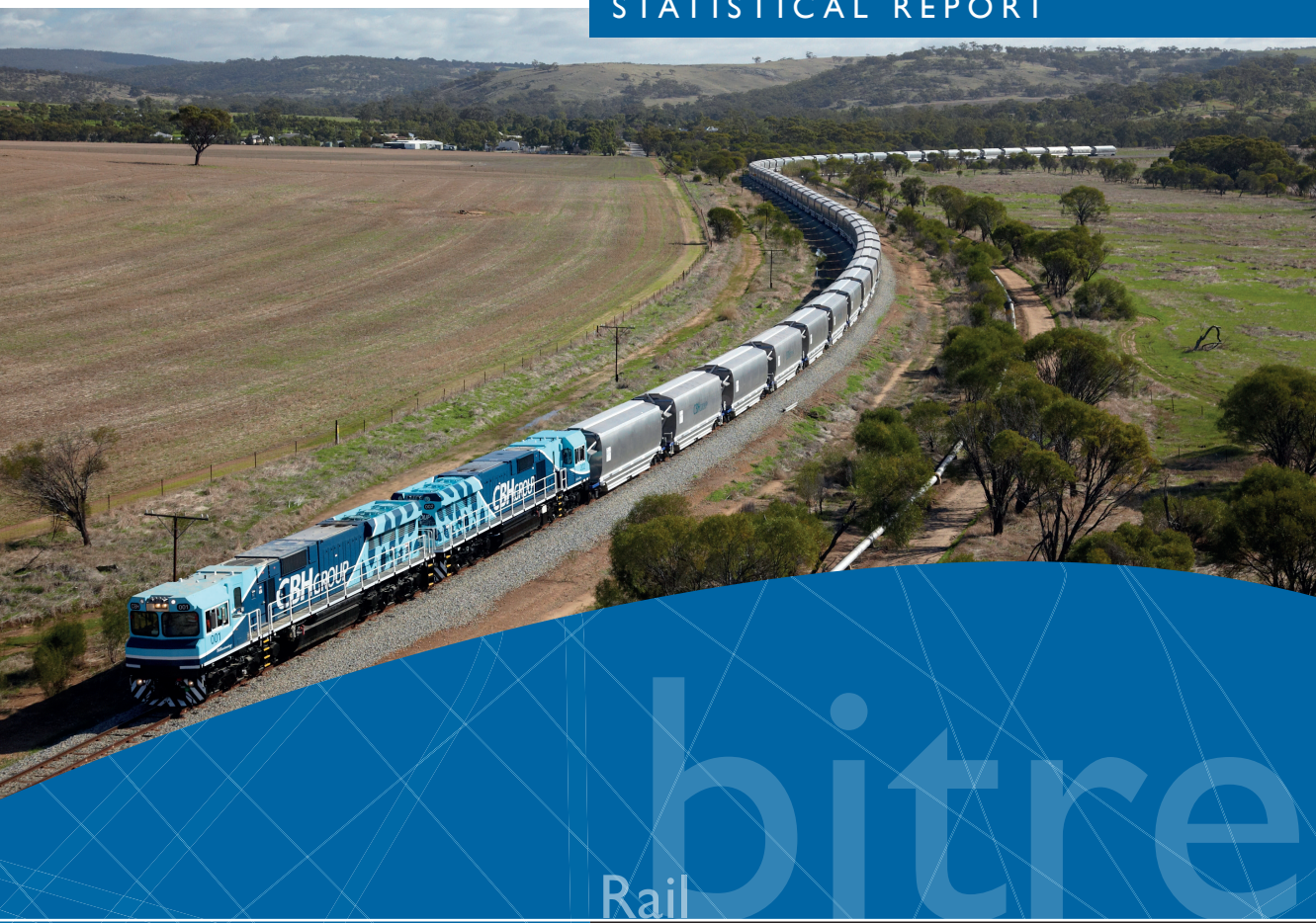
AUSTRALASIAN RAILWAY ASSOCIATION

STATISTICAL REPORT



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Rail

Trainline 6

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

Trainline 6

Statistical Report

Department of Infrastructure, Regional Development, and Cities
Canberra, Australia

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Foreword

Trainline 6 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. *Trainline 6* also has a case study on the Australian Rail Track AK track inspection cars' operations.

The *Trainline* series are a collaboration between BITRE and the Australasian Railway Association (ARA).

We acknowledge the assistance of those organisations which (voluntarily) provided data and other information about the Australian railway industry and provided answers to follow up questions. We also acknowledge also the assistance and cooperation of the ARTC in preparing this year's case study.

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November 2018

At a glance

Results

- According to below-rail provided data, intermodal designated tonnages in 2016–17 grew on all sectors of the north-south interstate network, particularly between Sydney and Melbourne. Results were mixed on the east-west corridor. Westbound intermodal traffic grew on all sectors between Melbourne and Adelaide, following previous declines. Non-intermodal tonnages grew on most sectors of the interstate network.
- National level above-rail tonnages are unavailable for 2016–17 due to a lack of data provision.
- Scheduled intermodal freight train transit times on the ARTC and Arc Infrastructure interstate corridors in 2018 were largely unchanged from 2017. The fastest Melbourne to Perth train completes its journey in a scheduled 46 hours and 55 minutes, while the fastest Sydney to Perth trains completes its journey in 53 hours and eight minutes. There has been a decline in the number of scheduled Melbourne to Perth and Perth to Melbourne trains. There were three Melbourne to Sydney intermodal trains per week in 2018 where there had been none the previous year.
- Total urban heavy rail patronage for 2016–17 was 702.9 million passenger journeys, while for light rail there was 231.4 million passenger journeys.
- Patronage on all urban heavy rail networks grew in 2016–17 (compared to the previous financial year), except Perth and Brisbane, which experienced minor declines. Patronage in Sydney grew by approximately 5.5 per cent in 2016–17.
- There was modest light rail patronage growth in all cities with light rail services
- Non-urban rail patronage grew in all states that provide these services, except in Western Australia, where patronage continued to decline. New South Wales (Trainlink) had the highest increase, at 11 per cent, due to growth in intercity travel. Regional Trainlink services had a small patronage decline.
- Sydney still has Australia's busiest urban heavy rail passenger network, with approximately 341 million passenger journeys in 2016–17.
- Most cities exceeded their urban heavy and light rail punctuality targets, while non-urban punctuality results were poorer.
- The Office of the National Rail Safety Regulator now has nationwide management of rail safety. This will facilitate future consistent nationwide reporting on rail related safety.

Railway networks and assets

- Australia has an estimated 33 221 route kilometres of operational heavy railways, approximately 10 per cent of which is electrified.
- Australia has 291 route kilometres of operational light rail/tramways.
- Melbourne has Australia's largest heavy and light urban (excluding inter-urban) passenger rail networks at an estimated 401 route kilometres and 250 route kilometres, respectively.
- The principal iron ore railways are in Western Australia's Pilbara region (2 642 route kilometres). The principal coal networks are the central Queensland systems (1 979 route kilometres) and the New South Wales Hunter Valley Coal network (approximately 785 route kilometres). Grain flows run from agricultural hinterlands to ports and for domestic consumption. There are approximately 5 100 route kilometres of operational railway that are largely or exclusively used for grain haulage.
- In July 2018, there was an estimated 1 997 operational locomotives in Australia. Approximately 50 per cent of the fleet was aged 11 years or less, compared to approximately 13 years or less the previous year.

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CHAPTER 1

Australia's railway industry

Trainline is a compendium of Australia's rail industry. It provides data and an analysis of the industry[1].

Australia's railways are evolving, with changes both outside and within the industry. This includes:

- **Urban patronage**. The introduction of frequent urban rail services with high average speeds, good bus, cycling, and parking links to high amenity stations has generated strong patronage growth in some Australian cities.
- **Resurgence of light rail**. In addition to Melbourne's extensive tram/light rail network, Sydney, Adelaide, and the Gold Coast's light rail networks are expanding. Construction is almost complete on the ACT's light rail network. Sydney has had exceptionally strong light rail patronage growth between 2014–15 and 2015–16.
- **Regional and inter-urban passenger service**. Regional passenger services, specifically in Victoria, have been upgraded both in rollingstock and infrastructure within the last decade.
- **Logistics**. Interlinked chains of international and domestic production and distribution have revolutionised the production and consumption of manufactured and processed goods. Logistics systems for bulk commodities have also been improved and broadened, such as with containerised grain and ores rail heads to ports.
- **Commodity flows**. Australia is a major exporter of iron ore and coal, with virtually all of this being transported by rail from mine to port. These exports have grown exponentially, enabled partly by new, expanded and upgraded railways.
- **Technology**. Railway operations have embraced leading-edge technology, such as the world's heaviest wagon axle loads and development of remotely-controlled iron ore trains in Western Australia, the introduction of driverless metro trains in Sydney, improvements in vehicle design and performance, and shifts towards predictive and real time maintenance.

The following chapters give an overview and data on railway transport's tasks; characteristics of the railways and train operators' rolling stock; aspects of railway performance, including safety, environment and reliability; and a case study on ARTC's AK Car track inspection operations.

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, information on railway infrastructure investment levels will be provided in BITRE's 2017 issue of the Australian Infrastructure Statistics Yearbook.

CHAPTER 2
Rail traffic

This chapter examines the Australian railway industry's principal tasks. It discusses the major freight commodities moved and markets served. It also discusses passenger transport.

Overview

Railways excel at transporting large volumes of both freight and passengers. In Australia, this primarily involves moving bulk commodities (for export) and urban and intercity passenger transportation.

Weekday commuting to central city areas is the key passenger rail task. The previous surge in rail patronage in Perth commencing in 2006 illustrates the growth in some commuter services (BITRE 2012, p. 55). Similarly, strategic investments in track and trains on some of regional Victoria's railway corridors have brought exceptionally strong patronage growth (BITRE 2014, p. 68).

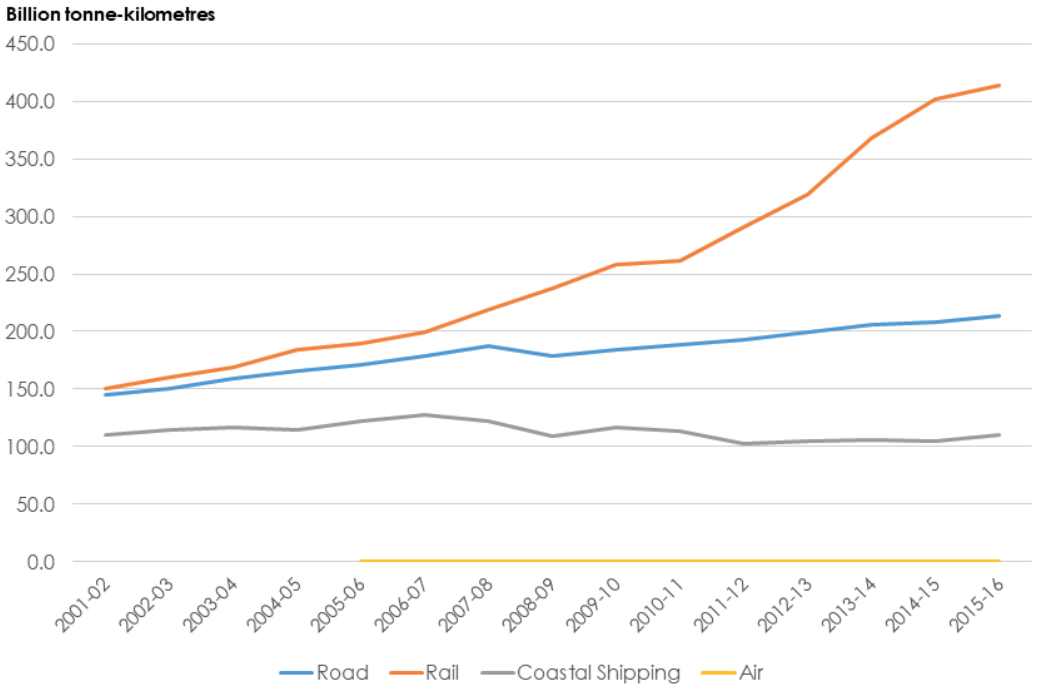
Rail transport's role in the Australian economy has increased sharply in recent years; see Figure 1. Rail now accounts for more than one-half of Australian freight transport activity, up from approximately 36 per cent at the turn of the century. Rail freight transport's strong position is primarily founded on the transportation of iron ore, coal and other bulk products such as grain primarily to ports for export. BITRE estimates Pilbara iron ore transportation accounted for approximately 64 per cent of the national net tonne kilometres (NTK) in 2015–16, while combined coal transportation in Queensland and New South Wales comprised approximately 20 per cent of the national NTKs for the same period[2].

Rail is also often central to moving other bulk commodities, such as grains, sugar, and timber, especially to ports, as well as containerised export agricultural commodities. Rail and road transport compete strongly for short-haul and long-distance non-bulk freight, but as distances increase rail transport's competitiveness increases. Rail's mode share of non-bulk freight is highest between the eastern states and Perth (the East–West Corridor)[3].

2 BITRE does not have an estimate of how much grain was transported by rail in Queensland and New South Wales for the same period.

3 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 2014a, 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 (2017), (Table T2.1c, p.55).

The recovery of rail's freight market share rose sharply, particularly from the 2007–08 financial year. This rise was driven by growth in commodity exports, with three times the volume of iron ore production in 2012 relative to 2002 and black coal production rising by 45 per cent in the decade to 2012–13[4].

Growth in commodity exports 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. Newcastle is the world's largest coal export port.

Rail's non-bulk freight performance faces greater competition from road transport, but there are strong performing areas. Rail accounts for the majority of inter-capital origin–destination non-bulk freight on the East–West corridor. According to the latest published estimates, rail has approximately 30 per cent market share of non-bulk freight travelling between Brisbane and Melbourne (BITRE 2014a, p. 3). Rail also performs a key role in some regional freight flows, mainly between inland terminals and ports. The Murrumbidgee Irrigation Area (Griffith and south-west New South Wales) to Melbourne is one example.

4 This is still the latest available estimate.

National rail freight task, tonnes

Due to one major operator electing not to provide BITRE and the ARA with details of its annual tonnages[5], this year's edition of *Trainline* is unable to assess the national rail freight task. Table 1, below, shows reported tonnages until 2015–16.

Table 1 National rail freight task, thousand net tonnes

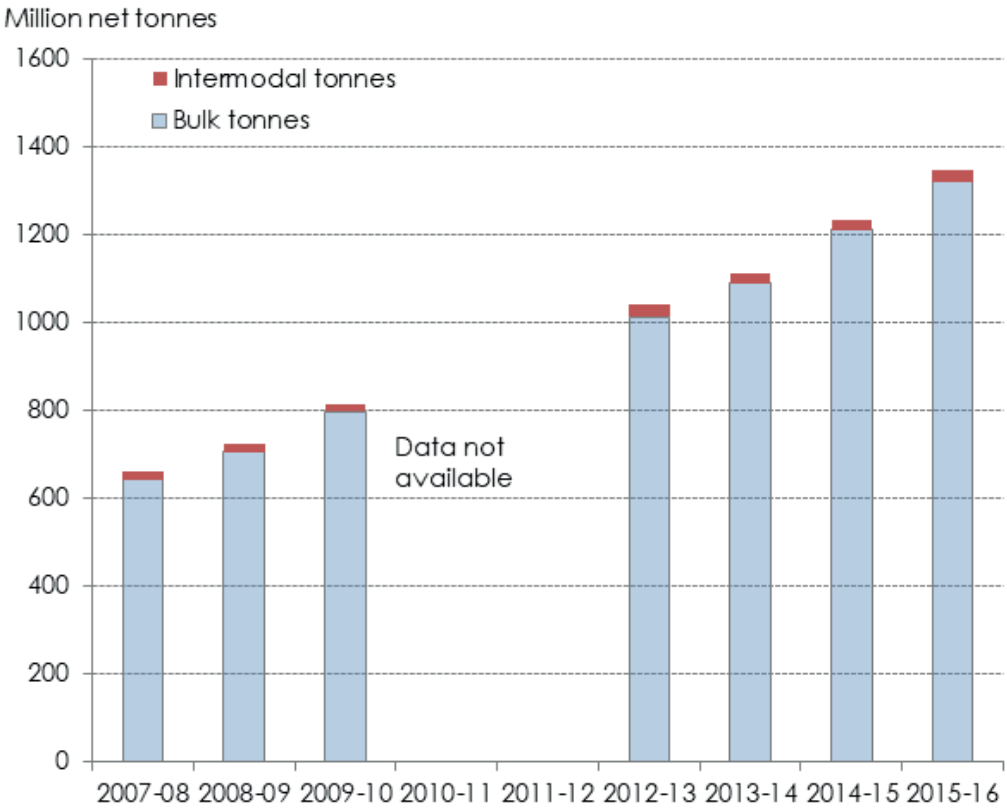
Year	Bulk	Bulk NTKs	Intermodal	Intermodal NTKs	Total	Total NTKs
2007–08	642 826	n/a	19 519	n/a	662 345	n/a
2008–09	705 039	n/a	17 481	n/a	722 520	n/a
2009–10	798 763		16 521		815 284	
2010–11	-	n/a	-	n/a	-	n/a
2011–12	-	n/a	-	n/a	-	n/a
2012–13	1 012 997	n/a	27 559	n/a	1 040 556	n/a
2013–14	1 089 566		21 891	n/a	1 111 457	n/a
2014–15	1 210 949	349 014 582	24 272	n/a	1 235 221	n/a
2015–16	1 322 085	381 125 118	25 366	32 364 817	1 347 451 934	413 489 935
2016–17	n/a	n/a	n/a	n/a	n/a	n/a

Notes: The table excludes traffic data for some of the smaller train operators, such as Sydney Rail Services. Data for 2010–11, 2011–12, and 2016–17 are not available.

Sources: BITRE estimates; Previous *Trainline* editions that sourced operator provided data.

5 BITRE and ARA are only able to obtain operators' data by voluntarily contribution.

Figure 2 National rail freight task, 2007–08 to 2015–16



Notes: The chart excludes traffic data for some of the smaller train operators, such as Southern Shorthaul Railroad and Sydney Rail Services. Data for 2010–11, 2011–12, and 2016–17 are not available.

Sources: BITRE estimates; (BITRE 2012a; 2014; 2015); 2015–16 data was provided by Pacific National, Aurizon, Fortescue Metals Group, BHP Billiton, Rio Tinto, Roy Hill Holdings, Genesee & Wyoming Australia (including *Freightliner*), SCT Logistics, Tasrail, QUBE, Watco, and Fletcher International Exports.

Trainline uses specific definitions for bulk and non-bulk freight. In principle, 'bulk' freight involves large quantities of homogenous product that is conveyed in wagons. Non-bulk freight is generally any containerised or unitised freight either placed on container wagons, transported in an enclosed wagon (for example, SCT Logistics) or transported on a wagon with a secure fastening capability. However, 'non-bulk' freight is not always containerised. Conversely bulk commodities sometimes travel in containers. In this report, 'bulk' refers to anything not considered 'intermodal', where 'intermodal' is generally considered to be containerised freight or freight in a louvre wagon. Steel may also be deemed intermodal, particularly on Pacific National trains that carry both intermodal and steel products on intermodal designated trains. Box 1 provides more insight into these definitions.

Figure 3 Genesee and Wyoming Australia intermodal train in the Northern Territory

Note: The train carries its own fuel, directly behind the locomotives for 'in line' refuelling. Note also the crew car behind the fuel wagon. Long distance intermodal trains operating through remote locations carry additional crew, who rest in the crew car when not driving, on a rotational basis. Photo courtesy of Genesee and Wyoming Australia.

Box 1 Defining intermodal and other trains

Trainline reports 'intermodal', and 'bulk' freight movement statistics. The definition *Trainline* uses for intermodal freight is 'market-based'. Defining the traffic in terms of the market served (such as relatively high priority goods for which road transport is a strong competitor) can be clearer than when defined in terms of the type of goods (notably, non-bulk) conveyed or the type of wagon used. Where data for 'intermodal' trains is reported, such trains are typically defined as trains with axle loads up to and including 21 tonnes and a maximum speed of up to 115 kilometres per hour. In terms of ARTC infrastructure charges, intermodal designated trains now include mixed trains that carry both intermodal and steel products. Because these trains carry steel products, they are subject to 80 kilometres per hour speed restrictions. These mixed trains complicate measuring tonnages for ARTC as they weigh whole trains, not components of a train. ARTC's below-rail measured tonnages are the sum of intermodal and steel train volumes.

Wagon types 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. 'Intermodal' traffic consists of wagons conveying containers on flat (or well) wagons as well as by louvre (or box) wagons. Further, the goods themselves may be bulk goods (such as grains or hay) as well as non-bulk (such as palletised tinned pet 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 grain or minerals. When compiling data presented in this report, train operators have classified containerised bulk goods trains (such as ores, grains, and mineral sands) as bulk.

National freight task, by operator

There is some publicly-available data that report national rail freight activity. Aurizon provides quarterly train-operator traffic data[6] to the Australian Stock Exchange (ASX). That material forms the basis of the data shown in Table 2, with more details in Appendix C. Pacific National (formerly part of the Asciano group that was split into three separate businesses in August 2016), no longer reports data publicly as it is no longer a publicly listed company, hence there is no Pacific National data after 2015–16.

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

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

Period	Pacific National				Aurizon					Combined
	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
2014–15	30.9	5.1	23.8	59.8	49.1	10.4	-	12.9	72.4	132.2
2015–16	31.8	4.4	22.4	58.6	49.7	9.6	-	12.3	71.6	130.2
2016–17	n/a	n/a	n/a	n/a	47.6		15.4[a]	12.2	n/a	n/a
2017–18	n/a	n/a	n/a	n/a	50.4		13.4		63.8	n/a

Sources: Aurizon (2018, pp.15, 17); Previous *Trainline* editions that sourced ASX data.

Note: [a] Bulk for the 2016–17 and 2017–18 financial years includes iron ore.

For 2017–18, Aurizon reported its above rail results as coal and bulk only.

Data sources and (where published) a breakdown of information into quarters (where possible) and half-years are shown in Appendix C and Appendix D.

Traffic volumes reflect rail's competitiveness with other transport modes (particularly for intermodal traffic) and prevailing economic conditions. Variations in individual commodity flows arise from international demand for commodities as well as train operators winning or losing major contracts.

Table 3 Train operator traffic trends (TEUs (000))

Period	Pacific National[a]	Aurizon	Combined
2014–15	771.5	372.0	1143.5
2015–16	799.1	372.6	1171.7
2016–17	n/a	405.2	n/a
2017–18	n/a	266.0[b]	n/a

Note: [a] The historical Pacific National figures are those which the former parent company, Asciano, reported to the ASX as a publically listed company and which BITRE reported in previous editions of *Trainline*.

[b] Aurizon ceased interstate intermodal operations in December 2017.

Sources: Aurizon (2018 p.21); previous *Trainline* editions that sourced ASX data.

In addition to measuring freight transport by tonnes and NTKs, transport by twenty-foot equivalent (TEU) units of shipping containers provides another measure. This measure shows freight activity by volume rather than weight.

The Genesee and Wyoming parent company reports its results to the New York Stock Exchange[7]. It reports its volumes as carloads rather than tonnages.

7 See Securities and Exchange Commission (USA), 2018.

Table 4 Genesee and Wyoming Australia carloads

Period	2016 calendar year	2017 calendar year	Change (per cent)
Agricultural Products	43 362	51 909	19.71
Coal and Coke	35 203	359 791	n/a[8]
Intermodal	59 688	58 848	–1.41
Metallic Ores	13 807	29 458	113.36
Minerals and Stone	64 060	51 872	–19.03
Petroleum Products	275	277	.073
Total Carloads	**216 395**	**552 155**	**n/a**

Source: (Genesee and Wyoming 2018).

Tasrail reports its freight task in its annual report. Table 5, below, shows and compares Tasrail's freight task for the 2015–16 and 2016–17 financial years.

Table 5 Tasrail freight task (net tonne kilometres)

Period	2015/16	2016/17	Change (per cent)
Coal	28 001 167	44 863564	60
Cement	25 743 097	28 136 132	9
Mineral concentrates	22 434 584	22 923 272	2
Bauxite	5 205 395	-	–100
Logs	18 810 476	19 285 427	2.5
Intermodal general	220 180 774	229 820 283	4
Intermodal paper	122 470 351	127 867 540	4
Total	**442 845 844**	**472 896 217**[9]	**7**

Source: Tasrail 2017, p.16.

8 It is not feasible to compare coal and coke carloads as the 2017 figure represents coal and coke GWA hauled after its December 2016 Glencore Rail acquisition. Trainline does not report a total carloads percentage change also for this reason.

9 The total does not balance due to rounding of decimals.

Box 2 Further freight rail operator traffic data resources

No single data source covers the entire Australian network. Data sources are train operator data, and track/infrastructure manager data.

Tasrail provides information on tonnages of some commodities that it transports, such as logs and minerals. (Tasrail 2017, p. 16)

Some one-off studies provide traffic flows data. 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.

Figure 60 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 2018; Aurizon 2018a-e);
- ARTC's aggregated Hunter Valley network quarterly coal tonnage throughput (ARTC n.d.);
- ARTC's aggregated annual network tonnages are reported in its annual reports.

Traffic data and projections can also be provided to the infrastructure managers' economic regulators, which may then publish that material[10].

While explicit rail 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). BITRE's *Freightline* series (being published a series of reports) also presents freight flows by commodity. (BITRE 2014a and BITRE 2014b, BITRE 2016a, BITRE 2018).

An informal source of east-west rail activity at Gheringhap in Victoria is on Graham Elliott's web site: http://ghaploop.railpage.org.au/ and in the BITRE report on that data source. (BTRE 2007)

Interstate network traffic

This section reports interstate freight traffic flows by line segment based on below-rail (track infrastructure manager) provided data. It only includes tonnages on the interstate network that the ARTC and Arc Infrastructure each manages. Table 6 and Table 7 show intermodal and total gross tonnes by line segment, with line segments ordered from north to south and east to west. Figure 4, Figure 5, Figure 6 and Figure 7 also show the data. ARTC's data excludes regional import/export trains that join the network at such locations as Harefield (Junee). There are three factors to note when reviewing the tonnages.

10 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); Arc Infrastructure is the Economic Regulation Authority [WA] (http://www.erawa.com.au/rail/rail-access).

- Where freight does not move along the entire length of a segment, it has been weighted by the proportion of the line segment travelled. Tonnages are calculated as gross. Empty wagons and locomotive weights are therefore included.
- 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 New South Wales Southern Highlands. In those locations, coal tonnages are higher than all other commodities carried.
- ARTC and Arc Infrastructure provided tonnages are not comparable with the above rail tonnages reported because the above rail tonnages cover the whole of Australia, whereas the below rail data only measures traffic on the ARTC and Arc Infrastructure interstate networks. The two measures are therefore not 'like for like' in scope.

Interstate intermodal traffic

Table 6 and Table 7 show intermodal and total tonnage levels on line segments of the interstate network.

Table 6 Below-rail gross tonnes by line segment, North-south corridor

Line segment, by direction of freight	Million gross tonnes					
	Intermodal			Total		
	2014–15	2015–16	2016–17	2014–15	2015–16	2016–17
Acacia Ridge to Casino	2.22	2.63	2.94	2.37	2.82	3.09
Casino to Acacia Ridge	3.29	4.02	4.48	3.43	4.26	4.63
Acacia Ridge – Casino	5.50	6.65	7.43	5.80	7.09	7.72
Casino to Maitland	2.26	2.65	2.96	2.86	3.53	3.64
Maitland to Casino	3.30	4.02	4.50	3.97	5.01	5.22
Casino–Maitland	5.56	6.68	7.46	6.82	8.53	8.86
Macarthur to Tahmoor	4.38	4.35	4.73	8.04	8.71	9.44
Tahmoor to Macarthur	4.24	4.56	4.92	10.87	12.79	14.45
Macarthur–Tahmoor	8.62	8.91	9.66	18.92	21.51	23.88
Tahmoor to Moss Vale	4.39	4.36	4.73	8.87	9.53	10.48
Moss Vale to Tahmoor	4.25	4.56	4.92	13.72	15.61	17.61
Tahmoor – Moss Vale	8.64	8.92	9.65	22.59	25.14	28.09
Moss Vale to Marulan	4.50	4.48	4.89	9.64	10.20	12.13
Marulan to Moss vale	4.30	4.58	4.96	15.44	16.96	21.34
Moss Vale – Marulan	8.80	9.07	9.85	25.08	27.16	33.47
Marulan to Goulburn	4.50	4.48	4.89	7.64	8.08	9.72
Goulburn to Marulan	4.30	4.58	4.96	9.40	10.38	13.85
Marulan–Goulburn	8.80	9.07	9.85	17.05	18.46	23.58
Goulburn to Cootamundra	4.50	4.48	4.89	6.31	6.45	7.44
Cootamundra to Goulburn	4.30	4.58	4.96	8.75	9.19	11.35
Goulburn–Cootamundra	8.80	9.06	9.85	15.05	15.63	18.80
Cootamundra to Junee	3.03	3.04	3.64	5.20	5.54	6.87
Junee to Cootamundra	2.80	2.72	3.16	5.76	6.08	7.28
Cootamundra–Junee	5.83	5.76	6.80	10.96	11.62	14.15

(continued)

Line segment, by direction of freight	Million gross tonnes					
	Intermodal			Total		
	2014–15	2015–16	2016–17	2014–15	2015–16	2016–17
Junee to Albury	2.80	2.72	3.64	6.01	6.23	7.32
Albury to Junee	3.03	3.04	3.16	5.95	6.14	7.23
Junee–Albury	5.83	5.76	6.80	11.96	12.37	14.55
Albury to Tottenham	3.03	3.04	3.64	5.68	5.64	7.22
Tottenham to Albury	2.80	2.72	3.13	4.48	4.41	5.17
Albury–Tottenham	5.83	5.76	6.77	10.17	10.06	12.39

Notes: Totals are subject to rounding.

Sources: Data provided by ARTC.

Table 7 Below-rail gross tonnes by line segment, East-West corridor

Line segment, by direction of freight	Million gross tonnes					
	Intermodal			Total		
	2014–15	2015–16	2016–17	2014–15	2015–16	2016–17
Cootamundra to Parkes	1.48	1.45	1.26	2.71	2.51	2.91
Parkes to Cootamundra	1.51	1.87	1.81	4.12	4.24	5.93
Cootamundra–Parkes	2.99	3.33	3.07	6.83	6.75	8.85
Parkes to Broken Hill	2.50	2.40	2.27	3.00	2.85	2.79
Broken Hill to Parkes	2.50	2.64	2.26	3.74	3.59	3.68
Parkes – Broken Hill	5.00	5.04	4.73	6.74	6.44	6.47
Broken Hill to Crystal Brook	2.51	2.43	2.26	4.77	4.42	4.05
Crystal Brook to Broken Hill	2.48	2.63	2.45	3.24	3.31	3.07
Broken Hill – Crystal Brook	4.98	5.06	4.71	8.01	7.73	7.12
Tottenham to Dimboola	3.62	3.29	3.37	6.72	5.52	7.92
Dimboola to Tottenham	4.22	3.99	4.27	5.94	5.43	6.77
Tottenham–Dimboola	7.84	7.29	7.64	12.66	10.95	14.69
Dimboola to Tailem Bend	4.24	4.01	4.13	4.81	4.45	4.88
Tailem Bend to Dimboola	3.64	3.31	3.24	3.84	3.58	3.72
Dimboola – Tailem Bend	7.88	7.31	7.38	8.66	8.03	8.60
Tailem Bend to Dry Creek	3.68	3.34	4.17	3.88	3.61	4.93
Dry Creek to Tailem Bend	4.27	4.04	3.27	4.87	4.50	3.75
Tailem Bend – Dry Creek	7.95	7.37	7.44	8.75	8.11	8.68
Dry Creek to Crystal Brook	4.60	4.38	5.55	9.38	8.91	7.49
Crystal Brook to Dry Creek	5.57	5.42	4.55	7.52	7.21	10.00
Dry Creek – Crystal Brook	10.17	9.81	10.10	16.90	16.12	17.49
Crystal Brook to Port Augusta	7.56	7.33	7.29	8.92	8.83	8.96
Port Augusta to Crystal Brook	6.62	6.54	6.48	8.13	8.31	9.30
Crystal Brook – Port Augusta	14.18	13.87	13.77	17.06	17.13	18.25
Port Augusta to Tarcoola	8.07	7.73	7.71	9.35	8.05	8.15
Tarcoola to Port Augusta	6.65	6.59	6.65	11.28	7.19	8.26

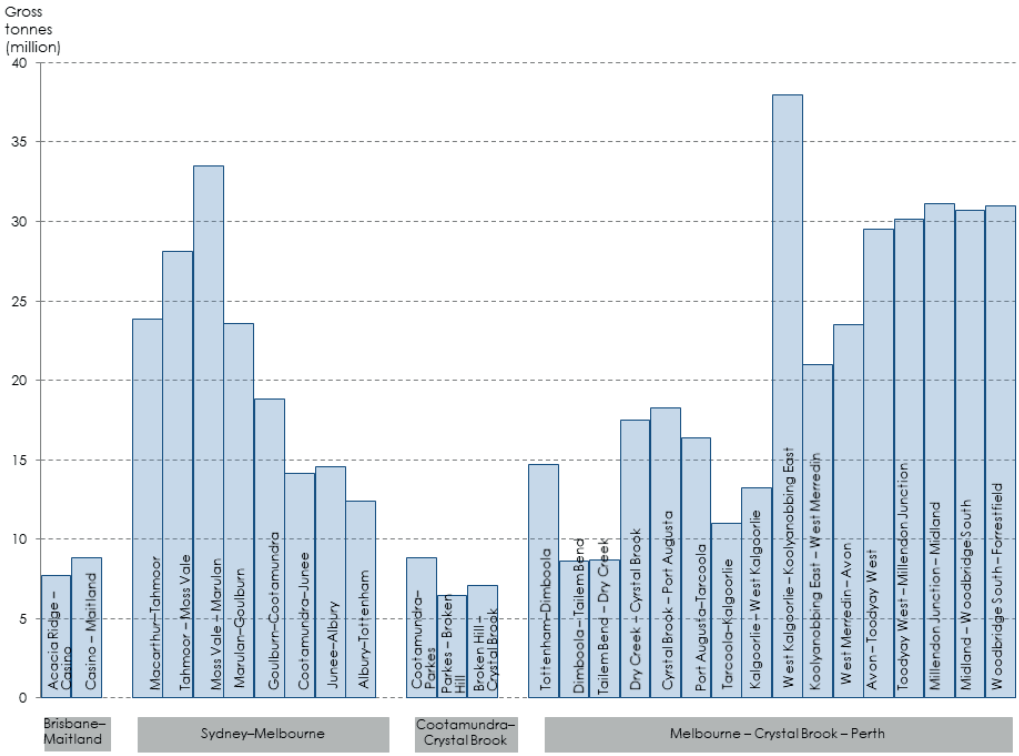
(continued)

Line segment, by direction of freight	Million gross tonnes					
	Intermodal			Total		
	2014–15	2015–16	2016–17	2014–15	2015–16	2016–17
Port Augusta – Tarcoola	14.72	14.33	14.36	20.63	15.25	16.41
Tarcoola to Kalgoorlie	4.49	4.44	5.85	4.95	4.98	5.99
Kalgoorlie to Tarcoola	6.08	5.78	4.48	6.28	6.07	5.04
Tarcoola – Kalgoorlie	10.58	10.22	10.33	11.23	11.05	11.02
Kalgoorlie to West Kalgoorlie	n/a	n/a	5.55	n/a	n/a	7.15
West Kalgoorlie to Kalgoorlie	n/a	n/a	4.45	n/a	n/a	6.06
Kalgoorlie – West Kalgoorlie	n/a	n/a	10.00	n/a	n/a	13.21
West Kalgoorlie to Koolyanobbing East	4.96	4.86	5.48	15.89	15.97	16.00
Koolyanobbing East to West Kalgoorlie	3.61	3.63	4.42	22.12	21.65	21.96
West Kalgoorlie – Koolyanobbing East	8.58	8.49	9.90	38.01	37.62	37.97
Koolyanobbing East to West Merredin	4.96	4.86	5.47	13.39	13.66	13.02
West Merredin to Koolyanobbing East	3.61	3.63	4.41	7.70	7.75	7.97
Koolyanobbing East – West Merredin	8.58	8.49	9.89	21.09	22.90	20.99
West Merredin to Avon	4.96	4.86	5.48	15.75	15.15	14.95
Avon to West Merredin	3.61	3.63	4.42	8.05	7.75	8.52
West Merredin – Avon	8.58	8.49	9.90	23.81	22.90	23.47
Avon to Toodyay West	4.96	4.86	5.48	19.27	18.56	19.71
Toodyay West to Avon	3.61	3.63	4.40	8.93	8.59	9.77
Avon – Toodyay West	8.58	8.49	9.88	28.20	27.15	29.49
Toodyay West to Millendon Junction	4.96	4.86	5.48	19.86	18.87	20.21
Millendon Junction to Toodyay West	3.61	3.63	4.41	9.05	8.86	9.93
Toodyay West – Millendon Junction	8.58	8.49	9.89	28.91	27.53	30.15
Millendon Junction to Midland	4.96	4.86	5.48	20.40	19.29	20.21
Midland to Millendon Junction	3.61	3.63	4.41	9.21	8.77	9.93
Millendon Junction – Midland	8.58	8.49	9.89	29.62	28.06	30.15
Midland to Woodbridge South	4.97	4.86	5.48	20.32	19.22	20.94
Woodbridge South to Midland	3.62	3.64	4.41	9.14	8.70	10.16
Midland – Woodbridge South	8.59	8.50	9.89	29.46	27.92	31.10
Woodbridge South to Forrestfield	4.97	4.86	5.51	20.40	19.30	20.90
Forrestfield to Woodbridge South	3.62	3.64	4.43	9.21	8.78	10.11
Woodbridge South – Forrestfield	8.59	8.50	9.94	29.61	28.08	31.01

Notes: Totals are subject to rounding. Arc Infrastructure has revised its calculation methodology and now includes Kalgoorlie – West Kalgoorlie. This new methodology applies from 2016–17 data.

