

High Speed Rail Study

Phase 2 Report



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Overview

A strategic study on the implementation of a High Speed Rail (HSR) network (the study) on the east coast of Australia between Brisbane, Sydney and Melbourne was announced by the Minister for Infrastructure and Transport, the Hon Anthony Albanese MP, in August 2010.

The study has been conducted in two phases. Phase 1, published in August 2011, identified a short-list of corridors and station options and estimated preliminary costs and demand for HSR on the east coast of Australia. Phase 2 built on phase 1, but was considerably broader and deeper in objectives and scope, and so refined many of the phase 1 estimates, particularly the demand and cost estimates. This phase 2 report presents detailed findings on the 12 advisory objectives established for the study.

Drawings and maps have been prepared for the purpose of depicting the recommended alignment for the HSR system and to enable civil construction cost estimates to be made.

Key findings



Definition of the preferred HSR system

The HSR network would comprise approximately 1,748 kilometres of dedicated route with four city centre stations, four city-peripheral stations (one in Brisbane, two in Sydney and one in Melbourne) and 12 regional stations.

- HSR would require a dedicated railway network to deliver the necessary level of system performance, in terms of journey time and reliability, to be competitive with other modes of transport, particularly aviation.

To meet expected demand, the HSR system would offer a combination of services, including direct express services and limited stop services.

- Typical express journey times would be two hours and 37 minutes between Brisbane and Sydney, one hour and four minutes between Sydney and Canberra, and two hours and 44 minutes between Sydney and Melbourne.

- The HSR would operate frequent services between capital cities and regional centres.
- In 2065, it is forecast that peak period demand for Sydney-Melbourne would be met by two non-stop inter-capital express services per hour per direction and three one-stop inter-capital express services per hour per direction, calling at either Sydney South or Melbourne North city peripheral stations.

The dedicated HSR network would need to be integrated into the hubs of existing urban public transport systems and road networks to maximise its connectivity with other transport networks.

- All city centre stations must be integrated with other public transport networks and the city-peripheral stations must have good access to major road networks.
- Most of the stations on the network would require some local enhancements to public transport services, parking and interchange arrangements to ensure good connectivity.



Cost of constructing the HSR system

The estimated cost of constructing the preferred HSR alignment in its entirety would be about \$114 billion (in 2012 terms), comprising \$64 billion between Brisbane and Sydney and \$50 billion between Sydney, Canberra and Melbourne.

- The preferred HSR alignment has been designed first and foremost to meet market needs (in terms of journey times and reliability), while also being environmentally and economically sustainable.
- Tunnelling has been adopted where no dedicated surface route could be created without unacceptable dislocation and/or

environmental costs. Tunnels make up 144 kilometres (eight per cent) of the preferred alignment and are the most significant construction cost element (29 per cent of total construction costs). Access to and from Sydney would require the most tunnelling (67 kilometres) compared to Brisbane (five kilometres), Melbourne (eight kilometres) and Canberra (four kilometres).

- The HSR system would adopt internationally proven and available technology for train sets and associated systems (such as train control and power supply systems), which would cost less than if a customised design were required.



Forecast HSR demand

Between 46 million and 111 million passengers are forecast to use HSR services for inter-city¹ and regional trips², if the preferred HSR network were fully operational in 2065, with a central forecast of 83.6 million passengers per year.

- By 2065, HSR could attract 40 per cent of inter-city air travel on the east coast and 60 per cent of regional air travel (primarily long regional). On the three main sectors, Sydney-Melbourne, Sydney-Brisbane and Sydney-Canberra, HSR could attract more than 50 per cent of the air travel market.
- Actual passenger numbers would depend on the rates of population and economic growth, the levels of congestion at airports, including travelling to and from airports, and the fares charged.
- Sydney-Melbourne is expected to be the largest market for HSR, with about 19 million passenger trips per year forecast. This is considerably more than the next largest market, Brisbane-Sydney, with nearly

11 million passenger trips per year, and almost four times as many as the Sydney-Canberra market, with about five million passenger trips per year.

- Inter-city and long regional travel (>250 km) are expected to account for 49 per cent and approximately 36 per cent of total passenger trips and 62 per cent and 35 per cent of total passenger kilometres travelled respectively. Short regional travel (<250 km) would represent 14 per cent of total trips, and only a small per cent of total passenger kilometres travelled. Business travellers would account for about 35 per cent of total trips and 42 per cent of total passenger kilometres on the entire HSR system.
- For the purpose of assessing demand, average fares for business and leisure travel were set to be comparable to, and competitive with, air fare rates on the main inter-capital routes on the east coast. In practice, a range of fares would be offered, targeted to market segments and influenced by seat utilisation patterns and competitive pressures, as is currently the case with the airlines.



Staging the development of HSR

The optimal staging for the HSR program would involve building the Sydney-Melbourne line first, starting with the Sydney-Canberra sector. Subsequent stages would be Canberra-Melbourne, Newcastle-Sydney, Brisbane-Gold Coast and Gold Coast-Newcastle.

- International experience of large infrastructure developments shows that approximately ten years could be required for planning, consultation and environmental approvals, and five years for preconstruction and procurement activities.

1 The inter-city market is defined as journeys over 600 kilometres between the six main towns and cities in the corridor based on population – Brisbane, Gold Coast, Newcastle, Sydney, Canberra and Melbourne.

2 The regional market has been broken into long regional trips greater than 250 kilometres, which includes Sydney-Canberra, and short regional trips less than 250 kilometres, which includes Brisbane-Gold Coast and Newcastle-Sydney.

Table 1 Commencement and operational milestones for optimal staging

Stage	Main construction commences	Operations commence
Sydney-Melbourne line		
Sydney-Canberra	2027	2035
Canberra-Melbourne	2032	2040
Brisbane-Sydney line		
Newcastle-Sydney	2037	2045
Brisbane-Gold Coast	2043	2051
Gold Coast-Newcastle	2048	2058

- Some preliminary ('enabling') works to enable construction of the HSR at Sydney Central station (e.g. moving platforms and utilities) would be undertaken before 2027.
- Construction of the whole HSR system would take around 30 years.
- The Sydney-Melbourne line has stronger forecast demand than the Brisbane-Sydney line, would be less expensive to build and is predicted to have higher economic and financial returns. It should therefore be completed first.
- The preferred staging of construction for the Brisbane-Sydney line (Newcastle-Sydney, Brisbane-Gold Coast and then Gold Coast-Newcastle) reflects both market demand and economic characteristics.
- For the purpose of evaluation, the study assumed the initial stage between Sydney and Canberra would operate from 2035, with the Sydney-Melbourne line operational from 2040.
- Brisbane-Gold Coast would be completed in 2051.
- Gold Coast-Newcastle would be the last stage to be built, with the complete Brisbane-Melbourne line operational by 2058.

It is possible the program could be accelerated, with the Sydney-Melbourne line operational by 2035. In this case the Sydney-Canberra stage could be operational by 2030.

- Assuming funding, financing and all relevant approvals were in place and preliminary design had been completed, the earliest that main construction work could reasonably start would be 2022.
- Bringing the program forward would reduce the economic benefits, primarily because the market volumes would be lower when operations began.

Table 2 Commencement and operational milestones for accelerated staging

Stage	Main construction commences	Operations commence
Sydney-Melbourne line		
Sydney-Canberra	2022 (earliest possible start)	2030
Canberra-Melbourne	2027	2035
Brisbane-Sydney line		
Newcastle-Sydney	2032	2040
Brisbane-Gold Coast	2038	2046
Gold Coast-Newcastle	2043	2053



Financial assessment

The HSR program and the majority of its individual stages are expected to produce only a small positive financial return on investment.

- The distribution of the economic benefits of HSR between users of the system and the operator(s) would depend on the prices charged.
- Based on charging competitive fares, the HSR operations and ancillary services (such as car parking and lease revenues from related property development) would not deliver sufficient revenue to fund or recover the expected capital costs of the HSR program.

Governments would be required to fund the majority of the upfront capital costs.

- The potential to attract private finance is limited. An expected return of at least 15 per cent would be required at this stage of project development to be attractive to commercial providers of debt and equity to major infrastructure projects. HSR would fall well short of this.
- The estimated real financial internal rate of return (FIRR) is 1.0 per cent for Sydney-Melbourne and 0.8 per cent for the whole network.
- If potential commercial funding were maximised, a funding gap in the order of \$98 billion, or 86 per cent of the up-front capital cost of the HSR program, would remain.

If HSR passenger projections were met at the fare levels proposed, the HSR system, once operational, could generate sufficient fare revenue and other revenue to meet operating costs without ongoing public subsidy.

- Post construction, the HSR program as a whole, and each of its sectors (with the exception of Sydney-Canberra as a stand-alone sector) are expected to generate sufficient operating income to cover their ongoing operational and asset renewal costs.

HSR fares adopted for the study have been assumed to be comparable to air fares on the inter-capital routes, and it would appear HSR could sustain higher fares.

- Increasing the cost of fares would increase the financial returns and reduce the funding gap, although doing so would reduce the number of people using the system. Even so, the economic benefits of the program would remain positive.
- Given that airfares in Australia are already highly competitive on major routes, it is not expected that airlines would respond to HSR competition by reducing fares on a sustained basis. It has been assumed, in line with international experience, that airlines would quickly reduce capacity, either by reducing frequencies or aircraft sizes, to locations within the HSR corridor where there is significant passenger diversion to HSR. It is likely that any reduction in capacity would be redeployed to routes outside the HSR corridor.
- Nevertheless, to the extent that airlines are able to innovate in ways that have not been anticipated in this study, there would be an impact on HSR patronage and capacity to meet operating costs. The sensitivity tests included one scenario in which airfares were reduced by 50 per cent for two years.



Economic assessment

Investment in a future HSR program could deliver positive net economic benefits.

- The Sydney-Melbourne line would deliver a slightly higher economic internal rate of return (EIRR) on investment than the whole network would. The EIRR of Sydney-Melbourne is estimated at 7.8 per cent, compared to 7.6 per cent for an investment in the staged HSR program as a whole.
- The economic benefit cost ratio (EBCR) calculates the ratio of the present value of benefits to the present value of costs. When calculated using a discount rate of four per cent, the EBCR is 2.5 for Sydney-Melbourne and 2.3 for the whole network.
- The economic net present value (ENPV) of costs and benefits associated with a program of investment in the preferred HSR system would be \$70 billion for Sydney-Melbourne and \$101 billion for the network as a whole,

calculated using a discount rate of four per cent a year until the start of construction in 2027 (financial year 2028), and expressed in \$2012.