Sources: Data provided by ARTC and Arc Infrastructure.

Figure 4 Total below rail gross tonnes on the interstate network, by line segment, 2016–17



Sources: Data provided by ARTC and Arc Infrastructure.

The following specific flows explain variations in intermodal traffic:

- Changing intermodal train composition. ARTC-provided intermodal tonnages are calculated from intermodal designated trains that operate on its network, not on the actual products each intermodal designated train carries. Some Pacific National intermodal designated trains carry steel products. This differs from the earlier practice where it carried steel products on steel designated trains only. To account for this change, ARTC-reported intermodal volumes are the sum of volumes from all intermodal designated trains and steel trains. Steel is moved along the East–West corridor between New South Wales (Newcastle and Port Kembla) and South Australia and Western Australia (Port Augusta, Whyalla and Perth). Steel trains also operate between Melbourne and Port Augusta and Perth. On the North-South corridor, there are also steel train movements primarily between Port Kembla and the interstate capitals.
- Intermodal traffic on the North–South segment between Sydney (Macarthur) and Cootamundra (West) includes diverging/converging traffic at Cootamundra from the East–West Corridor (via Broken Hill).
- Some intermodal rail traffic originates/terminates in terminals at Parkes/Goobang for the East–West Corridor (via Broken Hill). SCT Logistics, for example, generally operate one Goobang—Crystal Brook train per week in each direction.
- Higher intermodal traffic volumes west of Crystal Brook, where the Melbourne/Adelaide and Sydney/Parkes traffic to and from Perth and Darwin share the track.

- Intermodal flows fall to the west of Tarcoola; the junction with the Darwin line.
- Interstate capital city to capital city intermodal trains sometimes pick up and drop off freight at regional locations en route (for example the Logic terminal at Barnawartha in Victoria and Ettamogah in New South Wales).

According to ARTC's data, below-rail intermodal tonnages increased on all sectors of the North-South corridor, in both directions of travel compared to the previous financial year. The largest intermodal increase was southbound tonnages between Cootamundra and Tottenham (Melbourne), at 19.6 per cent. Increased Port Kembla—Melbourne steel coil volumes and increased Melbourne-Brisbane volumes partially account for the increase.

On the East-West Corridor, intermodal freight volumes grew on some sectors and declined on others in 2016–17. Between Parkes and Crystal Brook, intermodal tonnages declined on all sectors in both directions of travel. Westbound traffic between Tottenham and Dry Creek (Adelaide) increased, following previous declines. Westbound tonnages also increased on the Adelaide to Crystal Brook sector (where Melbourne to Perth and Sydney to Perth trains converge), but decreased to Tarcoola. Westbound tonnages increased on all sectors from Tarcoola to Western Australia. It is not possible this year to compare both intermodal and 'other' tonnages between Kalgoorlie and Perth due to Arc Infrastructure's revised calculation methodology.

Eastbound traffic from Dimboola to Melbourne increased, while from Adelaide to Dimboola it decreased. All sectors of eastbound traffic from Kalgoorlie to Adelaide similarly recorded declines, except for Tarcoola to Port Augusta. This suggests eastbound traffic from Perth to Melbourne and Sydney declined. Increased volumes from Tarcoola to Port Augusta suggests increased volumes originating from the Northern Territory.

Changes in tonnages are a comparison only to the previous financial year for each given sector. Some sectors that recorded declines still had greater tonnages in 2016–17 than other sectors that saw increases.

"Other" traffic on the interstate network

There is significant non-intermodal freight traffic, classified as "other" in Figure 5, Figure 6 and Figure 7[11].

Other significant non-intermodal freight flows are as follows:

- **Grain movements** generally join the network from a web of branch and secondary lines, connecting agricultural hinterlands to the ports. Movements on the interstate network are heaviest close to Perth and in New South Wales.
- **Aggregate, sand and limestone quarries** in the southern New South Wales Southern Highlands boost tonnages between Macarthur and Goulburn. The exhaustion of quarries in Western Sydney has resulted in expansion of mining activity in the Southern Highlands. These are a significant contributor to the relatively high tonnages between Macarthur and Marulan.
- **Iron Ore** from Mount Walton from the Yilgarn Region in Western Australia contributes a major proportion of tonnages on the West Kalgoorlie—Forrestfield line segment. Iron ore is railed in two directions. It moves east from Koolyanobbing, via Kalgoorlie, to Esperance Port. It also moves west from the Mount Walton mine to Kwinana.

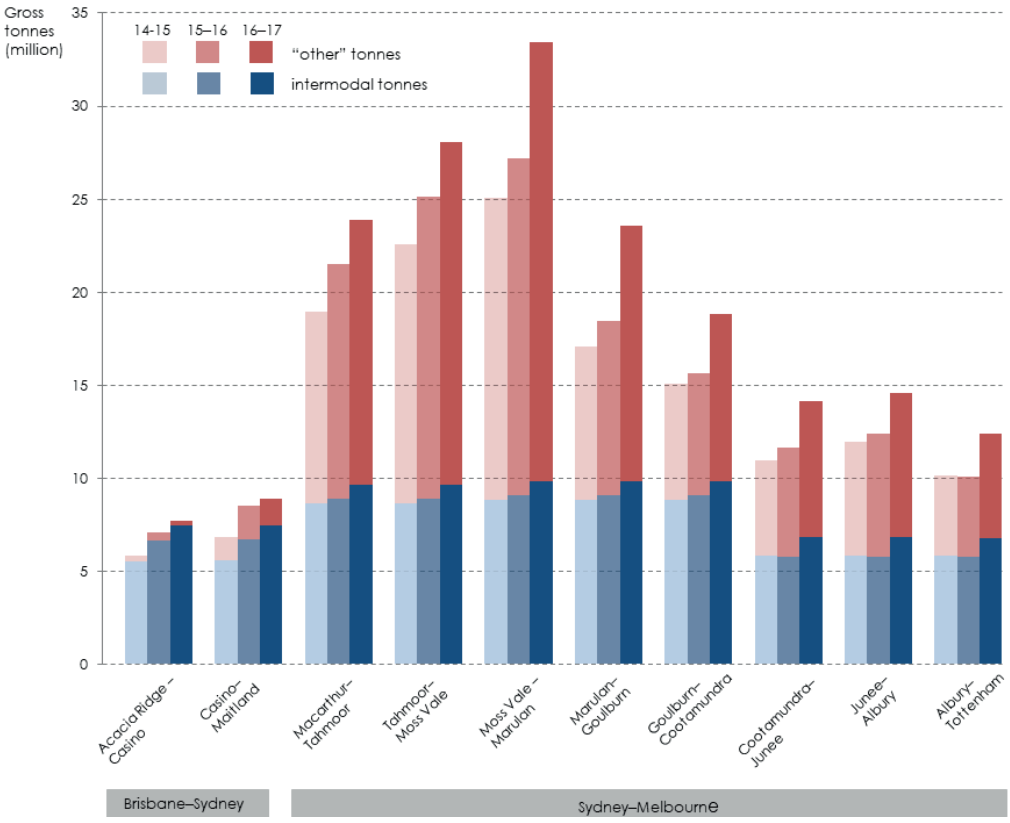
11 To obtain 'other tonnages, deduct the intermodal component from the total figure.

'Other' tonnages increased on all sectors of both the North-South and East-West corridors except:

- Acacia Ridge (Brisbane)—Islington Junction (both directions of travel);
- Broken Hill—Crystal Brook (both directions of travel); and
- Tarcoola to Kalgoorlie.

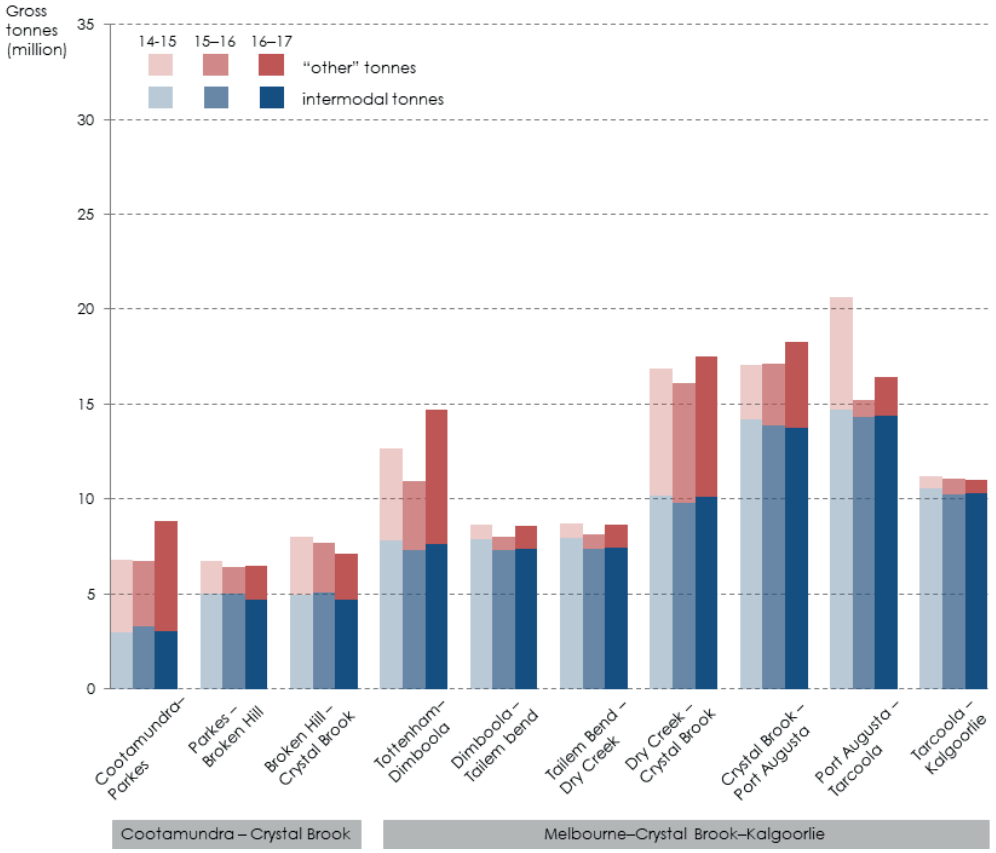
Increases between Albury and Macarthur (Sydney) may be due to significantly higher grain traffic following that season's large crop harvest. It is not feasible to compare changes by percentage for 'other' tonnages as some sectors with large increases have small baseline tonnages, which makes fluctuations more pronounced.

Figure 5 Gross tonnage on the North–South corridor, by line segment, 2014–15 to 2016–17



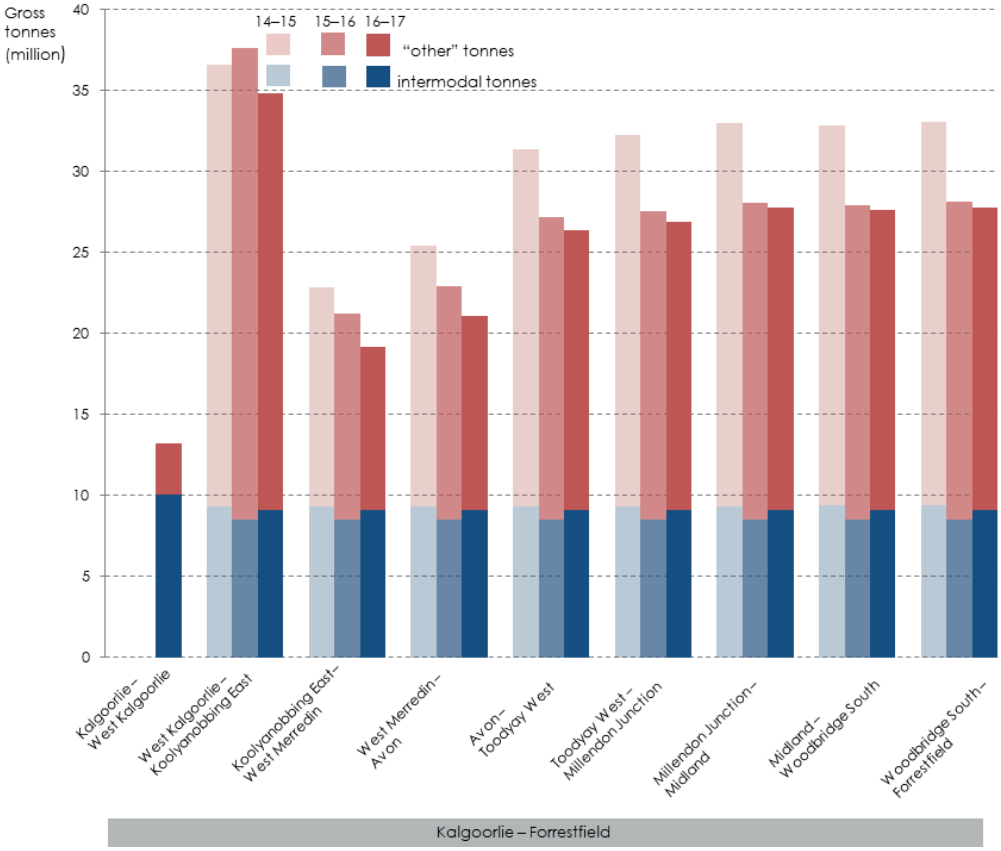
Source: Data provided by ARTC.

Figure 6 Gross tonnage on the East–West corridor, by line segment, 2014–15 to 2016–17



Source: Data provided by ARTC.

Figure 7 Gross tonnage on the East–West corridor, by line segment, 2014–15 to 2016–17

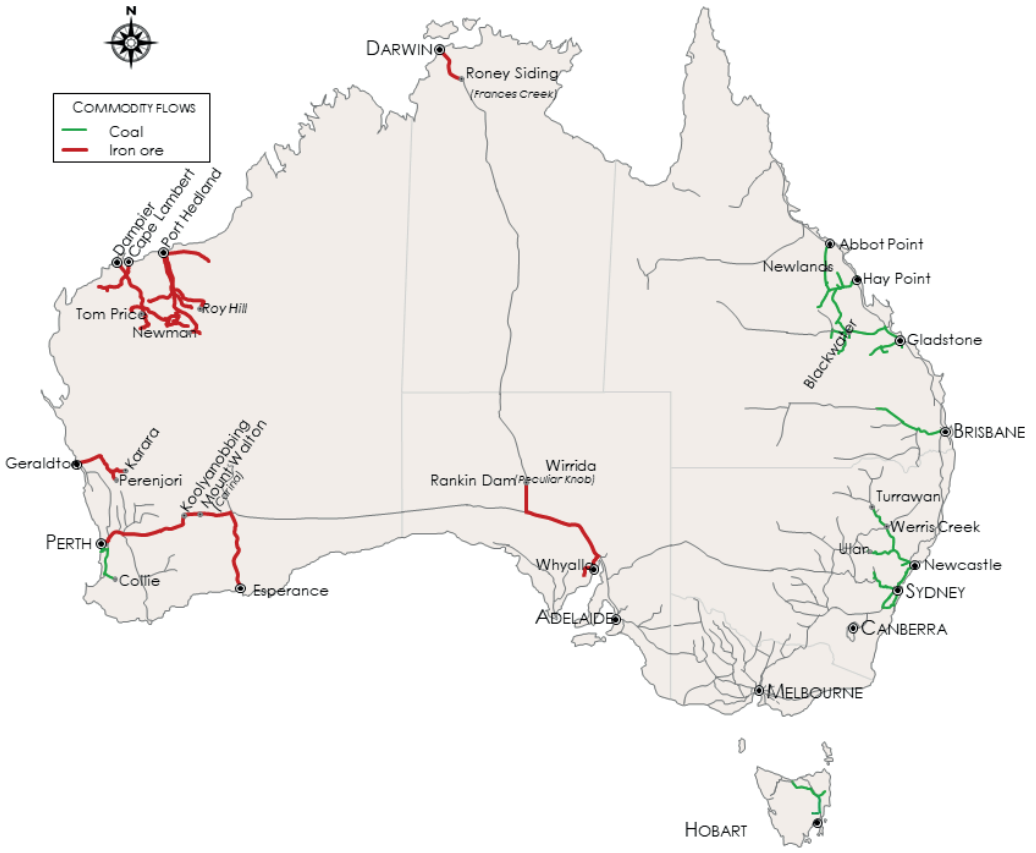


Source: Data provided by Arc Infrastructure.

Rail freight traffic, by commodity

This section discusses rail freight traffic by commodity or market. Iron ore and coal are the rail industry's two largest bulk freight flows.

Figure 8 Principal iron ore and coal flows



Iron ore traffic

Australia exports most of its iron ore,[12] almost all of which is moved to port by rail[13]. The largest flows are in the Pilbara region of Western Australia, which accounts for over 94 per cent of Australia's iron ore exports (BITRE, 2014b). The integrated railways of the Pilbara region, by infrastructure owner (Figure 9), are:

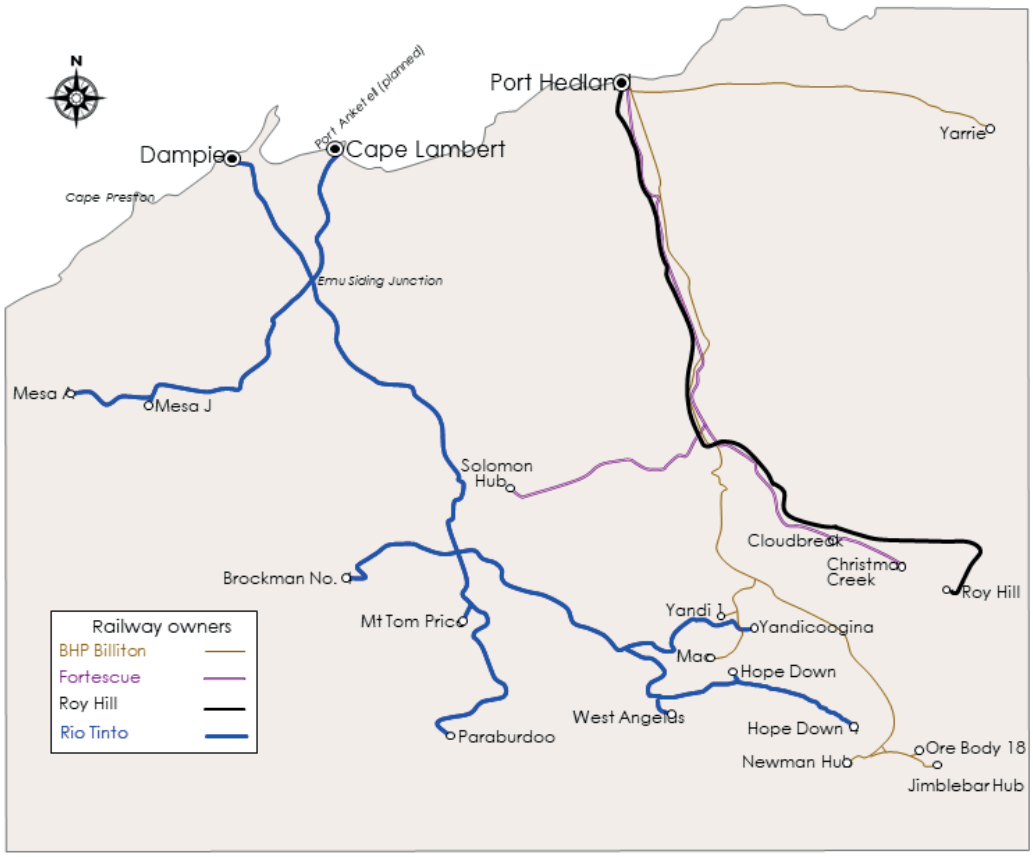
- **Rio Tinto:** The Robe River to Cape Lambert and the former Hamersley Iron's network to Port Dampier. Since 2012, trains on the Hamersley railway have been approximately 2.4 kilometres long and with a capacity of 26 000 tonnes (BITRE 2013, p. 31). Rio Tinto inaugurated its first driverless train revenue service on 10 July 2018. The train carried 28 000 tonnes of iron ore over 280 kilometres from Tom Price to Cape Lambert (Rio Tinto 2018).

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

13 Rail has an estimated 86 per cent share of the domestic iron ore freight task, with road having an estimated two 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 2014b, p.21.

- **BHP Billiton:** The Goldsworthy line (to Yarrie) and the Newman line run to Port Hedland. Each train on the Newman line can carry approximately 37 000 tonnes (BITRE 2013, p. 27). The Goldsworthy (to Yarrie) line ceased operations 2014 but remains mothballed.
- **Fortescue Metals Group:** The Fortescue Hamersley line from Solomon Hub and the Christmas Creek line run to Port Hedland. Trains on these lines can haul approximately 33 000 tonnes each (BITRE 2013, p. 27).
- **Roy Hill Holdings:** A 344 kilometre railway from Roy Hill to Port Hedland. These trains typically haul 232 ore cars, with a payload of more than 32 000 tonnes of ore.

Figure 9 Pilbara iron ore railways, by infrastructure owner



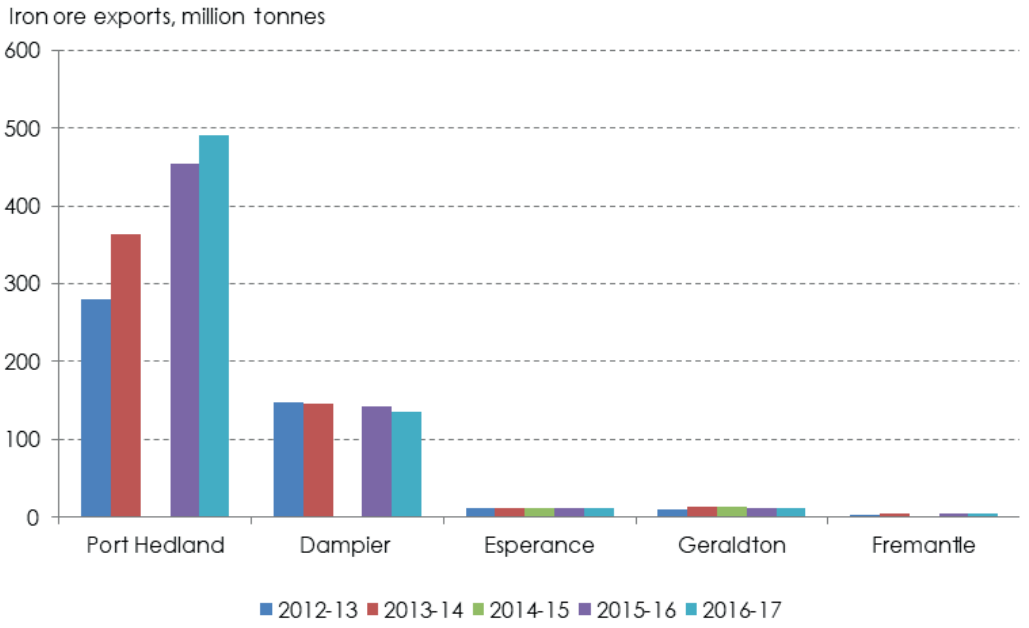
The scale of the task means rail is the most efficient means for transporting iron ore from mine to port. Tonnages exported, by principal port, denote tonnages hauled by the iron ore railways. See Table 8.

Table 8 Iron ore exports, million tonnes, 2016–17

Port Hedland[14]	Dampier	Cape Lambert (Port Walcott)	Esperance	Geraldton	Fremantle (Perth)	Total
490.9	135.1	N/A	11.2	11 8	4.3	641.5

14 The Pilbara Ports Authority source document reports total throughput, itemised by commodity type as a percentage of the total. The totals listed here for Port Hedland and Dampier are what BITRE has calculated according to the iron ore percentage of the total.

Figure 10 Iron ore exports by financial year



Notes: Cape Lambert iron ore facilities lie within the administrative area of Port Walcott. The data for Port Walcott is not available for the reporting periods.

Segmented data for Port Hedland and Dampier for 2014–15 is not available. According to the Pilbara Ports Authority's 2014–15 annual report though, approximately 579 million tonnes of iron ore was exported through the two ports combined (Pilbara Ports Authority 2015, p.24,)

Sources: Pilbara Ports Authority (2017, p.20); Southern Ports (2017, p.45); Fremantle Ports (2017, p.34); Mid West Ports (2017, p.27); BITRE (2014b)

Coal traffic

Similar to iron ore, rail is the best and dominant transport option for transporting coal from mine to port, particularly given the coalfields are mostly located well inland. Most Australian (black) coal production is in Queensland and New South Wales. Queensland coal is predominantly metallurgical (used in steel making) while the New South Wales coal is predominantly thermal (typically used in electricity generation)[15].

15 BITRE (2013, p. 9) gives an overview of coal attributes.

Australia's principal rail coal haulage is from these two states. Aurizon manages the Central Queensland Coal Network, which is narrow gauge track with train axle loads of 26.5 tonnes. The network comprises five coal systems. ARTC largely manages the New South Wales (standard gauge) Hunter Valley system. The systems are:

- **Newlands (Queensland)**. This system runs through the northern end of the Bowen Basin, to the port at Abbot Point. The line services mines at Collinsville, Sonoma, Newlands, Lake Vermont and Clermont. Aurizon recently linked it to the Goonyella Rail Corridor (For more details see Aurizon 2018a).
- **Goonyella (Queensland)**. Goonyella is an electrified system that services the Bowen Basin coal region. It primarily serves the terminals at Hay Point and Dalrymple Bay. (For more details, see Aurizon 2018b.)
- **Blackwater (Queensland)**. This system services the Bowen Basin coal region. It delivers coal to the two export terminals at the Port of Gladstone. It also services domestic users such as the Stanwell and Gladstone power stations, Cement Australia and Comalco refinery. The system consists of mostly electrified duplicated lines that extend west from Rockhampton. (For more details see Aurizon 2018c.)
- **Goonyella to Abbot Point (GAP (Queensland)**. This system corresponds to the 68 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 [Goonyella Abbot Point Expansion] through to and at) the port of Abbot Point.
- **Moura (Queensland)**. This system is approximately 242 route kilometres and services the Boundary Hill, Dawson, and Callide mines. It is single track with passing loops and is linked to the Gladstone power station, Comalco refinery, Queensland Alumina Limited, Cement Australia and the R G Tanna and Wiggins Island coal terminals at the Port of Gladstone. (For more details see Aurizon 2018d.)
- **Hunter Valley (New South Wales)**. Coal is transported to three coal-loading terminals in Newcastle and to domestic users. Train axle loads are up to 30 tonnes (ARTC 2017, p.22). According to ARTC, 2017 contracted export volumes were 192.5 million tonnes per annum, which will remain stable until 2024, at which time ARTC forecasts it to drop to 152 million tonnes per annum by 2027 (ARTC 2018, p 4).

Table 9 Annual coal traffic, Queensland and New South Wales, 2017–18

	Queensland					NSW
	Blackwater/WIRP[16]	Goonyella	Moura	Newlands	GAPE	Hunter Valley
Net tonnes (m)	**62.7**	**126.5**	**11.1**	**13.1**	**16.2**	**158**

Notes: Queensland tonnages include all above rail operators.

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)

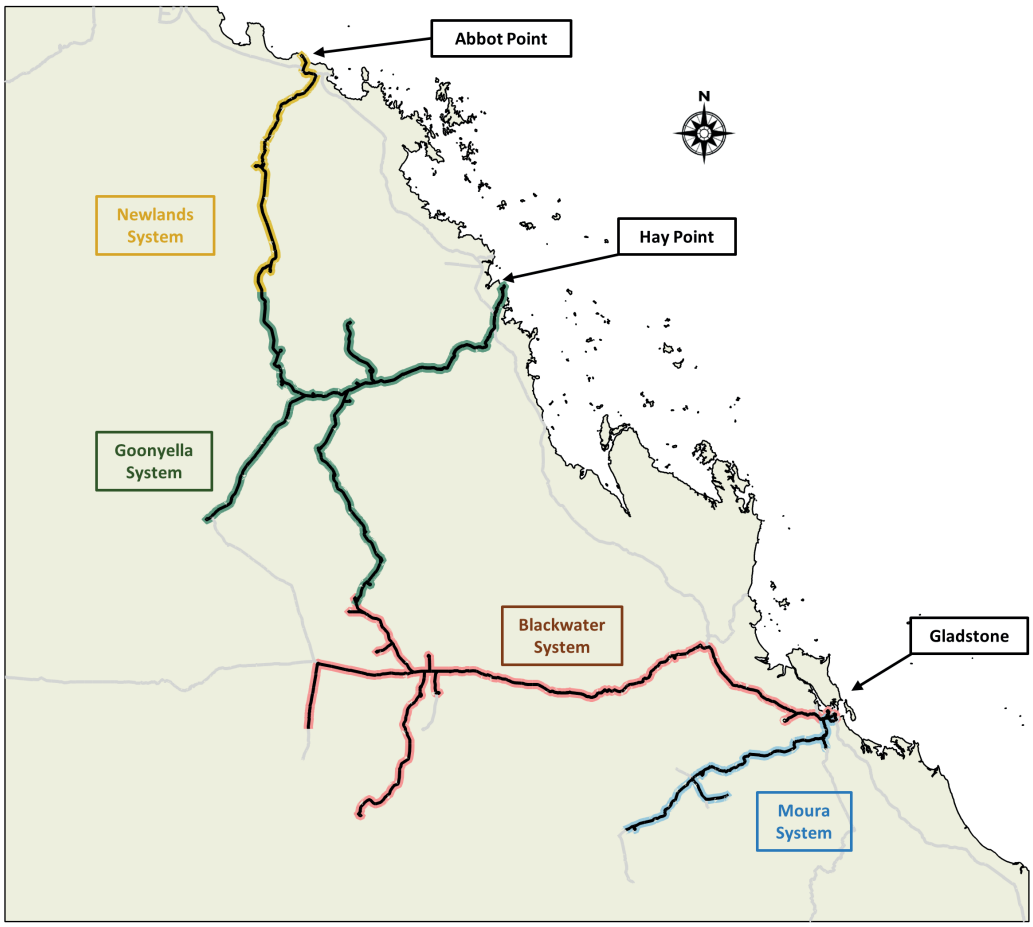
Sources: Aurizon (2018e, p.71); ARTC n.d. (multiple issues).

16 Wiggins Island Rail Project

Figure 11 ARTC Hunter Valley Coal Network

Map courtesy of ARTC.

Figure 12 Central Queensland Coal Network



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

- The West Moreton coal fields in southern Queensland);
- The Southern mine region at Wongawilli Colliery, New South Wales;
- The Metropolitan Colliery, near Helensburgh, New South Wales;
- The Tahmoor colliery, near Picton, New South Wales;
- The Western coal region, near Lithgow, New South Wales; and
- Fingal, in Tasmania, by Tasrail.

Aurizon and Pacific National dominate coal haulage, with involvement also by Genesee and Wyoming Australia and Southern Shorthaul Railroad[17]. Aurizon is the main coal train operator in Queensland.

17 Southern Shorthaul Railroad operate coal trains in New South Wales on behalf of Centennial Coal.

Table 10 Aurizon above rail coal haulage, Queensland and New South Wales

	2016–17	2017–18
Tonnes (million)	198.2	212.4
Net tonne kilometres (billion)	47.6	50.4

Source: Aurizon (2018e, p.35)

Approximately 90 per cent of coal extracted in Queensland and 73 per cent in New South Wales is exported. Coal extracted in Tasmania is used domestically. Table 11 shows coal export volumes by port for 2016–17 and Figure 13 shows port specific coal exports over the four years 2013–14 to 2016–17.

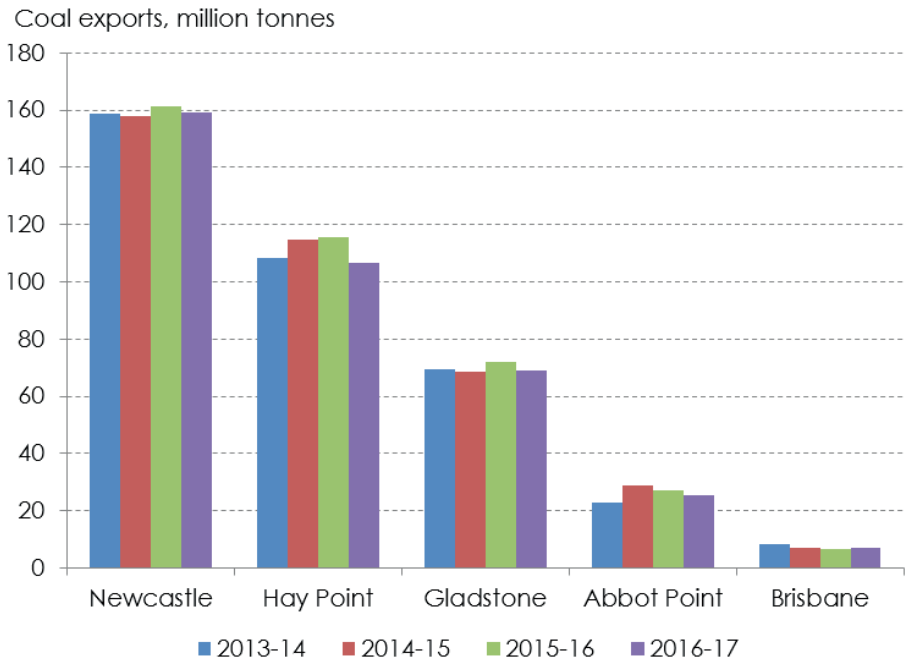
Table 11 Coal exports, by principal ports, (million tonnes), 2016–17

Newcastle[a]	Hay Point	Gladstone	Abbot Point	Port Kembla	Brisbane
159.01	106.5	68.9	25.4	n/a	6.9

Note: The Port of Newcastle figure is for the 2017 calendar year.

Sources: Port of Newcastle (2017); North Queensland Bulk Ports Corporation (2018); Port of Brisbane (2018), Gladstone Ports Corporation (2018).

Figure 13 Coal exports by port



Sources: Port of Newcastle (2017); North Queensland Bulk Ports Corporation (2018); Port of Brisbane (2018); Gladstone Ports Corporation (2018); previous editions of *Trainline*

Grain traffic

A major role for Australia's railways is hauling agricultural produce from rural areas to ports for export and, to a lesser extent, domestic consumption. Grain harvests are predominated by cereal grains (for example wheat, barley and oats), but also pulses and oilseeds.

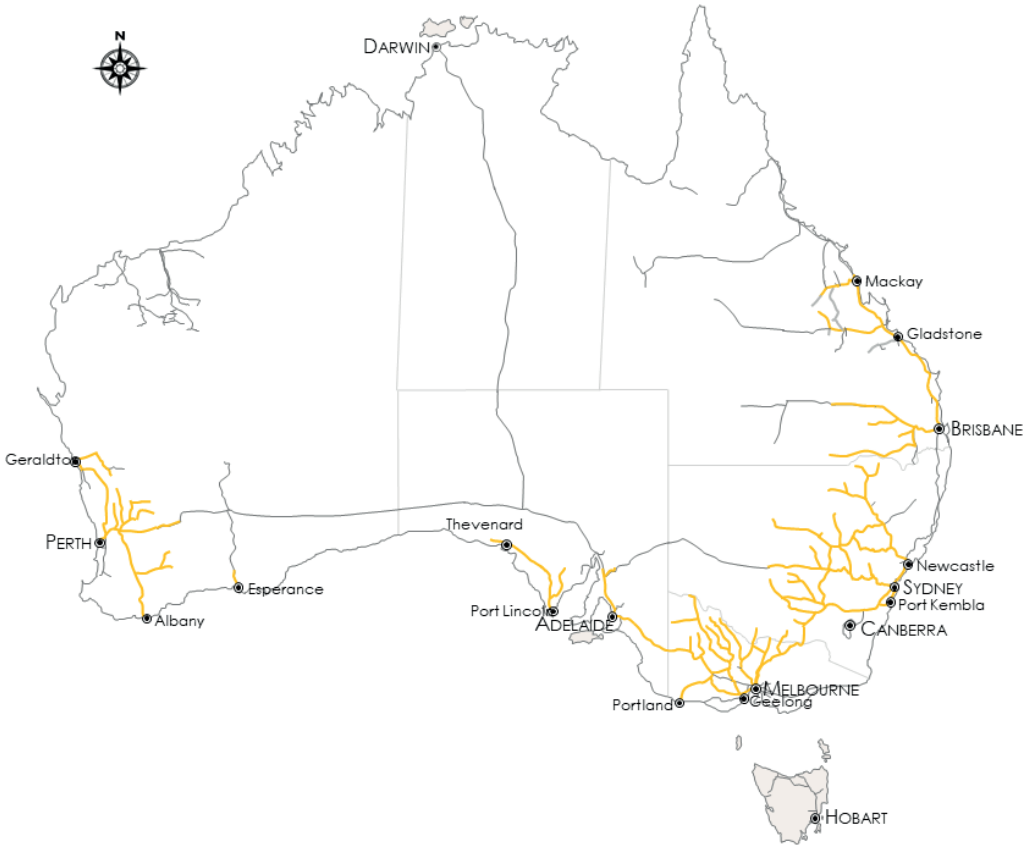
Average annual grain production between the years 2010 and 2015 (wheat, coarse grains, pulses and oilseeds) was 45 million tonnes, 33 per cent more than average annual production levels for 2005 to 2010. ABARES estimates that Australia produced almost 38 million tonnes in 2017–18, down from approximately 56.5 million tonnes the previous financial year (ABARES, 2018).

Approximately 73 per cent of the harvest over the five years 2010 to 2015 was exported (Grain Growers 2016, p.2). According to the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES), approximately 85 per cent of Australian wheat produced in 2012–13 was exported, at a value of $6.3 billion (ABARES 2015, pp.4, 13).

US based company Watco currently hauls grain in Western Australia for CBH Group. In July 2018, the company announced it had signed a contract with GrainCorp to provide the company's rail transport of its Queensland crop. This will include hauling grain to Mackay, Gladstone, and Fisherman Islands. As part of the agreement, Watco is purchasing eight locomotives from the United States and an unspecified number of new wagons from China. Watco expects to commence services in the last quarter of 2019. (The Despatch, July 2018, p.2)

Figure 14 shows grain flows by rail. This traffic largely uses dedicated grain haulage branch lines, which connect with main lines. In September 2018, there was an estimated 5 100 route-kilometres of operational railway track that was largely or exclusively used for grain haulage.

Figure 14 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"). 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. Rice and oilseeds are also included.

The map shows grain flows along the railway lines that are designated as operating in July 2018. Some railways — notably in south-west Western Australia and in central New South Wales — are not shown as they are classified non-operational.

As discussed in BITRE 2013 (pp. 109–10), eighteen major ports regularly export grain.[18]

Rail has traditionally dominated grain transport over long distances, while road transport becomes more competitive over shorter distances.

AEGIC (2014, p. 33) illustrated 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[19] through to the export vessel. As a major supply chain cost, therefore, the mode choice plays a major role in the overall costs.

18 These rail ports are, in decreasing order of 2011–12 grain exports, Fremantle, Albany, Geraldton, Melbourne, Newcastle, Esperance, Port Adelaide, Port Lincoln, Port Kembla, Geelong, Brisbane, Portland, Port Giles, Sydney, Wallaroo, Gladstone, Mackay, Thevenard. (See BITRE 2013, p. 110.)

19 The farm gate price is the global price the grain grower receives, minus expenses.

Grain traffic trends

While rail transport has a traditional advantage for grain transportation over long distances and is the preferred mode choice, this advantage is not absolute and has been partially eroded by other factors that have improved road transport's competitiveness or restricted rail transport's efficiency[20]. These include:

- Variable infrastructure quality across the networks, slower speeds, the need in places to change locomotives from mainline types to branch line types, chokepoints and short crossing loops at strategic locations[21];
- Variable rolling stock age and capacity, which can at times be less than what the infrastructure can accommodate;
- Degrees of grain handlers' investment in grain receival sites, including closure of smaller sites;
- Improved roads and road transport services;
- Increased containerisation of grain;
- Deregulation of grain export marketing, which has seen smaller shipments being moved on diverse pathways for a broader range of bulk handlers and export marketers;
- Rail industry restructuring, funding and ownership changes;
- Rail transport and infrastructure availability;
- Increased domestic grain consumption of wheat produced in New South Wales, for which road transport is better suited;
- Coordinating train loading times with port receival times; and
- Weather events.

While track infrastructure may reduce rail transport's efficiency, this should be seen in the context of how much grain travels on the lower grade lines. According to advice from John Holland Rail, for example, the amount of grain traffic on these lines is already low; thus, the significance of these restrictions should be seen in that context.

For the 2016–17 season, most grain in Victoria travelled by road to ports due to the reduced availability of rail transport caused by track management issues. Previously 60 per cent of product in the state travelled by rail, but in 2016–17 the mode share was reversed. According to Emerald Grain, the company had to pay for rail transport that they could not use while also paying for road transport (ABC, 2017). Graincorp advised BITRE that the loss of each 40 wagon train requires 45 B-Double replacement trucks. This increased road traffic includes both taking the product to port and return trips to the receival sites.

The Murray Basin Rail Project, currently underway, is aimed at mode shift from road to rail, including grain transport. Central to the project is conversion of Victoria's north west rail network from broad to standard gauge, upgrading and re-opening of the Ararat to Maryborough standard gauge line, and increasing axle loads to 21 tonnes. Gauge standardisation will boost port access for the Murray Basin rail network. Post completion, trains originating from the Murray Basin will also have direct access to the deep-sea Port of Portland, which has standard gauge access only, in addition to the ports of Geelong and Melbourne, both of which have both broad and standard

20 Trainline 3 discusses in detail these changes and challenges to grain transport by rail. (See BITRE, 2015)
21 For more information on track infrastructure constraints, from a grain grower's perspective, see (Grain Central 2017)

gauge access[22]. The option of using either the Port of Geelong or Portland, which are nearly equidistant from the north west, is anticipated to stimulate competition between the two ports. The deeper water at Portland also means rail freight originating from the Murray Basin region can be exported on larger bulk carriers. Stage 2—standardisation of the line from Mildura/Yelta to Dunolly, reconstruction of the previously non-operational Maryborough to Ararat standard gauge line, and track upgrades is now complete. The following works are not yet completed:

- Standardisation and upgrade of the lines from Maryborough to Manangatang, Korong Vale to Sea Lake, and Warrenheip to Gheringhap;
- Gauge standardisation of the line from Dunolly to Manangatang, Korong Vale to Sea Lake, and Warrenheip to Gheringhap; and
- Freight-passenger traffic separation from Maryborough to Warrenheip.

The project is due for completion in late 2020. (See Minister for Public Transport (2018))

Figure 15 Reconstruction of Ararat-Dunolly line

Note: The image above shows a ballast train at Amphitheatre during reconstruction of the Ararat-Dunolly line as part of the Murray Basin Rail Project, January 2018. Photo courtesy of Rodney Avery

In 2014, Graincorp commenced its Project Regeneration, whose aim, it claims, is a better network of grain storage sites in eastern Australia and more efficient rail transport of its products, which will provide higher storage capacity, more efficient turnaround times, and faster train cycle times (Graincorp 2017). Project Regeneration is anticipated to return one million tonnes of grain presently moved truck back to rail with half of that expected to occur in Victoria. The project is expected to be completed in 2020. According to Graincorp, three receival sites in Victoria and

22 For more information, see Public Transport Victoria 2015

six in New South Wales have been completed, with another 10 planned or under construction in 2017, including one (Yamala) in Queensland. According to Graincorp, the completed sites have provided savings which has created some mode shift back to rail. Graincorp also claims it has $200 million in funds, which it is ready to invest should governments invest (further) in track infrastructure.

Grain transport by rail in New South Wales has become more efficient and hence competitive through improvements to the state's Country Rail Network (CRN), which John Holland Rail manages under contract to Transport for NSW as part of the Annual Works Plan. Annual Works Plan expenditure is approximately $180–200 million per annum. While the company works with and advises Transport for NSW, the latter decides what work will be done, which John Holland Rail, as track infrastructure manager in turn, implements. The works are not standalone projects but are done in conjunction with routine maintenance.

Such improvements include replacement of pre-existing rail with used heavier rail and replacement of old sleepers with approximately 500 000 steel sleepers. According to advice from John Holland Rail, all continuously-welded sections of the CRN are now steel sleepered, following completion of the steel sleeper insertion program on the Werris Creek-Armidale line. Timber sleepers are now only on jointed sections of rail. The sleeper replacement works are expected to be completed by 2022.

These track improvements enable heavier axle loads, which means heavier and more powerful locomotives can operate on sections of the CRN where they previously could not and grain hoppers can carry heavier loads. 83 per cent of the CRN has a capability of 81 tonne gross or higher (which is the maximum capacity of more than 80 per cent of the current bulk grain wagon fleet). This translates to reduced transport costs and improved competitiveness of rail transport in turn[23].

John Holland Rail has also received funding under the NSW Government's Fixing Country Rail programme for:

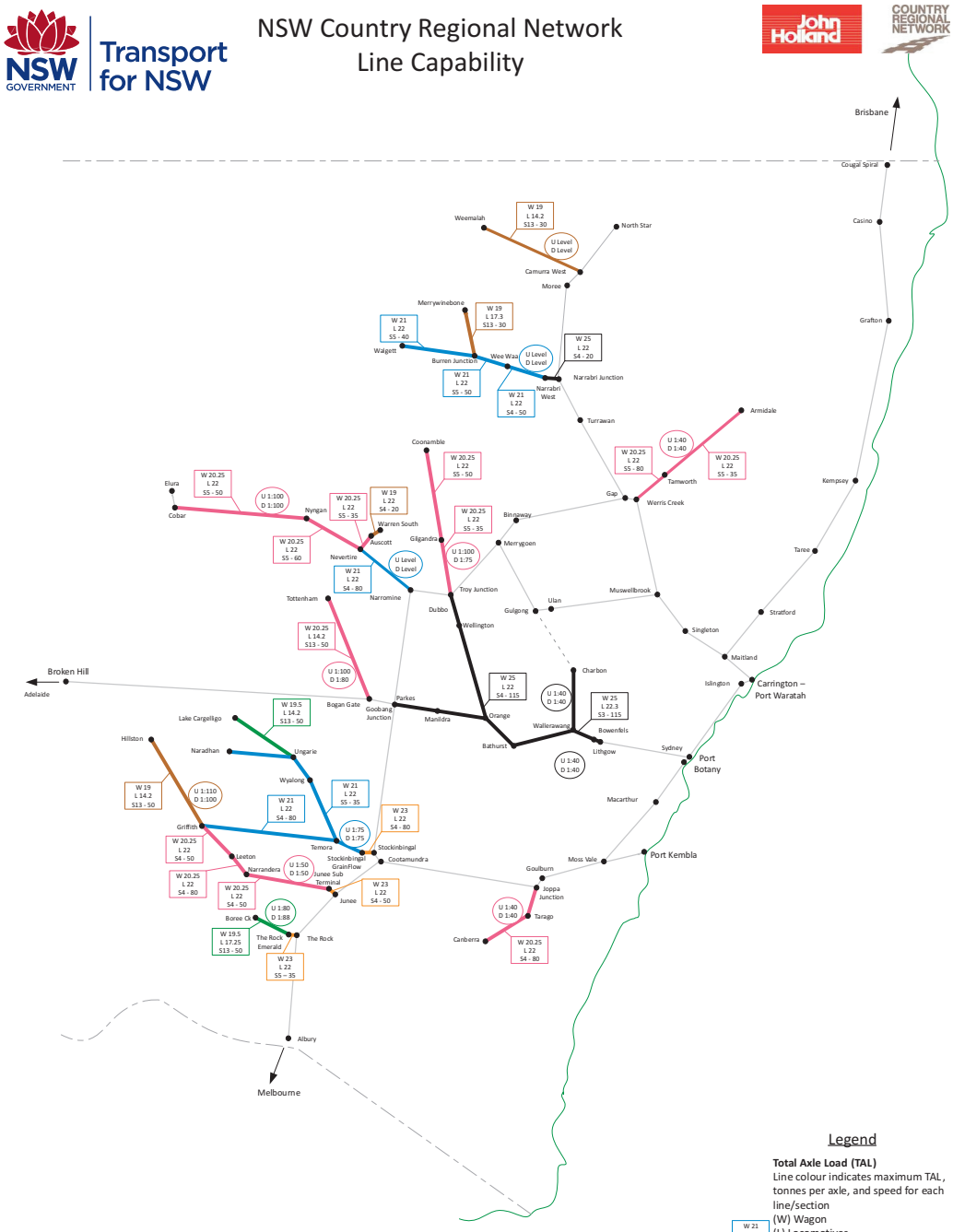
- Junee North triangle (design);
- Hermidale siding (construction); and
- Junee – Griffith rail replacement and line upgrade (construction).

According to John Holland Rail, reinstatement of the Junee North triangle would allow services from north of Junee to run directly to Sydney, without having to enter the Junee yard for reversing. The Hermidale siding will increase capacity between Nyngan and Cobar. The Junee – Griffith line rail replacement project will enable 25 tonne train axle loads, up from the current 20.25 tonne limit.

On 18 April 2018, Watco hauled the longest grain train in Australian history. The train consisted of 120 wagons carrying 9 100 tonnes of wheat and was almost 1800 metres in length.

23 For further information on Transport for NSW's CRN works see https://www.transport.nsw.gov.au/projects/current-projects/country-regional-network-crn

Figure 16 New South Wales Country Rail Network Infrastructure Standards



Note: The map above shows the New South Wales CRN network capabilities by line. Map courtesy of Transport for New South Wales.

Box 3 Further reading on railway grain handling

Overviews:

- A *review of trends in containerised grain exports* can be found in the article written by Mark Fitzgerald "Container exports open market opportunities", (*Grain Business*, July 2014).

Queensland reports:

- Transport, Housing and Local Government Committee (Queensland, 2014), Rail freight use by the agriculture and livestock industries, Report No. 45.

New South Wales reports:

- 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).
- Pollard 2012, "Moving NSW wheat: the post deregulation experience", *Railway Digest*, reviews the logistics changes to wheat haulage in New South Wales.

Victoria

- *Victorian rail freight network review. Switchpoint: the template for rail freight to revive and thrive!* (2007)
- *Grain Logistics Taskforce Report, Department of Transport* (2011)

Non-bulk and short-haul rail freight traffic

Non-bulk and short-haul (a distance that is shorter than that which intermodal rail transport is usually considered viable) rail freight movements are mostly containerised, although SCT Logistics, for example, typically uses louvre wagons for their palletised traffic. (See Box 1 for further discussion of defining non-bulk rail freight.) Short-haul traffic is often thought to be uncompetitive with road freight, due to the relative short distances over which the freight is moved. It can, however, be successful. To succeed, short-haul rail traffic needs:

- Minimised drayage costs between the hinterland and intermodal terminal;
- Low line haul and high road haul costs; and
- A convergence of parties who encourage short haul and viable hinterland terminals (BITRE 2016b, pp v-vi)24.

24 BITRE 2016b (Why short-haul intermodal rail services succeed), provides an in depth discussion on the (potential) vialbility of short-haul rail transport in Australia.

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), is a primary example.
- Regional export movements, from inland terminals to the port. This traffic includes agricultural commodities, such as grain, hay, sugar, cotton, grains, livestock, wine and logs.
- 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). These local rail services also shift empty containers. SCT Logistics' daily container shuttle train from its Penfield intermodal terminal to the Port of Adelaide for Treasury Wines Estate is an example.
- Export maritime activities are generally based around single commodities and/or a single company's logistics-based hub, such as agricultural produce from the Fletchers International terminal at Dubbo.

The following discussion focuses on port rail flows to or from capital cities and urban shuttles, while noting other non-capital city flows can operate.

Rail (and road) volumes of containers through the primary capital city ports are reported in BITRE's regular Waterline series. (BITRE 2017a gives the latest figures.)

Landbridge and regional movements

Port of Brisbane — Fisherman Islands

Figure 17 shows the rail container flows between Queensland intermodal terminals and the Port of Brisbane (Fisherman Islands).

Figure 17 Rail container operations serving the Port of Brisbane (Fisherman Islands)

The Port of Brisbane used to manage export traffic, including seasonal cotton, from Dalby and Goondiwindi, but these ceased in late 2009 and September 2014 respectively. According to advice from Aurizon, the cessation of these operations was due to the inability of rail to transport anything higher than 8'6" high containers due to the Toowoomba Range profile (tunnel restrictions). This made rail transport from these centres unviable and the traffic has switched to road transport. The Queensland government is currently lowering the tunnels to facilitate the transportation of 9'6" containers. (*Railway Digest,* June 2018, p.15)

Containers are still moved to/from northern destinations to the Port of Brisbane.

Sydney Ports — Port Botany

Figure 18 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 moves a range of containerised commodities, primarily agricultural, to Port Botany. These commodities include:

- Specialised grain, conveyed from Forbes, Narrabri, Dubbo, Coonamble and Narromine;
- Containerised grain and cardboard (from Visy's plant at Tumut) from Harefield (near Junee)[25];
- Viterra pack cereals (wheat and barley), oilseeds and pulses from Narrabri;
- Cotton from Warren, Nevertire, Wee Waa, Narrabri, and Trangie South;
- Logs from Bathurst/Kelso and Newcastle (Sandgate);
- Logs from Goulburn to Port Botany and Port Kembla;
- Grain, oilseeds, pulses, and refrigerated meat from Dubbo; and
- Aluminium ingots and various agricultural produce from Newcastle.

NSW Port's estimate of rail's modal share for the Port of Botany for the calendar year to date at June 2017 was 18.8 per cent. (NSW Ports 2017, p.4)

Figure 19 QUBE Logistics Port Botany to Harefield Train

Note: The image above shows a QUBE Logistics train from Port Botany to Harefield near Yass. Photo courtesy of Rodney Avery.

25 QUBE Logistics, which operates this service, has been alternating between using the Port of Melbourne and Port Botany for this service.

Port of Melbourne

Figure 20 shows the major regional container export flows through the Port of Melbourne. It does not show rail container flows through the port that originate or are destined for Tasmania.

Figure 20 Rail container freight operations serving the Port of Melbourne

The non-urban movements can be categorised into western and eastern Victoria flows, and southern New South Wales flows. Products transported by rail are as follows.

Intrastate Victoria.

- Merbein (Mildura) – grain, wine, grapes, fruit;
- Donald - peas, grain;
- Westvic Container Export Services, at Warrnambool - meat and dairy products;
- Wimmera Container Line, at Dooen (near Horsham) - grain, hay, and pulses;
- Maryvale in the Latrobe Valley – containerised paper;
- SCT Logistics rail hub at Barnawartha – cotton for export to Asia; and

Southern New South Wales.

Export flows to the Port of Melbourne, including:

- Deniliquin – containerised rice[26];
- Tocumwal - grain, hay, rice, potatoes, cottonseed, dairy;
- Griffith and the Wumbulgal terminal – containerised wine;
- Containerised cereals, cotton and hay from Wumbulgal;
- Rice and pelleted feeds for animals, from Leeton; and

26 BITRE estimates 13 million tonne kilometres of rice was transported by rail from southern New South Wales to Melbourne in 2015–16. See BITRE 2018, p.7.

- Containerised paper from the Ettamogah Rail Hub.

Port of Fremantle — Inner Harbour

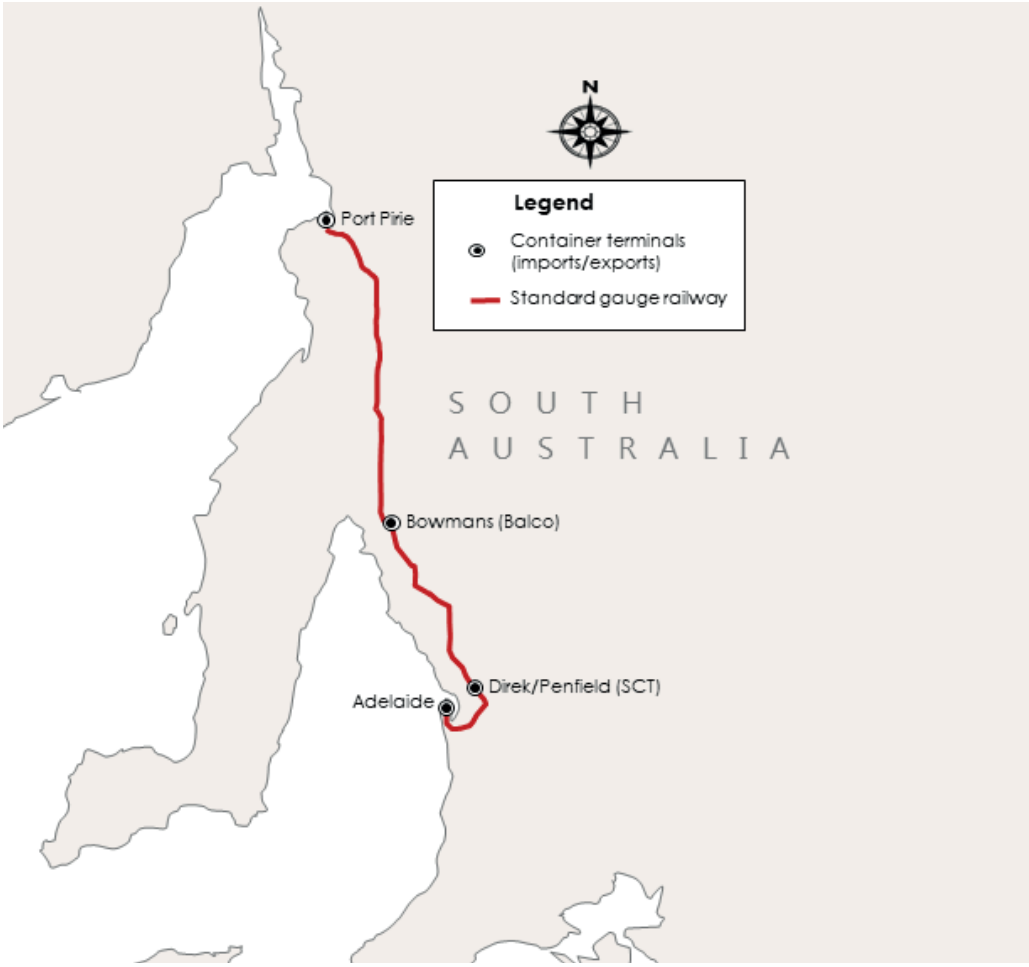
Figure 21 Rail container operations serving Kwinana

The primary regional container export flows are nickel from Malcolm (near Leonora) and nickel products from a nickel smelter south of Kalgoorlie.

Port Adelaide

There are regional maritime container traffic flows to Port Adelaide. 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 22 Rail container operations serving Port Adelaide



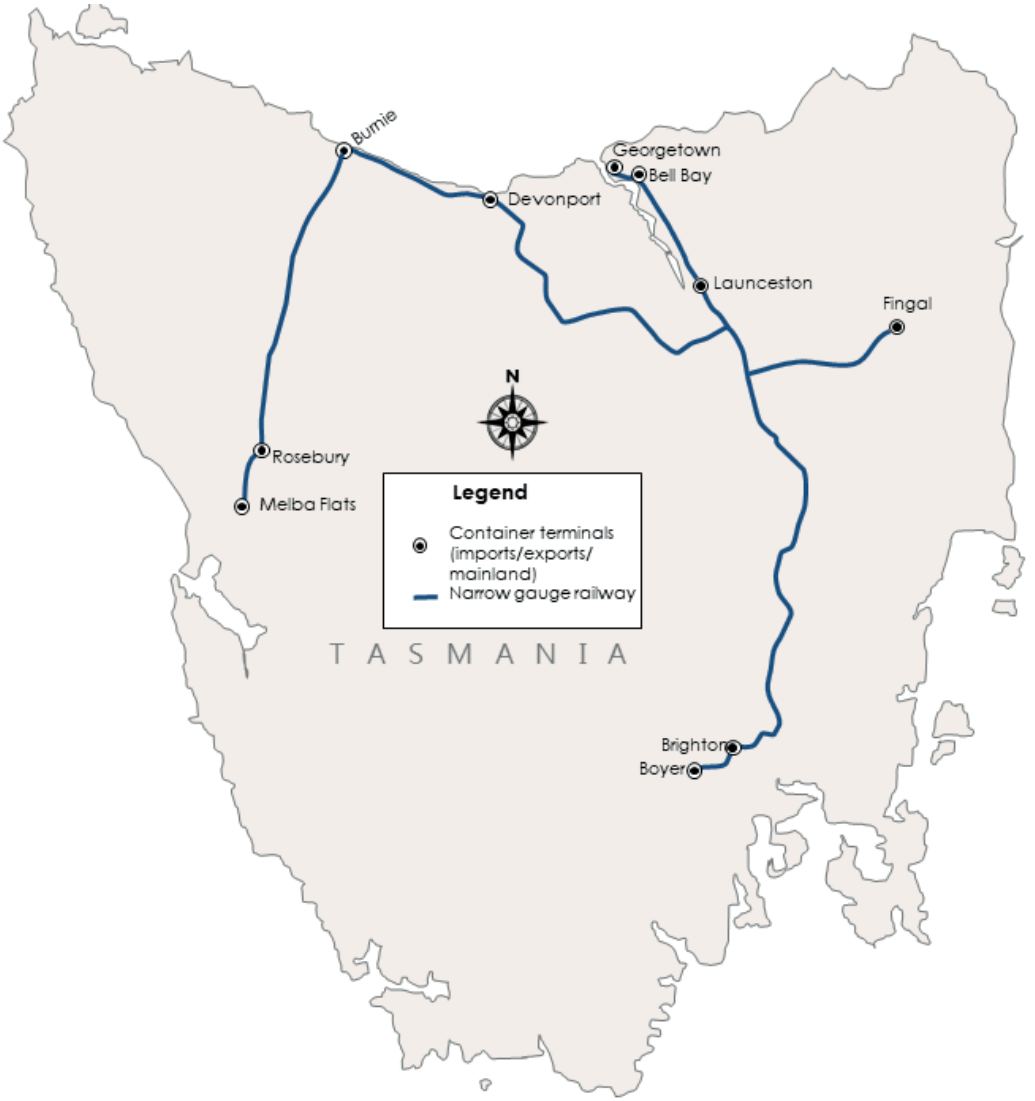
According to advice from Bowmans Rail, regional trains operate between the Bowmans Rail's intermodal terminal (operated by Balco Australia) and Outer Harbor. The terminal is used for the export of agricultural products such as hay, pulses, lead, mineral sands and project materials. The facility is also used as a consolidation point for a range of commodities, a task that would otherwise be done at the port. The terminal is served by rail services that convey containers to Outer Harbor. Some Bowmans container trains also serve the Nyrstar lead smelter at Port Pirie. Containerised lead is collected from the smelter for export through Outer Harbor.

Genesee and Wyoming Australia also transports Oz Minerals copper concentrates for export from Prominent Hill in northern South Australia to the Inner Harbor Port Adelaide berth #29 bulk precinct.

Tasmania

Tasmania has a growing freight rail network which is operated and maintained by Tasrail, the state's fully integrated railway. With modernised terminals located at Burnie, Brighton and George Town (Bell Bay), Tasrail provides freight haulage and storage services throughout the state. Containerised freight services connect major industrial areas to Tasmania's premier shipping ports where freight is moved across Bass Strait. Bulk freight services provide efficient, integrated, end-to-end supply chain services and the haulage of bulk commodities to storage facilities for onward export. Tasrail also operates Tasmania's only publicly-owned bulk handling, storage and ship loading facility for bulk mineral concentrates, which is located within the Burnie Freight Terminal precinct.

Figure 23 Rail container operations serving Tasmanian ports



Rail traffic terminals in Tasmania include:

- George Town: A multi modal-terminal with container storage area handling containerised general freight, metal ingots and bulk log freight;
- Devonport: A freight terminal handling containerised general freight;
- Burnie: An upgraded multi-modal freight terminal, which handles containerised general freight, bulk metal concentrates, paper products, and metal ingots;
- Launceston: A freight terminal handling containerised general freight; and
- Brighton: A multi-modal freight terminal with container hardstand and storage area that handles containerised general freight, bulk log freight, and metal ingots.

Tasrail also hauls zinc ingots, containerised metal concentrate, bulk cement, coal, paper products sugar, recycled metal, glass bottles, fish food, fertiliser, construction materials, consumer goods, groceries and aluminium ingots.

Short-haul urban maritime container movements

Short-haul urban shuttle trains provide a rail link from seaports to surrounding intermodal (distribution) centres. These services are advantageous by virtue of the fact they reduce road congestion into and out of the ports and connecting arterial roads. There are several flows of short-haul urban maritime container movements. These are:

- Yennora – Port Botany (approximately 40 kilometres);
- Minto – Port Botany (approximately 55 kilometres);
- Enfield – Port Botany (approximately 18 kilometres);
- Direk/Penfield – Outer Harbor, Port Adelaide (approximately 25 kilometres);
- Kewdale/Forrestfield – Fremantle (Inner Harbour) (approximately 24 kilometres); and
- Fremantle (North Quay) – Kwinana (approximately 28 kilometres).

The Yennora and Minto operations handle imports and exports. The terminals conduct 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 (Penfield) and Outer Harbor in South Australia involves the export of wine.

According to advice from Fremantle Ports, the Western Australian Government subsidises (loaded) containers between intermodal facilities at Forrestfield and Kwinana and North Quay at Fremantle at $50 per TEU. Empty containers and non-metropolitan movements are not subsidised. Intermodal Link Services (a part of the Intermodal Group) operate the train service between Fremantle and Forrestfield with 2–3 trains operated per day, 6–7 days per week. Aurizon operate two scheduled return trains per day between Kwinana and North Quay, carrying products off the Malcolm train and its Kalgoorlie-Perth freight trains.

The federal and Victorian state governments have announced a jointly funded $58 million plan to build rail connections to suburban intermodal terminals. The existing terminals at Altona and Lyndhurst will need connecting to the rail network, while the Austrak terminal at Somerton is already rail connected. This will provide for rail shuttles between the Port of Melbourne and these terminals. The Victorian Government is currently assessing funding grant applications. (Transport for Victoria, 2018)

Box 4 Further resources on non-bulk freight activity

Most of Australia's major ports report throughput statistics by freight type, freight origin, and freight destination on their websites, through a search facility.

In 2013, Port of Brisbane provided survey data on rail and road container movements through the port (Port of Brisbane 2013, pp. 10, 26).

BITRE's Waterline series reports quarterly data on rail traffic volumes through the mainland state capital city ports (where traffic is measured in, twenty-foot container equivalent unit (TEU) containers).

Urban rail passenger traffic

Each of the mainland state capital cities operate urban passenger rail services. These services enable the mass movement of passengers to and from capital city centres. Urban passenger rail services provide an alternative to private cars, which minimises road congestion.

Table 12 Urban rail patronage (millions of journeys), 2016–17[a]

	Brisbane[b]	Sydney[c]	Melbourne[d]	Adelaide	Perth	Gold Coast
Patronage – heavy rail	51.0	340.7	236.8	14.3	60.1	-
Patronage – light rail	-	10.4	204.0	9.2	-	7.8

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

[b] Brisbane's patronage figure is based on Queensland Rail's City Train network, whose scope is what it defines as south east Queensland. The quoted patronage also does not include the separately administered Airtrain line.

[c] According to the data source (see below), Sydney data from 2013–14 onwards is for Sydney Trains patronage only. There are two urban heavy rail operators in Sydney: Sydney Trains and NSW TrainLink, both of which were formed on 1 July 2013. Sydney Trains is the main operator, while NSW TrainLink provides additional express services using intercity trains that stop at a small number of Sydney urban stations ('shared stations').

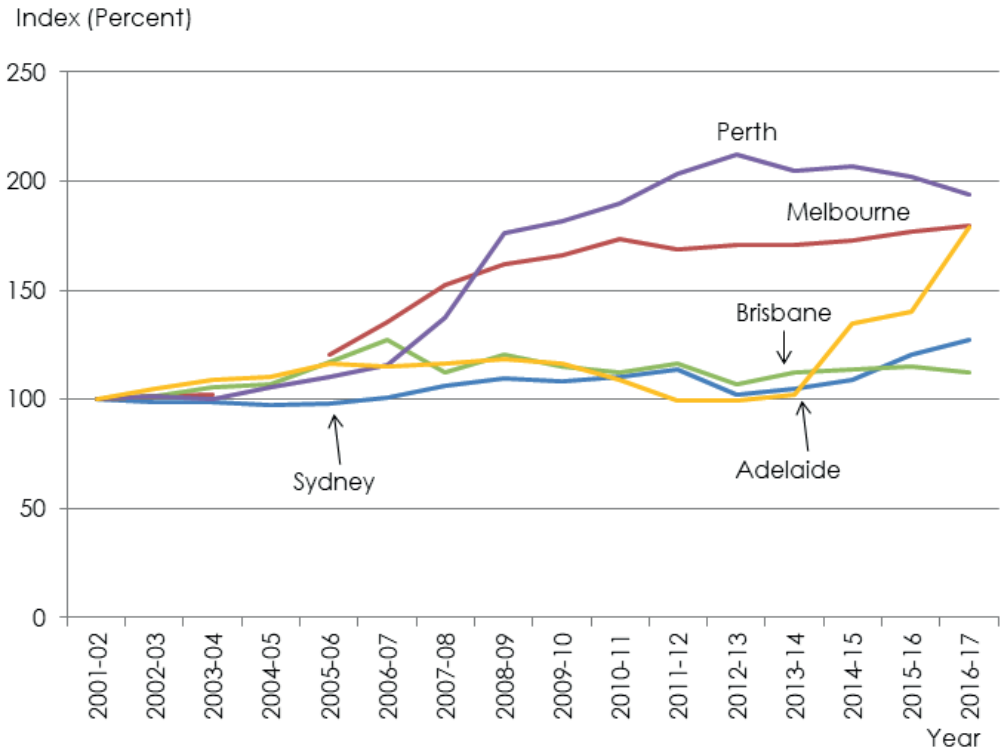
[d] Melbourne's light rail patronage includes the CBD free travel zone which commenced on 1 January 2015.

Sources: Public Transport Authority of Western Australia (2017, p.21); Public Transport Victoria (2017, p21, 22); Department of Planning, Transport and Infrastructure (2017, p.21); Department of Transport and Main Roads (2017, p.221); Transport for NSW (2017, p.17); advice from Sydney Trains.

Total urban heavy rail patronage for 2016–17 was 702.9 million passenger journeys. As Figure 24 shows, heavy rail urban passenger traffic grew in all cities, except for Perth and Brisbane. In 2016–17, Perth's patronage decreased by four per cent, while Brisbane's dropped by 2.6 per cent. Sydney continues to have the highest levels of urban heavy rail patronage – approximately 44 per cent higher than Melbourne. In 2016–17, Sydney's patronage grew by approximately 5.6 per cent, Melbourne 1.4 per cent, and Adelaide 27.2 per cent.

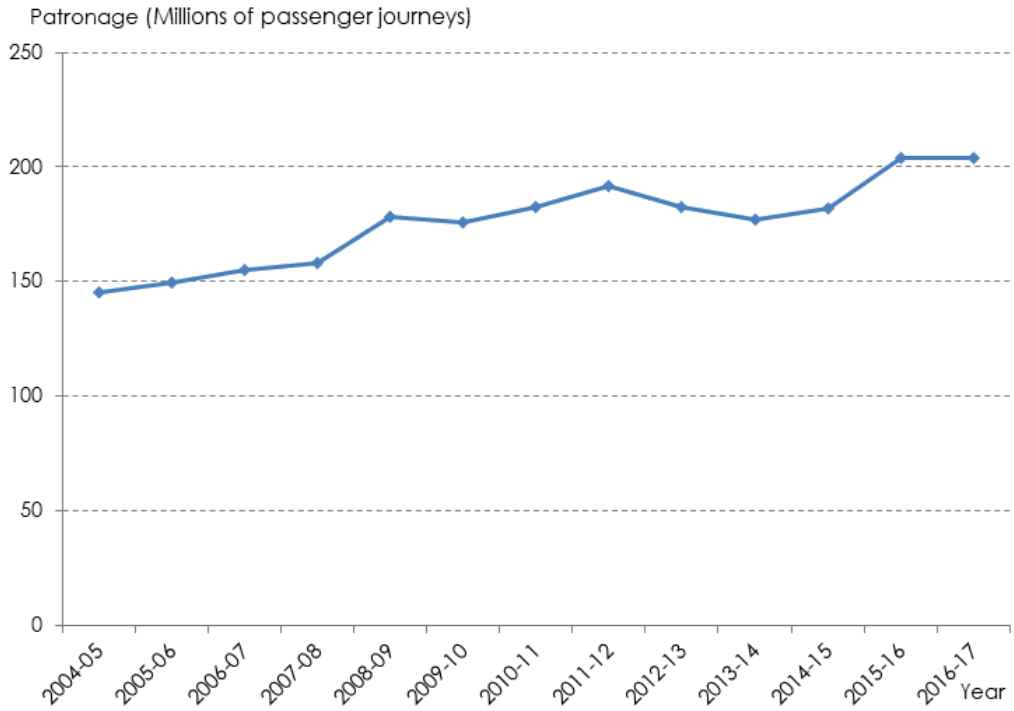
Total light rail patronage for 2016–17 was 231.4 million passenger journeys. Light rail patronage grew modestly on all networks (Melbourne 0.1 per cent, Adelaide 4.1 per cent, Sydney 3.5 per cent, and Gold Coast 3.5 per cent). Sydney's modest growth follows strong growth in previous years.

Figure 24 Index of urban heavy rail patronage in Australian cities



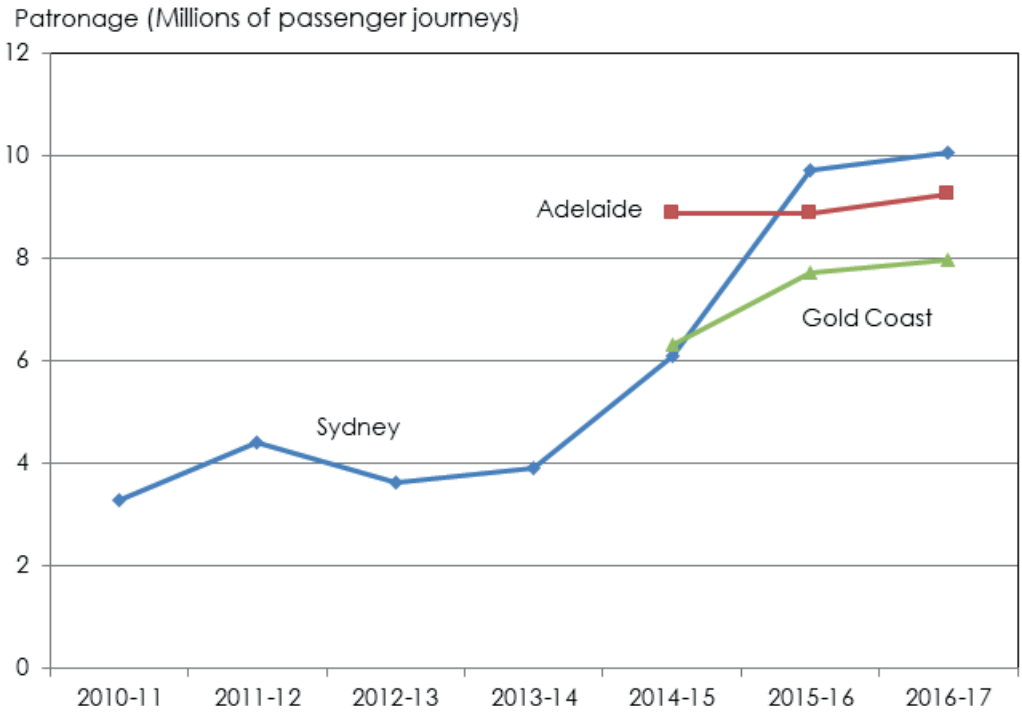
Sources: Index based on patronage data from: BITRE (2012 and previous *Trainline* editions); Public Transport Authority of Western Australia (2017, p.21); Public Transport Victoria (2017, p21, 22); Department of Planning, Transport and Infrastructure (2017, p.21); Department of Transport and Main Roads (2017, p.221); advice from Sydney Trains; historical annual reports.