- The economic results remain positive under a range of changed assumptions. When calculated using a seven per cent discount rate, which represents a higher hurdle rate for judging economic performance, the EBCR would be 1.1 and the ENPV would be \$5 billion.
- Most of the economic benefits (90 per cent) would accrue to the users of the HSR system. About two-thirds of the user benefits are attributable to business users travelling long distances, which reflects in part the relatively higher value of time attributed to business travellers compared to leisure travellers.
- Externalities would be relatively minor, accounting for only about three per cent of the benefits.



Environmental and social assessment

The preferred HSR alignment has been selected to avoid major environmental and social impacts. The residual impacts on natural environments and heritage can be managed by appropriate mitigation and, where necessary, offsets.

- Potential significant impacts in urban areas, such as noise and large scale property acquisition, have largely been avoided by the use of tunnelling on the approaches to capital cities.



Broader impacts of HSR

Aligning public policies, programs and capabilities across Australian Government, state/territory government and local government agencies as part of a corridor regional development concept would be necessary to realise the full benefits of HSR.

- The implementation of HSR would substantially improve accessibility for the regional centres that it serves, providing the opportunity for – but not the automatic realisation of – increased regional economic development. The ability of these

centres to take advantage of the opportunities created by improved accessibility would require coordinated and complementary policies to be implemented.

- Emerging international evidence suggests that wider economic benefits may be generated by regional accessibility improvements, but the quantitative estimates are neither sufficiently certain nor robust for inclusion in the main economic assessment.



Implementing a future HSR program

Both the public and private sectors would play a significant role in the planning and implementation of a future HSR system.

- Governments would need to have a central role in the planning and development of the HSR system, including securing the necessary approvals. The primary public sector roles would be executed through a single HSR development authority.
- As HSR would be predominantly publicly funded, the Australian, ACT and relevant state governments would be the owners of the system and would assume the key role in the specification and procurement of network infrastructure, the allocation of its capacity for transport services and the specification of minimum service requirements.
- The private sector would be responsible for building the HSR infrastructure under contract

to the HSR development authority, and for the delivery of train services to the public. Control of the movement of trains and maintenance of infrastructure would also be the role of the private sector, under competitively tendered concession arrangements.

The key risks to the HSR program and its successful performance are common to all major greenfield infrastructure projects; most notably, a lack of certainty about future demand and revenues, and the potential for cost over-runs during construction.

- Allowance for risk and uncertainty has been included in the demand, economic and financial assessments, but the risks cannot be perfectly controlled and a program of this nature, particularly extending over a long period of time, contains significant uncertainties.



Key public policy issues for a decision to proceed

Whether to proceed with planning for a future HSR program must necessarily be a policy decision, taking account of many factors that cannot be known with certainty, and in the context of risks which cannot be perfectly controlled.

- This study estimates that HSR would have positive net economic benefits, using the Australian Transport Council's cost-benefit methodology guidelines, which are conventionally applied to major transport infrastructure projects. However, this appraisal extends to 2085, a necessarily distant time horizon for program delivery and market impact compared to most infrastructure feasibility studies.
- The long-term future is inherently uncertain and requires caution when making a judgement, but it is most likely that demographic and economic trends will support a steadily improving case for HSR on the east coast rather than otherwise. In that case, policy-makers, whether or not yet convinced of the merits of committing to HSR, may also legitimately weigh the possible consequences of not taking actions to preserve that option at some time in the future.
- In this regard, inaction is not benign. In the absence of a protected route, the spread of cities and other developments in the preferred corridor will gradually reduce the constructability and increase the potential capital costs of a future HSR program, rendering it increasingly more difficult to implement, even while the fundamental trends may become increasingly favourable.

As in all publicly-funded infrastructure projects, the balance between public benefit and public cost should be considered.

- The positive economic performance that is estimated to be achievable from an investment in HSR, most of which would directly benefit the users of the system, contrasts with low financial returns, which would need to be supported by public funding. Although this is true of many transport infrastructure projects, including national highways, it is an issue that must be confronted.

- The external benefits of HSR – fewer road accidents, reduced road congestion and so on – which might contribute to its rationale, would be positive but are estimated to fall far short of the public funding required.
- By contrast, the opportunities for urban and regional development in the HSR corridor will be considered by many people in Australia to have a high potential value in public policy terms, but those benefits do not follow automatically or with certainty. There would need to be confidence that they would be actively exploited and realised to justify any great weight in the decision on whether to proceed. That in turn would require policy commitment at all levels of government to pursuing an integrated corridor development strategy, synchronised with the delivery of the HSR program.

A related policy issue is the extent to which the initial capital costs of an HSR program should be recovered from users.

- Taxpayers would need to make a substantial contribution to the up-front costs of establishing an HSR system. The analysis suggests that charging higher fares than those assumed would be feasible, and would improve financial returns, but would reduce overall economic benefits as fewer people would use the system.
- While economic principles suggest that the community's economic welfare is best pursued by charging users only the marginal cost of infrastructure, establishing the balance between recovery of public investment in infrastructure and maximising its economic benefits is ultimately a policy matter.
- If an HSR program were adopted, there would need to be an up-front understanding of what principles would be applied to infrastructure pricing and cost recovery. Certainly, if passenger numbers were to grow over time, governments would be in a position to begin to recover some proportion of its capital investment.

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ES

Executive summary

The expected growth in travel demand

Population and employment growth will continue to challenge the capacity of existing transport networks and public infrastructure along the east coast of Australia¹. Travel on the east coast of Australia is forecast to grow at around 1.8 per cent per year over the next 20 years, increasing by approximately 60 per cent by 2035. By 2065, travel on the east coast will have more than doubled, from 152 million trips in 2009 to 355 million trips per year².

Without HSR, aviation would remain the primary means of transport for long distance interstate (and some inter-regional) trips and road-based travel by private vehicle would remain the primary mode for connections with, and between, regional centres. Together these would carry over 90 per cent of the trips on the east coast, subject to capacity being available.

This strategic study investigates how HSR can play an effective role in meeting future travel demand by providing an alternative mode of transport that would be attractive for people to use.

1 Australian Bureau of Statistics (ABS) mid-range population projections estimate that between 2011 and 2050, the population will grow by 37 per cent in NSW, 49 per cent in Victoria and 80 per cent in Queensland. ABS, Population Projections Australia 2006 to 2101, catalogue no. 3222.0.

2 See **Chapter 2** for detail of how these forecasts were determined.

What is HSR?

HSR is generally defined as a purpose-built, fixed-track mode of transport, capable of moving people at speeds of at least 250 kilometres per hour, usually over long distances. Internationally, it typically offers services between major cities, competing in the same travel market as aviation, but also provides opportunities for intermediate stops in regional areas and fast commuter rail services from outer metropolitan areas. HSR stations are typically located within city centres, close to population and business centres.

Originating in Japan in the 1960s, HSR systems now operate in 14 countries³. Total global kilometres of track have increased from just over 1,000 kilometres in 1980, to 15,000 kilometres in 2011⁴. China is currently constructing an additional 10,000 kilometres of HSR network⁵.

Most HSR systems operate on dedicated tracks at a maximum speed of between 250 and 300 kilometres per hour, with some systems now operating in excess of 300 kilometres per hour⁶. Some HSR services also use sections of conventional tracks at lower speeds, either on entry to cities or to extend beyond a dedicated line⁷. All current HSR systems use conventional steel wheels on rails and are powered by electric traction, although there are several variants in terms of rolling stock and infrastructure.

Definition of the preferred HSR system

HSR alignment and station locations

The preferred HSR route on the east coast of Australia has been developed first and foremost to meet market needs (in terms of journey times and reliability), while also being environmentally and economically sustainable. The route, illustrated in **Figure ES-1**, broadly follows a coastal alignment between Brisbane and Sydney followed by an inland alignment from Sydney to Melbourne, with spur lines to the Gold Coast and Canberra.

City centre stations would be terminal stations within the CBDs of the capital cities. These locations are the single most important origin and destination in each city and provide ready access to, and integrate with, other metropolitan transport services. CBD stations would be located beneath the Brisbane Transit Centre in Brisbane and on the eastern fringe of Civic in Canberra, and would share existing stations at Central in Sydney and Southern Cross in Melbourne. Each of the three main capital cities (Sydney, Melbourne and Brisbane) would also have a peripheral station (in Sydney's case it would have two – one to the north and one to the south of the urban area), for passengers who would find it more convenient to access HSR without having to travel into or out of the CBD.

The minimum corridor width required to accommodate two dedicated HSR tracks is 30 metres. This represents a refinement of the phase 1 evaluation, which was based on a 200 metre width to ensure that any significant issues were captured when comparing initial corridor options. The 30 metre width does not include the additional width required for embankments or cuttings necessary to maintain the smooth vertical alignment required for HSR.

In many developed urban areas, surface alignments would not permit competitive access times to the city centres for HSR services without major dislocation of the urban population and, in such cases, the alignment would be placed in tunnel. Sections of the regional alignment would also be built in tunnel or on viaducts to avoid built-up or environmentally sensitive areas. Although tunnels add to the capital cost, they would allow the infrastructure to be delivered in a way that minimises any potential negative impacts on the community and environment during construction and operation, and minimises delays and difficulties during construction.

3 Japan, Italy, France, Germany, Spain, Switzerland, Belgium, Netherlands, Luxembourg, China, United Kingdom, Korea, Taiwan and Turkey.

4 Derived from The World Bank, *High speed rail: the fast track to economic development?*, 2010 (updated).

5 Zhang Jianping, *Planning and Development of High Speed Rail Network in China*, UIC 8th World Congress on High Speed Rail, 2012.

6 For example, both France and Spain operate services with speeds of over 300 kilometres per hour in commercial service.

7 Particularly in France and Germany and, to a limited extent, in Japan and China.

Regional stations were selected on the basis of potential patronage and have been proposed at the Gold Coast, Casino, Grafton, Coffs Harbour, Port Macquarie, Taree, Newcastle, Central Coast, Southern Highlands, Wagga Wagga, Albury-Wodonga and Shepparton. To minimise cost and

avoid disruption to built-up areas, these stations would be located outside the current urban areas, although they would typically be within ten to 20 kilometres of the town centre and would have both car parking facilities and facilities to interchange with local public transport services.

Figure ES-1 Preferred HSR alignment and stations for the east coast of Australia



Types of HSR services

The market assessment showed strong demand on the east coast, now and into the future, for high speed travel between the capital cities and to and from regional centres. The preferred HSR system would therefore offer two types of services:

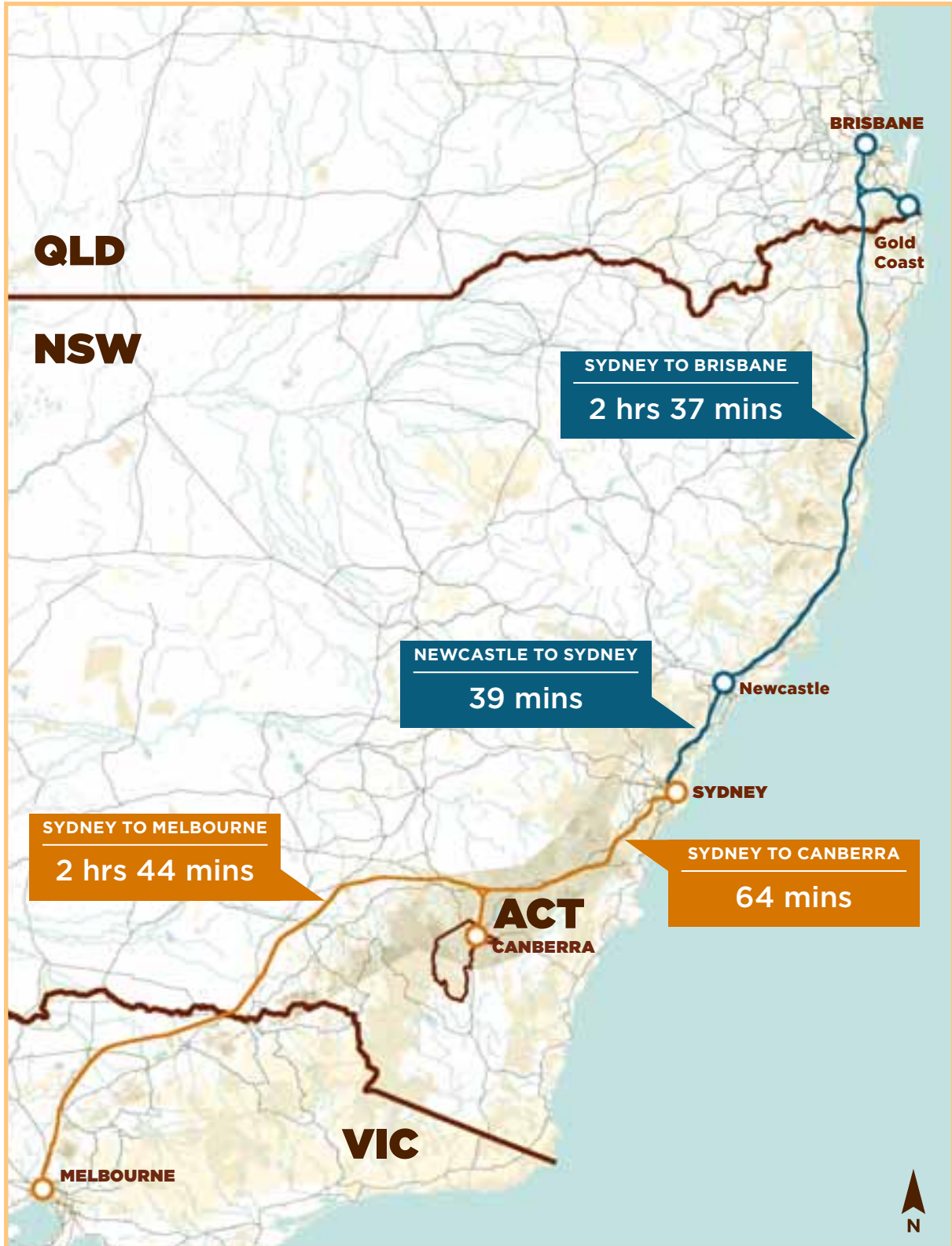
- Inter-capital express services, mostly operating non-stop between the capital city central stations but with some also stopping at the city peripheral stations.
- Inter-capital regional services offering high speed services between the capital cities and major regional centres. Regional services would also facilitate travel between regional stations, although some inter-regional movements with low demand may require passengers to change from one service to another at an intermediate station to complete their journey.

If built, the system would also have the capacity to accommodate fast commuter rail services between the capital cities and their nearer regional centres (such as the Central Coast and Newcastle in NSW), many of which currently have relatively slow, if any, services. Commuter services would probably be operated by third parties. They have been allowed for in the physical planning but they would not positively contribute to the financial performance of HSR, nor would they be the source of any significant incremental economic benefit in the cost-benefit analysis of HSR. Commuter demand was therefore excluded from the economic and financial appraisals.

HSR service characteristics

Australian market research and international experience have indicated that HSR would need to offer competitive door-to-door journey times, high standards of comfort and convenience and a competitive fare structure to successfully compete with other modes of transport, especially air. HSR could deliver non-stop journey times under three hours city centre to city centre, between Brisbane and Sydney and Sydney and Melbourne, as shown in **Figure ES-2** and **Table ES-1** and **Table ES-2**.

Figure ES-2 HSR travel times between major cities



KEY State border Roads
 HSR preferred alignment Station locations

Not to scale

Table ES-1 Typical HSR travel times and distances between selected stations on Brisbane-Sydney line

		Destination				
		Coffs Harbour	Newcastle	Central Coast	Sydney	
		Regional	Regional	Regional	Express	Regional
Origin	Brisbane	1hr 11min* (332km)	2hr 28min (662km)	2hr 43min (714km)	2hr 37min (797km)	3hr 09min (797km)
	Coffs Harbour		1hr 09min (330km)	1hr 30min (382km)	-	1hr 50min (465km)
	Newcastle			0hr 14min (52km)	-	0hr 39min (134km)
	Central Coast				-	0hr 27min (83km)

*With one stop. One hour 23 minutes with three stops.

Note: Distances may not add due to rounding.

Table ES-2 Typical HSR travel times and distances between selected stations on Sydney-Melbourne line

		Destination					
		Southern Highlands	Canberra		Albury-Wodonga	Melbourne	
		Regional	Express	Regional	Regional	Express	Regional
Origin	Sydney	0hr 29min (98km)	1hr 04min (280km)	1h 11min (280km)	1hr 55min (540km)	2hr 44min (824km)	3hr 03min (824km)
	Southern Highlands		-	0hr 39min (183km)	1h 31min* (442km)	-	2hr 29min (727km)
	Canberra				1hr 16min (366km)	2hr 10min (651km)	2hr 28min (651km)
	Albury-Wodonga					-	1hr 09min (284km)

*Plus interchange time at Wagga Wagga.

Note: Distances may not add due to rounding.

Services would typically operate 18 hours per day for 365 days per year. Service frequencies would typically be at least hourly, increasing as demand grew to reach peak period service frequencies in 2065, as shown in **Table ES-3**.

Ultimately, train frequencies would be influenced by future market needs and the preferred train operating strategy (operating speeds and stopping patterns) but the indicative frequencies established for this study are compatible with the forecast demand and efficient train utilisation.

Table ES-3 Peak service frequencies in 2065 (per hour in each direction)

Route	Inter-capital express	Inter-capital regional
Brisbane-Sydney	3-4	2
Gold Coast-Sydney	-	4
Sydney-Canberra	1	2
Sydney-Melbourne	5	2
Canberra-Melbourne	1	1

Fares would be structured to be competitive with alternative modes of transport. For the purposes of the main demand assessment, average fares for business and leisure travel were designed to be comparable to, and competitive with, air fares on the main inter-capital routes on the east coast, taking into account the types of fares typically purchased by the different types of passenger⁸. In practice, a range of fares would be offered, targeted to market segments and influenced by seat utilisation patterns and competitive pressures, as is currently the case with the airlines.