Figure 25 Melbourne light rail patronage



Source: Public Transport Victoria (2017 p.22).

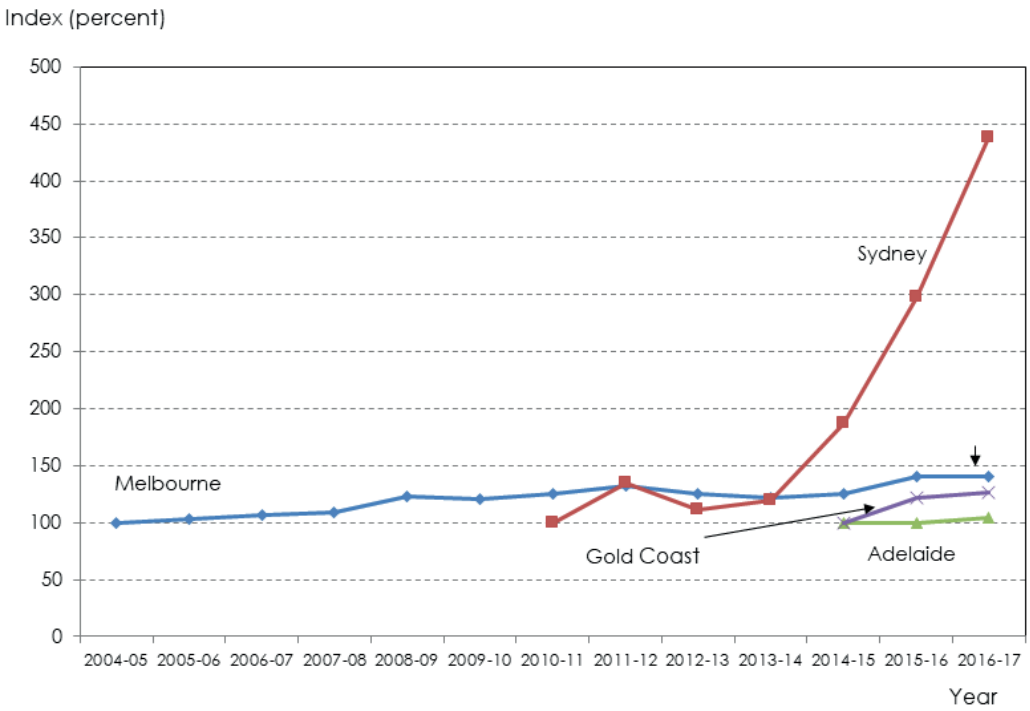
Figure 26 Sydney, Adelaide and Gold Coast light rail patronage



Note: Earlier data for Adelaide is not shown due to a patronage calculation methodology change.

Sources: Department of Planning, Transport and Infrastructure (2017, p.21); Department of Transport and Main Roads (2017, p.221); Transport for NSW (2017, p.17); historical annual reports.

Figure 27 Index of light rail patronage Melbourne, Sydney, Adelaide and Gold Coast



Sources: Index based on Public Transport Victoria (2017, p.22); Department of Planning, Transport and Infrastructure (2017, p.21); Department of Transport and Main Roads (2017, p.221); Transport for NSW (2017, p.17); and historical annual reports.

National (external) and local (network-specific) factors explain urban heavy rail and light rail patronage trends. The former includes economic activity (influencing employment and disposable income) and fuel prices. Another factor that affects mode choice is the non-financial relative generalised cost of rail travel. This cost includes quality of service, in-vehicle travel times, network scale and the standards of rollingstock and other infrastructure amenity. In the case of Gold Coast light rail patronage, Keys (2016, p.6) argues that while patronage may appear healthy and in line with forecasts, there has been a corresponding decrease in local bus patronage, thus there has been no overall mode shift from private to public transport.

Specific local factors that may have some bearing or future bearing on the city travel trends are as follows:

- **Brisbane.** Following fare decreases in January 2010, Queensland reduced fares again in December 2016 for travel within south east Queensland, in what is known as the Fairer Fares package. The package includes outright cheaper fares, reduction of travel zones from 23 to eight, extending off peak discounts, and increased eligibility for concession or free travel (*Railway Digest*, February 2017, p.15).
- **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).

Opening of Sydney Metro Northwest, due in the first half of 2019, will provide rail transport for the north western suburbs of Sydney from Chatswood to beyond Rouse Hill, an area which currently has no rail transport. This may boost patronage.

- **Melbourne.** According to Public Transport Victoria, heavy rail patronage increases were greatest in peak hour travel periods. This was partly offset though by level crossing removal project planned disruptions (Public Transport Victoria 2017, p.21). Regarding Light rail patronage growth similarly occurred during peak hour travel periods. Public Transport Victoria also attributes patronage growth to the introduction of more (higher capacity carrying) E Class trams. It notes, however, growth was low due to traffic congestion speed limits and reliability (Public Transport Victoria 2017, p.22).
- **Adelaide's** heavy rail patronage has continued to increase following previous declines that occurred during the period of infrastructure enhancement and the Rail Revitalisation Programme renewal works, which saw various temporary line closures.
- **Perth.** According to the Public Transport Authority of Western Australia, the 2016–17 drop in patronage occurred in all fare categories except free travel by seniors, aged and disability pensioners, and carers (Public Transport Authority of Western Australia 2017 p.20).

Table 13, below, shows Sydney Trains' busiest morning peak hour services, as Transport of NSW Transport Performance and Analytics surveyed on 6 September 2017 (Transport for NSW Open Data 2018). For the purpose of the survey Transport for NSW defined AM peak as services that arrived at Sydney Central Station between 08:00–08:59 hours. The load factor shows how each service was at as it departed the designated station during its journey, not at its point of departure. Transport of NSW defines its load factors as:

- "100 per cent means there is a seat for each customer. At 135 per cent, an additional 5 people are standing on each level and 15 in each vestibule"; and
- "135 per cent is the benchmark beyond which customers experience crowding and service dwell times can impact on-time running." (Transport for NSW Open Data 2018).

Table 14 shows Sydney's PM top services on 6 September 2017, for trains departing Central Station between 17:00–18:00 hours. Load factors were between 162 to 185 per cent in both the AM peak and 141 to 185 per cent in the PM peak.

Table 13 Sydney AM peak top services, 6 September 2017

Line	Origin	Arriving Central	Station	Load Factor %[27]
T1 Northern via Strathfield	Epping	8:24 AM	Redfern	185%
T1 Northern via Strathfield	Epping	8:38 AM	Redfern	185%
T1 Western	Richmond	8:41 AM	Redfern	176%
T2 Airport	Revesby	8:47 AM	Green Square	174%
T1 Western	Blacktown	8:32 AM	Redfern	171%
T2 Airport	Revesby	8:12 AM	Green Square	168%
T1 Western	St Marys	8:35 AM	Redfern	168%
T1 Western	Schofields	12:00 AM	Redfern	166%
T2 Airport	East Hills	8:35 AM	Green Square	165%
T1 Western	St Marys	8:17 AM	Redfern	162%

27 The load factor is calculated for trains upon their departure from the listed stations.

Table 14 Sydney PM peak top services, 6 September 2017

Line	Destination	Departing Central	Station	Load Factor %
T1 Western	Penrith	5:23 PM	Redfern	185%
T1 Western	Blacktown	5:17 PM	Redfern	165%
T1 Northern via Strathfield	Epping	5:48 PM	Redfern	160%
T1 Western	Penrith	5:26 PM	Redfern	159%
T1 Western	Emu Plains	5:38 PM	Redfern	149%
T1 Western	Richmond	5:30 PM	Redfern	146%
T1 Central Coast via Shore	Wyong	5:11 PM	North Sydney	145%
T1 Northern via Strathfield	Epping	5:36 PM	Redfern	145%
T1 Western	Blacktown	5:33 PM	Redfern	141%
T1 Northern via Strathfield	Epping	5:20 PM	Redfern	139%

Commuting traffic

Urban passenger rail services are largely aligned to service weekday commuter demand to and from city centres. The task is skewed to the morning and afternoon peak periods. In 2016, urban heavy rail's mode share increased in all cities except Brisbane and Perth compared to 2011. Sydney had the highest heavy rail mode share, at 19.1 per cent (See Table 15). Melbourne's combined heavy rail and light rail share was 17.6 per cent, while Brisbane and Perth's rail mode share was 7.3 and 7.5 per cent respectively.

Table 15 Urban rail journey-to-work mode shares, 2016

	Brisbane	Sydney	Melbourne	Adelaide	Perth
Heavy rail (%)	7.3	19.1	13.7	2.8	7.5
Light rail (%)	–	0.2	3.9	0.6	–

Notes: Cities refer to greater metropolitan areas. For the 2016 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.

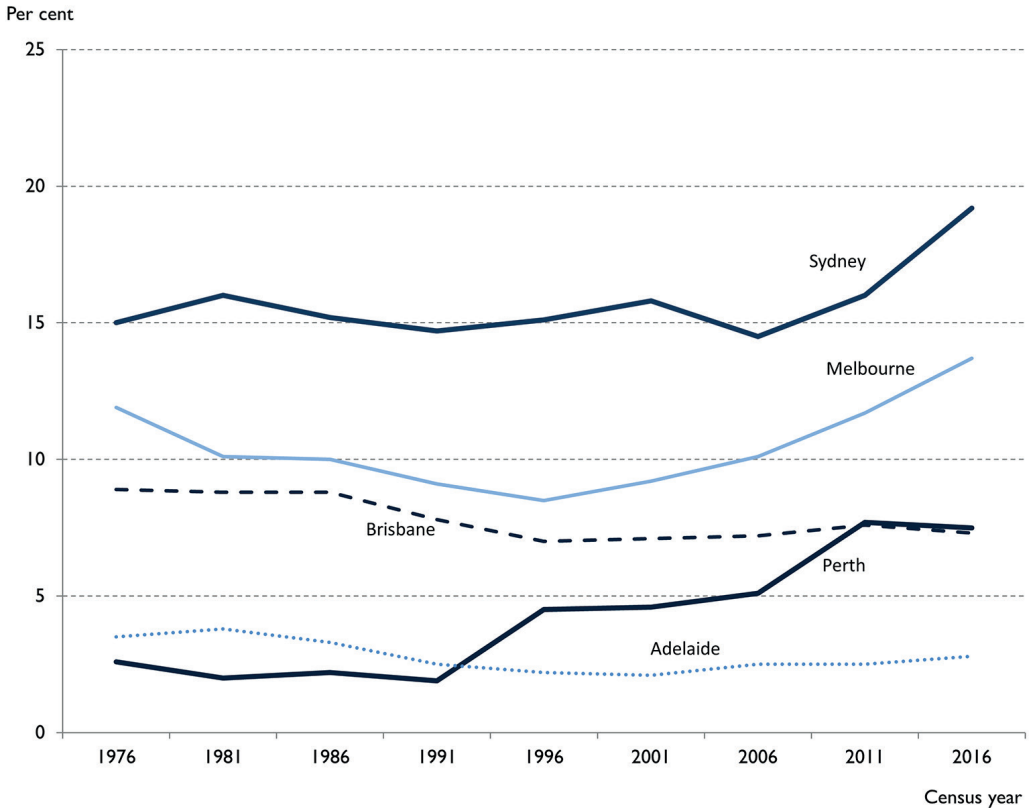
Tram/light rail census data includes respondents who: caught a tram/light rail; caught a train and tram/light rail; caught a bus and tram/light rail. The tram/light rail data is therefore an underestimate because it does not include all possibilities, for example, car and tram/light rail.

Source: ABS 2016.

Following long-term declines in urban rail patronage for all cities from the mid–1970s, ridership began recovering in the 1990s[28]. Figure 28 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.

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

Figure 28 Journey-to-work mode share, urban heavy rail, 2016



Note: Cities refer to greater metropolitan areas.

Sources: ABS (2016); Mees and Groenhart (2012).

Box 5 Further reading

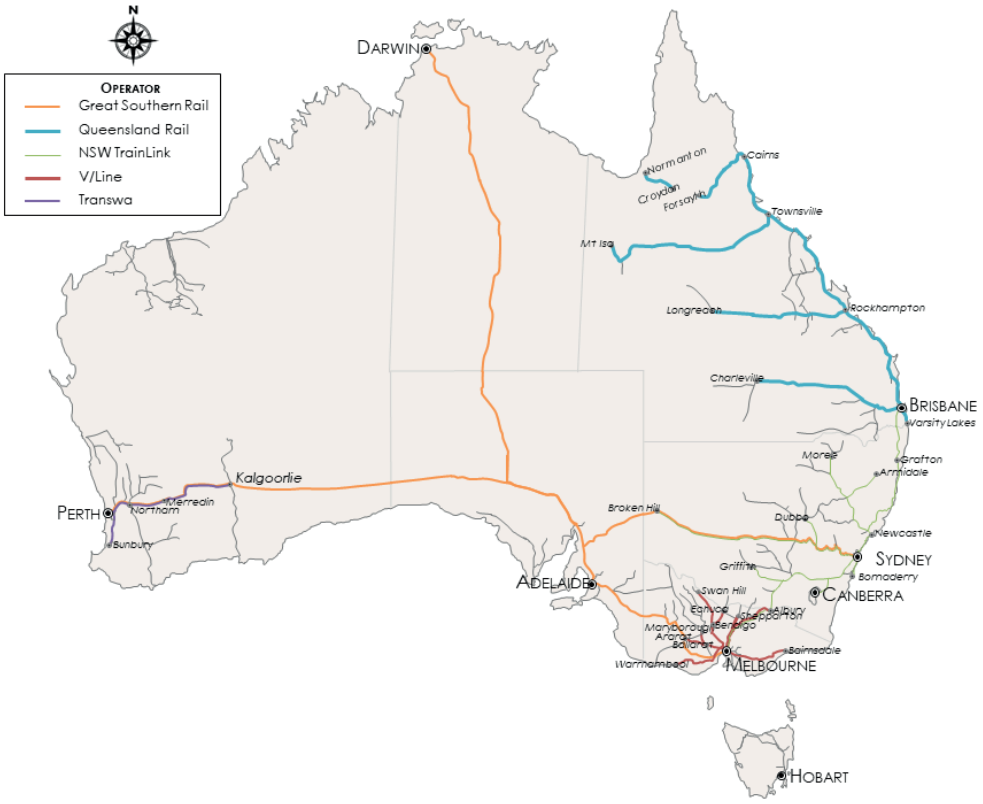
For further information on urban passenger trends, see BITRE information sheets: *Urban transport: updated passenger trends—Information Sheet 59* (BITRE 2014c); and *Long-term trends in urban passenger transport—Information Sheet 60* (BITRE 2014d).

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 also service the inter-city, regional and long-distance passenger markets.

Figure 29 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:

- "Intercity" or "regional" travel, such as Sydney–Hamilton, Sydney–Wollongong/Bomaderry, Melbourne–Ballarat and Perth–Bunbury. Such services could include daily commuting or day-return business or leisure travel;
- Long-distance connections between cities (such as Brisbane–Sydney) and regional centres, such as Melbourne-Bairnsdale and Perth–Kalgoorlie;
- Heritage railway travel, for nostalgia and leisure purposes; and
- Tourist-focused services such as the *Kuranda Scenic Railway* (Queensland Rail), and Adelaide–Darwin (*The Ghan*) (Great Southern Rail).

The scale of an operator's passenger task is largely determined by the function of their railway. Table 16 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 regional travel. The majority of passengers use intercity services.

Table 16 Non-urban rail patronage, by operator, 2016–17

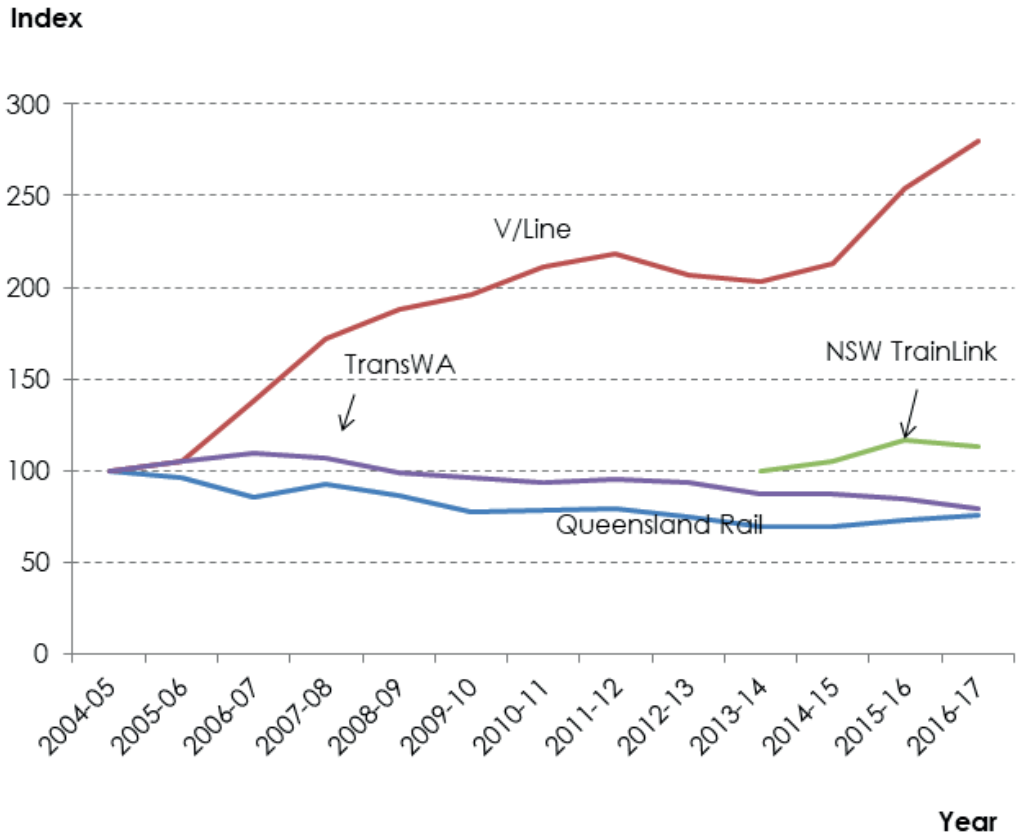
	Queensland Rail	NSW TrainLink		V/Line	Transwa
		Regional	Intercity		
Patronage (million trips)	.76	1.2	40.7	17.9	.19

Notes: Data excludes patronage on services delivered under the Queensland "TransLink" brand.

Sources: NSW Trains (2017 p.8); Advice from Transport of NSW; Public Transport Authority of Western Australia (2017, p.28); Queensland Rail (2017 p.29); (V/Line 2017a, p. 14).

Similar to urban patronage, non-urban patronage is influenced by broad, macroeconomic factors and local, network specific factors. Figure 30 shows patronage trends by operator. The index for NSW TrainLink is truncated to 2013–14 due to the patronage data revision.

Figure 30 Index of non-urban rail patronage, by operator



Notes: The NSW TrainLink index is the sum of regional and intercity patronage. There is no New South Wales data presented for the period prior to 2012–13 due to the formation of TrainLink on 1 July 2013, which merged regional and intercity services under one operator. Including previous years' data would not be comparing 'like for like'.

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

Sources: NSW Trains (2017 p.8); Advice from Transport of NSW; Public Transport Authority of Western Australia (2017, p.28); Queensland Rail (2017 p.29); V/Line (2017a, p. 14); historical annual reports.

Some noteworthy trends are:

- **Queensland Rail** patronage, which is heavily tourism dependent, grew by approximately 3.5 per cent, after slightly stronger growth the previous year.
- **NSW TrainLink**. It is now possible to assess meaningful patronage trends following the formation of TrainLink on 1 July 2013, which merged the former intercity and regional/long distance services. In 2016–2017, patronage grew by more than five per cent, following 11 per cent growth the previous financial year. Intercity patronage grew by 5.6 per cent, while regional travel declined by 1.6 per cent. The NSW Trains annual report claims improved patronage calculation methodology following the introduction of the Opal card has contributed to the recorded overall increase (NSW Trains, 2017, p.18).
- **Transwa** patronage continued its decline, in 2016–17, falling by approximately six per cent. The *Australind*, which accounts for almost half of Transwa's total rail patronage, continued its decline in 2016–17, at almost seven per cent. All other services experienced patronage declines also in 2016–17. Public Transport Authority of Western Australia attributes declined patronage on the *Australind* to mechanical issues and track shut downs. (Public Transport Authority of Western Australia 2017, p.28)
- **V/Line** patronage continues to grow upon previous strong growth, at 9.2 per cent, but the rate of growth has eased. All corridors had experienced growth, ranging from one per cent on the Seymour line to almost 14.25 per cent on the Ballarat line. V/Line attributes part of the growth to additional services and the opening of the Caroline Springs station on the Ballarat line (V/Line 2017a, p. 17).

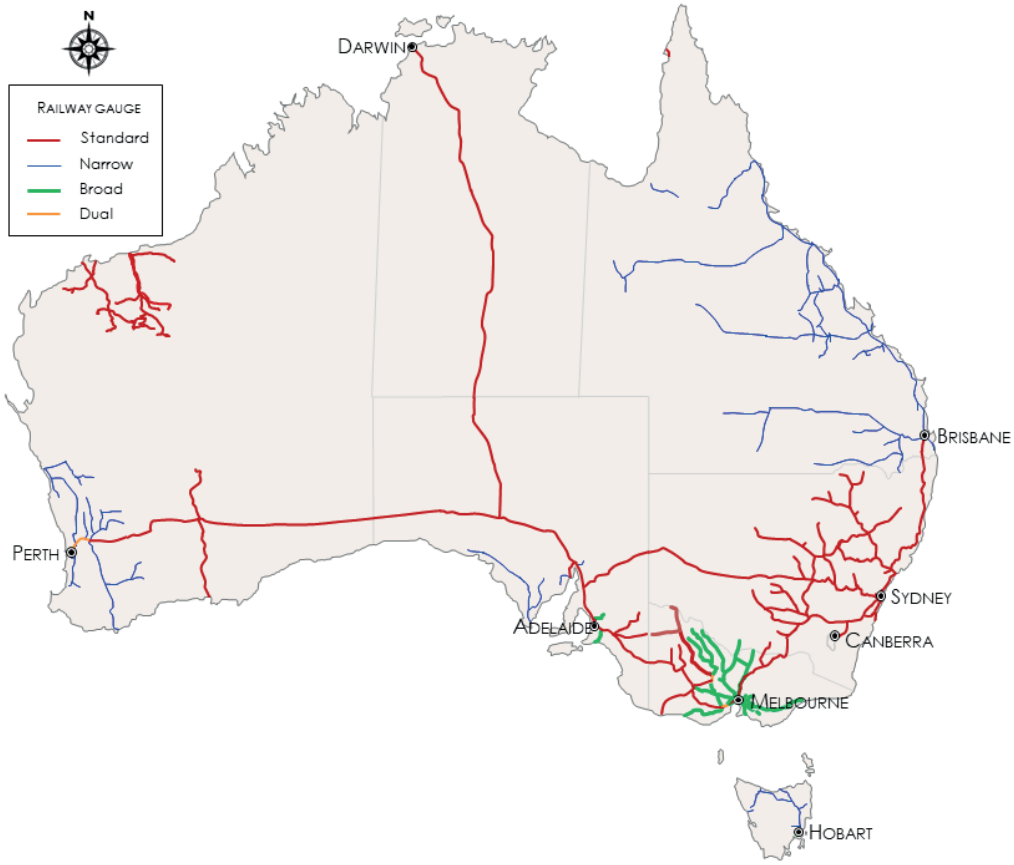
CHAPTER 3

Infrastructure and rolling stock provision

Railway network

Australia's colonies (then states in the post-federation era) commenced construction of the continent's railways, as separate networks with different gauges. The networks mostly radiated from the state (previously colonial) capitals, with cross-border links coming only after intrastate (intra-colonial) lines met at the borders. The exception is Queensland, whose early railways consisted of a network of disparate railways that connected inland areas with coastal ports. These railways were eventually linked, forming the current Queensland network. While aspects of the break of gauge legacy remain, interstate trains now operate across a continuous 1435 mm 'standard' gauge.

Figure 31 Railway network, by track gauge, June 2018



Notes: The lines shown here are the railways that are open for traffic at June 2018.
Broad ("Irish") gauge is 1600 mm; standard ("Stephenson") gauge is 1435; and narrow ("Cape") gauge is 1067 mm.

Table 17 shows route kilometres of electrified and non-electrified railways in each jurisdiction. Queensland, Western Australia and New South Wales have similar-sized networks. Most of the network is single-tracked (approximately 89 per cent) with some exceptions, such as most urban network sections, 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 Metals Group double track).

Table 17 Estimate of route kilometres of open (operational) heavy railways in September 2018, by jurisdiction, gauge and electrification

	State or Territory								
	ACT	NT	NSW	Qld	SA	Tas	VIC	WA	Total
Route kilometres by gauge									
Broad			73		253		2309		2635
Narrow		3		8146	561	611	16	2970	12307
Standard	6	1690	7104	117	2561		1904	4558	17940
Other			1	4		7	30		42
Dual				36	22		32	207	297
Total	**6**	**1693**	**7178**	**8303**	**3397**	**618**	**4291**	**7735**	**33 221**
1 500V DC			641				383		1024
25 kV AC				2173	44			181	2398
33 kV AC			8						8
Total			**649**	**2173**	**44**		**383**	**181**	**3430**

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.

Excludes light rail and sugar tramways.

Queensland standard gauge figures include the 19 kilometre railway at the Rio Tinto bauxite mine at Weipa.

Sources: BITRE estimates; Data provided by Sydney Trains; Data provided by Aurizon; Rio Tinto Alcan, and Tasrail; Avery (2013, p.144).

Around 10 per cent of the Australian network route-kilometres are electrified. Appendix E 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).

Queensland has the largest electrified network, principally due to the electrified line between Rockhampton and Brisbane and a number of coal lines in the Central Queensland coal network. Elsewhere, overhead power systems have been installed on lines with relatively intensive urban and some intercity passenger services.

New railways

Approximately 920 route-kilometres of freight track and 110 route-kilometres of passenger (heavy and light-rail) track have been opened since 2010. Table 18 provides a list of all new rail track additions since 2010, grouped by traffic type/purpose.

Table 18 Railways opened since 2010

Traffic	Location	Year	State	Length (km)	Project	Infrastructure builder
Iron ore	Mesa K – Waramboo (Mesa A)	2010	WA	49	Mesa A	Rio Tinto
Iron ore	Cloudbreak – Christmas Creek	2011	WA	50	Christmas Creek extension	Fortescue Metals Group
Iron ore	Tilley Siding (Morawa) – Karara	2012	WA	85	Karara Rail Spur	Karara Mining Ltd
Iron ore	Solomon Junction – Solomon	2012	WA	130	Solomon extension	Fortescue Metals Group
Iron ore	Hope Downs 4 railway	2013	WA	53	Hope Downs extension	Hope Downs Joint Venture (Hancock – Rio Tinto)
Iron ore	Roy Hill-Port Hedland	2015	WA	344	Roy Hill	Roy Hill Holdings
Coal	Cameby Downs Loop	2010	Queensland	7	Cameby Downs Loop	Queensland Rail
Coal	Goonyella–Newlands	2011	Queensland	68	Northern missing link	Aurizon
Coal	Middlemount Rail Spur	2011	Queensland	16	Middlemount Rail Spur	Macarthur Coal
Coal	Moranbah-Caval Ridge	2014	Queensland	12	Caval Ridge Spur	Billiton Mitsubishi Alliance
Coal	Maules Creek-Werris Creek line	2015	NSW	20	Maules Creek	Whitehaven
Coal	Aldoga-Wiggins Island	2015	Queensland	13	Wiggins Island Coal Export Terminal	Aurizon
Coal	Boggabri	2016	NSW	17	Boggabri Rail Spur	Idemitsu
Coal	Byerwen	2017	Queensland	5	New branch line in GAPE system	Private and Aurizon
Coal	Baralaba	2018	Queensland	6	New branch in Moura system	Private and Aurizon
Intermodal	Sefton–Macarthur	2012–13	NSW	36	Southern Sydney Freight Line	ARTC
Grain	Moree-Broadbent Grain facility	2017	NSW	3.5	Broadbent Grain facility- Moree connection	ARTC
Inter-Urban passenger	Deer Park-West Werribee	2015	Victoria	27	Regional Rail Link	V/Line
Urban passenger	Darra-Richlands	2010	Queensland	4.5	Springfield Branch	Queensland Rail
Urban passenger	Glenfield-Leppington	2015	NSW	12	Leppington line	RailCorp
Urban passenger	Epping – South Morang	2012	Victoria	4	South Morang Extension (re-opening)	Metro Trains Melbourne
Urban passenger	Richlands-Springfield	2013	Queensland	9.5	Springfield Branch	Queensland Rail
Urban passenger	Noarlunga–Seaford	2014	SA	6	Noarlunga Line extension	Department of Planning, Transport and Infrastructure

(continued)

Traffic	Location	Year	State	Length (km)	Project	Infrastructure builder
Urban passenger	Clarkson–Butler	2014	WA	8	Joondalup Line extension	Transperth (Public Transport Authority)
Urban passenger	Petrie – Kippa-Ring	2016	Queensland	13	Moreton Bay Railway	Queensland Rail
Urban passenger	South Morang – Mernda	2018	Victoria	8	Mernda Rail Extension	Metro Trains Melbourne
Urban passenger light rail	Gold Coast University Hospital – Broadbeach	2014	Queensland	13	Gold Coast Light Rail	Queensland and Australian governments; Gold Coast City Council, GoldLinQ
Urban passenger light rail	Lilyfield – Dulwich Hill	2014	NSW	6	Inner West Light Rail extension	Transport for NSW
Urban passenger light rail	North Terrace – Entertainment Centre	2010	SA	3	Port Road Light Rail Extension	Department of Planning, Transport and Infrastructure
Urban passenger light rail	Gold Coast University Hospital – Helensvale	2017	Queensland	7.3	Gold Coast Light Rail	Queensland and Australian governments; Gold Coast City Council, GoldLinQ

Notes: 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 1980 is at Appendix B.

Sources: BITRE estimates, data provided by Aurizon and Gracosway.

Expansion of the mining industry in the Pilbara region of Western Australia underpins much of the recent rail infrastructure expansion and subsequent rail freight task. Development of iron ore mines in the Pilbara region 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 largest mining company in the region is Fortescue Metals Group, which opened a railway between Cloudbreak Mine and Port Hedland in 2008. In 2015, Roy Hill Holdings added 344 route kilometres of track to the network, connecting the newly developed Roy Hill Mine to the port facility in Boodarie Industrial Estate south of Port Hedland. The operation uses Roy Hill's two new berths, SP1 and SP2, at Stanley Point within the port. Enhancements to track and train specifications mean trains in the region are amongst the longest and heaviest in the world, with scope for additional axle load increases. Following construction of the Roy Hill line, there is currently an estimated 2639 route kilometres of railway in the Pilbara region.

Since 2010, 177 kilometres of railway have been constructed for coal haulage. Coal exports, centred on Queensland's Bowen, Galilee and Surat Basins and the Hunter Valley network in New South Wales, rely on rail transport. New lines and additional capacity have enabled a substantial expansion of exports. Such new lines and additional capacity include the Goonyella–Newlands railway in Queensland, part of the Goonyella to Abbot Point Expansion ("GAPE") project; and the Wiggins Island Rail Project (WIRP), which was completed in December 2015. Other projects have included substantial Commonwealth investment in the interstate network, with new signalling, passing loops and passing lanes, re-railing, re-sleepering and re-ballasting.

The Northern Sydney Freight Corridor Program has eased rail traffic congestion through Northern Sydney and at Gosford. The program included a third track between Epping and Thornleigh, construction of the North Strathfield underpass and two new passing loops at Gosford (Transport for NSW, 2017a). 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. The Gawler line electrification project is currently in its preliminary stages (Government of South Australia, 2017).

Infrastructure activities extend beyond new railway construction, however, with a range of enhancement projects across the country. This includes Victoria's level crossing removal and Murray Basin rail projects.

As Table 19, below, shows, 83 route-kilometres of heavy and light railways were under construction in June 2018. Of this, 56 kilometres were heavy rail and 27 were light rail.

Table 19 Heavy and light railways under construction, June 2018

Traffic	Location	State	Length (route km)	Project	Infrastructure builder
Heavy Rail	Epping–Cudgegong Road	NSW	23	North West Rail Link	Transport for NSW
Light rail	CBD and South East Light Rail	NSW	12	CBD and South Est Light Rail	Transport for NSW
Light rail	Canberra	ACT	12	Capital Metro	ACT Government
Heavy Rail	Perth	WA	8	Forrestfield-Airport Link	PTA WA
Heavy Rail	Chatswood-Sydenham	NSW	16	Sydney Metro City & Southwest	Transport for NSW
Heavy Rail	Melbourne	Vic	9	Metro Tunnel	Melbourne Metro Rail Authority
Light Rail	Adelaide	SA	1	City Tram Extension	Department of Planning, Transport and Infrastructure
Light Rail	Newcastle	NSW	2	Newcastle Light Rail	Transport for NSW

Dedicated commodity networks

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

Iron ore and coal networks

The iron ore and coal networks are shown in Figure 8. Mining companies built the iron ore railway networks in the Pilbara region exclusively to serve the iron ore mines, as was the Karara (Western Australia) spur line and the Middleback railways (near Whyalla) in South Australia. As bespoke developments, these lines were generally built to very high standards to accommodate the large envisaged traffic. There has been extensive subsequent capacity expansion (signalling, track and train capacity) on many of the lines.

Coal lines were developed in eastern Australia, generally being grafted onto the existing mixed-traffic networks. While the track standards are high, and include some electrified systems in Queensland, they are generally of a lower standard than the dedicated iron ore lines.

Grain railways

Grain railways usually feed into secondary or main lines. By contrast, with iron ore and many coal railways, the grain lines are generally of a lower technical and operational standard. Some are in a poor condition and traffic is seasonal.

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 standards (and, thus weight-bearing capability or train speed), their economic importance, or to their viability. The respective categories across the states[29] are outlined below.

Queensland

The "network capabilities" of railways in Queensland are classified according to the maximum permitted axle loads on a given section of track. Network information packs for access seekers provide details about track standards and permitted axle loads and train speeds[30]. Often the axle-load limits are 15 tonnes. It has been noted that rail cannot be used to haul containerised grain due to these load limits (Transport, Housing and Local Government Committee [Queensland] 2014, p. 24).

New South Wales

While the New South Wales government's grain railways are categorised by class of track – from Class 1 to Class 5, this is an engineering standard only; not an operational standard. Operationally, there is considerable variation within each standard. According to advice from John Holland Rail, for example, a Class 3 track can range in operational capability from 81 to 100 tonnes gross (See Figure 16).

Victoria

Victoria has six track standard classifications. The highest standard is Class 1, and the lowest is Class 5 (VicSig 2018). Details are as follows:

- Class 1: Sections of the Regional Fast Rail network;
- Class 2: Standard for metropolitan and country passenger lines;
- Class 2U: A modified version of Class 2 for Regional Fast Rail but of a lower standard than Class 1;
- Class 3: Passenger lines with low volumes and some grain lines;
- Class 4: Lesser branch lines; and
- Class 5: Lines that are short or have very little traffic, with minimal track maintenance.

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

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 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 transport. 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 Western Australian 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

Australia's urban heavy rail networks are extensive, even if the network coverage is not dense (see Table 20). The networks are mostly radial, reflecting the historical development of Australian cities, with lines branching from dense Central Business Districts (CBDs) into the surrounding, low density suburbs[31].

Table 20 Network characteristics of urban passenger heavy railways, 2018

	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 urban passenger lines (km)	n/a	220	128	126	180
Shared metropolitan freight/passenger lines (km)	n/a	181	268	-	1
Total route length (km)	381	401	396	126	181
Electrified route length (km)	381	370	396	44	181
Metropolitan stations (number)	178	221	152	87	71
Average distance between stations (km)	2.1	1.8	2.6	1.4	2.5
Metropolitan passenger route length under construction (km)	23	9	-	-	8
Passenger network gauge	Standard	Broad	Narrow	Broad	Narrow

Notes: Distances are route kilometres.

Urban networks are defined by urban passenger operator boundaries. The Brisbane calculations are based on the limits of Queensland Rail's City Train network, including the privately owned Airport line.

The Sydney Trains network figures are revised, based on data which Sydney Trains provided. Due to this revision, BITRE does not currently have an estimate of dedicated passenger lines and shared passenger and freight lines.

Does not include freight only track.

Sources: BITRE estimates; Data provided by Sydney Trains; Public Transport Authority of Western Australia (2016, p. 18); Queensland Rail (2016, p.6); Data provided by Adelaide Metro; Data provided by Aurizon.

31 Maps of these systems are provided in BITRE (2012).

The following characteristics and trends make each system distinctive:

- **Network expansion**. Perth's system has grown significantly over the last 20 years. New lines from Perth to Joondalup/Currambine/Butler (41 km), and Mandurah (70 km), and the Thornlie branch (three km) have transformed urban transport in the city. (See Appendix B for dates of railway openings.)
- **Network form**. Perth's system is also distinctive relative to the other Australian networks due to the nature of its new railways. Table 20 shows Perth's network is 30 per cent longer than Adelaide's, but has 16 fewer stations. This station spacing facilitates significantly higher average train speeds on Perth's Mandurah line and, to a lesser extent, the Butler line (see Figure 44). With fewer stations, good station access is inherent to station design through rail-bus interchanges, extensive park-and-ride facilities and encouragement of (nearby) Transit Oriented Development (TOD).
- **Shared networks**. Brisbane, Melbourne, Adelaide and Perth use a different track gauge to the interstate network. This has separated most urban passenger traffic from interstate and some intrastate freight trains operating on the standard gauge. Examples of shared track 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 (via the Frankston urban line). Sydney's network is 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 Southern Sydney Freight Line, however, provides a dedicated southern access to Sydney freight yards, which has eliminated the previous southern Sydney curfew on freight trains operations during peak passenger commuting periods and the Epping to Thornleigh third track gives additional train capacity.
- **Electrification**. Electrified services began in Sydney and Melbourne[32] from the early inter-war period using Direct Current (DC) traction power. Cities that electrified their networks later use more advanced Alternating Current (AC) traction. Perth and Brisbane electrified their networks relatively recently—Brisbane from the late 1970s and Perth from the early 1990s. In Adelaide, the Rail Revitalisation Programme includes track enhancements and system electrification. Electric train operation commenced on the Seaford and Tonsley lines in 2014.