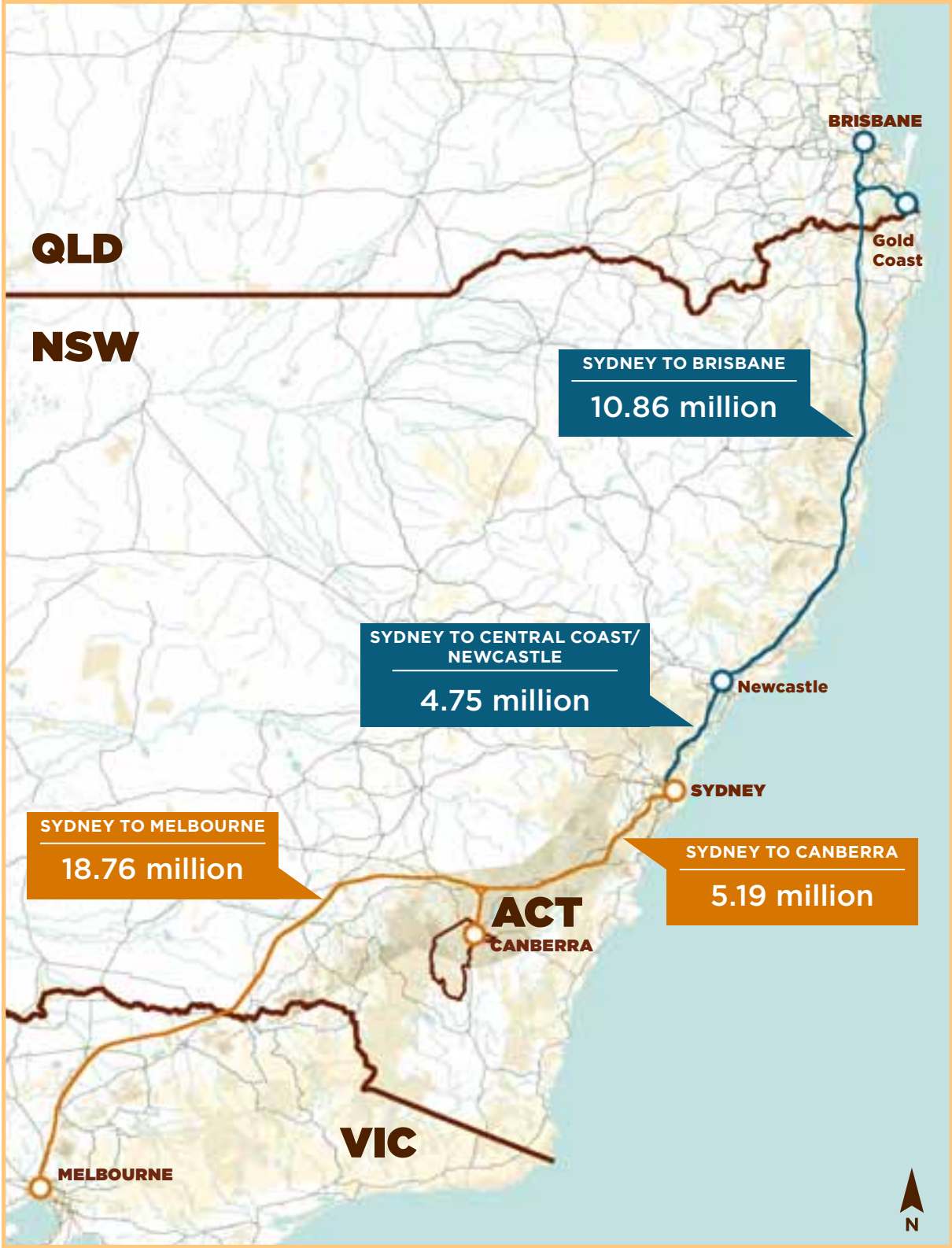
Forecast HSR demand

An HSR system would significantly increase long and medium-distance transport capacity on the east coast of Australia and would provide an alternative mode of transport that, according to market research and supported by international evidence, would be attractive to many travellers. If the complete HSR network was fully operational, the study predicts that, under the reference case assumptions⁹, it could attract approximately 83.6 million passenger trips by 2065, as shown in **Table ES-4**. **Figure ES-3** illustrates the main inter-city passenger trip flows.

8 For example, the average HSR single fares assumed in the reference case between Sydney and Melbourne were \$141 for the average business passenger and \$86 for the average leisure passenger but sensitivity tests also considered fares up to 30 per cent and 50 per cent greater. The corresponding average fares paid by air passengers were estimated as \$137 and \$69 respectively.

9 The reference case is part of the central case established for evaluation.

Figure ES-3 HSR travel demand in 2065 between major cities – passenger trips



KEY State border Roads
 HSR preferred alignment Station locations

Not to scale

Table ES-4 HSR travel market for 2065

Total travel market (inter-city and regional)	
Trips without HSR (million)	355
Trips with HSR (million)*	389
HSR travel market (inter-city and regional)	
HSR trips (million)	83.6
HSR passenger kilometres (billion)	53.1

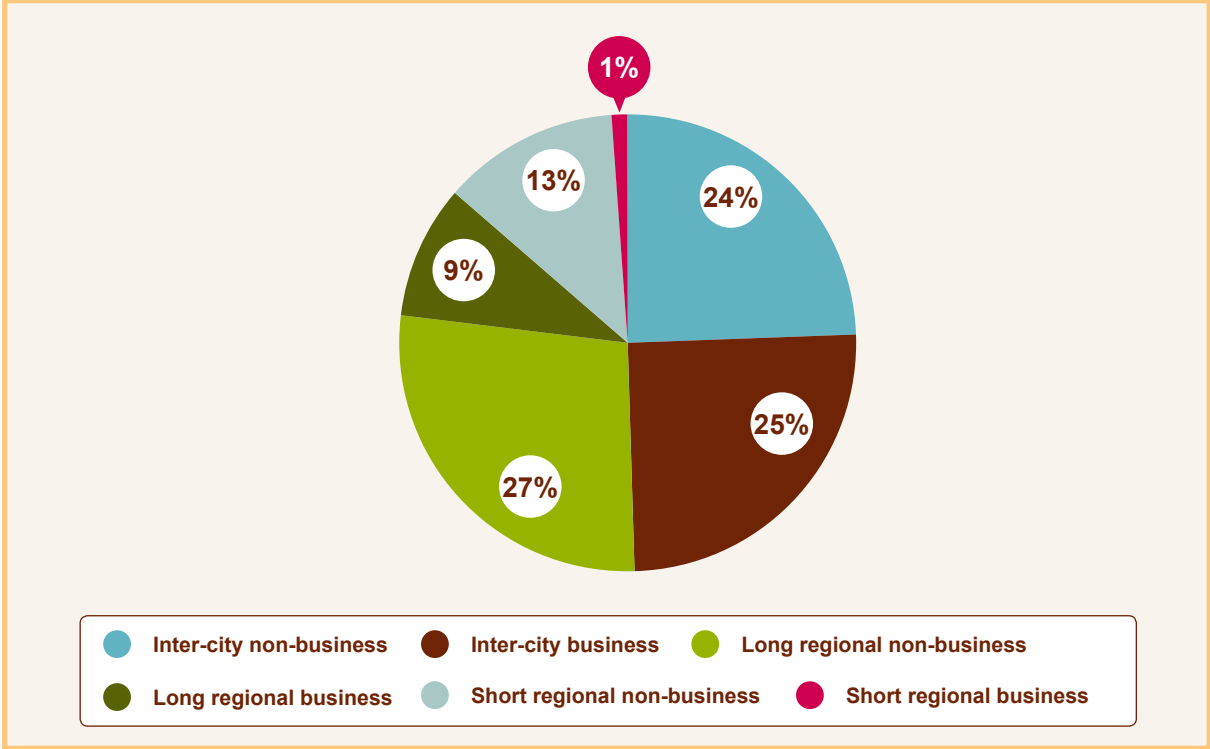
*Includes new demand induced by the construction of HSR. Assumes the full system is operational.

A set of alternative assumptions produced forecasts for HSR in 2065, assuming a full system were to be operational, of between 46 million and 111 million passenger trips. The alternative assumptions included variations in population and economic growth, increases in airport capacity at Sydney (and hence improvements in the aviation level of service) and variations in HSR fares relative to the projected air fares and car running costs.

Forecast HSR travel demand by journey type in the reference case is presented in **Figure ES-4** (for passenger trips) and **Figure ES-5** (for passenger kilometres). Travel for business accounts for 35 per cent of forecast HSR patronage, with inter-city business travel being the most important¹⁰. Inter-city travel would make up about 49 per cent of total passenger trips and 62 per cent of passenger kilometres. Regional travel would represent about 50 per cent of total passenger trips and 38 per cent of passenger kilometres.

¹⁰ Inter-city trips are defined as journeys over 600 kilometres between the six main towns and cities in the corridor based on population (Brisbane, Gold Coast, Newcastle, Sydney, Canberra and Melbourne). Regional trips have been broken into long regional trips of greater than 250 kilometres, which includes Sydney-Canberra, and short regional trips of less than 250 kilometres, which includes Brisbane-Gold Coast and Newcastle-Sydney.

Figure ES-4 HSR travel demand in 2065 by journey type (assuming the full HSR network was operational) – passenger trips



Note: Total does not add to 100% due to rounding.

Figure ES-5 HSR travel demand in 2065 by journey type (assuming the full HSR network was operational) – passenger kilometres

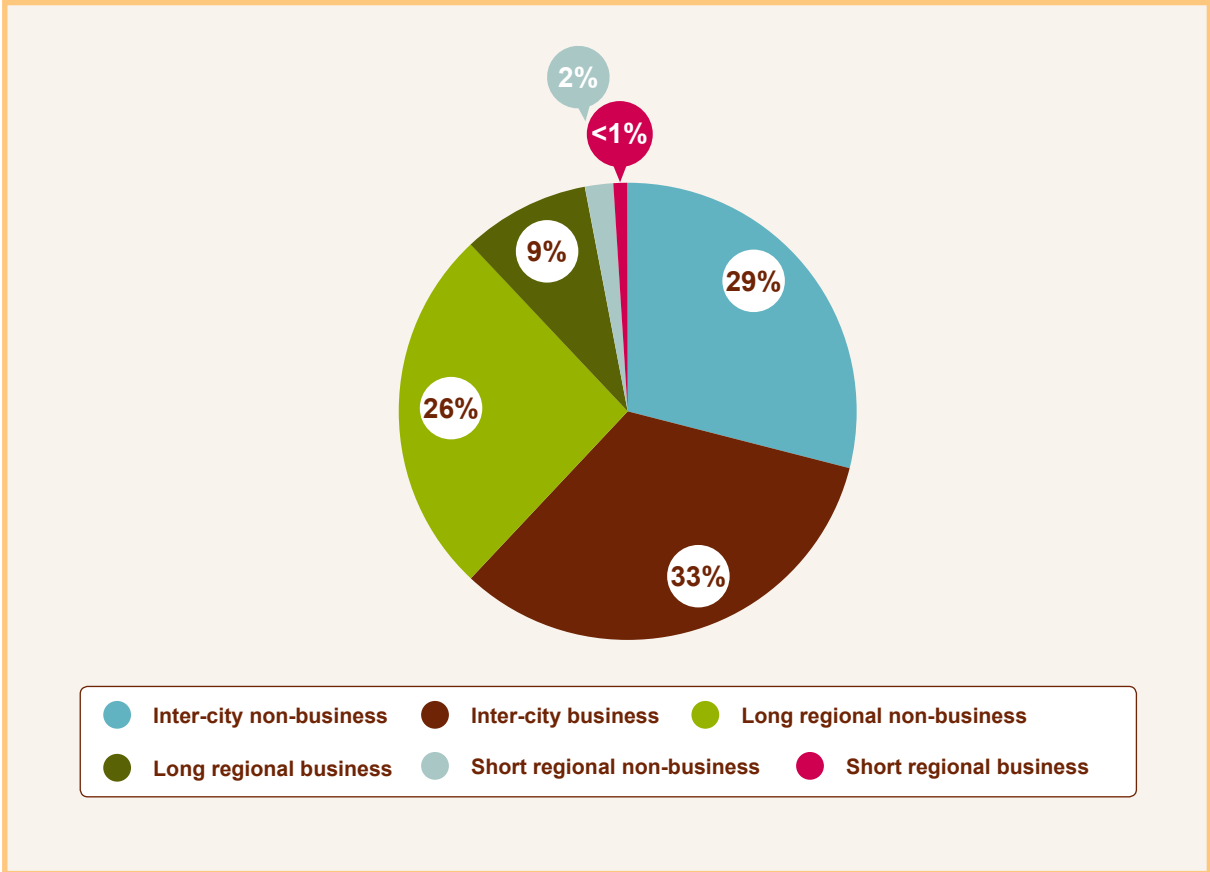


Table ES-5 shows the forecast travel matrix for the reference case in 2065 when the full network would be operational. Intermediate stations between capital centres are aggregated for presentation purposes. Excluding commuter markets, Sydney-Melbourne is the largest market segment for HSR with about 19 million passenger trips, considerably more than the next largest, Brisbane-Sydney, with nearly 11 million passenger trips and almost four times Sydney-Canberra, with about five million passenger trips.

Some travel was omitted from the matrix because it covered only a short distance, or would be best served by car, implying that few such journeys would be likely to transfer to HSR. This included all travel wholly within each of the intermediate

areas, other than that to and from Wollongong. A small proportion of the omitted longer trips could use HSR, and to this extent, the HSR forecasts are conservative. Trips to and from places external to the study area were also excluded. The excluded trips referred to above are shown by an X in the table.

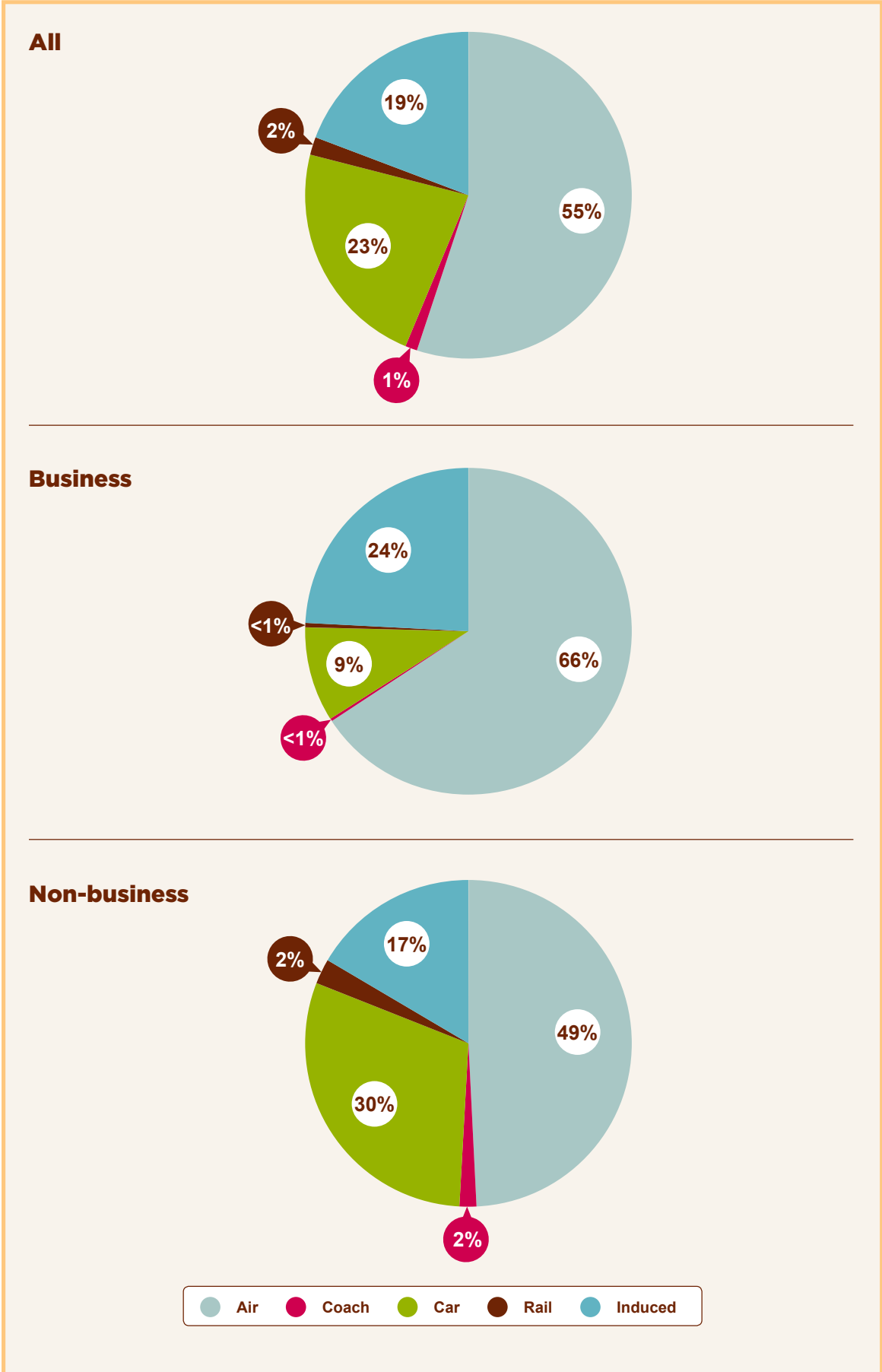
About half of the HSR demand would be diverted from forecast air travel as shown in **Figure ES-6**. About 19 per cent of total trips would be new demand generated by the introduction of an HSR service (shown as induced demand).

Table ES-5 HSR travel market matrix for 2065 ('000 trips in both directions per year)

Sectors	Brisbane	Gold Coast	Intermediate	Newcastle	Intermediate	Sydney	Intermediate	Canberra	Intermediate	Melbourne	Total
Brisbane	X	2,210	1,650	750	600	10,860	1,240	1,130	730	2,490	
Gold Coast		X	900	520	580	3,830	610	190	440	340	
Intermediate			X	810	X	5,500	190	330	X	850	
Newcastle				X	170	1,760	220	250	150	330	
Intermediate					X	2,990	20	300	X	730	
Sydney						X	2,690	5,190	2,290	18,760	
Intermediate							80	480	100	2,320	
Canberra								X	640	2,720	
Intermediate									X	4,660	
Melbourne										X	
Total											83,600*

*Cells may not exactly sum to the total due to rounding.

Figure ES-6 Source of HSR travel demand in 2065 by journey type (passenger trips)



How the total HSR and air market would be shared between the two modes of transport is a key issue in the demand assessment. Considerable evidence has been assembled in the international literature on the impacts of HSR on inter-capital air travel in Europe and East Asia. In **Figure ES-7**, the international markets are represented by the blue dots, which show the proportion of the combined air and HSR travel market captured by HSR on selected routes. For HSR journey times of less than two hours, this is typically over 80 per cent, whereas if HSR journey times exceed four and a half hours, the HSR share falls below 30 per cent. For trips of up to three hours (as for Sydney-

Melbourne and Sydney-Brisbane), observed HSR market shares range from around 55 per cent up to around 70 per cent.

This study's reference case inter-capital forecasts for 2035 have been included in the figure for comparison and show a high degree of consistency with the international experience. Sydney-Canberra is lower than the expected range for journeys less than two hours, but this is largely explained by the relatively high proportion of passengers transferring to connecting flights, which are assumed in the forecasts not to divert to HSR.

Figure ES-7 HSR share of combined HSR/air travel market, comparing the final model forecast for 2035 with international evidence



Cost of constructing the HSR network

Internationally, HSR systems are very reliable when they operate as closed systems dedicated to high speed services with purpose-built infrastructure and train sets. Although mixing HSR services with conventional rail services on shared infrastructure may reduce capital costs, particularly for access into the urban areas, operational performance can diminish dramatically. Such systems are generally not capable of delivering the journey times that would be necessary for an HSR system on the east coast of Australia to achieve the required levels of reliability and competitiveness.

To achieve the target journey time of under three hours for Sydney-Melbourne and Brisbane- Sydney, an average journey speed of approximately 300 kilometres per hour would need to be achieved. This would require a system capable of a maximum operating speed of 350 kilometres per hour, to allow for some slower sections of track due to terrain or other operating conditions. Such average speeds would not be possible on the existing conventional rail infrastructure on the east coast of Australia, even if it was only used for short sections for city access and egress, so dedicated HSR infrastructure would be required. If the HSR network were used to provide fast commuter services, it is likely they would not operate at such high speeds; a maximum operating speed of 200- 250 kilometres per hour would effectively serve the commuter market, given the relatively shorter distances and more intensive stopping patterns of fast commuter services.

In addition to the physical components of capital cost (land, earthworks, structures, track, equipment and facilities), the cost estimates also include design, program and construction management, and asset renewal when it would fall due. Cost components were developed from Australian unit costs and benchmarked against international HSR systems to ensure the robustness of the estimates. Rolling stock (train sets) is equivalent to a further nine per cent of the total capital cost, but this would only be expended as demand built up over the appraisal period and service frequencies increased.

Tunnelling would be used where the terrain requires it, but would also be adopted where no dedicated surface route could be created without unacceptable community dislocation and/or environmental costs. This is particularly the case where the route passes through the middle and inner suburbs of the capitals, where no suitable easements are available. It has also been used in some locations which are highly environmentally sensitive. In total, the preferred alignment includes 144 kilometres of tunnel along the route, representing around 29 per cent of the total cost of construction. Sixty per cent of the tunnel length is in urban areas, with 67 kilometres in Sydney, eight kilometres in Melbourne, five kilometres in Brisbane and four kilometres in Canberra.

The cost estimates reflect the use of proven HSR system technology (such as train control and power supply systems) and train sets already in service, and readily available, and take account of a range of manufacturers' delivered costs for existing HSR systems.

The capital costs have been risk-adjusted to reflect uncertainty, principally around the scope of the major construction, engineering and operational elements of a future HSR program. Expected construction costs are expressed throughout this chapter in terms of risk-adjusted value, in \$2012.

In total, the risk adjustment process increased capital costs by about 10.8 per cent¹¹.

The estimated capital cost for the full HSR system, excluding the cost of train sets¹², is \$114.0 billion in \$2012, as shown in **Table ES-6**.