Urban light rail passenger networks

Australia has 291 route kilometres of operational light rail. The technological and operational differences between tramways, light rail and heavy rail are increasingly blurred[33]. This report refers to Australia's light rail operations as having shared characteristics with tramways, particularly in Melbourne. Former heavy rail corridors form parts of the network in Melbourne, Sydney and Adelaide.

32 Only Melbourne's Frankston–Stony Point line remains un-electrified.

33 Tramways generally 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. Melbourne's light rail vehicles operate on former heavy rail lines to St Kilda and Port Melbourne, but most of the network shares right-of-way with road traffic.

By route distance, Melbourne has the world's largest light rail network. Single route operations are on the Gold Coast, Sydney and Adelaide (see Table 21).

Table 21 Network characteristics of light railways, 2018

	Gold Coast	Sydney	Melbourne	Adelaide
Total route length (km)	20.3	12.8	250	15
Segregated right of way	segregated	largely segregated	24% segregated	largely segregated
Routes (no.)	1	1	24	1
Number of stops (no.)	19	23	1 717	29

Sources: Currie and Burke (2013); Yarra Trams (2017); Advice from Yarra Trams; G:link (2018).

Melbourne's network is distinct, with only a small proportion of the network segregated from road traffic, and with close spacing between stops. 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 significantly lower than other cities.

Sydney and Adelaide had significant tramway systems prior to the middle of the 20th century. Adelaide's single remaining line runs between the 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 heavy rail corridor, with a small segment of on-road (largely segregated) operation between Haymarket and Central Railway Station. Sydney is expanding its light rail network by 12 kilometres, with 19 new stops. The extension will travel from Central Station to Circular Quay and through Surry Hills to Moore Park, Kensington, Kingsford and Randwick. Services are expected to commence in 2019.

The Gold Coast light railway runs between the Helensvale and Broadbeach. The line runs 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). In December 2017, the 7.3 kilometres Stage 2 expansion to Helensvale railway station opened.

Non-urban passenger network

The non-urban passenger services are almost entirely integrated with other rail operations through shared track access. Typically, the non-urban services share track with urban passenger and freight trains, although the June 2015 opening of the Regional Rail Link reduced this in Victoria.

Table 22 Network coverage of non-urban passenger rail services, 2018

	Queensland Rail	NSW TrainLink	V/Line	Transwa	Great Southern Rail	Heritage operators
Electrified route kilometres	728	445	-	-	-	1
Total route kilometres	4 380	4 261	1 737	836	7 446	511 (approx.)

Notes: This is an estimate of route kilometres. Shared corridors between multiple services are only counted once. For example, TrainLink's Sydney-Brisbane estimate includes all other TrainLink services that operate anywhere on that corridor between Sydney Central and Casino.

The estimate includes the designated urban networks through which non-urban passenger rail services transit.

The Queensland Rail route lengths includes the Varsity Lakes - Brisbane service.

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

Source: BITRE estimates.

Train operator equipment stock (excluding freight wagons)

Locomotives

BITRE estimates that in September 2018 there were 1997 operational locomotives in Australia (See Table 23). This excludes locomotives in storage, available for hire, or due for scrapping. Data presented here use the age of the locomotive since built new, or the age since rebuilt, whichever is the most recent[34]. The age of the fleet reflects a range of different underlying influences on rolling stock investment.

Figure 33 shows approximately 50 per cent of the fleet was aged approximately 11 years or less in mid–2018, compared to approximately 13 years or less the previous year. Figure 32 shows the age distribution by gauge. The newest locomotives at the time of analysis were six AC EVO, ES44ACi locomotives that belong to Rio Tinto Iron Ore. Of the youngest 50 per cent of locomotives, approximately 38 per cent are used in the Pilbara.

Approximately 40 per cent of the fleet aged 11 years or less were built or rebuilt in Australia, with the remainder being built in the United States of America, China and Germany. Approximately 70 per cent of the fleet operate on the standard gauge network.

The analysis is for locomotives that almost exclusively perform freight duties only. V/Line is expanding its diesel multiple unit (DMU) VLocity fleet. This rollingstock, by virtue of being DMU, is excluded from the age analysis and affects the broad gauge analysis as new DMU sets replace locomotive hauled passenger trains. The lesser freight task on the broad gauge compared to the standard and narrow gauges is also reflected in the relatively small broad gauge locomotive fleet numbers. To illustrate, only 16 per cent of the operational broad gauge fleet is aged 12 years or younger. Due to the lack of new broad gauge locomotives, operators often have to use old locomotives, some of which were built in the 1950s and 1960s.

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

The status of the locomotive fleet is fluid, with locomotives frequently switching between active operations and being in storage. What the table and figures below also do not show is the degree of and type of locomotive usage. Newer locomotives tend to be assigned primary 'frontline' duties such as hauling intermodal trains across the continent or hauling coal or iron ore trains, while older locomotives tend to be assigned lesser secondary duties such as providing additional motive power behind newer locomotives or doing yard duties only. BITRE is currently unable to measure the degree of locomotive usage. While the large NR class locomotive fleet, which is the mainstay of Pacific National's intermodal services, is now more than 20 years old, Pacific National has upgraded them, including with new engines. They are arguably new locomotives.

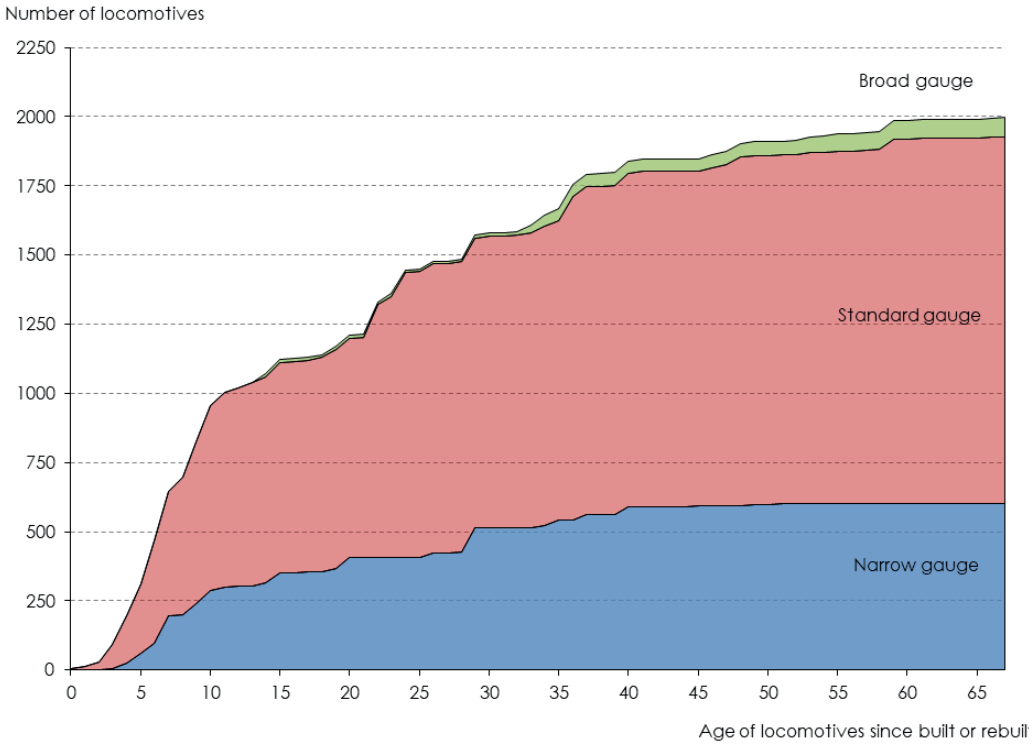
Care is also needed when comparing locomotive ages by gauge, particularly between the broad and standard gauges, where there is considerable re-gauging of the previous Victorian government owned locomotives, such as the G, T, and N classes, many of which now operate outside Victoria. For example, V/Line has converted four of the previous all broad gauge N class locomotives to standard gauge for its Melbourne—Albury passenger services. Much (originally Victorian) C class locomotive operations are now intrastate New South Wales services, although there are still cross border and intrastate operations in Victoria.

Table 23 Locomotive ages

Age range (years)	Narrow Gauge	Standard Gauge	Broad Gauge	Total
0–5	60	250	0	310
6–10	227	417	0	644
11–15	65	92	10	167
16–20	53	35	0	88
21–25	2	239	0	241
26–30	107	23	0	130
31–35	29	23	35	87
36–40	47	122	3	172
41–45	2	8	0	10
46–50	7	50	5	62
51+	2	65	19	86
Total	**601**	**1324**	**72**	**1997**

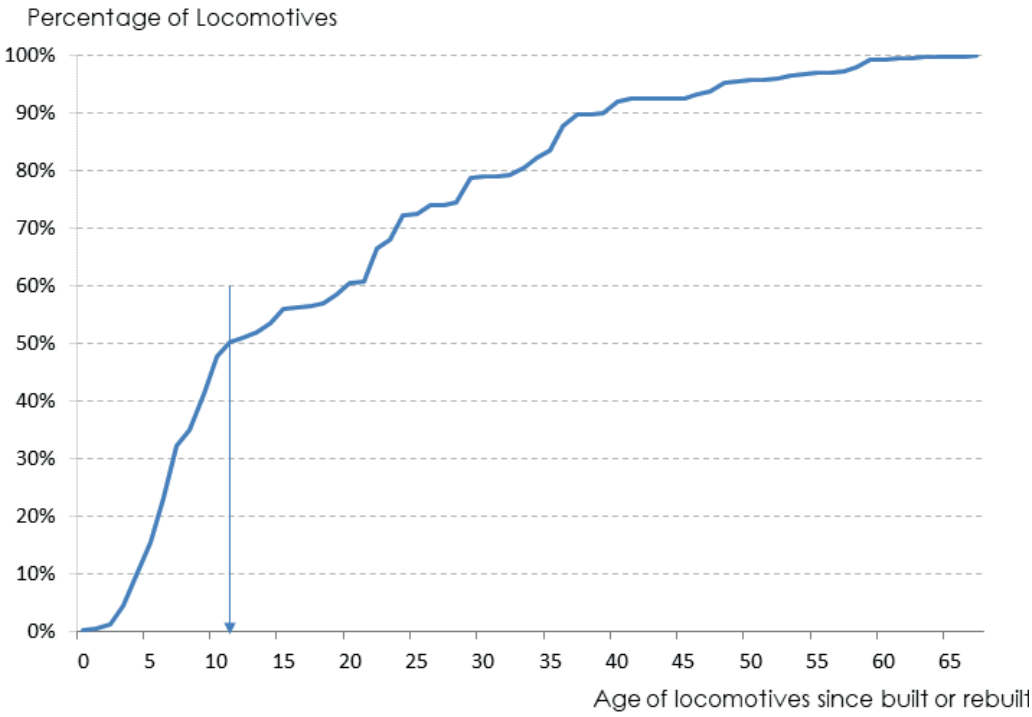
Sources: BITRE analysis of data from Pacific National, Aurizon, BHP Billiton, Fortesque Metals Group, Genesee and Wyoming Australia, Rio Tinto, SCT Logistics, Tasrail, Queensland Rail, Roy Hill, Fletchers International, Southern Shorthaul Rail, Public Transport Victoria, and QUBE Logistics; Clark (2015); Railpage (2018).

Figure 32 Cumulative locomotive age profile, by number of locomotives



Sources: BITRE analysis of data from Pacific National, Aurizon, BHP Billiton, Fortesque Metals Group, Genesee and Wyoming Australia, Rio Tinto, SCT Logistics, Tasrail, Queensland Rail, Roy Hill, Fletchers International, Southern Shorthaul Rail, Public Transport Victoria, and QUBE Logistics; Clark (2015); Railpage (2018).

Figure 33 Cumulative locomotive age profile, per cent



Source: BITRE analysis of data from Pacific National, Aurizon, BHP Billiton, Fortesque Metals Group, Genesee and Wyoming Australia, Rio Tinto, SCT Logistics, Tasrail, Queensland Rail, Roy Hill, Fletchers International, Southern Shorthaul Rail, Public Transport Victoria, and QUBE Logistics; Clark (2015); Railpage (2018).

Box 6 Further resources

The monthly magazines *Railway Digest* compiles a list of current and recently completed rolling stock contracts and deliveries of locomotives, wagons, permanent-way vehicles and passenger stock. This list is published regularly in the magazine. Railpage.com.au also provides regularly updated and historical details of locomotives by gauge, operational status, and current operator.

Urban passenger rolling stock

The levels of rolling stock networks required are a function of factors that include the following:

- Traffic levels;
- The network size and length of individual lines;
- The range of 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).

Passenger heavy rail stock

Urban heavy rail rolling stock is generally modern. Most current rolling stock is air-conditioned, with Sydney's remaining, non-air-conditioned, S-Set trains used on low patronage lines and for stand-by services only (See Table 24).

"Multiple unit" stock using permanently coupled carriages provide most services. Sydney's fleet generally run as four car units, coupled into eight car trains. Elsewhere, most trains are three-car units, generally paired as six-car trains. Adelaide's rolling stock, with large numbers of one and two-car units, enables Adelaide Metro to cater for modest traffic levels with a broad range of configurations. There are also some two-car operations in Perth.

Table 24 Urban Heavy rail rolling stock, July 2018

	Brisbane	Sydney	Melbourne	Adelaide	Perth
Vehicles (no.)	633[a]	1 619[b]	1 350	130[c]	297[d]
Air-conditioned vehicles (no.)	633	1 427	1 350	130	294
Carriage format	Single-deck	Double-deck	Single-deck	Single-deck	Single-deck
Multiple-unit format	165 three car 23 six car	248 four car 78 eight car	three car		48 two car 67 three car
Common train formations	EMUs coupled as six-car sets	EMUs coupled as eight-car sets	EMUs coupled as six-car sets	DMU, up to four-car; EMUs, normally as three-car sets, can couple as six car sets	EMUs coupled as six-car sets on new lines

Notes: a The Brisbane total excludes interurban rollingstock. It includes the New Generation Rollingstock.
b Sydney Trains is retaining its remaining S-set rollingstock until at least 2019 for stand-by services.
c The Adelaide vehicles includes the 4000 class, six cars of which are currently under repairs.
d The Transperth total is what was current at 30 June 2017.

Sources: Data provided by Transport for NSW, Public Transport Victoria, Queensland Rail, and Adelaide Metro; Public Transport Authority of Western Australia (2017, p.19).

Sydney is the only system to use double-deck carriages, which it began introducing in 1964 to increase passenger capacity on the existing network. Its double deck trains may have longer dwell times, however, due to passengers from the upper and lower decks meeting at the carriage doors and fewer doors per carriage than single deck trains. In August 2016, NSW TrainLink signed a $2.3 billion contract for the construction and maintenance of 512 EMU cars, to serve its intercity operations. The electric multiple units (EMU) will be designed and built in South Korea, with UGL Ltd. support. The trains are expected to enter service between 2019–2022. (*Railway Gazette International*, September 2016, p. 17)

In February 2016, Queensland Rail received the first of 75 New Generation Rollingstock (QNGR) six car set EMUs for use in south east Queensland. While replacing existing ageing EMU sets, the QNGR fleet is expected to increase capacity by approximately 30 per cent (*Railway Digest*, April 2016 pp. 30–31). The trains began revenue services in December 2017.

Light rail

Melbourne's light rail fleet is much larger and more varied than the other cities; see Table 25. Melbourne's older rolling stock, such as the Z and A classes, introduced between 1975 and 1984 and 1984–1986, respectively, are comparatively short and have low passenger capacity.

Over the past 30 years, there has been a progression 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 tram, introduced from 2013, is more than twice the length of the earlier Z and A classes. Similarly, rolling stock introduced in the last decade in other cities is all over 30 metres in length. The new trams are a mix of imported and locally built vehicles. Bombardier manufactures the Australian built vehicles at its Dandenong plant in Victoria. These vehicles are used in Melbourne and Adelaide. Since 2017, Yarra Trams has received an additional six E Class trams, and retired its two remaining B1 Class trams and one Z3 class vehicle. Overall, the fleet has thus increased. The Adelaide fleet includes three new Citadis trams that are have just entered or are about to enter into service.

Table 25 Light rail rolling stock, 2018

City	Vehicle type	Length (metres)	No. vehicles
Gold Coast	Flexity 2	43	18
Sydney	Urbos 3	33	12
Melbourne	A1 class	15	27
	A2 class	15	42
	B2 class	23.6	130
	C class	23	36
	C2 class	32.5	5
	D1 class	20	38
	D2 Class (Combino)	29.9	21
	E Class	33.5	66
	Z3 class	16.6	113
	W6 class	14.2	1
	W7 class	14.2	1
	W8	14.2	6
	SW6 class	14.2	6
Melbourne total			492
Adelaide	100 Flexity Classic	30	15
	200 Citadis	32	9
Adelaide total			21

Notes: Fleet numbers are based on rollingstock estimated to be in service.
Adelaide retains two heritage H class trams for tourist trips and special events.

Sources: Advice from G:Link; Advice from Adelaide Metro; Advice from Transdev NSW; Advice from Transport for Victoria.

Non-urban passenger rolling stock

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 all stopping, semi-fast, and express services on a given line); and
- The average speed of services (with faster operations requiring fewer train sets).

There is a wide range of non-urban passenger services in Australia. Thus, rolling stock, designed for individual markets and service types, vary. Table 26 shows the number of individual vehicles/cars, by type and operator.

Table 26 Non-urban passenger rolling stock in service, by vehicle type and operator, 2018

	Queensland Rail[a]	NSW TrainLink	V/Line[b]	Transwa
Electric multiple unit cars (no.)	138	417	-	-
Diesel multiple unit cars (no.)	27	65	252	14
Locomotives (no.)	27	19	30	-
Carriages (no.)	62	60	133	-
Total cars/vehicles	254	561	415	14

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

[a] The Queensland Rail total excludes the New Generation Rollingstock. Most of that fleet is used in suburban operations, although they are also used on the Gold Coast Line.

[b] The V/Line carriages total includes power vans but excludes the three flat wagons in its fleet.

The above lists individual vehicles rather than sets.

Queensland Rail carriage totals excludes power cars.

The estimate of Victorian carriages includes those in storage or undergoing repair.

No data is available for Great Southern Rail's trains.

Sources: Data provided by Department of Economic Development, Jobs, Transport and Resources, Transport for NSW, Transwa, and Queensland Rail

Locomotive hauled trains are primarily used for long-distance routes although V/Line still uses them on some commuter route services, such as Melbourne—Seymour. Some Queensland Rail long-distance services are locomotive hauled. V/Line's N class locomotives haul long distance trains on both the broad and standard gauges. New South Wales uses both XPT trains and Xplorer DMU sets on its long distance services. While the XPTs are capable of travelling at 160km/h, track conditions such as tight curves restrict their ability to travel at such speeds across much of its network. The New South Wales Government has announced plans to replace the XPT and Xplorer fleet, but without a firm date on when this will occur (Transport for NSW, 2016).

Medium-distance regional/commuter services are generally DMU operated. VLocity DMUs, that operate at speeds of up to 160km/h, are used on Victoria's Regional Fast Rail services. Transwa uses DMUs for all its rail services. The Perth-Kalgoorlie Prospector DMU also travels at up to 160km/h.

NSW TrainLink and Queensland Rail have large EMU fleets, which are largely used for intercity/commuter services. New South Wales uses its EMU fleet for Sydney—Newcastle, Sydney—Lithgow and Sydney—Kiama (via Wollongong) services. Queensland Rail's intercity EMUs are used on the Sunshine Coast and Gold Coast lines.

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

CHAPTER 4
Railway performance

Network indicators

Safety

The Office of the National Rail Safety Regulator (ONRSR) now has nationwide coverage after Queensland passed the required legislation on 1 July 2017.

ONRSR, which, in 2016–17, had regulatory safety oversight for South Australia, New South Wales, Tasmania, Northern Territory, Victoria[35], Western Australia[36], and the Australian Capital Territory, stated in its *Rail Safety Report 2016–2017* there were 89 notified fatalities on railways that the Rail Safety National Law (2012) regulates. These fatalities were:

- 73 acts of suspected suicide;
- nine incidents of trespassers struck by rolling stock;
- four level crossing collisions between a train and a road vehicle;
- one assault of a member of the public at a train station;
- one incident of a trespasser impaling themselves on a boundary fence;
- one incident of a passenger who fell down the stairs of a train. (ONRSR, 2017, p.9)

This compares to 83 fatalities for the previous financial year.

Further 'key occurrence' category incidents include:

- 84 serious injuries, of which over 45 per cent related slips, trips, and falls, while approximately 26 per cent related to attempted suicide.
- Eight passenger train running line derailments, three of which were not carrying passengers;
- 30 freight train running line derailments; and
- 23 track maintenance rolling stock derailments. (ONRSR, 2017, p.10)

In Queensland, where the Department of Transport and Main Roads administered rail safety during the reporting period, there were 57 Category A notifiable occurrences during that financial year, an increase of 14 per cent compared to the previous financial year, but a decrease of 29 per cent over the preceding four years. (Department of Transport and Main Roads 2017a, p.16)

35 ONRSR's oversight in Victoria excludes tramways and some tourist and heritage railways. Victorian law regulates these operations.
36 2016–17 was the first year ONRSR had full oversight for Western Australia.

The department defines a Category A notifiable occurrence as:

- 'an accident or incident that caused significant property damage, serious injury or death;
- a running line derailment;
- running line collision between rolling stock;
- a collision at a railway crossing between rolling stock and either a road vehicle or a person;
- a fire or explosion on or in rail infrastructure or rolling stock that affects the safe carrying out of the railway operations or has endangered one more persons;
- a terrorist attack or an act or event suspected to be a terrorist attack; or
- an accident or incident involving an inadequacy in the safety management system for the railway operations that could have caused significant property damage, serious injury or death.' (Department of Transport and Main Roads 2017a, p.15)

Of the Category A occurrences, there were eight fatalities as a direct result of railway operations and four fatalities incidental to railway operations. These fatalities exclude (suspected) suicides. (Department of Transport and Main Roads 2017a, p.17)

Environmental performance

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.

Changing requirements, such as higher performance and, for passenger rail, air-conditioning and on-board electronics, may increase emissions intensity. Table 27 shows BITRE's revised carbon dioxide equivalent emissions estimate of the rail industry since 2006. According to the current estimate, emissions have increased by approximately 32 per cent since 2006. The increased rail transport of bulk materials, particularly iron ore, is likely to be a cause of the higher level of emissions, as is the increased passenger task.

The emissions intensity of rolling stock and locomotive fuel efficiency also affects the industry's performance and competitiveness. Manufacturers and operators focus on maximising energy efficiency in such ways as Aurizon using regenerative braking on its electrified Central Queensland coal network, which provides 17 per cent of the operator's energy needs on the electrified Goonyella and Blackwater systems (Aurizon 2016).

Table 27 Rail industry's full fuel cycle carbon dioxide equivalent emissions (billion grams)

Year											
2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
CO_2 emissions											
4 592	4 869	5 023	5 097	5163	5231	5 366	5 420	5 607	5 886	6 014	6 083

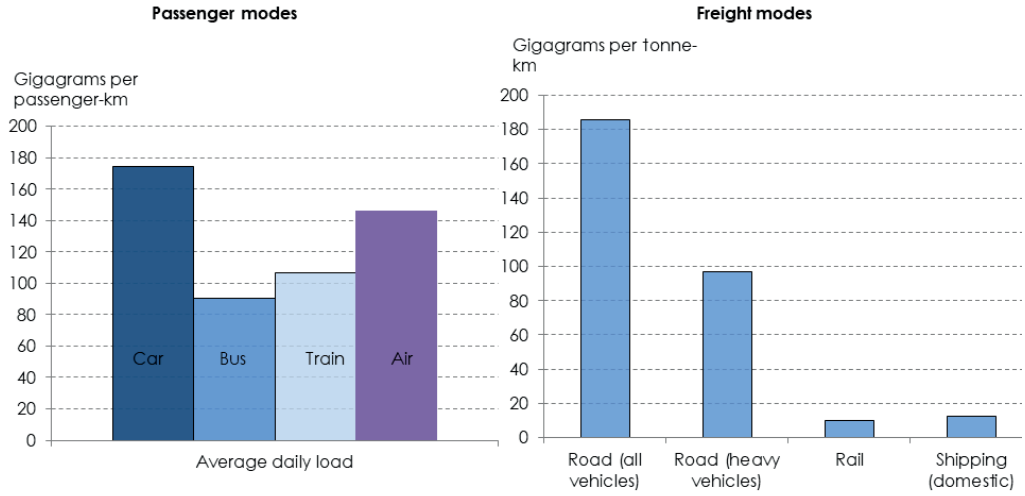
Note: Preliminary/provisional estimate.

Source: Revised BITRE estimates.

The emissions intensity of freight rail is low relative to road freight vehicles[37]. (Figure 34).

Urban passenger rail transport creates less relative pollution than cars, especially during peak period travel. Over the full day, the gap in average emissions intensity is less substantial, however, since off-peak rail services generally have lower patronage and road vehicles are less subject to congestion.

Figure 34 Estimated emissions intensity of passenger and freight modes, 2017, carbon dioxide equivalent



Source: BITRE estimates.

Interstate network indicators

Access revenue yield indicator (ARTC)

The access revenue yield data that ARTC provides is the revenue per '000 GTK that a reference superfreighter train generates for ARTC in specific line segments.

Access revenue is the infrastructure manager's income made from train operators using the railway. ARTC's access charge has two parts: 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 a train's tonnage increases, the average access charge per tonne declines.

This access charging regime encourages train operators to operate longer trains. Longer trains enable infrastructure managers to increase tonnage throughput, as there are limited train paths. However, longer trains require track that can accommodate the longer trains. Consequently, interstate network infrastructure managers have upgraded their networks to accommodate longer trains.

37 These figures have not been updated.

Table 28, below, is ARTC's revised index of the maximum access yield for the interstate network it manages. The indicator measures the changes (relative to the base year) in the maximum access revenue yield per gross tonne kilometre. As the access revenue yield is calculated on a nominal reference train, this measure essentially identifies if there have been any real changes in access charges. 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).

Table 28 Index of real maximum access revenue yield, interstate network (2009–10 = 100)

	2007–08	2008–09	2009–10	2010–11	2011–12	2012–13	2013–14	2014–15	2015–16	2016–17
North–South corridor										
Acacia Ridge – Border Loop			100.00	99.97	100.01	100.00	100.00	99.95	99.94	100.00
Border Loop – Newcastle	100.00	99.94	100.00	99.97	100.01	100.00	100.00	99.95	99.94	100.00
Macarthur–Albury	100.04	99.95	100.00	99.99	100.03	100.00	100.00	99.98	99.97	100.00
Albury–Tottenham	107.97	99.95	100.00	99.99	100.03	100.00	100.00	99.98	99.97	100.00
East–West corridor										
Melbourne–Adelaide	96.97	99.93	100.00	99.99	100.04	100.00	100.01	99.98	99.96	100.00
Adelaide–Kalgoorlie	92.15	99.94	100.00	99.97	100.02	99.99	99.99	99.97	99.94	100.00
Cootamundra–Parkes	100.07	99.93	100.00	99.99	100.04	100.01	100.01	99.97	99.94	100.00
Parkes – Broken Hill	100.00	99.94	100.00	99.97	100.02	100.00	99.99	99.96	99.93	100.00
Broken Hill – Crystal Brook	84.71	99.94	100.00	99.97	100.02	100.00	99.99	99.96	99.93	100.00

Note Numbers are subject to rounding.

Source: Data provided by ARTC.

Interstate network utilisation

Train frequency on the interstate network

Table 29 shows the numbers of scheduled weekly intermodal trains that originate and terminate in the given city pairs. These origins and destinations are those of trains, not those of goods on the trains. For example, Brisbane—Melbourne trains will dwell in Sydney where goods are loaded and unloaded. Caution is also needed when comparing train numbers. Lower train numbers can be more than offset by longer train lengths.

The number of scheduled intermodal-designated trains on the North–South corridor has increased or remained static, despite Aurizon's exit from intermodal operations in December 2017. Pacific National and SCT Logistics have increased their services, resulting in no change to the number of Brisbane—Melbourne services. Pacific National has also introduced three Melbourne to Sydney services. It is not known if this is in response to Aurizon's cessation of services or possible changes in the consist of Melbourne—Wollongong mixed steel/intermodal steel designated trains[38].

On the East–West corridor, the number of scheduled intermodal trains operating Melbourne-Perth has decreased, due to the cessation of Aurizon's services. Pacific National and SCT Logistics have increased their services but not to the extent there has been no net loss of services. The number of Sydney-Perth trains (for which there were no previous Aurizon services) is unchanged.

The number of scheduled intermodal trains operating between Melbourne and Adelaide has decreased by one. Excluded from the Sydney—Perth train numbers are the SCT Goobang (Parkes)—Perth services, of which there is one train per direction each week and the four return Adelaide/Port Augusta-Goobang 'shuttle' trains which carry freight that connects with or has come off its Melbourne-Perth services[39].

Table 29 Number of scheduled weekly intermodal designated train services, by city pair

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
North–South corridor											
Brisbane to Sydney	1	1	1	1	2	2	2	2	5	5	6
Sydney to Brisbane	0	0	0	0	0	0	0	2	5	5	4
Sydney to Melbourne	3	0	2	2	3	2	2	1	1	2	2
Melbourne to Sydney	3	0	2	2	3	2	2	0	0	0	3
Brisbane to Melbourne	16	17	15	15	15	15	15	16	12	16	16
Melbourne to Brisbane	17	17	15	15	15	16	16	16	12	16	16
Brisbane to Adelaide	5	3	3	3	2	2	2	2	2	2	1
Adelaide to Brisbane	4	3	3	3	2	2	2	2	2	2	1
East–West corridor											
Melbourne to Adelaide	17	17	11	12	9	9	8	6	6	5	5
Adelaide to Melbourne	17	17	11	12	9	9	9	6	6	6	5
Melbourne to Perth	16	15	18	19	20	20	20	20	18	18	15
Perth to Melbourne	16	15	17	19	20	20	20	20	19	19	15
Sydney to Perth	8	7	7	7	8	9	10	8	7	7	7
Perth to Sydney	8	7	7	7	8	9	10	9	7	7	7
Adelaide to Perth	2	2	0	0	0	0	0	0	0	0	0
Perth to Adelaide	2	2	0	0	0	0	0	0	0	0	0
Central corridor											
Adelaide to Darwin	5	7	7	6	7	6	6	6	6	6	6
Darwin to Adelaide	5	6	6	6	7	6	6	6	6	6	6

Sources: Working timetables of infrastructure managers (ARTC, Sydney Trains, Arc Infrastructure and Genesee & Wyoming Australia) as at April 2018.

38 In 2018, BITRE has observed Melbourne-Wollongong trains carrying steel products only, in contrast to previous recent years where the trains carried both steel and intermodal freight.

39 SCT bridges the gap between Goobang and Sydney by road transport, as part of its integrated logistics services.

Weekly trains by interstate line segment

Table 30 shows the number of scheduled weekly interstate intermodal and steel trains on each line segment. This indicates how intensely the interstate network is used. Table 30 differs from Table 29 because it includes all trains that travel along a given corridor, including those that continue on to another corridor, and steel trains. For example, BITRE counts a train travelling from Melbourne to Perth on all line segments on that route. Table 29 also includes interstate trains that do not travel from capital city to capital city, such as the Melbourne—Griffith trains.

Crystal Brook—Port Augusta remains the busiest segment. The segment is a convergence point for interstate intermodal trains travelling to and from Perth; intermodal trains between Adelaide and Darwin; and steel trains from Newcastle, Melbourne, Adelaide, and Perth to Port Augusta and Whyalla.

The Sydney—Cootamundra and Cootamundra—Melbourne line segments remain the busiest on the North–South corridor. In addition to intermodal and steel trains, passenger and bulk commodity (mostly grain) trains used these segments extensively. The significant increase in 2018 is due largely to QUBE Logistics redirecting many of its Harefield trains from Port Botany to Melbourne. The trains to Port Botany were not included in previous years' counts because they were not interstate by nature.

Table 30 Total scheduled weekly interstate intermodal and steel trains, by line segment

Line segment	2010	2015	2016	2017	2018
North–South corridor					
1. Brisbane–Sydney	49	42	48	58[a]	56
2. Sydney–Melbourne					
Sydney–Cootamundra	68	58	60	70	71
Cootamundra–Melbourne	53	49	49	58	71
East–West corridor					
3. Sydney–Crystal Brook via Broken Hill					
Sydney–Parkes via Lithgow	9	11	6	6	6
Cootamundra–Parkes	20	20	22	22	20
Parkes–Crystal Brook	29	33	30	30	32
4. Melbourne – Crystal Brook					
Melbourne–Adelaide	71	59	55	53	46
Adelaide – Crystal Brook	57	64	60	60	55
5. Crystal Brook – Perth					
Crystal Brook – Port Augusta	86	90	84	84	80
Port Augusta – Tarcoola	71	77	69	69	63
Tarcoola–Perth	**59**	**65**	**57**	**57**	**51**

Note: [a] This is a revised estimate.

Sources: Working timetables of infrastructure managers (ARTC, Sydney Trains, Arc Infrastructure, and Genesee & Wyoming Australia) as at April 2018.

Train flow patterns on the interstate network

Train flow indicators based on scheduled running times provide information about the flow of trains across the network.

Table 31, below, only provides information about intermodal designated scheduled services, which share the line with other trains such as bulk goods trains, steel designated trains and passenger trains. Changes to the nature and scale of these other trains' operations may influence intermodal train flow patterns in the infrastructure managers' path planning. Assessing what influences other trains' operations may have on intermodal train flow patterns is outside the scope of this publication. Train flow patterns are based on scheduled times. Actual times for individual trains may differ due to operational reasons.

Table 31 Scheduled inter-capital intermodal train flow patterns

Line segment/ direction	Number of weekly services		Average speed (kph)		Average stops		Average transit time (mins)		Average dwell time (mins)		Percentage dwell time (per cent)		Dwell time per stop (mins)	
Year	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
North-South corridor														
Brisbane to Sydney	21	23	55	54	8	8	1063	1083	154	181	15%	17%	20	22
Sydney to Brisbane	21	21	56	55	6	7	1049	1054	136	148	13%	14%	22	22
Sydney to Melbourne	18	18	66	64	3	4	875	905	81	86	9%	10%	28	24
Melbourne to Sydney	16	19	70	69	3	4	828	836	43	67	5%	8%	13	18
Brisbane to Melbourne	16	16	58	60	11	11	2002	1959	299	269	15%	14%	28	22
Melbourne to Brisbane	16	16	61	62	10	12	1912	1865	227	239	12%	13%	22	21
East-West corridor														
Melbourne to Adelaide	23	20	67	68	3	3	748	738	54	51	7%	7%	17	17
Adelaide to Melbourne	24	20	57	58	5	5	874	868	167	153	19%	17%	34	29
Adelaide to Perth	18	15	65	67	12	12	2462	2366	350	326	14%	14%	28	27
Perth to Adelaide	18	15	58	59	17	18	2764	2689	652	646	24%	24%	39	35
Cootamundra to Crystal Brook	3	4	67	67	5	4	1138	1136	263	266	23%	23%	53	61
Crystal Brook to Cootamundra	7	8	61	57	5	4	1248	1326	382	350	31%	26%	79	79
Brisbane to Adelaide	2	1	52	54	14	17	3230	3145	918	840	28%	27%	63	49
Adelaide to Brisbane	2	1	51	53	14	15	3292	3180	916	860	28%	27%	65	57
Central corridor														
Tarcoola to Darwin	6	6	71	64	4	4	1906	2098	262	266	14%	13%	68	67
Darwin to Tarcoola	6	6	68	68	4	4	1986	1976	297	285	15%	14%	71	68

Notes: 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.

Sources: Working timetables of infrastructure managers (ARTC, Sydney Trains, Arc Infrastructure and Genesee & Wyoming Australia) as at April 2018.

(a) Dwell time and number of stops

Dwell time indicators show the time trains are scheduled to spend dwelling (stationary) in railway yards and passing loops. Reasons for dwelling include:

- Operational — such as changing train crews or refuelling;
- Loading and unloading freight at intermediate destinations; and
- Track capacity and traffic — trains may need to wait in passing loops/lanes and sidings for others to pass or overtake.

North–South corridor

Changes to Brisbane-Melbourne services following Aurizon's exit makes comparisons to 2017 problematic. On the Sydney—Melbourne corridor, the introduction of the three Melbourne to Sydney services has contributed to the increased average number of stops. These three new services, for instance, average three stops each.

Sydney is a major market served by the Brisbane—Melbourne and Brisbane—Adelaide trains, where freight is loaded and unloaded, as is Barnawartha and Ettamogah. This affects the corridors' average dwell times.

Average dwell times on the North-South corridor have mostly increased compared to 2017. Following Aurizon's withdrawal of all intermodal services, Pacific National has introduced three Melbourne to Sydney services. Each of these trains dwell at the Ettamogah rail hub for 37 minutes, which affects average dwell times between Melbourne and Sydney.

East–West corridor

Assessing traffic flows on the East-West corridor is more complex because it consists of several intersecting lines that, for Perth-bound trains, intersect at Crystal Brook Junction in South Australia and diverge for those travelling in the opposite direction. Sydney-Perth and Perth-Sydney train calculations do not include Sydney—Cootamundra (part of the North-South corridor) and the alternative Sydney—Parkes via Lithgow route. Rather, BITRE calculates times from Cootamundra, where westbound trains travel north to Goobang Junction (Parkes), then west to Broken Hill and Crystal Brook. The reverse applies for eastbound trains[40].

There has been no significant change or patterns of change in the average number of stops or dwell times.

Adelaide is the largest intermediate city on the corridor. Pacific National operates a terminal at Islington while SCT Logistics operate from their terminal in Bolivar. Another significant intermediate terminal is at Goobang (Parkes) in New South Wales.