Table ES-6 Risk-adjusted HSR program costs (\$2012, \$billion)

	Sydney-Canberra	Canberra Junction-Melbourne	Newcastle-Sydney	Brisbane-Gold Coast	Gold Coast Junction-Newcastle	Total HSR system
Project development	2.2	2.5	1.7	1.0	3.1	10.4
Construction	20.8	24.4	17.2	10.0	31.2	103.6
Total capital costs	23.0	26.9	18.9	11.0	34.3	114.0

Notes: Total does not add up exactly due to rounding.

The references to 'Canberra Junction' and 'Gold Coast Junction' describe the points at which the Gold Coast and Canberra spurs leave the main alignment.

Figure ES-8 presents the results of the @RISK analysis for total construction costs including development costs for the future HSR program¹³.

The analysis illustrates that:

- In 50 per cent (P50) of simulations, total construction costs are expected to be less than \$113.9 billion (\$2012).
- In 90 per cent (P90) of simulations, total construction costs are expected to be less than \$127.0 billion (\$2012).
- In ten per cent (P10) of simulations, total construction costs are expected to be less than \$102.0 billion (\$2012).

11 This is the expected risk-adjusted cost and is within one per cent of the median risk-adjusted cost, commonly known as the P50; the difference between them is due to the risk adjustment applied to the individual cost components being non-symmetrical. Taking into account the allowances included in developing the non-risk-adjusted costs, the risk allowance is comparable with what would be allowed as a physical contingency for a project at a similar early stage of development.

12 Train sets are assumed to be leased in the financial assessment.

13 The frequency represents the likelihood of the total construction costs being within a \$1 billion band centred on the corresponding point on the curve. Thus there is a two per cent chance that the cost will lie between \$100.5 billion and \$101.5 billion and a four per cent chance they lie between \$107 billion and \$108 billion.

Figure ES-8 Total construction costs (including development costs) (\$2012, \$billion)

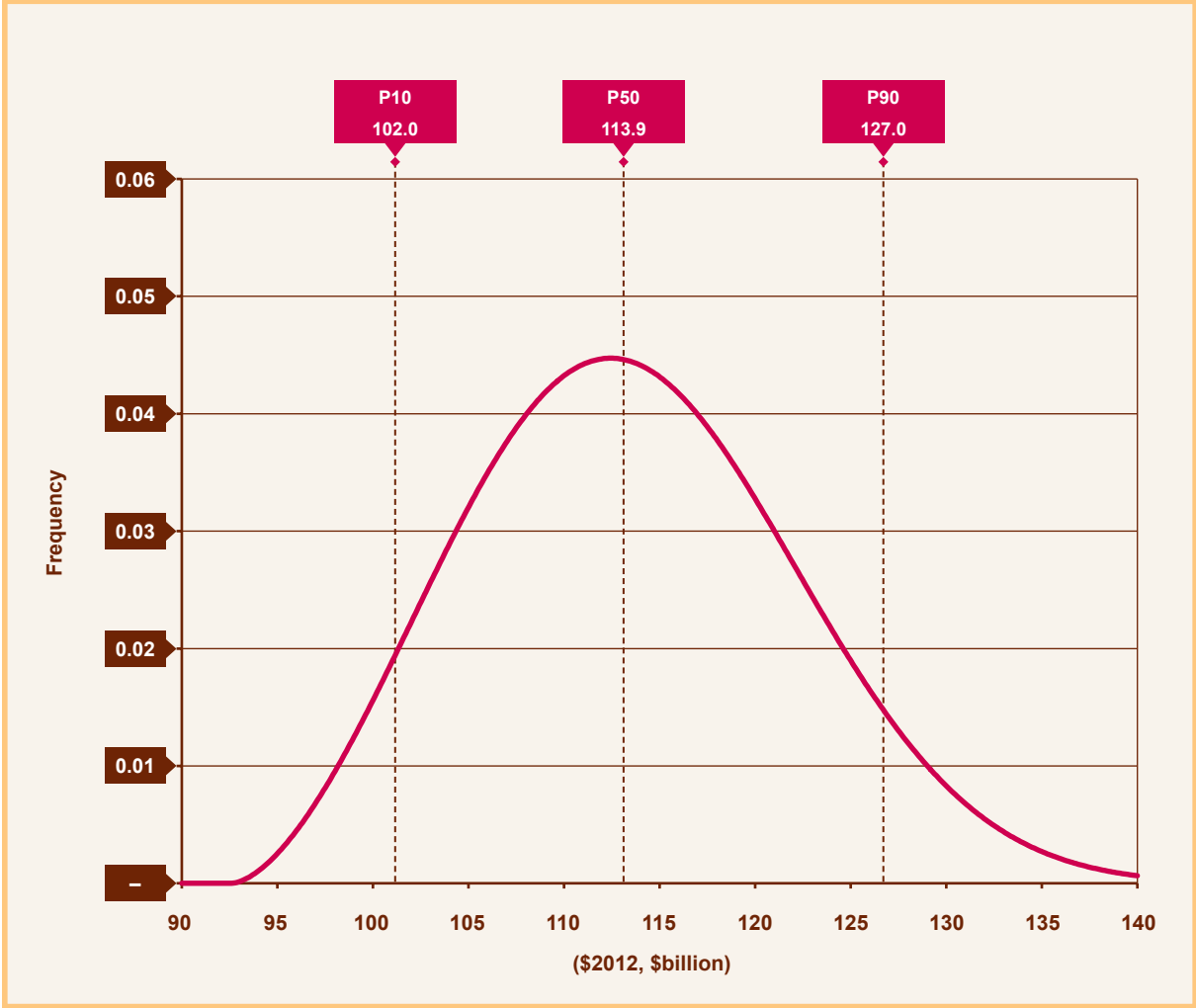
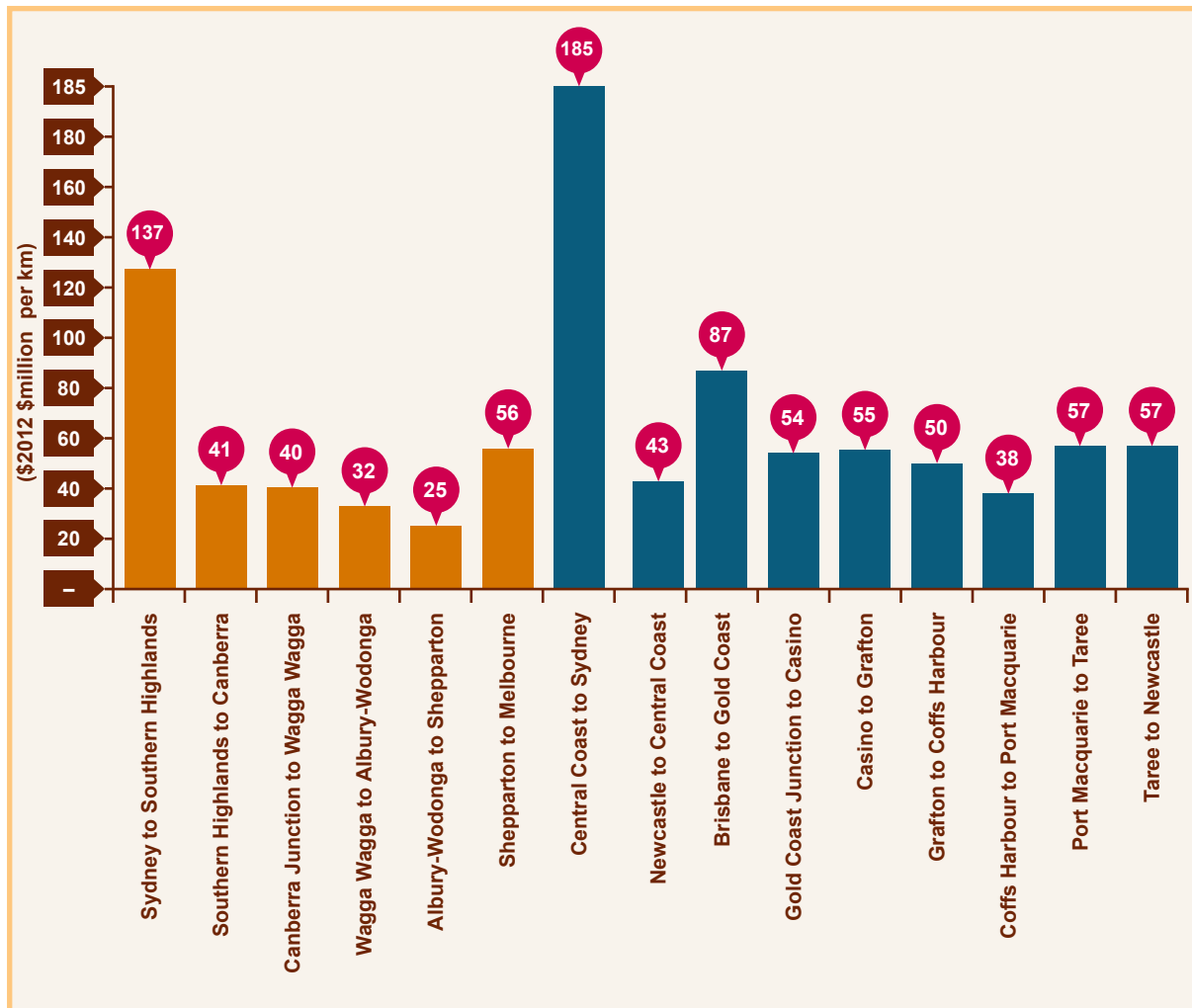


Figure ES-9 presents estimated average construction costs per route kilometre on a segment by segment basis. The extensive tunnelling required for access into and out of Sydney increases the cost per route kilometre for these segments by two to three times compared to the costs for the remainder of the network.

Parts of the route between Brisbane and Newcastle also have high costs, reflecting the volume of earthworks required in these areas.

Figure ES-9 HSR program average construction costs per route-kilometre in staging order (\$2012, \$million)



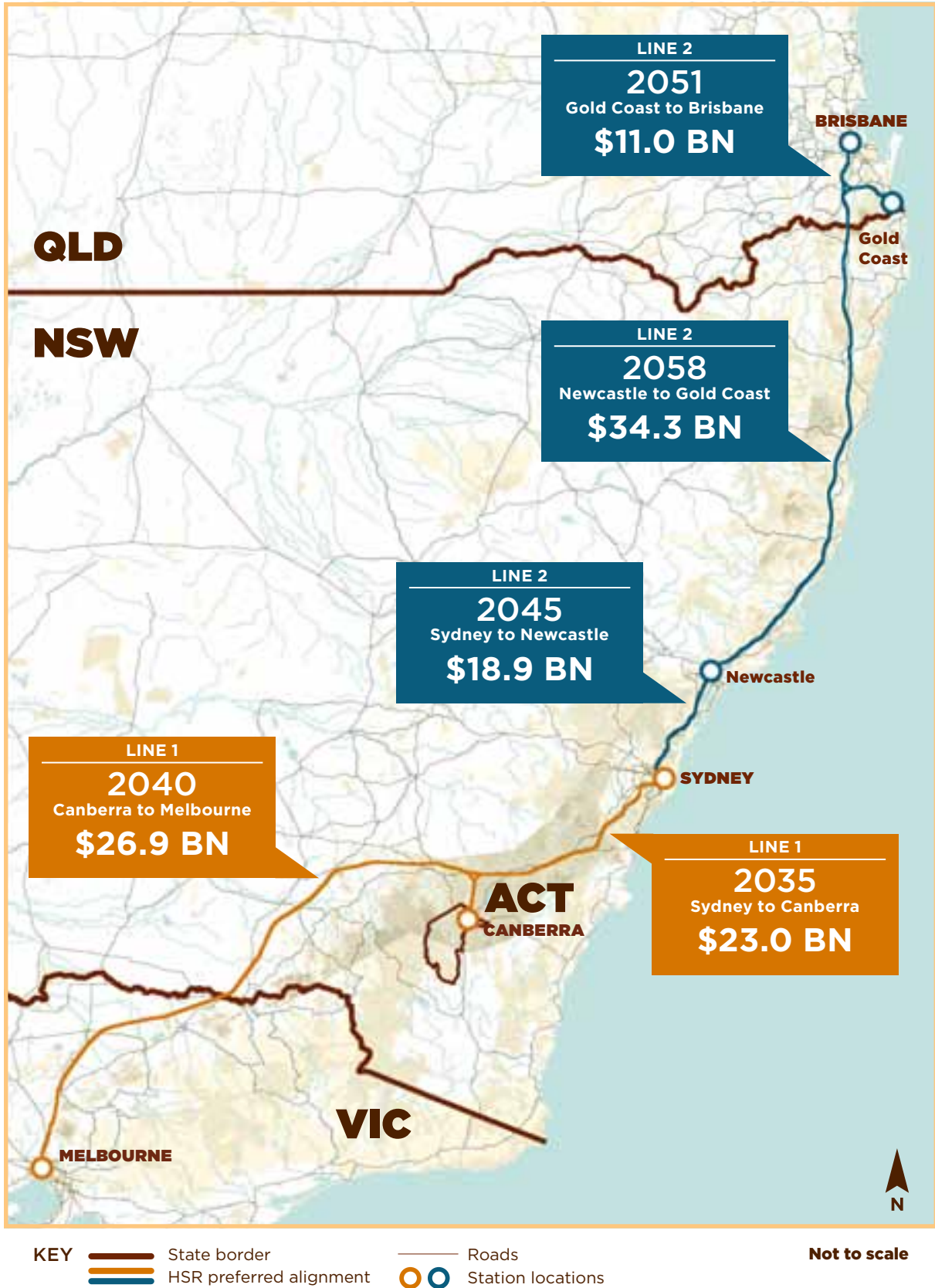
Staging the development of HSR

The size and complexity of an HSR system on the east coast of Australia would be such that it could not be delivered as a single project; instead, it would be delivered in stages linking the principal centres. Even these stages would be large projects by Australian standards. Staging would not only allow the upfront funding to be reduced and smooth future funding requirements, but would also better match system development to market growth and would allow revenue to be generated on sections of the system as they are completed.

The study has concluded that the benefits of HSR are strongly related to the volume of travel between the capital cities, in particular Sydney-

Melbourne, and that establishing this link would be the first priority for any HSR network on the east coast of Australia. At a construction cost of about \$50 billion in \$2012 (risk-adjusted), the Sydney-Melbourne line would represent a major undertaking and would itself need to be staged. Canberra, which would be connected by a spur line to the Sydney-Melbourne line, is the next most important city on this line from a demand viewpoint and would be an appropriate terminal for the first stage to ensure revenue would be generated as early as possible.

Figure ES-10 Staging of the preferred HSR system – commencement of operations



The staging of the preferred HSR system assumed in the financial and economic evaluations, as shown in **Figure ES-10** and **Table ES-7**, takes into account the extent to which individual sections capture the forecast market, the cost of construction and the economic and financial returns of each stage.

Table ES-7 Staging of the preferred HSR system

	Built track (km)*	Risk-adjusted cost (\$b)	Cost per km (\$m)	Potential operational date
Line 1 Sydney-Melbourne	894	49.9	56	2040
- Stage 1: Sydney-Canberra	283	23.0	81	2035
- Stage 2: Canberra-Melbourne**	611	26.9	44	2040
Line 2 Brisbane-Sydney	854	64.1	75	2058
- Stage 3: Newcastle-Sydney	134	18.9	141	2045
- Stage 4: Brisbane-Gold Coast	115	11.0	96	2051
- Stage 5: Gold Coast-Newcastle**	606	34.3	56	2058
Total	1,748	114.0	65	2058

* Note that the built track includes spur junctions and other connections. These distances are different from the travel kilometres in **Table ES-1** and **Table ES-2**.

** Construction of Stages 2 and 5 would start at the Canberra Junction and Gold Coast Junction respectively, the points at which the Gold Coast and Canberra spurs leave the main alignment.

Note: Totals do not add up exactly due to rounding.

Figure ES-11 Staging of the preferred HSR system – cumulative capital costs (\$2012, \$billion)

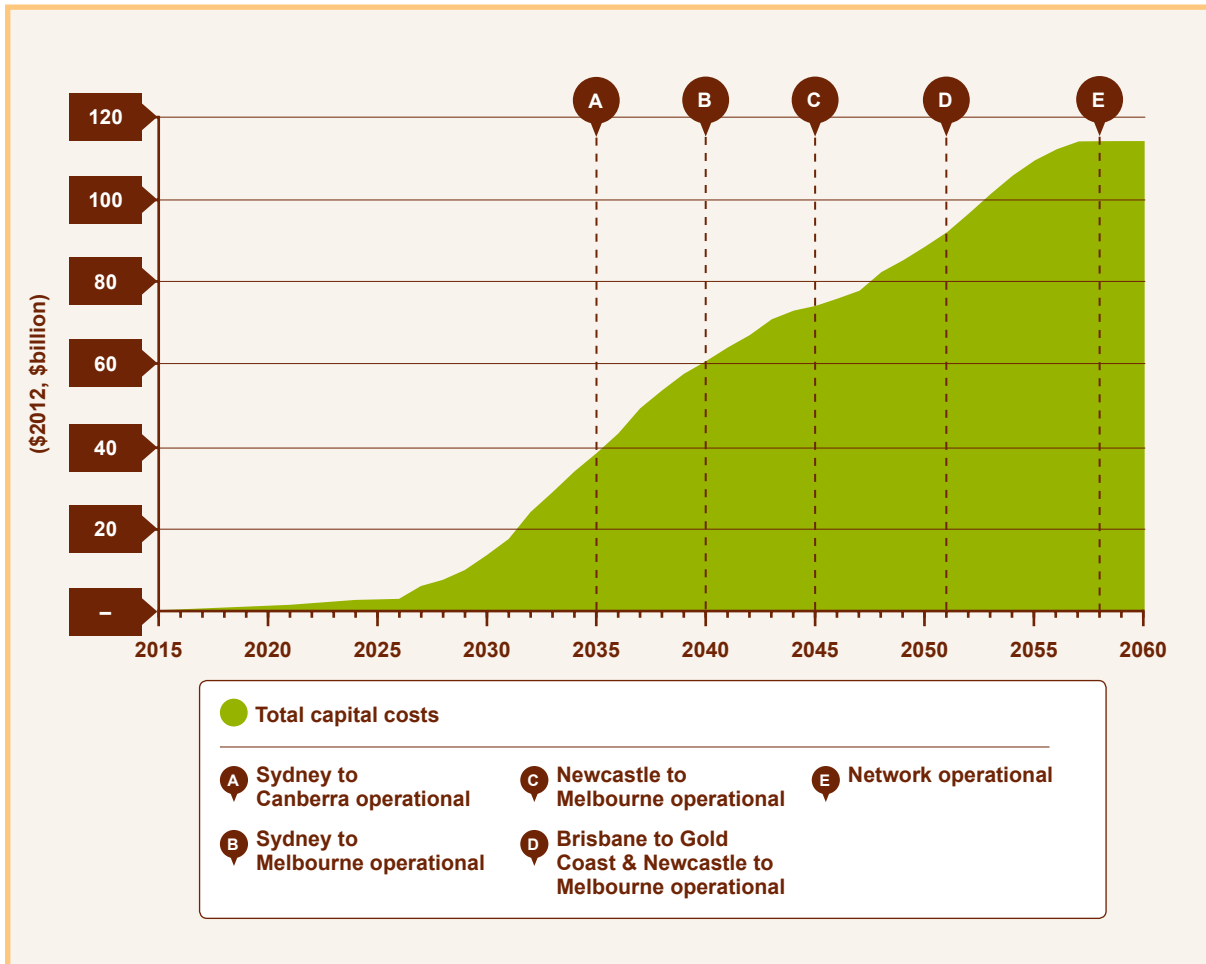


Figure ES-11 shows the profile of cumulative capital costs over the HSR program.

Line 1 between Sydney and Melbourne would be a major undertaking in terms of planning, construction, testing and commissioning and, based on current industry experience, would need to be done in discrete stages. For evaluation purposes, a start date of 2035 was assumed. Working back from that date, enabling legislation would need to be passed by 2019. Prior to 2019, the final preferred route and station locations would be determined, further technical investigations completed and all necessary government approvals obtained. Steps would also be taken to preserve the preferred HSR corridor prior to any commitment to proceed.