Two other significant operational dwell locations are at Cook and Spencer Junction (Port Augusta) in South Australia. Both locations are used for crew rest breaks, crew changes and the refuelling of some trains. As with other train pattern indicators, train operator factors influence dwell times and number of stops, such as operators loading and unloading freight en route and operators

40 Sydney-Perth trains take either the more direct but steeper route via Lithgow or the longer but flatter route via Cootamundra West. All Perth-Sydney trains travel via Cootamundra West.

holding their trains for extended periods at points en route, such as some eastbound trains at Port Augusta and Adelaide[41].

Central corridor

Dwell times and numbers of stops are largely unchanged. Genesee & Wyoming Australia, which is the sole freight train operator on the corridor, has the following characteristics:

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

(b) Average speed

Average train speed is a measure of a train's in motion speed plus its dwell time. The measure can be used to assess railway performance, both train and infrastructure. Prevailing speeds also reflect a range of infrastructure-based factors, including the number of stops, track alignment, and track condition.

There is a clear distinction between travel times for trains travelling to Perth and those travelling from Perth. Westbound trains complete the trip faster. Trains travelling from Melbourne to Perth complete the trip on average 15 per cent faster than Perth to Melbourne trains and have an average 15 stops en route compared to eastbound trains' 23. Comparing travel times from and to Sydney is more complicated due to the split of routes westbound trains take. Premium express services to Perth travel via Lithgow while non-express services take the longer (in distance and travel time) but flatter route via Cootamundra. All eastbound services travel via Cootamundra. When comparing times via the Cootamundra route the difference is only marginal. Sydney-bound trains take an average 0.05 per cent longer than Perth bound trains, with an average 21 stops compared to 18.

Table 31 shows that average scheduled speeds have remained largely unchanged on all corridors, except Tarcoola to Darwin, which has decreased by almost 10 per cent.

Track indicators for the interstate network

The indicators 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. Figure 35 and Figure 36 show the average scheduled intermodal transit time for trains travelling in both directions on nine city pairs, for the North–South, Central and East–West corridors respectively. Table 31 shows the scheduled transit time figures.

41 For example, Pacific National holds one Perth-Melbourne train overnight at Adelaide.

Scheduled transit times are influenced by factors including line speed; the number of stops en route; the number and type of other trains on the line (particularly when the route has single track or in shared urban and intercity networks); operator-dependent factors such as time spent in intermediate cities; and, for Sydney—Perth trains, the route used.

Average scheduled transit times between Sydney and Brisbane have reduced slightly, while transit times between Melbourne and Sydney and Melbourne, and Brisbane have increased, due possibly to the SCT trains dwelling at Barnawartha.

Scheduled transit times on the east-west corridor are largely unchanged, except for Brisbane-Adelaide trains, whose scheduled transit times have increased by almost five per cent.

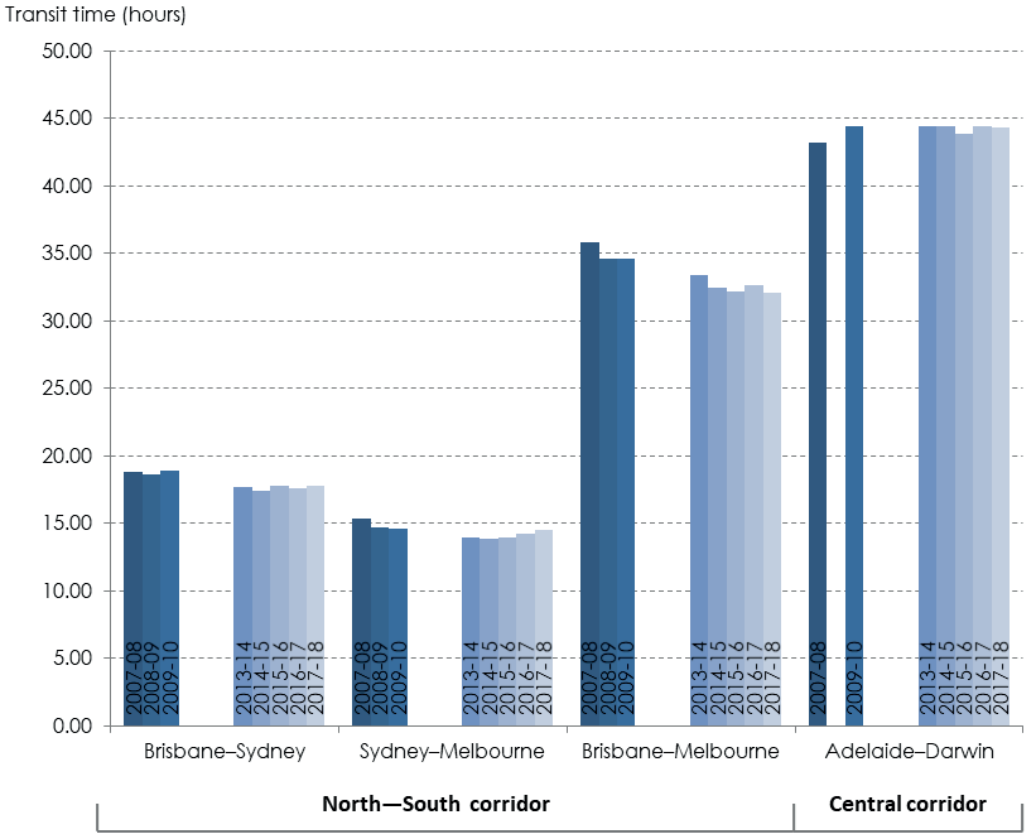
Scheduled transit times on the central corridor have increased by less than two per cent.

Box 7 7MP7 and 3SP7: Examples of scheduled fast running

Some Perth-bound trains from Melbourne and Sydney provide fast premium services, for which the operator, Pacific National, pays a premium track access fee that gives them priority over other trains. While the average total travel time from Melbourne to Perth is 55 hours 47 minutes, 7MP7 completes the journey in 46 hours 55 minutes. The train departs Melbourne at 0110 hours (eastern standard time) on Saturdays and arrives at Perth at 2215 hours (western time) on Sundays. It has 12 stops compared to the average of 17 (Melbourne to Perth trains) and a dwell time of 311 minutes compared to the average of 620 minutes. Between Cook and Parkeston (Kalgoorlie), a distance of 862 kilometres, the train maintains an average speed of 100 kilometres per hour and has no intermediate stops. Its average speed from Melbourne to Perth, including dwell time, is 83 kilometres per hour, compared to the average 62 kilometres per hour.

3SP7 completes its journey in 53 hours and eight minutes travelling via the Blue Mountains, compared to the average 66 hours and 18 minutes that non-premium Sydney to Perth trains travelling the longer but flatter route via Cootamundra West take. It departs Sydney at 2312 hours (eastern standard time) on Tuesdays and arrives at Perth at 0230 hours (western time) Fridays. It has 10 stops compared to the non-premium average of 18 and a dwell time of 260 minutes compared to the non-premium average of 776 minutes. Between Cook and Parkeston, the train also maintains an average speed of 100 kilometres per hour and has no intermediate stops. The train's average speed from Sydney to Perth, including dwell time, is 82 kilometres per hour, compared to the non-premium service via Cootamundra average of 62 kilometres per hour.

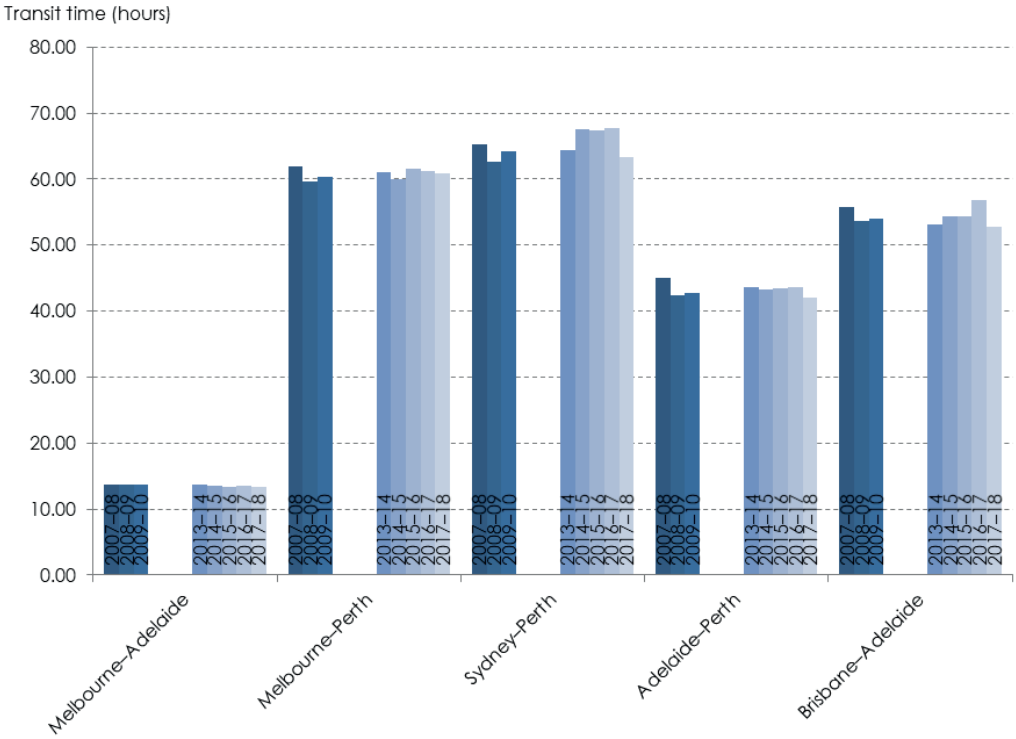
Figure 35 Average scheduled transit times, North–South and Central corridors, 2006–07 to 2017–18



Notes: Calculations include all intermodal designated trains on a given line segment travelling in both directions. The Sydney–Melbourne calculations, for example, include Brisbane–Melbourne trains.

Sources: Infrastructure managers' working timetables (ARTC, Sydney Trains, Arc Infrastructure, and Genesee & Wyoming Australia) as at April 2018.

Figure 36 Average scheduled transit times, East–West corridors, 2006–07 to 2017–18



Notes: Calculations include all trains on a given line segment, as at May 2018. The Melbourne–Adelaide calculations therefore include Melbourne–Perth trains.

Calculations for westbound Sydney-Perth trains are based on both the via Cootamundra West and Lithgow routes.

The Sydney-Perth calculations are revised for the years 2013–14 to 2015–16.

Sources: Infrastructure managers' working timetables (ARTC, Sydney Trains, Arc Infrastructure and Genesee & Wyoming Australia) as at April 2018.

Train reliability on the interstate network

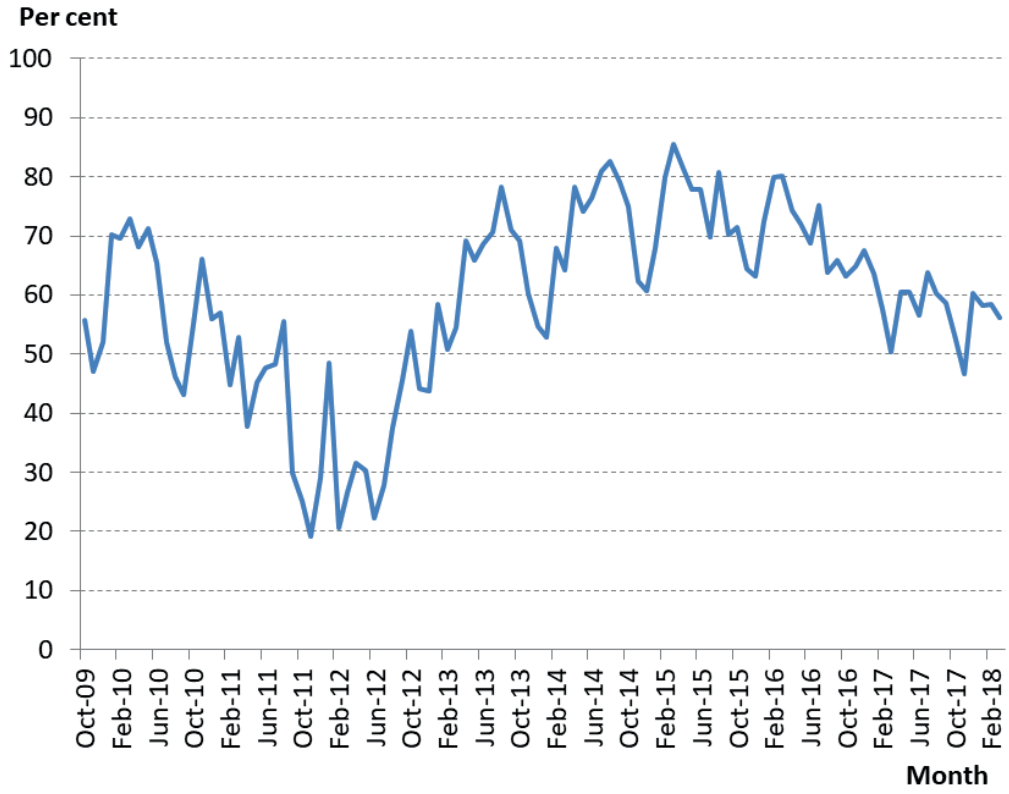
ARTC publishes performance indicators relating to service quality areas including reliability. Detailed information regarding reliability by city pair is available on ARTC's website.

Train and track issues affect reliability. Problems for train operators include mechanical issues with rolling stock, delays at terminals, flow on problems from other operators' delays, and problems beyond operators' control such as trespass and vandalism. These problems can cause significant delays across the network and for trains entering the network. This requires infrastructure managers to allocate train paths without compromising their obligations to other operators.

Infrastructure issues also affect reliability. Track quality problems can result in (temporary) speed restrictions and track closures. Signalling failures also cause delays. Infrastructure maintenance and renewal, as well as weather conditions, are important aspects in infrastructure reliability.

Figure 37 and Figure 38 show the percentage of intermodal trains that left the ARTC network within 30 minutes of schedule. The data are collected monthly and are subject to significant variation due to the impact of individual events.

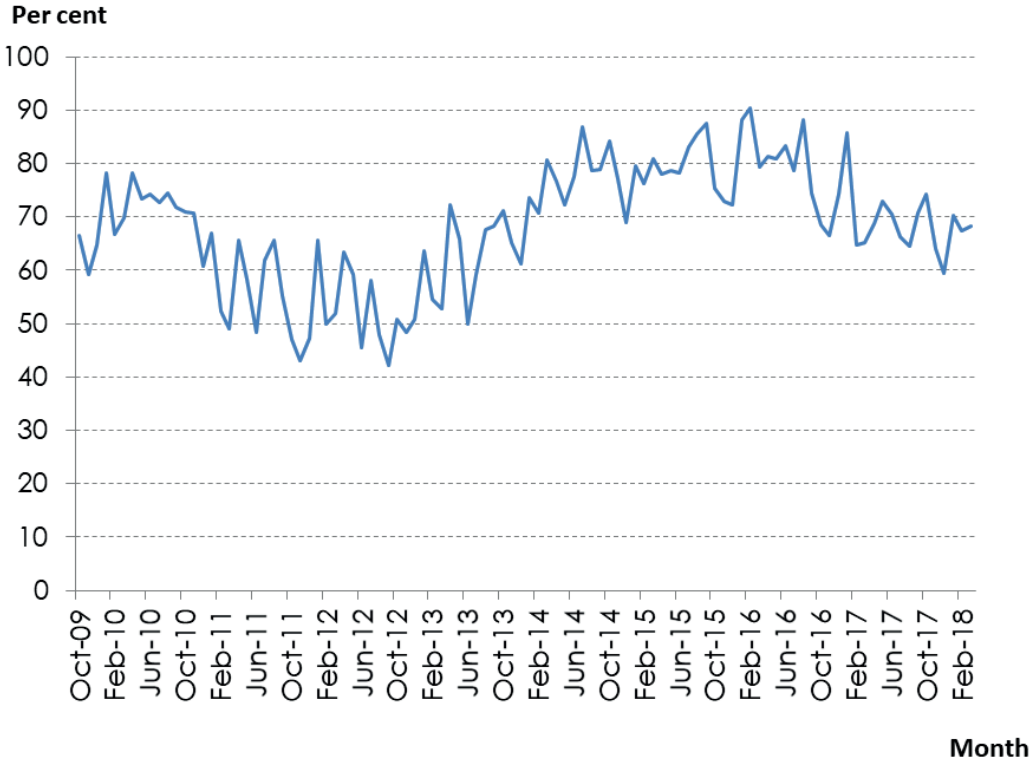
Figure 37 North–South corridor, percentage of intermodal trains exiting the network within 30 minutes of schedule



Source: Data provided by ARTC.

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 many temporary speed restrictions and increased maintenance activity due to reported rough riding and mud holes (ATSB 2013, p.5). In December 2011, the ARTC commenced the "Ballast Rehabilitation Programme", to replace fouled ballast and improve track drainage on the corridor. Temporary speed restrictions have been progressively removed and reliability improved from mid–2012 to a high point of 85 per cent in March 2015. Since then reliability has trended downwards. In February 2018, reliability was 58 per cent.

Figure 38 East-West corridor, percentage of intermodal trains exiting the network within 30 minutes of schedule



Source: Data provided by ARTC.

Reliability on the East–West corridor (Cootamundra West/Parkes–Kalgoorlie and Melbourne–Kalgoorlie) reached a high point of 90 per cent in February 2016, but dropped to 59 per cent in December 2017. In February 2018, it had increased again, to 67 per cent.

Permitted train lengths on the interstate network

Permitted train lengths influence track capacity. On Australia's predominantly single track, crossing loops and passing lanes contribute to capacity. Since the mid–1990s in particular, infrastructure managers have built longer crossing loops and passing lanes (approximately 6–8 kilometres in length) across the interstate network. Track alignment and gradients also determine permitted train lengths.

Permitted unrestricted train lengths on the interstate network are as follows:

- 1500 metres Brisbane–Sydney;
- 1500 metres Melbourne–Adelaide (1800 metres restricted); and
- 1800 metres Sydney–Melbourne, Cootamundra–Crystal Brook, Adelaide–Perth, Tarcoola–Darwin.

The 'unrestricted' train length is the maximum length operators can operate any scheduled service without reference to the infrastructure manager. The length is shorter than the 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[42] added on the single track sections between Junee and Melbourne to allow the unrestricted use of 1800 metre trains.

Double stacking capability on the interstate network

Double stacking containers on wagons also influences capacity. In Australia, double stacking involves stacking one hi-cube (9 feet 6 inch, or 2.896 metres high) container on top of another in 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 Goobang (Parkes) and west of Adelaide. Figure 39, below, illustrates.

Clearances on the North–South corridor are restricted to single stacking of hi-cube containers. The increasingly prevalent higher maxicube (10 feet 6 inch, or 3.20 metre) containers travel in low-floor well wagons.

The central corridor line can accommodate double stacked containers and road freight vehicles 'piggybacked' on rail flat wagons.

42 A passing lane differs from a passing loop by viritue of the fact they are approximately eight kilometres in length, as opposed to approximately 1500 metres and 1800 metres, which is the typical crossing loop length on the interstate network, depending on the corridor. This enables trains to cross each other without stopping, subject to timings.

Figure 39 Double stacking capability on the interstate network

Track quality of the interstate network

The maintenance and standards of railway infrastructure are important to train operating performance. The infrastructure quality, maintenance regime and underlying economic life of the infrastructure influence the permitted track speed and smoothness of wagon ride.

Figures 40 to 43 illustrate physical measures of average track condition by line segment. These indicators use a 'track quality index' (TQI). Lower index numbers equates to higher track quality.

The figures show trends in track condition for given line segments. The rate of track quality decline is influenced by such factors as 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 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 are comparable.

Box 8 Calculating track quality indices

For safety, maintenance, planning and regulatory reasons, infrastructure managers regularly measure the condition of their track. Managers measure the extent to which the railway track deviates from the 'designated' (or 'true') alignment. Infrastructure managers can report a global indicator of track condition on a given line segment. ARTC produced 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.

Infrastructure managers regularly operate a train with a 'track geometry measuring car'. The carriage is equipped to measure and record a range of geometric parameters. There is a variety of track geometry measuring cars in Australia and hence a variety 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.

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

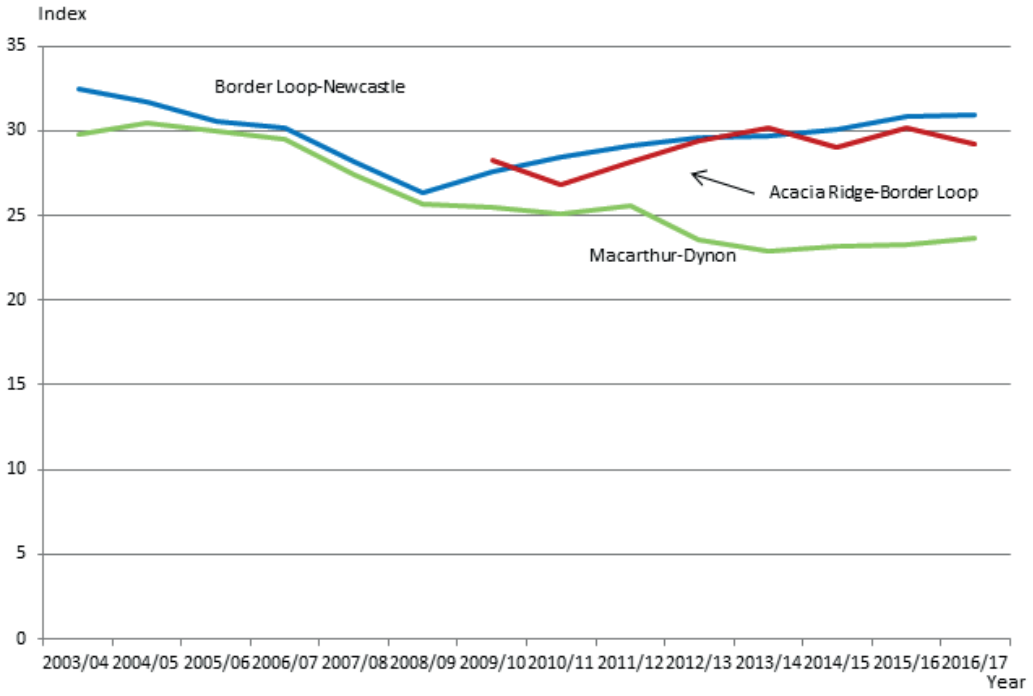
- Gauge;
- Twist (short), measured over two metres;
- Vertical irregularities ('top'), deviation over a 20 metre inertial reading (average of left and right rail); and
- Horizontal line irregularities ('versine'), 5/10 metre chord emulation (average of left and right rail).

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

As Figure 40, below, shows, ARTC's TQI has improved on the Acacia Ridge-Border Loop sector, while has deteriorated slightly on the other two sectors. Figure 41 shows that on the east-west corridor it has improved on all sectors.

Genesee & Wyoming Australia's TQI has fluctuated significantly on all sectors (See Figures 42 and 43). The break in the Katherine-Union Reef and Union Reef Darwin corridors in the first half of 2012 was due to the Edith Bridge derailment.

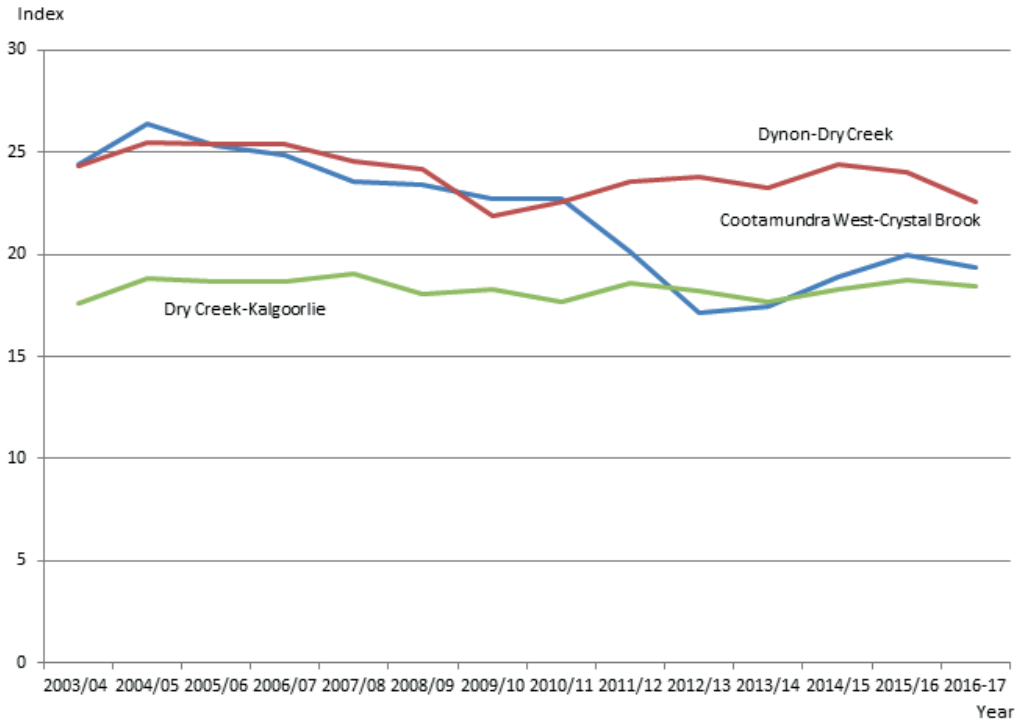
Figure 40 ARTC track quality index, North–South corridor



Note: Lower indices indicate higher track quality.

Source: Data Provided by ARTC.

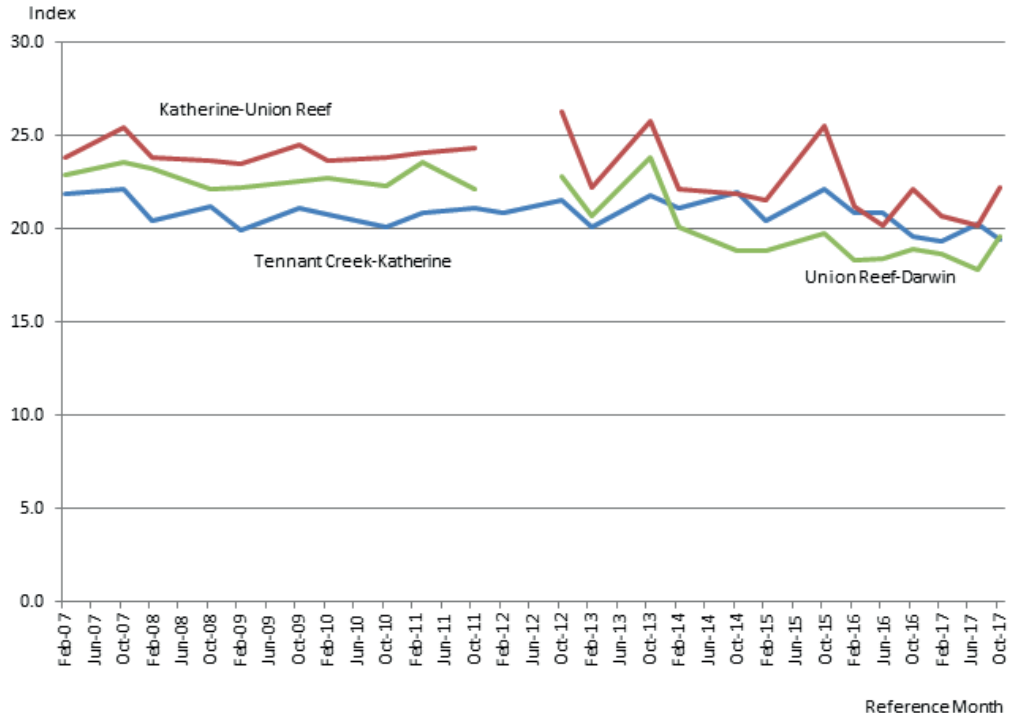
Figure 41 ARTC track quality index, East-West corridor



Note: Lower indices indicate higher track quality.

Source: Data Provided by ARTC.

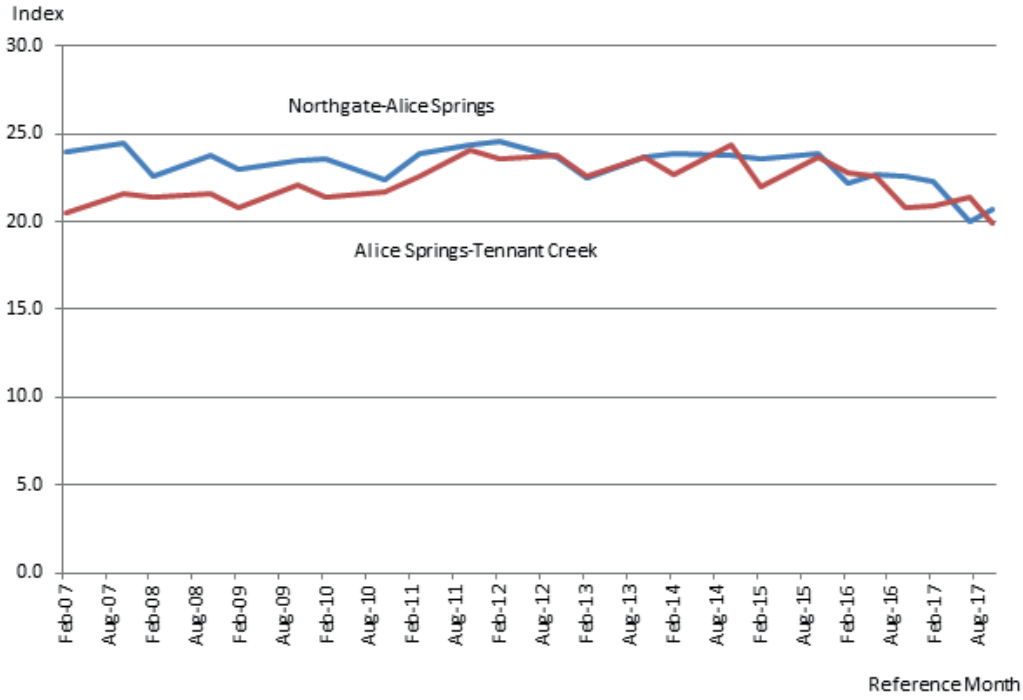
Figure 42 Genesee & Wyoming Australia track quality index, Darwin-Tennant Creek



Note: Lower indices indicate higher track quality.

Source: Data Provided by Genesee & Wyoming Australia.

Figure 43 Genesee & Wyoming Australia Track Quality Index, Tennant Creek-Northgate



Notes: Northgate is the start of the Genesee & Wyoming Australia track. It is located shortly north of Tarcoola, where it separates from the ARTC track.

Lower indices indicate higher track quality.

Source: Data Provided by Genesee & Wyoming Australia.

Intermodal train real time running

This section compares a sample of de-identified intermodal trains' real time running compared to the ARTC Master Train Plan (timetable) that was current for the corresponding period. The comparison is of all intermodal-designated trains that entered, transited through, then exited the Sydney Trains network, at the entry/exit points of Islington Junction and Macarthur South Junction/Glenlee for the period 1 June–31 August 2018. The analysis records what time trains departed the ARTC network and entered the Sydney Trains network at each point, and what time they re-joined the ARTC network at the opposite end. The analysis thus assesses how close to schedule the trains exited and re-entered the ARTC network and how long they took to transit the Sydney Trains network. BITRE acknowledges there are numerous factors that affect how close to scheduled times trains run. The analysis is not, and should not, be seen as a performance review and BITRE is unable to assess reasons for differences between scheduled and actual running times. The analysis only examines the given sector due to current data availability limitations BITRE has for train operations outside that sector.

Tables 32 and 33, below, show the results, noting the following:

- The number of scheduled services is the sum of that recorded in the ARTC Master Train Plan that was current at the time of the analysis period, while the number of actual recorded services are those whose times BITRE was able to record from its online real time running source.
- The number of actual recorded services is lower than scheduled services because:
  - Some scheduled trains have no record of having run;
  - Data is only available for part of some trains' journeys (this is why totals do not always balance); and
  - Some actual services bypassed Sydney, travelling instead via Dubbo.

Additionally, the analysis excludes services that ran but did not appear in the Master Train Plan as BITRE was not able to compare running times for these services as there were no published scheduled times for comparative purposes.

Table 32 Intermodal transit times Islington Junction to Macarthur South Junction, June-August 2018

Transit	
Number of scheduled services	227
Number of recorded services	193
Average scheduled transit time (hours:minutes)	05:27
Average recorded transit time	06:11
Number of services on schedule (transiting the Sydney Trains network 'on time' to the minute)	4
Number of services ahead of schedule	61
Number of services <30 minutes behind schedule	36
Number of services >30 minutes behind schedule	92
Average transit time faster than schedule	00:35
Average transit <30 minutes slower than schedule	00:14
Average transit >30 minutes slower than schedule	1:47
Arrive Islington Junction	
Number of services arriving at Islington Jcn on schedule ('on time' to the minute)	2
Number of services arriving at Islington Jcn ahead of schedule	127
Number of services arriving at Islington Jcn <30 minutes behind schedule	43
Number of services arriving at Islington Jcn >30 minutes behind schedule	28
Average earlier than scheduled arrival at Islington Jcn	00:30
Average later than scheduled arrival at Islington Jcn	00:33
Arrive Macarthur South Junction	
Number of services arriving at Macarthur South Jcn on schedule ('on time' to the minute)	3
Number of services arriving at Macarthur South Jcn ahead of schedule	78
Number of services arriving at Macarthur South Jcn <30 minutes behind schedule	38
Number of services arriving at Macarthur South Jcn >30 minutes behind schedule	82
Average time earlier than scheduled arrival at Macarthur Sth Jcn	00:36
Average time later than scheduled arrival at Macarthur Sth Jcn	01:19

Sources: Analysis of ARTC Master Train Plan (available at https://www.artc.com.au/customers/operations/mtp/) and 4-Trak (not publically available).

Table 33 Intermodal transit times Macarthur South Junction to Islington Junction, June-August 2018

Transit	
Number of scheduled services	223
Number of recorded services	191
Average scheduled transit time (hours:minutes)	05:28
Average recorded transit time	06:07
Number of services on schedule (transiting the Sydney Trains network 'on time' to the minute)	4
Number of services ahead of schedule	48
Number of services <30 minutes behind schedule	49
Number of services >30 minutes behind schedule	90
Average transit time faster than schedule	00:29
Average transit <30 minutes slower than schedule	00:13
Average transit >30 minutes slower than schedule	01:26
Arrive Macarthur South Junction	
Number of services arriving at Macarthur South Jcn on schedule ('on time' to the minute)	3
Number of services arriving at Macarthur South Jcn ahead of schedule	80
Number of services arriving at Macarthur South Jcn <30 minutes behind schedule	50
Number of services arriving at Macarthur South Jcn >30 minutes behind schedule	70
Average time earlier than scheduled arrival at Macarthur Sth Jcn	00:34
Average time later than scheduled arrival at Macarthur Sth Jcn	01:25
Arrive Islington Junction	
Number of services arriving at Islington Jcn on schedule ('on time' to the minute)	1
Number of services arriving at Islington Jcn ahead of schedule	35
Number of services arriving at Islington Jcn <30 minutes behind schedule	42
Number of services arriving at Islington Jcn >30 minutes behind schedule	116
Average earlier than scheduled arrival at Islington Jcn	00:26
Average later than scheduled arrival at Islington Jcn	01:42

Sources: Analysis of ARTC Master Train Plan (available at https://www.artc.com.au/customers/operations/mtp/) and 4-Trak data.

BITRE notes the following trends from the running time information:

- Trains travelling in both directions on average took longer to transit the Sydney Trains network longer than scheduled.
- Most southbound trains arrived at Islington Junction earlier than scheduled while most departed the Sydney Trains network later than scheduled.
- Most northbound trains arrived at Macarthur South Junction later than scheduled, with more still departing the Sydney Trains network later than scheduled.

- While the analysis does not comment on individual train services, some services consistently ran close to or ahead of schedule while other services ran consistent times that were later than scheduled. This suggests there may be deliberate train operator factors involved where their trains ran at a planned variance to the Master Train Plan.
- While the tables above do not show the daily degree of detail, no northbound Friday service transited the Sydney Trains network within schedule, but almost 70 per cent of the services arrived at Macarthur South Junction ahead of schedule; and
- There were no other standout trends by day of the week.

Passenger train indicators

(a) Punctuality

Punctuality is important to rail's competitiveness. The International Transport Forum (2010, p. 5) notes poor punctuality not only worsens the transport "experience" but can affect the commercial (work) and personal activities of those that depend on reliable transport services.

Urban rail punctuality

Customers rely on timetables for infrequent services in particular. Punctuality is therefore part of a journey's perceived time. Punctuality is less significant for frequent "turn up and go" services.[43] Real-time information at railway stations, light rail stops, online and through smart phone applications are playing a growing trip-planning role.

Measures of punctuality are largely determined by the definitions of "on time", which varies between operators. Table 34, below, shows operators punctuality targets and results. In 2016–17, Sydney, Perth, and Adelaide met their punctuality targets, unlike the previous financial year in which all operators met their targets. According to Public Transport Victoria, Melbourne did not meet its target "… in part as a result of infrastructure challenges and increasing passenger demand." (Public Transport Victoria, 2017, p.21) Queensland attributes its failure to meet its target due to train crew shortages (Department of Transport and Main Roads, 2017, p.222).

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

Table 34 Urban heavy and light rail punctuality, on time performance, 2016–17

	Sydney [a] [b]	Melbourne	Brisbane [c]	Perth	Adelaide	Perth
Heavy rail punctuality (%)	93.4	91.8	94.52	95.80	94.5	95.80
Heavy rail target (%)	92	92.5	95	95	94	95
Heavy rail measure	Arriving within 5 minutes of schedule at peak times	Arriving at destination no later than 4 minutes 59 seconds late.	Arriving within 3 minutes 59 seconds of schedule for suburban trains and within 5 minutes 59 seconds of schedule for inter-urban trains, adjusted for force majeure events	Arriving within 4 minutes of schedule	No more than 4 minutes 59 seconds after the timetabled arrival time at the destination	Arriving within 4 minutes of schedule
Light rail punctuality (%)	91.2	82.6	99.8	-	98	-
Light rail target (%)	-	82.9	"at the station for you when it's scheduled to be there"	-	98	-
Light rail measure	-	Departing no more than 59 seconds early or 4 minutes 59 seconds after scheduled time in the timetable.	-	-	No more than 4 minutes 59 seconds after the timetabled arrival time at the destination	-

Notes: [a] Sydney and Gold Coast light rail operators do not publish timetables as they operate on a 'turn up and go' basis.

[b] Sydney heavy rail is "urban lines". It does not include inter-city services that also use the Sydney urban network. Skipped stops are not counted as being punctual.

[c] Brisbane light rail refers to the Gold Coast

Sources: Public Transport Victoria (2017, pp. 21–22); Public Transport Authority of Western Australia (2017, p. 22); Department of Planning, Transport and Infrastructure (2017, p.5); Sydney Trains (2017, p.25); Queensland Rail (2017, p.13); Transport for NSW (2018); Advice from Queensland Rail; G:Link (2018).

Non-urban rail punctuality

Punctuality targets for non-urban rail services are generally higher for markets which are likely to have a higher value-of-time. For example, trains which service intercity commuter corridors, such as NSW TrainLink's peak intercity services and V/Line's commuter services have targets of at least 92 per cent. In contrast, QR Travel, which operates numerous long-distance services, have a punctuality target of only 75 per cent.

The punctuality results shown in Table 35 indicate long-distance services are generally less punctual than shorter distance services. Of note is Transwa's Prospector, for which punctuality was 36 per cent in 2016–17. According to the Public Transport Authority of Western Australia's annual report, this result was due to infrastructure works along the line (Public Transport Authority of Western Australia 2017, p. 28).

Table 35 Non-urban rail punctuality, on time performance, 2016–17

	Service type	Punctuality 2016–17 (%)	Punctuality target (%)	Measurement
Queensland Rail	QR Traveltrain	84.5	75	Arriving within 15 minutes, excluding the *Kuranda Scenic Railway* and Gulflander services
NSW TrainLink	Intercity (peak services)	88.8	>92	Arriving within 6 minutes
	Regional & interstate	74.8	>78	Arriving within 10 minutes
V/Line	Commuter	86.5	92	Arriving within 5 minutes
	Long distance	80.0	92	Arriving within 10 minutes
Transwa	Australind	88	90	Arriving within 10 minutes
	Prospector	36	80	Arriving within 15 minutes
	MerridinLink	57	95	Arriving within 10 minutes
	AvonLink	70	95	Arriving within 10 minutes

Sources: V/Line 2017.; V/Line 2017a, p13; NSW Trains 2017, p.15; Advice from Queensland Rail; Public Transport Authority of Western Australia 2017, p. 28

(b) Service attributes

Train speeds and station spacing – urban heavy rail

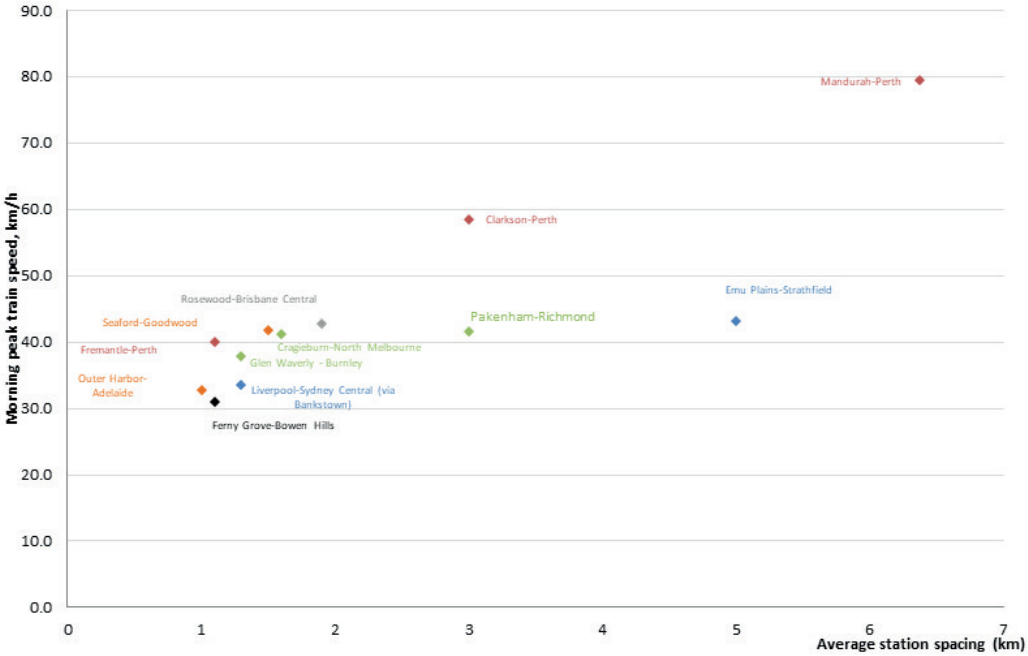
Figure 44 shows relationship between station spacing and corresponding average train speeds for selected Australian urban passenger rail lines. Australia's older passenger lines have relatively short station spacing. Mees and Dodson (2011) observed that Australian lines were often built as a way of supporting urban expansion with consequent short distances between stations.[44] A consequence of this, however, is the regular stops cause slower speeds.

In contrast, newer lines, such as Mandurah–Perth and, to a lesser extent, Clarkson–Butler have wider station spacing, which allows higher average speeds. In addition to speed, wider station spacing allows for simpler train schedules because there is little need for express services. Express services help overcome short station spacing.

All Pakenham-Richmond weekday services run semi express except seven, which run early morning or late at night. This line's station spacing shown in Figure 44 thus reflects the (typical) semi express running. There are also no Emu Plains-Strathfield all stopping trains. The number of stops between the stations varies by time of day and service. This too is reflected in Figure 44.

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

Figure 44 Station spacing and illustrative train speeds



Source: BITRE analysis.

Wide station spacing reduces the capacity for patrons to access railway stations by walking. Integration of the railway with other modes of transport, such as the provision of feeder bus or tram services and park and ride facilities therefore becomes crucial.

Speeds and station spacing – light rail

Average scheduled light rail speeds also generally correlate to stop spacing. Caution is needed when comparing Melbourne with other networks due to the wide variation in speeds that exist in that city. Currie and Burke (2013) analysed designated stop spacing and average speeds by line on Melbourne's network. Designated stop 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. Across the entire Melbourne network, average stop spacing is 254 metres.

Table 36 Light rail station spacing and speeds 2018

	Gold Coast	Sydney	Melbourne	Adelaide
Average station spacing (metres)	812	556	254	535
Average scheduled speed (km/h)	23	21.3	16	17.3

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

Sources: Currie and Burke 2013; BITRE analysis.

Light rail average speeds depend largely on a light railway's function and its operating environment. A line designed to operate in a dense pedestrianised zone has lower speeds than vehicles operating in a segregated corridor. Sometimes a single line will have a mixed infrastructure type. Sydney's light rail, for example, operates largely on a mostly segregated line. Between Haymarket and Central Station, however, it travels "on-road" (albeit largely separated from vehicles) through areas of significant pedestrian activity near Paddy's Market and George Street.

Frequency

Figures 45 to 50, below, show, urban heavy rail service frequency by the time between arrival at the relevant city central station, for services originating at different points across the networks.. All cities provide express and all stops services, to varying degrees.

Frequency is important to service quality and, therefore, mode choice. Frequency also influences overall travel times. It determines how long passengers wait for a train and how closely the train departure (or arrival) time is to a passenger's preferred time. Passengers' perceptions of service frequency are therefore closely related to their perception of total journey times (including waiting time, in-vehicle journey time and transfer time).

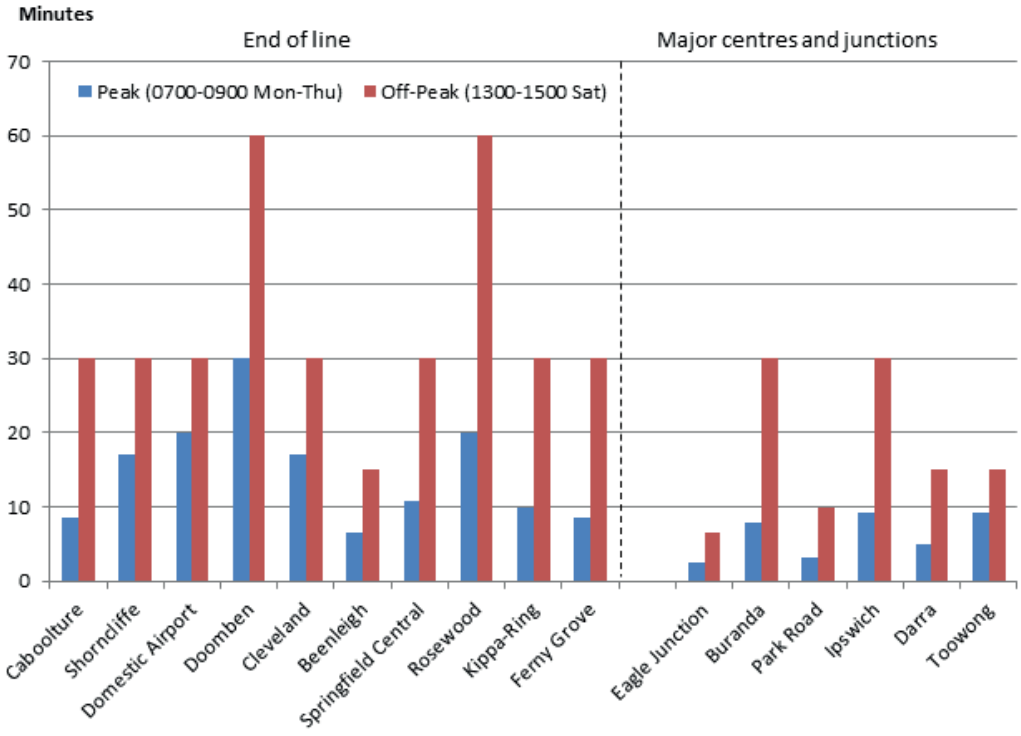
Frequency is also important in integrating rail services both with other rail lines and other transport modes. Services may have coordinated arrival and departure times for passenger interchanges between services. However, the scale of large urban networks can make coordination infeasible. In these cases, frequency is crucial in reducing passengers' interchange waiting times. Major centres and junction stations generally have high frequencies due to service densification. As Figures 45 to 50, below, show, all Australian capital cities with urban heavy rail services have greater service frequency during peak periods.

Service frequencies in 2018 were largely the same as the previous year. There have been some minor decreases and increases across the times of day periods measured, although this should not be interpreted to mean there are fewer services overall. A train that arrives at its destination at 09:01 hours on a weekday, for example, would be excluded as it is outside the peak period scope.

Brisbane heavy rail

Figure 45 shows average times between trains for arrivals at Roma Street Station in peak and off-peak times, from stations that are at the end of lines or at major centres and junctions. The peak period service frequency is for Monday-Thursday, as trains run to a separate timetable on Fridays.

Figure 45 Average time between trains for services arriving at Brisbane Central



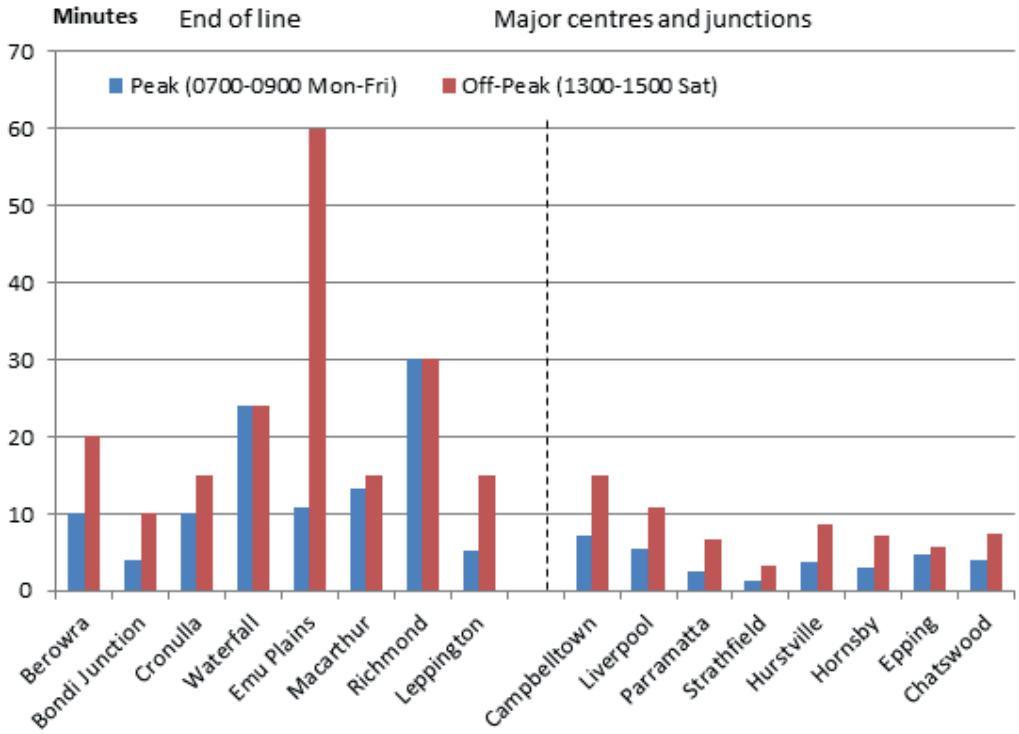
Source: Translink (2018).

Sydney heavy rail

Sydney Trains frequency depends on the time of day, service demand and network capacity. The Bondi Junction line has the most end of line AM peak services, with an average arrival at Sydney Central every four minutes, while the Richmond line has an average arrival every 30 minutes. There is less discrepancy for trains arriving from major centres and junctions in the AM peak, with arrivals at Sydney Central of between 1–7 minutes.

Off-peak service frequencies similarly vary significantly across the network from both points of origin and major centres and junctions.

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



Notes: The Carlingford line no longer has any direct services to Sydney Central. All passengers travelling from stations on the Carlingford line change trains at Clyde for onward travel to Sydney Central.

Source: Sydney Trains (2018a).f

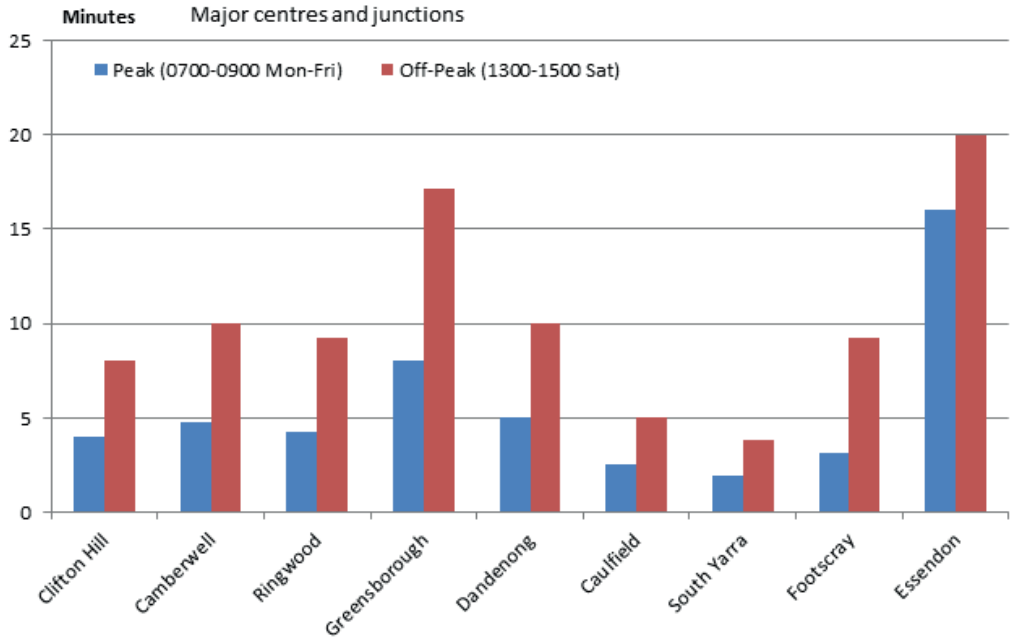
Figure 46 includes a number of stations listed in The New South Wales Government's Long Term Transport Master Plan as being "Regional Cities" (Parramatta and Liverpool) and "Major Centres" (Hornsby, Chatswood, Bondi Junction, Hurstville, Campbelltown, Macarthur)[45]. These locations are significant transport interchanges and destinations. Frequencies through these locations provide an important indicator of the value of the network in providing transport services other than radial-based commuting.

45 The full list of "Regional Cities" is: Paramatta, Liverpool, Penrith. Major centres are: Hornsby, Dee Why, Brookvale, Chatswood, Bondi Junction, Burwood, Bankstown, Kogarah, Hurstville, Campbelltown, Macarthur, Blacktown, Castle Hill. See New South Wales Government (2012, p.46).

Melbourne heavy rail

Melbourne peak hour frequencies similarly vary considerably across services (see Figures 47 and 48), with smaller branch lines running fewer trains. For end of line services, Alamein and Williamstown have the fewest through running peak time services, at intervals of 20 and 24 minutes respectively. Average off peak services vary from 10 minutes on the Frankston line to 40 minutes on the Hurstbridge and Sunbury lines. The Alamein and Williamstown lines have no direct services to Flinders Street station in the off-peak period. Rather, shuttle trains run to Camberwell and Newport, where passengers change trains for ongoing travel.

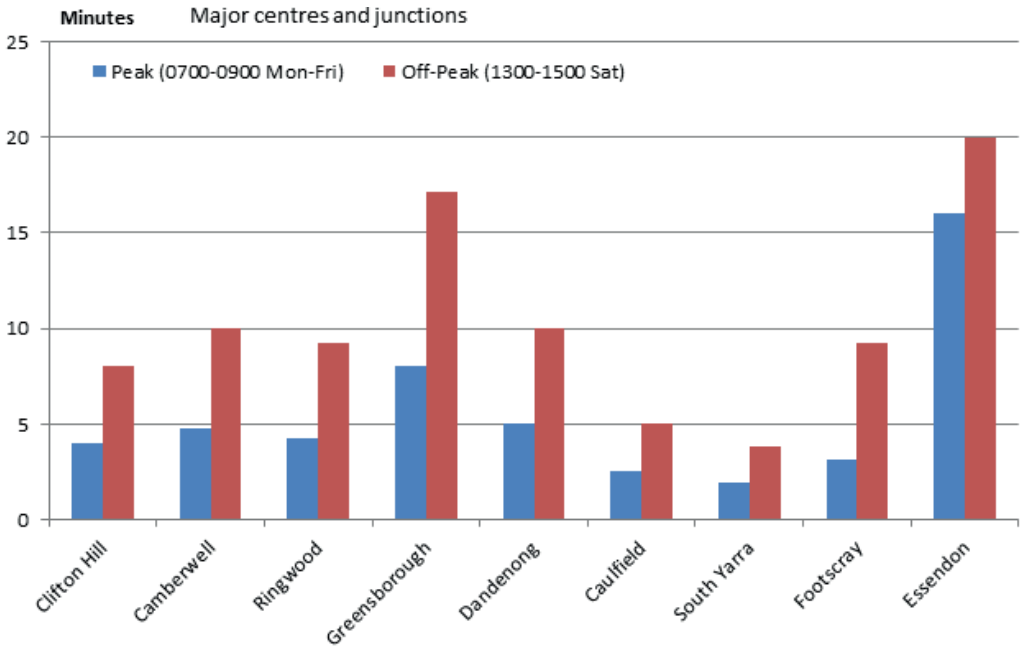
Figure 47 Average time between trains for services arriving at Flinders Street from end of line



Source: Public Transport Victoria (2018).

South Yarra is the busiest junction station, with an average departure every two minutes peak hours and four minutes off-peak hours. This is because it is one of Melbourne's busiest junctions, with trains from the Cranbourne, Pakenham, Frankston and Sandringham lines passing through the station. During off peak periods, service frequency at most of the major centres and junctions as shown in the graph is approximately half that of peak-hour services.

Figure 48 Average time between trains arriving at Flinders Street Station from major centres and junctions

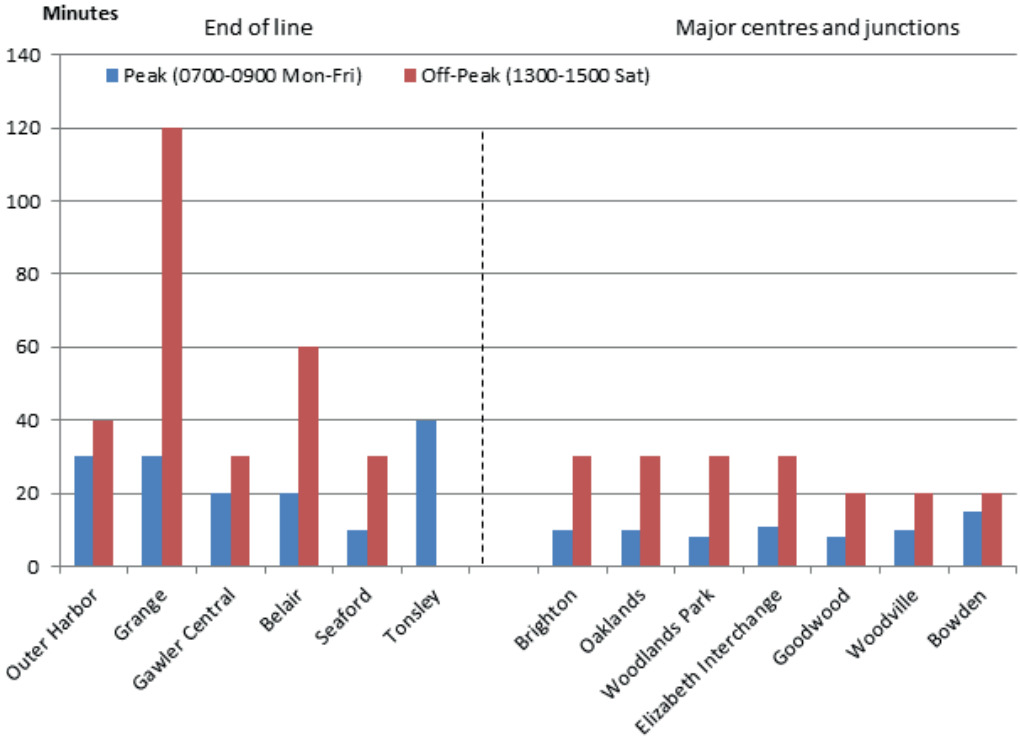


Source: Public Transport Victoria (2018).

Adelaide heavy rail

Adelaide heavy rail service patterns are strongly geared to peak-period commuting to Adelaide Railway Station (See Figure 49). Adelaide's lower service levels reflect its modest patronage compared to the other networks.

Figure 49 Average time between trains for services arriving at Adelaide Railway Station



Note: There are not weekend Tonsley line services.

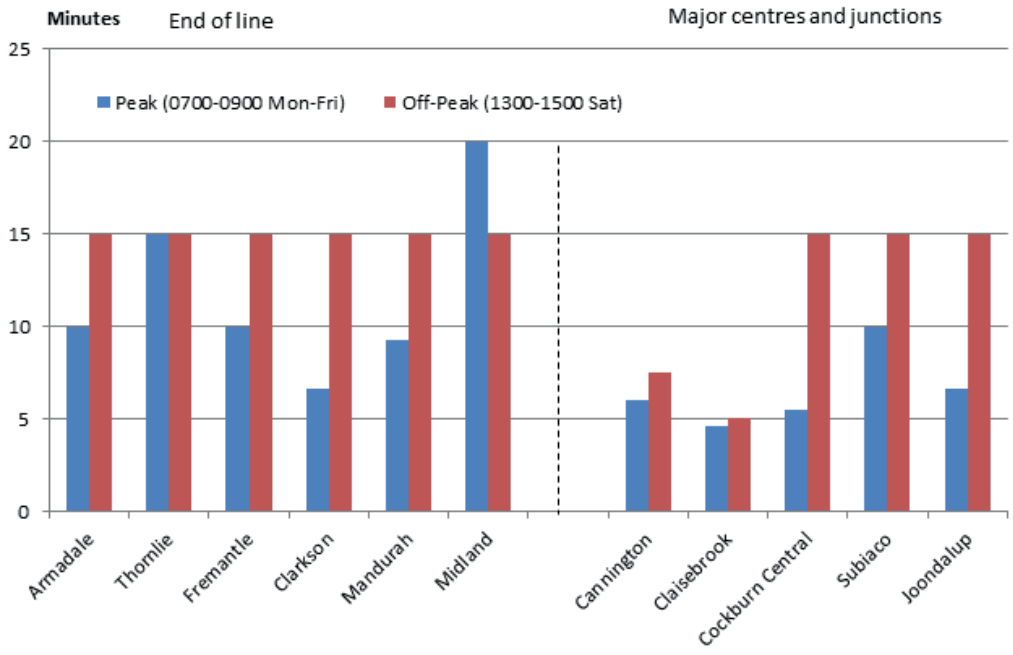
Source: Adelaide Metro (2018).

Perth heavy rail

There have been no changes to Transperth's service frequencies since publication of *Trainline* 5. Transperth's trains mostly stop at all stations. Its focus on maintaining low dwell times and long distances between stations on its Mandurah and Joondalup lines enables relatively high average line speeds. Consequently, there are no express services on these two lines, unlike the city's 'heritage' lines that have closer station spacing.

Having only two junctions outside the city centre reduces the service densification seen in other cities where lines merge, such as South Yarra in Melbourne.

Figure 50 Average time between trains for services arriving at Perth Central



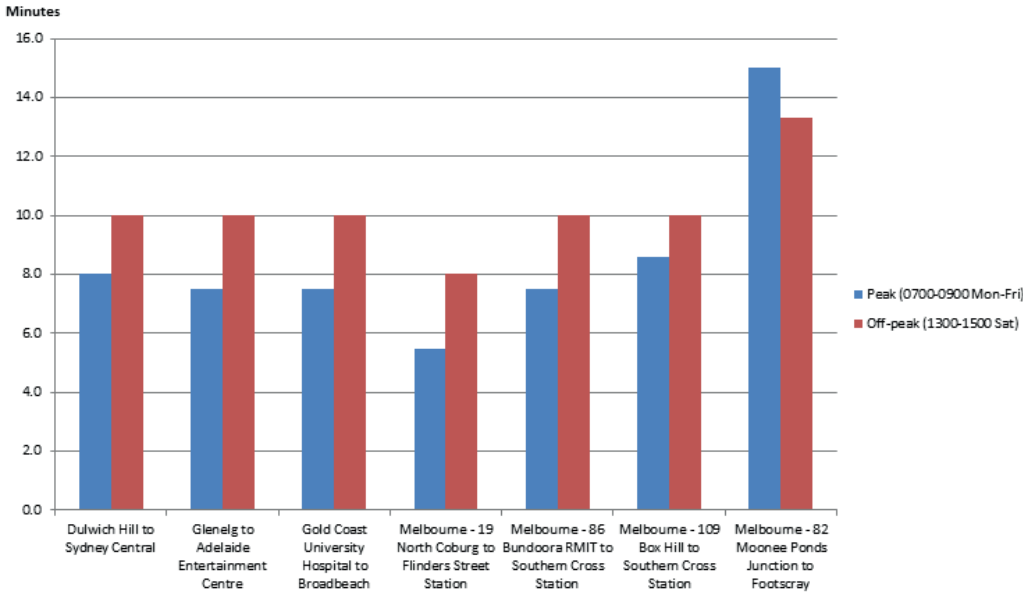
Source: Transperth (2018).

Light rail

Light rail frequencies in Australia vary (see Figure 51). Off-peak times between services are 15 minutes or less. Care is needed when comparing the single route Sydney, Gold Coast and Adelaide operations with Melbourne. Many Melbourne routes share tracks, meaning a passenger may have more than one tram route option, thus increasing frequency on shared tracks.

The selected routes for Melbourne indicate service frequency across the network's 23 routes. Routes 19 (Flinders Street Station to North Coburg) and 82 (Moonee Ponds Junction to Footscray) have the shortest and longest peak hour intervals on the network, respectively.

Figure 51 Average time between trams, by route and direction



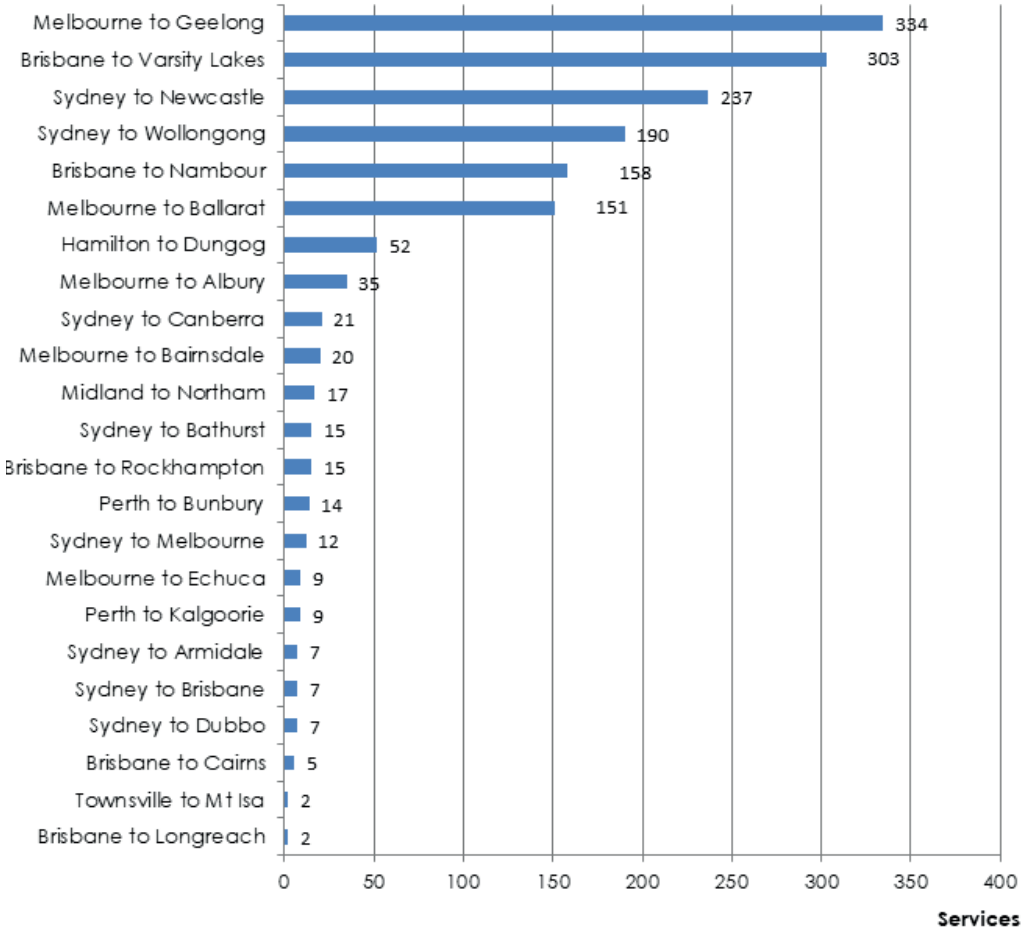
Notes: Gold Coast operations do not run to timetables. Melbourne tram services have a separate timetable for Fridays. As such, calculated peak hour frequency as shown above is based on the published Monday-Thursday timetables. Peak hour calculations are based on peak hour directions of travel.

Sources: Transport for NSW (2018a); G:link (2018); Public Transport Victoria (2018); Adelaide Metro (2018a).

Non-urban rail

Frequency is important for non-urban services because it determines how closely a train departure and arrival is to a passenger's preferred time. Service frequencies can also determine the amount of time a passenger waits for a train and is therefore closely aligned with perceptions of total travel time and its generalised cost.

Figure 52 Non-urban passenger rail services per week, 2018



Notes: Based on calculation of outbound 'down' services. Does not include return services.

The Sydney-Wollongong figures exclude truncated services that depart from Waterfall.

The Sydney-Newcastle figures include long distance services that stop at nearby Broadmeadow.

Services include trains that arrive at but do not terminate at destination, for example, Transport for NSW (Trainlink) services from Melbourne to Albury that continue on to Sydney.

Sources: Queensland Rail Travel (2018); Transport for NSW (2018a); Translink (2018) Transwa (2018); V/Line (2018).

Figure 53 Comparison of non-urban passenger rail services per week, 2018
(Number of services and percentage change)

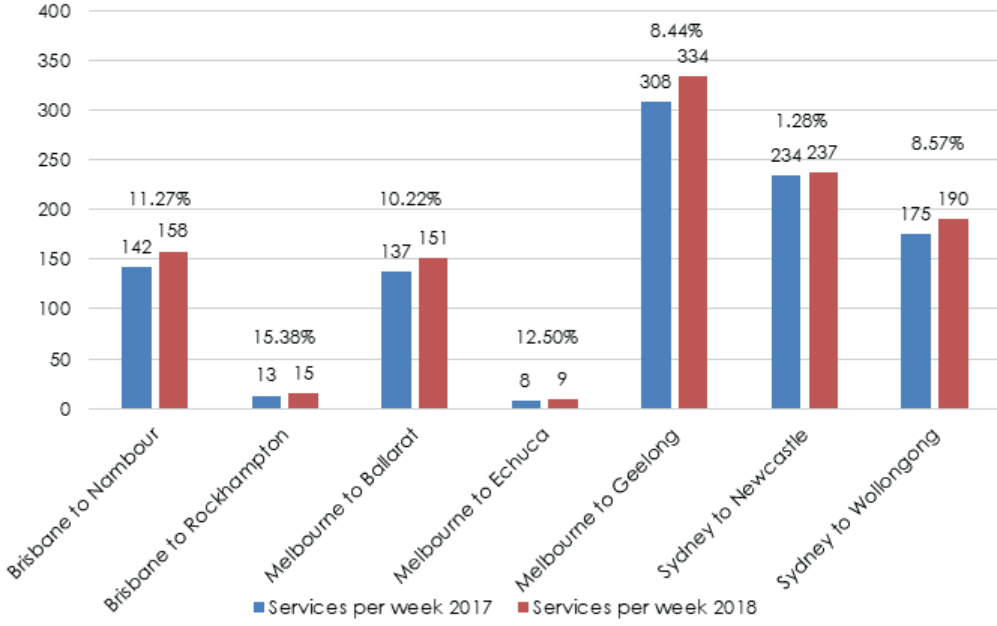


Figure 52, above, shows the number of weekly services on selected non-urban passenger rail services. These include both commuter and long-distance services. Figure 53 compares the number of services between 2018 and a revised estimate of 2017 where there have been changes to the selected services. Frequencies align with the function of each railway, the distance of the corridor and the size of the populations they serve. Railways that serve intercity and regional centre-capital city commuter markets generally have the highest service frequency.

While Brisbane to Rockhampton had the greatest percentage increase, Melbourne to Geelong had the largest increase in the number of services – from 308 to 334 timetabled services per week. Almost half of these increased services operate on weekdays. This is indicative of V/Line providing increased services in response to growing patronage on the line. Apart from Melbourne-Echuca and Brisbane-Rockhampton, all service increases occurred on commuter lines. There were no decreased services on any of the selected lines.

Transit times — non-urban

Transit times are important for commuter travel as one factor in determining rail's competitiveness against other transport modes. Commuter travellers may consider comparative door-to-door transit times rather than the top speed of a service when making transport mode choices. For non-urban services, the value of transit time varies according to the market. Time-rich tourist travellers are likely to value comfort ahead of time. The *Indian Pacific*, *Ghan*, and *Kuranda Scenic Railway* are cases in point. Conversely, the opposite would likely apply to commuters who are time poor. Rail travel also provides a community service to those who do not have access to other transport modes.

Table 37 Key characteristics of selected non-urban passenger services, 2018

	Operator	Gauge	Distance (km)	Electrified	Scheduled transit time	Average speed (km/h)	Stopping stations (no.)
Regional/intercity 3 hour 59 minutes or less							
Brisbane to Nambour	QR (TransLink)	Narrow	105	Yes	1h 52m	56	20
Brisbane to Varsity Lakes		Narrow	89	Yes	1h 20m	67	11
Hamilton to Dungog	NSW TrainLink	Standard	81	No	1h 21m	60	15
Sydney to Hamilton		Standard	165	Yes	2h 38m	63	15
Sydney to Wollongong		Standard	82	Yes	1h 36m	51	8
Sydney to Bathurst		Standard	238	No	3h 43m	64	7
Melbourne to Ballarat	V/Line	Broad	118	No	1h 7m	106	3
Melbourne to Echuca		Broad	250	No	3h 18m	76	5
Melbourne to Bairnsdale		Broad	275	No	3h 47m	73	14
Melbourne to Geelong		Broad	81.5	No	50m	97	3
Melbourne to Albury		Standard	305	No	4h 03m	75	11
Midland to Northam	Transwa	Standard	102	No	1h 20m	80	1
Perth to Bunbury		Narrow	183	No	2h 29m	73	11
Long-distance 4 hours or more							
Townsville to Mount Isa	QR Travel	Narrow	977	No	20h 55m	47	8
Brisbane to Longreach		Narrow	1 325	No	25h 10m	53	19
Brisbane to Cairns		Narrow	1681	No	24h 20 m	69	26
Brisbane to Rockhampton (electric Tilt Train)		Narrow	639	Yes	7h 45m	82	11
Sydney to Canberra	NSW TrainLink	Standard	330	No	4h 10m	79	9
Sydney to Dubbo		Standard	462	No	6h 27m	72	14
Sydney to Armidale		Standard	579	No	8h 5m	72	19
Sydney to Brisbane		Standard	987	No	14h 12m	70	21
Sydney to Melbourne		Standard	951	No	10h 48m	88	17
Perth to Kalgoorlie	Transwa	Standard	653	No	6h 50m	96	17
Adelaide to Darwin	GSR	Standard	2 971	No	53h 15m	56	3

Note: The speed shown is the average over the length of the service, including stops.

Sources: Queensland Rail Travel (2018); Transport for NSW (2018a); Translink (2018) Transwa (2018) V/Line (2018a) Great Southern Rail (2018).

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;
- Station spacing and scheduled stopping patterns; and
- For tourist-focused trains such as *The Ghan*, scheduled extended stops en route for passengers to do off train tours.

Comparative times to 2017 show little variance in scheduled transit times. There have been no increases or decreases in scheduled times greater than 10 minutes. Sydney-Newcastle and Dungog-Newcastle travel times have increased slightly, but this is most likely due to the extension of services from Hamilton to the newly opened Newcastle Interchange station.

The Brisbane–Nambour, Sydney–Hamilton, and Sydney–Wollongong intercity commuter services continue to have similar, relatively low average train speeds. 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 urban areas of Brisbane and Sydney respectively. In addition, the Sydney-Newcastle and Sydney–Wollongong rail corridors are slow and circuitous due to the 'steam era' alignments through the mountainous terrain in which they operate.

V/Line's medium-distance commuter services are relatively fast and peak-hour express services have relatively high average speeds and low travel times, as part of the Regional Fast Rail Project (completed by 2006) and Regional Rail Link (opened in June 2015).

While the Regional Rail Link has enhanced the Regional Fast Rail Project for services between Melbourne and Bendigo, Ballarat, and Geelong, Melbourne-Traralgon services still lack a dedicated corridor through the more expansive south-eastern suburbs of Melbourne, which affects transit times.

There is a wide dispersion of transit times across V/Line services, caused by different stopping patterns that cater for different market segments. The Melbourne-Ballarat service cited above, for instance, is based on an express peak hour service with only three stops. This, coupled with high quality infrastructure and fast VLocity train sets, enables a relatively high average speed.

Long-distance passenger trains in Australia have uncompetitive transit times compared to air and some road coach travel[46].

Figure 54 Melbourne to Sydney XPT train

Note: The image above shows a NSW Trainlink Melbourne to Sydney XPT service at Jindalee in New South Wales, October 2018. Photo courtesy of Rodney Avery

46 Long-distance trains provide services for centres along their route, thus acting as medium-distance services also.

CHAPTER 5:

Case Study: ARTC AK Track Inspection Car Operations

As part of its routine infrastructure management operations, the ARTC operates its 'AK car' track inspection train across its entire network and by contract to other standard gauge infrastructure managers, excepting the Pilbara. The AK car train can thus be seen operating anywhere on the standard gauge network from Brisbane to Perth to Darwin and the feeding branch lines. Each year the train completes approximately 80 000 kilometres of track inspection. Pacific National and Sydney Rail Services typically provide the motive power and locomotive crewing services on a hook and pull arrangement. The term 'AK' is a New South Wales descriptor for a special passenger train.

Figure 55 AK Car train at Brisbane's Roma Street Station

Note: Photo courtesy of Rodney Avery.

The AK car train consists of three carriages:

- Computer room with observation deck;
- Crew accommodation car (middle carriage); and
- Kitchen/dining car with observation deck.

The cars are those that previously formed the overnight Sydney-Brisbane Limited, and which have been modified for AK car operations.

ARTC's Enterprise Asset Management System schedules the inspection regime. Third party customers provide schedule requests based on their inspection regime. As a single assignment typically takes several days (for example Broadmeadow to Brisbane) the train stops at a siding each afternoon en route and the crew sleep on board the train.

The train measures the track while in motion, travelling usually at up to 80 kilometres per hour. Using Vista Geometry System, Laser Rail Measurement System and Pacific Realtime Roames software, the train measures top, twist, line, gauge, rail profile, ride quality, corrugation, and GPS location. The train also has externally mounted-cameras which provide a live feed for areas which cannot be directly observed from the observation car.

Crewing consists of two AK Car System Operators whose role is to operate the measurement system. Local track management representative(s) travel on board for their respective track area of responsibility. The local track management representatives change en route as the train transitions from one local area to the next. Their role is to review and communicate track condition to track maintenance chase teams.

The observation decks, which are at one end of the leading and end carriages, have large glass panels, which gives the local track management representatives a wide trailing end view of the track as the train passes over it.

Figure 56 Observation deck

Note: Photo courtesy of Rodney Avery.

Figure 57 Inside the observation car computer room.

Note: Photo courtesy of Rodney Avery.

ARTC's Enterprise Asset Management System records the track condition output and drives maintenance interventions where necessary.

Figure 58 Laser Rail Measuring System hardware

APPENDIX A

Significant railway events since 2000

Date	Event	Description
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 for 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	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
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

(Continued)

Date	Event	Description
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
October 2007	Lang Hancock Railway opens	58km Lang Hancock Railway opens between Hope Downs and existing Rio Tinto railway
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
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

(Continued)

Date	Event	Description
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 per annum)
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

(Continued)

Date	Event	Description
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
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 68 km "Northern Missing Link", Newlands – North Goonyella, Queensland
27 December 2011–29 February 2012	Darwin Line cut	Line broken near Katherine after floodwaters 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

(Continued)

Date	Event	Description
30 Jan–27 Feb 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 Logistics announced 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
27 March 2014	Sydney Inner West Light Rail	Sydney light rail extension from Lilyfield to Dulwich Hill opened.
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
20 July 2014	Gold Coast Light Rail	Gold Coast Light Rail commences operations
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
5 August 2014	Port Botany Terminal	Opening of the Hutchison rail terminal at Port Botany
21 September 2014	Butler Railway, Perth	Opening of the 9 km Butler urban railway extension from Clarkson
12 November 2014	North Quay Rail Terminal, Fremantle	Opening of extended North Quay Rail Terminal at Fremantle's Inner Harbour
25 December 2014	Newcastle Station Closure	Heavy rail line from Wickham to Newcastle closed
8 February 2015	South West Rail Link	Opening of Sydney's South West Rail Link, between Glenfield and Leppington

(Continued)

Date	Event	Description
23 February 2015	Canberra freight	Resumption of rail freight services on Canberra railway, with containerised scrap metal being shifted by Espee Railroad Services to Port Botany for export
25 March 2015	Sale of Freightliner	Genesee & Wyoming completed its acquisition of 94 per cent of Freightliner Group
30 March 2015	Great Southern Rail	Allegro Funds acquired Great Southern Rail from Serco
21 June 2015	Regional Rail Link	Opening of the Wyndham Vale – Tarneit section of the Regional Rail Link in Victoria
August 2015	Murray Basin Rail Project	Victorian government commits to implementing the project, following the release of the project's business case. The project involves standardising the rail gauge and increasing axle load capacities in the state's Murray Basin region. Associated critical maintenance works commence in October.
October 2015	Sydney CBD and South East Light Rail	Major construction works commence
December 2015	Wiggins Island Rail Project	Completion of (Stage One) of Wiggins Island Rail Project
10 December 2015	Roy Hill Holdings	First shipment loaded, using ore transported on the newly opened rail link from the mine sites to Port Hedland
June 2016	Northern Sydney Freight Corridor Programme	Epping to Thornleigh Third Track line opened
2 July 2016	New Melbourne port shuttle service	SCT Logistics and DP World commence weekly shuttle services from Altona to West Swanston terminal
12 July 2016	ACT Light Rail	Construction commences on ACT Light Rail. Initial work involves construction of the Mitchell depot and maintenance centre
19 August 2016	Asciano Acquisition	Asciano acquisition complete, with business split into three distinct businesses – Patrick, Pacific National, and Bulk and Automotive Port Services (BAPS)
30 August 2016	Aurizon shuttle trains	Aurizon commences freight shuttle trains between Port of Botany and Enfield Intermodal Terminal
3 October 2016	Petrie – Kippa-Ring line	Petrie – Kippa-Ring line officially opened
14 August 2017	Aurizon announcement	Aurizon announces it will cease all intermodal rail operations from December 2017
29 January 2018	Ararat-Maryborough Line Re-opening	Ararat-Maryborough line re-opens following reconstruction of the previously mothballed line.
27 February 2018	Mildura Line Re-opening	Dunolly-Mildura line re-opens following track upgrades and conversion to standard gauge
10 July 2018	Driverless Trains	First Rio Tinto driverless train revenue service. The train carries iron ore from Tom Price to Cape Lambert.

APPENDIX B

Significant network route additions from 1980

Opened	Route additions	Jurisdiction	Gauge	Route km	Project/market
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
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–Sagittarius	Qld	Narrow	14.0	Coal
	Moss Vale Triangle Loop	NSW	Standard	0.4	Mainline/rural freight
	Abbot Point – Kaili	Queensland	Narrow	16.0	Coal
	Annandale – Boundary Hill Mine	Queensland	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)	Victoria	Broad	3.0	Urban passenger
1985	Altona – Laverton Junction	Victoria	Broad	4.6	Freight/passenger
	Ulan–Gulgong	NSW	Standard	23.8	Coal
1986	Blair Athol Mine – Claremont	Qld	Narrow	22.0	Grain
	Fork at Rocklands	Qld	Narrow	0.8	Freight/non urban passenger
	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	Grain
	Yarrowlea–Ebenezer	Qld	Narrow	8.4	Coal
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

(Continued)

Opened	Route additions	Jurisdiction	Gauge	Route km	Project/market
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	Line deviations
	Mackay – Point "X"	Qld	Narrow	4.3	Line deviations
	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	Woodchips
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
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

(Continued)

Opened	Route additions	Jurisdiction	Gauge	Route km	Project/market
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	Limestone
	Fishermans Landing – Mount Miller	Qld	Narrow	8.3	Coal and Limestone
	Fisherman Islands – Dutton Park	Qld	Narrow/ Standard	20.4	Urban freight
	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	South Walker Junction – South Walker	Qld	Narrow	8.7	Coal
2003	Bidgerley Junction to Hail Creek	Qld	Narrow	46.7	Coal
2004	Darwin – Alice Springs	NT	Standard	1 418	Interstate
	Mt Miller– 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

(Continued)

Opened	Route additions	Jurisdiction	Gauge	Route km	Project/market
2012	Brockman 2 – Brockman 4	WA	Standard	41.0	Iron ore
	Tilley Siding (Morawa) – Karara	WA	Narrow	79	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
	Moranbah-Caval Ridge	Qld	Narrow	12	Coal
2015	Glenfield-Leppington	NSW	Standard	12	Urban passenger
	Deer Park-West Werribee (Regional Rail Link)	VIC	Broad	27	Intercity passenger
	Roy Hill	WA	Standard	344	Iron ore
	Aldoga-Wiggins Island	Qld	Narrow	13	Coal
	Maules Creek-Werris Creek	NSW	Standard	20	Coal
2016	Boggabri Coal Mine Expansion	NSW	Standard	17	Coal
	Petrie-Kippa-Ring	Qld	Narrow	13	Urban passenger
2017	Moree-Broadbent Grain facility Byerwen branch line	NSW Qld	Standard Narrow	3.5 5	Grain Coal
2018	Baralaba (Moura System)	Qld	Narrow	6	Coal
	Mernda Line Extension	Vic	Broad	8	Urban Passenger

Note: Does not include light rail/tramways.

Sources: Quinlan and Newland 2000; BITRE 2016c; Data provided by Aurizon,

APPENDIX C

Train operator traffic Asciano and Aurizon 2007–08 to 2015–16

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

	Asciano				Aurizon				
Period	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
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	-	-	-	-	-

(Continued)

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

	Asciano				Aurizon				
Period	Coal	Other bulk	Intermodal (including steel)	Total	Coal	Iron ore	Bulk	Non-bulk — plus residual bulk from 2011–12	Total
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
Sep–14	7.4	1.1	5.5	14	12.6	2.8	-	3.5	18.9
Dec–14	7.8	1.3	5.7	14.8	12.6	2.5	-	3.3	18.4
1HY–15	15.2	2.4	11.2	28.8	25.2	5.3	-	6.8	37.3
Mar–15	7.6	1.4	5.0	14	11.5	2.4	-	2.9	16.8
Jun–15	8.1	1.3	4.7	14.1	12.4	2.7	-	3.2	18.3
2HY–15	15.7	2.7	9.7	28.1	23.9	5.1	-	6.1	35.1
Full year 2014–2015	30.9	5.1	20.9	56.9	49.1	10.4	-	12.9	72.4
Sep–15	-	-	-		-	-	-	-	-
Dec–15	-	-	-		-	-	-	-	-
1HY–16	16.2	2.3	10.2	28.7	25.0	5.0	-	6.5	36.5
Mar–16	-	-	-		-	-	-	-	-
Jun–16	-	-	-		-	-	-	-	-
2HY–16	15.6	2.1	9.4	27.1	24.7	4.6	-	5.8	35.1
Full year 2015–2016	31.8	4.4	19.6	55.8	49.7	9.6	-	12.3	71.6

Sources: Announcements – no longer published, following August 2016 division of Asciano. Saved copies available from BITRE), Aurizon website (ASX Announcements).

APPENDIX D

Aurizon Traffic 2016–17

ASX train operator traffic trends (billion net tonne-kilometres)				
		Aurizon		
Period	Coal	Iron Ore	Freight	Total
Sep–16	12.3	2.2	3.2	17.7
Dec–16	12.5	2.5	3.4	18.4
1HY–16	**24.8**	**4.7**	**6.6**	**36.1**
Mar–17	11.7	2.2	2.8	16.7
Jun–17	11.1	2.3	2.8	16.2
2HY–17	**22.8**	**4.5**	**5.6**	**32.9**
Full year 2016–17	**47.6**	**9.2**	**12.2**	**69**
	Coal	Bulk[47]	Freight	Total
Sep–17	13.1	3.5	n/a	16.6
Dec–17	12.7	3.5	n/a	16.2
1HY–17	**25.8**	**7.0**	n/a	**32.8**
Mar–18	11.8	3.0	n/a	14.8
Jun–18	12.8	3.4	n/a	16.2
2HY–18	**24.6**	**6.4**	**n/a**	**31**
Full year 2017–18	**50.4**	**13.4**	**n/a**	**63.8**

Sources: Aurizon 2018e, p.35.

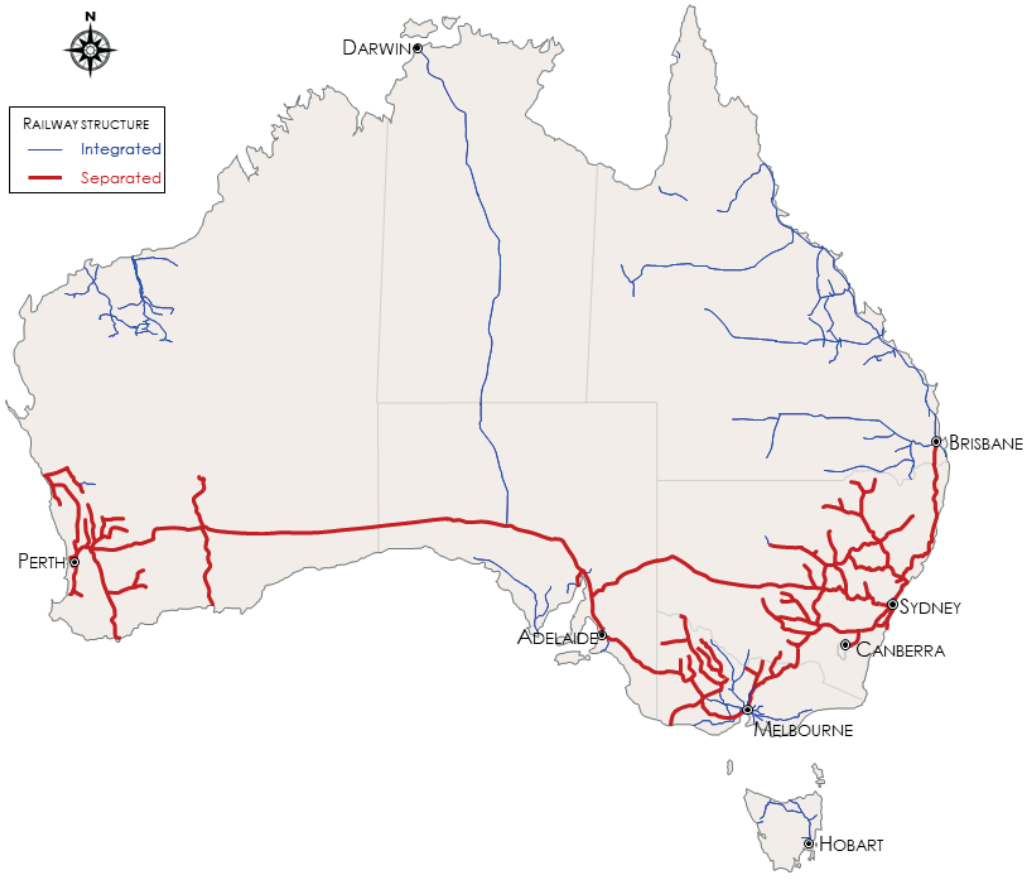
47 Aurizon reports bulk as including iron ore, agricultural products, and mining and industrial inputs. It no longer reports 'freight' tonnages due probably to its (planned) withdrawal from intermodal operations.

APPENDIX E

Industry structure

The Australian rail industry consists of vertically-separated and vertically-integrated railways. In vertically separated railways, the railway infrastructure manager does not operate revenue earning trains. Instead it sells track access to train operators under an "open access" regime. 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.

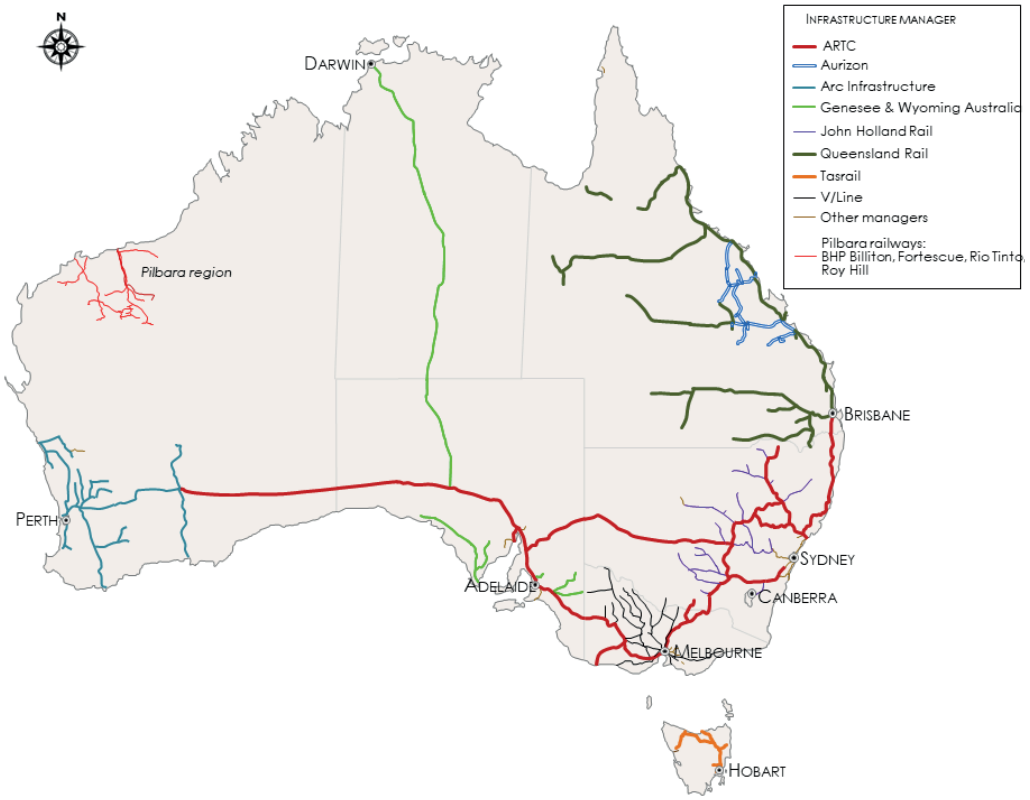
Figure 59 Australian rail industry structure



Infrastructure management

Australia's infrastructure managers are diverse in structure and operation. Figure 60 shows Australia's railway system by network manager.

Figure 60 Australian railways, by network manager, 2018



Notes: The lines shown here are the railways that were open for traffic at July 2017. The BHP Goldsworthy line in the Pilbara is shown but it was mothballed in 2014.

The pattern of the network management is, by traffic type:

- **Interstate.** ARTC and Arc Infrastructure manage most of the interstate network. Genesee & Wyoming Australia owns (long lease) the Tarcoola-Darwin line as a vertically integrated railway. Sydney-Perth trains that travel via Lithgow use John Holland Rail-managed track between Marrangaroo (Lithgow) and Parkes.
- **Iron ore — Pilbara.** These lines are vertically integrated operations, with lines owned by BHP Billiton, Rio Tinto, Fortescue Metals Group and Roy Hill.
- **Coal.** Coal railways in Central Queensland are vertically integrated. Aurizon manages infrastructure and operates trains in central Queensland and uses Queensland Rail infrastructure elsewhere. Aurizon provides third-party access to its central Queensland lines. Coal railways in New South Wales are vertically separated. ARTC manages the Hunter Valley coal network with John Holland Rail managing some other New South Wales coal lines.
- **Mixed.** Tasmania's railways are vertically integrated. Tasrail manages the system and operates the trains.

- **Grain.** Grain railways are vertically separated in Queensland (Queensland Rail), New South Wales (ARTC, John Holland Rail), Victoria (V/Line)[48] and Western Australia (Arc Infrastructure). Genesee and Wyoming Australia operates as a vertically-integrated operator in South Australia.
- **Passenger.** Urban systems are vertically integrated, except for Sydney where Sydney Trains both operates as vertically-integrated operator and provides track access to Trainlink that provides additional limited stops urban services. Non-urban passenger operations are a mix of vertical integration and separation.

Table 38 Principal infrastructure managers of Australian railways, 2018

Infrastructure manager	Structure	Primary usage
Interstate		
Australian Rail Track Corporation (ARTC)	Separated	Intermodal, grain, ores, steel, passenger
Arc Infrastructure	Separated	Intermodal, grain, ores, steel, passenger
Genesee & Wyoming Australia (GWA)	Integrated	Intermodal, ores, passenger
Intrastate		
Aurizon	Integrated	Coal
Queensland Rail	Integrated and Separated	Passenger (integrated), grain, coal, cattle, ores, intermodal (separated)
John Holland Rail	Separated	Intermodal, grain, ores, cotton, passenger
ARTC (New South Wales regional and Hunter Valley)	Separated	Intermodal, coal, grain, other agricultural produce, passenger
V/Line	Integrated (passenger); Separated (freight)	Passenger, grains, other agricultural produce, mineral sands, intermodal
ARTC (Portland, Benalla–Yarrawonga)	Separated	Grain, mineral sands
Tasrail	Integrated	Intermodal, coal, ores, timber
GWA (intrastate South Australia)	Integrated	Grain, gypsum, ores
Arc Infrastructure Rail (intrastate Western Australia)	Separated	Grain, ores
BHP Billiton	Integrated	Iron ore
Rio Tinto	Integrated	Iron ore
Fortescue Metals Group	Integrated	Iron ore
Roy Hill Holdings	Integrated	Iron ore
MTM (Metro Trains Melbourne)	Separated	Passenger, freight
Sydney Trains	Separated	Passenger, freight
Urban		
Queensland Rail (Brisbane, Gold Coast)	Integrated	Passenger
Airtrain CityLink Limited	Integrated	Passenger
Sydney Trains	Integrated and Separated	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 an estimated 511 route-kilometres.

48 Also in Victoria, the ARTC manages the Maroona-Portland and Benalla (Victoria)–Oaklands (New South Wales) lines.

Above rail operators

Numerous organisations provide train operation services.

- **Heavy rail urban passenger** operators are largely integrated organisation. Most are publically-owned entities, with the exception of Metro Trains Melbourne, which is a privately-owned joint venture that operates trains and manages the network on behalf of the Victorian Government under a franchise agreement.
- **Non-urban passenger services** are largely government operated with a few exceptions, including Great Southern Rail, which operates the long-distance *Ghan*, *Indian Pacific* and Overland trains.
- **Heritage passenger railways.** Around 40 heritage volunteer-based organisations manage and operate railways.
- **National rail freight operators.** The two largest national rail freight train operators are Pacific National and Aurizon. Both company's core activity is coal haulage in Queensland and New South Wales, with other important ancillary bulk-haulage activities. Pacific National operates intermodal services on the open access interstate network.
- **Regional rail freight operators.** Genesee & Wyoming Australia is a major train operator in South Australia and the Northern Territory, including running intermodal trains from Adelaide to Darwin. Other significant players include Southern Shorthaul Railroad and Freightliner Australia (a subsidiary of Genesee & Wyoming Australia). Tasrail provides all rail freight services in Tasmania while CBH contracts Watco WA Rail to provide grain haulage in Western Australia.
- **Logistics companies** — notably SCT Logistics and QUBE Logistics — operate intermodal services for their own logistics chains. They also operate a small number of bulk services. SCT Logistics has a diverse portfolio of rail and road activities. QUBE Logistics also has a diverse intermodal and bulk portfolio, with a primary focus on local and regional port-based operations. Fletcher International provides agricultural product rail services from Dubbo to Port Botany in New South Wales. (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 Roy Hill operate trains on their own railways.

Table 39 Principal train operators in Australia, 2018[49]

Train operator	Infrastructure network used	Primary tasks
Aurizon	Aurizon, Queensland Rail, ARTC, Arc Infrastructure	Coal, iron ore, minerals, cattle, grain, mixed bulk, intrastate intermodal (Queensland)
Pacific National	Aurizon, Queensland Rail, ARTC, V/Line, John Holland Rail, Sydney Trains, Arc Infrastructure, Metro Trains Melbourne	Coal, ores, intermodal, steel, grain, mixed bulk
Genesee & Wyoming Australia (including Freightliner and Glencore)	Genesee & Wyoming Australia, ARTC, Sydney Trains, John Holland Rail	Intermodal, ores, agricultural produce, coal
SCT Logistics/Specialised Bulk Rail	ARTC, Arc Infrastructure, Sydney Trains	Intermodal, grain, iron ore
QUBE Logistics	ARTC, V/Line, Sydney Trains, John Holland Rail, Metro Trains Melbourne	Intermodal, grain, mixed bulk
Watco	Arc Infrastructure	Grain, urban freight
Southern Shorthaul Railroad	ARTC, Sydney Trains, John Holland Rail, V/Line, Metro Trains Melbourne	Coal, grain, intermodal, infrastructure works
Tasrail	Tasrail	Intermodal, coal, ores, timber
Fletcher's International	ARTC, John Holland Rail, Sydney Trains	Agricultural produce
Rio Tinto	Rio Tinto	Iron ore
BHP Billiton	BHP Billiton	Iron ore
Fortescue Metals Group	Fortescue Metals Group	Iron ore
Roy Hill Holdings	Roy Hill Holdings	Iron Ore
Queensland Rail	Queensland Rail, AirTrain CityLink Limited	Heavy Rail Passenger (urban, intercity, and long distance)
NSW TrainLink	Sydney Trains, ARTC, John Holland Rail, V/Line, Queensland Rail	Heavy Rail Passenger (long distance, interstate, intrastate, urban, intercity)
V/Line	V/Line, ARTC, Metro Trains Melbourne	Heavy Rail Passenger (intercity and non-urban)
Transwa	Transperth, Arc Infrastructure	Heavy Rail Passenger (non-urban)
Great Southern Railway	Sydney Trains, John Holland Rail, ARTC, Arc Infrastructure, Genesee and Wyoming Australia	Heavy Rail Passenger (interstate premium tourist oriented)
Sydney Trains	Sydney Trains	Heavy Rail Passenger (urban)
Metro Trains Melbourne	Metro Trains Melbourne	Heavy Rail Passenger (urban)
Adelaide Metro	Adelaide Metro	Heavy Rail Passenger (urban)
Transperth	Transperth	Heavy Rail Passenger (urban)
GoldLinQ	GoldLinQ	Light Rail Passenger
Transdev	Transport for NSW	Light Rail Passenger
Yarra trams	Yarra trams (Keolis Downer EDI Rail)	Light Rail Passenger
Adelaide Metro	Adelaide Metro	Light Rail Passenger

49 Chicago Freight Car Leasing Australia (CFCLA) is a major rail operator in Australia through the leasing of locomotives and other rail rollingstock.

APPENDIX F

Urban heavy rail network maps – June 2018

Figure 61 Adelaide

Figure 62 Brisbane

Figure 63 Melbourne

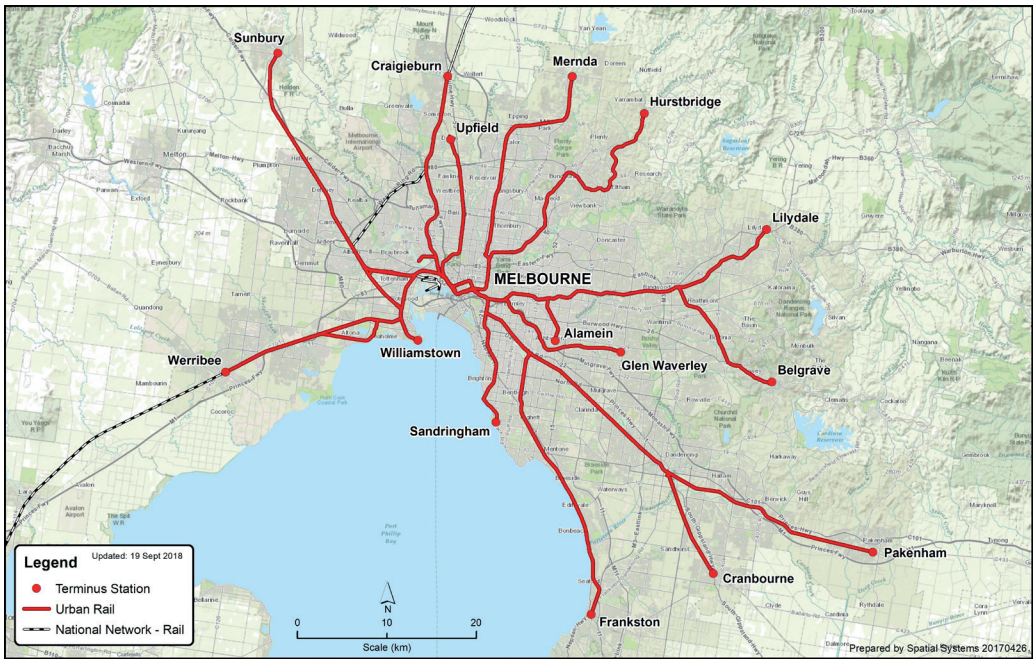


Figure 64 Perth

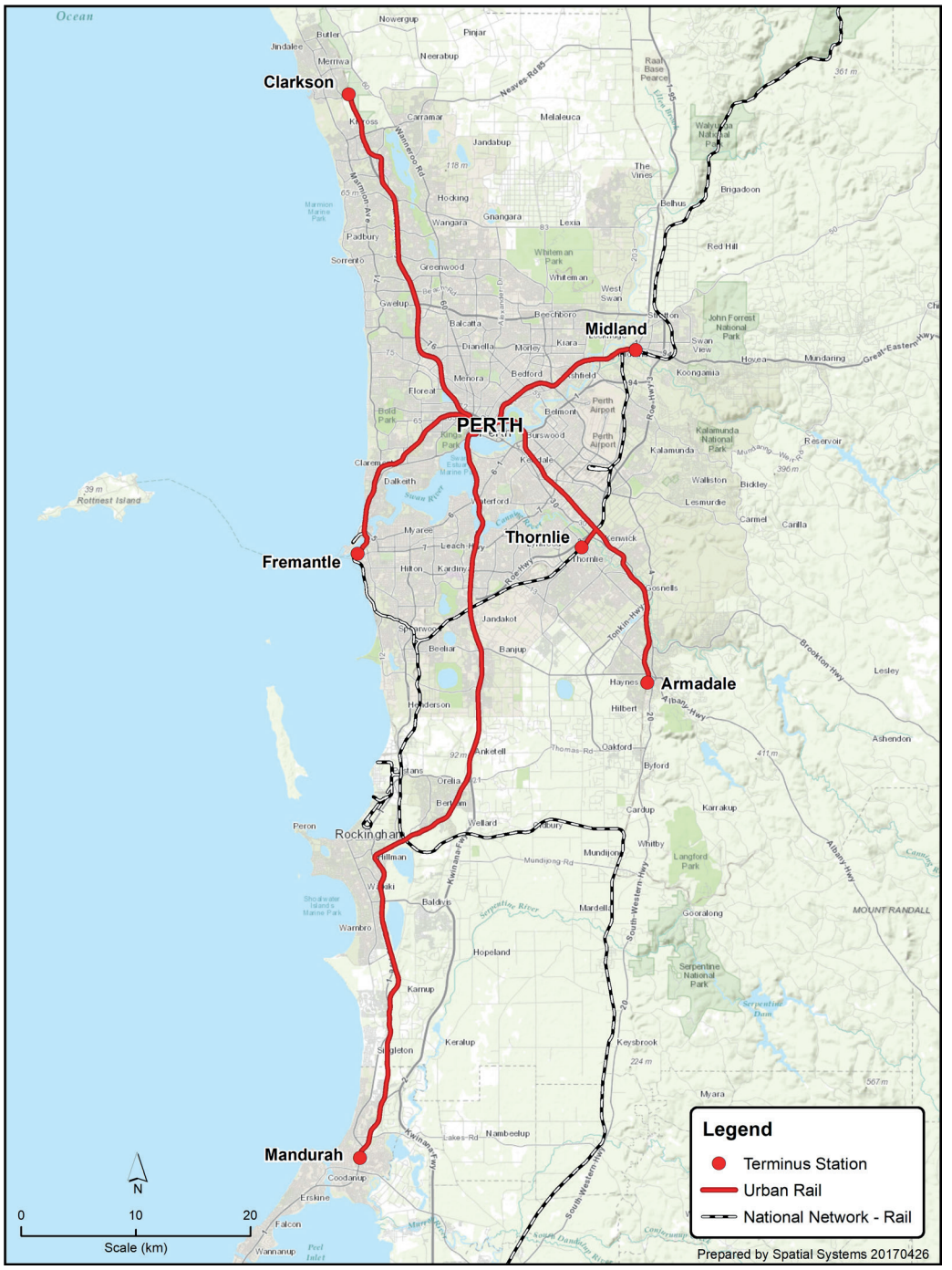
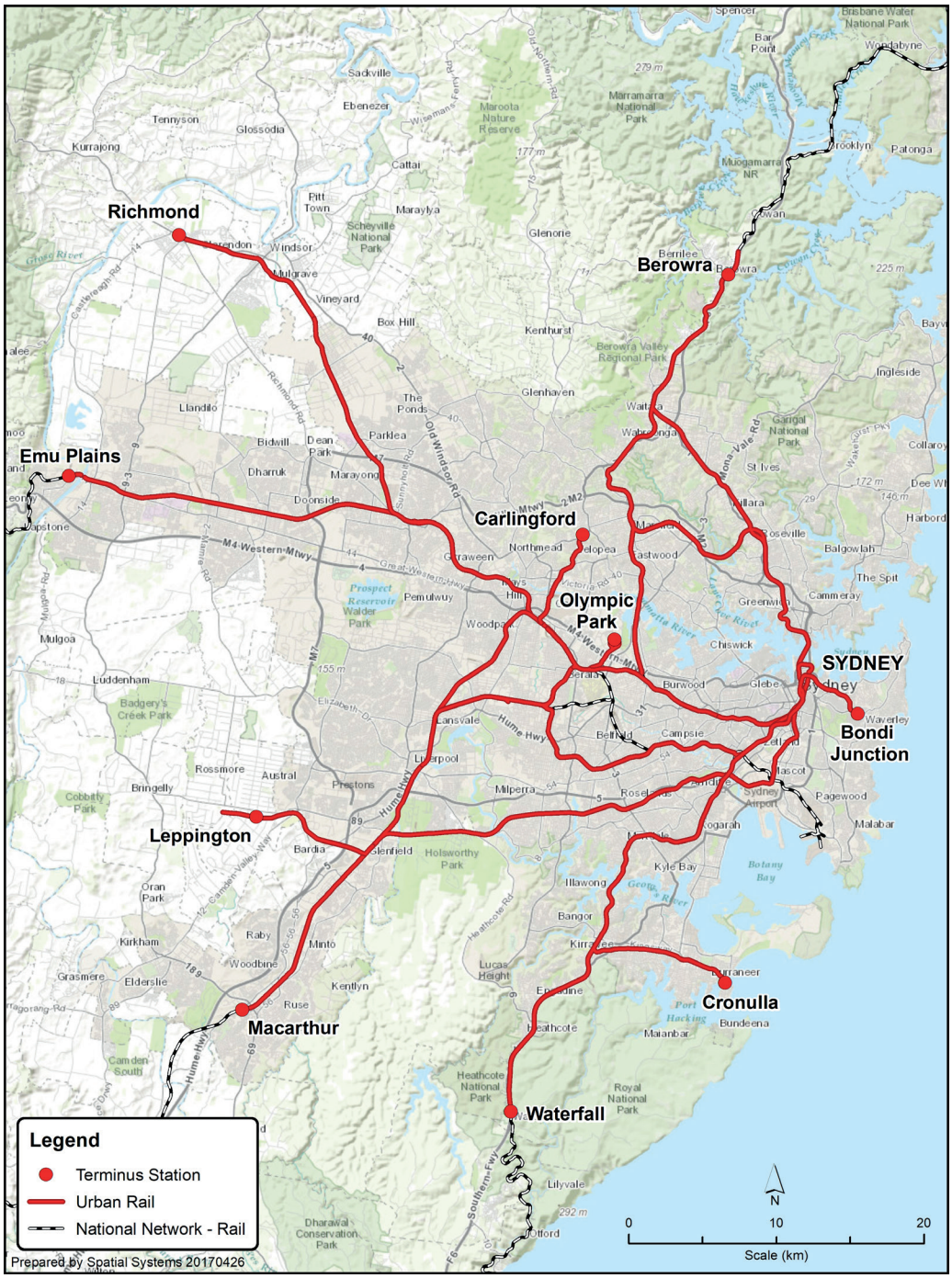


Figure 65 Sydney



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ARTC – See Australian Rail Track Corporation

ATSB—see Australian Transport Safety Bureau

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