Following enabling legislation, a period of more than two years would be required for concept design, environmental impact assessment and public consultation, before a decision to proceed to implementation would be made in 2021. There would then be a procurement period of two to three years to let contracts and to acquire land. Enabling works would then be undertaken (critically at Sydney’s Central station). These works are anticipated to take four years to divert the current services within the existing operational station before the main implementation contracts could commence in 2027 (i.e. financial year 2028).

The implementation program of a further 84 months reflects the actual program to deliver the Taiwan HSR and includes a period of 34 months for testing and commissioning. Based on this evaluation program, the first public HSR services would start in April 2035. Subsequent stages would be delivered at five to seven year intervals, with planning of each stage overlapping with construction of the previous stage. Under these assumptions, the entire network could be in operation by 2058.

The staging assumed in **Table ES-7** could, however, be accelerated by about five years, although it would likely incur additional cost and risk. The time taken to pass the relevant legislation and to make a formal decision to proceed could be accelerated. The enabling works could also be started earlier, so as not to delay the commencement of implementation works at Sydney Central station; this would require funding in advance of the formal decision to proceed, but could save 18 months. There is also potential for the construction period to be shortened by as much as 24 months, but this would require extended working hours and could be limited by a lack of qualified resources. An accelerated program could therefore start with the Sydney enabling works in 2019, with Sydney-Canberra operational by 2030 and Sydney-Melbourne operational by 2035. Under this accelerated program, the full network could be operational by 2053.

Financial assessment

The future HSR program and the majority of its individual stages are expected to produce only a small positive financial return on investment.

The estimated real financial internal rate of return (FIRR) for the program as a whole is 0.8 per cent. For Sydney to Melbourne, the estimated (post-tax) real FIRR is 1.0 per cent. These fall well short of the financial returns that would be required by commercial providers of debt and equity to major infrastructure providers¹⁴. At a four per cent discount rate, the financial net present value (FNPV) of financial costs and revenues associated with an investment in HSR would be negative \$47 billion¹⁵. Governments would be required to meet the majority of construction and establishment costs for the HSR network.

Post construction, the future HSR program and its stages (with the exception of Sydney-Canberra as a stand-alone stage¹⁶) are expected to generate sufficient operating income to cover ongoing operational and asset renewal costs. This forecast holds true for all but one of the scenarios and sensitivities tested. As a consequence, HSR operations would be financially self-sustaining if traffic and cost assumptions were met.

Table ES-8 summarises the results of the FNPV and FIRR analysis on a pre and post-tax basis for the future HSR program and its stages. These are presented on a cumulative present value basis, with the summary costs and revenue obtained by discounting cashflows by the evaluation discount rate of four per cent to financial year 2028. Sydney-Canberra delivers a negative financial return. Neither the program as a whole, nor any of the stages, returns a positive FNPV at a four per cent discount rate.

14 These would typically be around 15 per cent or more.

15 Discounted to 2028 and in \$2012.

16 That is, if Sydney-Canberra was operated independently of any other HSR line.

Assumptions about the timing of the various stages are also shown in **Table ES-8**.

Table ES-9 sets out the summary of risk-adjusted capital costs, revenues, operating costs and asset renewals over the evaluation period to 2085. The HSR program as a whole delivers a positive net operating surplus. That is, for the preferred HSR system, revenues would cover ongoing

operating costs and the costs of renewing assets when they wear out. Therefore, provided traffic forecasts and costs estimates are met, no ongoing government subsidy would be required to sustain HSR operations once the system is constructed and operational. As traffic builds up, the ability of transport operations to return some of the capital costs would increase.

Table ES-8 Summary of FNPV and FIRR results (present value discounted to 2028, \$2012, \$billion, 4% discount rate)

	Future HSR program				
	Sydney- Canberra	Sydney- Melbourne	Newcastle- Melbourne	Brisbane- Gold Coast & Newcastle- Melbourne	Network complete ¹⁷
Year operations commence	2035	2040	2045	2051	2058
Total costs	20.9	41.1	52.8	58.3	72.0
Net operating result*	-0.4	10.5	11.6	11.3	15.5
FIRR (real)	n/a	1.0%	0.9%	0.4%	0.8%
FIRR (real, pre-tax)	n/a	1.4%	0.9%	0.4%	0.8%
FNPV	-21.5	-26.5	-35.2	-41.3	-47.0
FNPV (pre-tax)	-21.5	-25.0	-35.2	-41.3	-47.0

Notes: * Revenues less operating costs including payments for rolling stock leases and asset renewal. Due to accumulated tax losses (primarily from depreciation on the infrastructure asset base), only the Sydney-Melbourne HSR stage pays corporation tax during the evaluation period. Where tax is not payable, the FIRR and FNPV do not differ on a pre and post-tax basis.

'n/a' denotes an FIRR of less than zero per cent that cannot be mathematically calculated.

17 Network complete represents the entire HSR network between Brisbane and Melbourne.

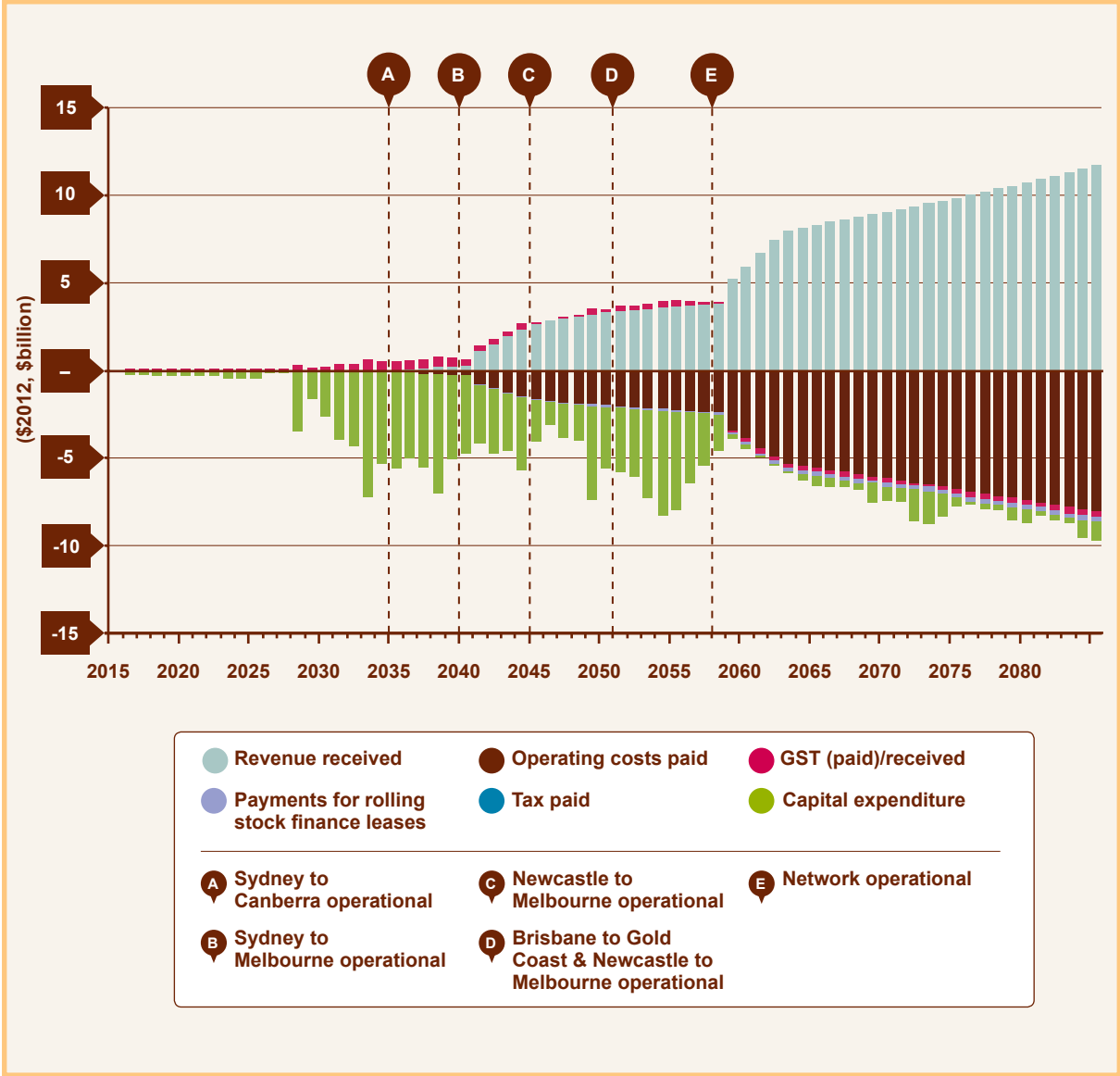
Table ES-9 Summary risk-adjusted capital costs, revenues, operating costs and asset renewals over the total evaluation period to 2085 (present value discounted to 2028, \$2012, \$billion, 4% discount rate)

	Sydney- Canberra	Sydney- Melbourne	Newcastle- Melbourne	Brisbane- Gold Coast & Newcastle- Melbourne	Network complete
Year operations commence	2035	2040	2045	2051	2058
Total development costs	2.3	4.7	6.1	6.8	8.8
Total construction costs	18.6	36.4	46.7	51.5	63.2
Total capital costs	20.9	41.1	52.8	58.3	72.0
Total revenue	5.0	39.4	43.0	43.5	62.7
Total operating costs	4.4	25.1	27.3	27.9	42.2
Total payments for rolling stock finance leases	0.1	1.3	1.3	1.3	1.8
Total asset renewals	1.0	2.5	2.8	3.0	3.2
Total operating result	-0.4	10.5	11.6	11.3	15.5
Terminal value	-0.2	4.0	5.6	5.4	9.1
FNPV	-21.5	-26.5	-35.2	-41.3	-47.0

Note: Total may not be exact due to timing and rounding differences.

Risk-adjusted project cashflows for each year of the evaluation period, reflecting the proposed staging of the HSR program, are shown in **Figure ES-12**. Total annual project capital expenditure ranges from \$2 billion to \$8 billion in each of the eight years prior to the opening of the Sydney-Canberra section in 2035, and then continues at between \$2 billion and \$7 billion per year for the next 23 years until the full network is operational in 2058.

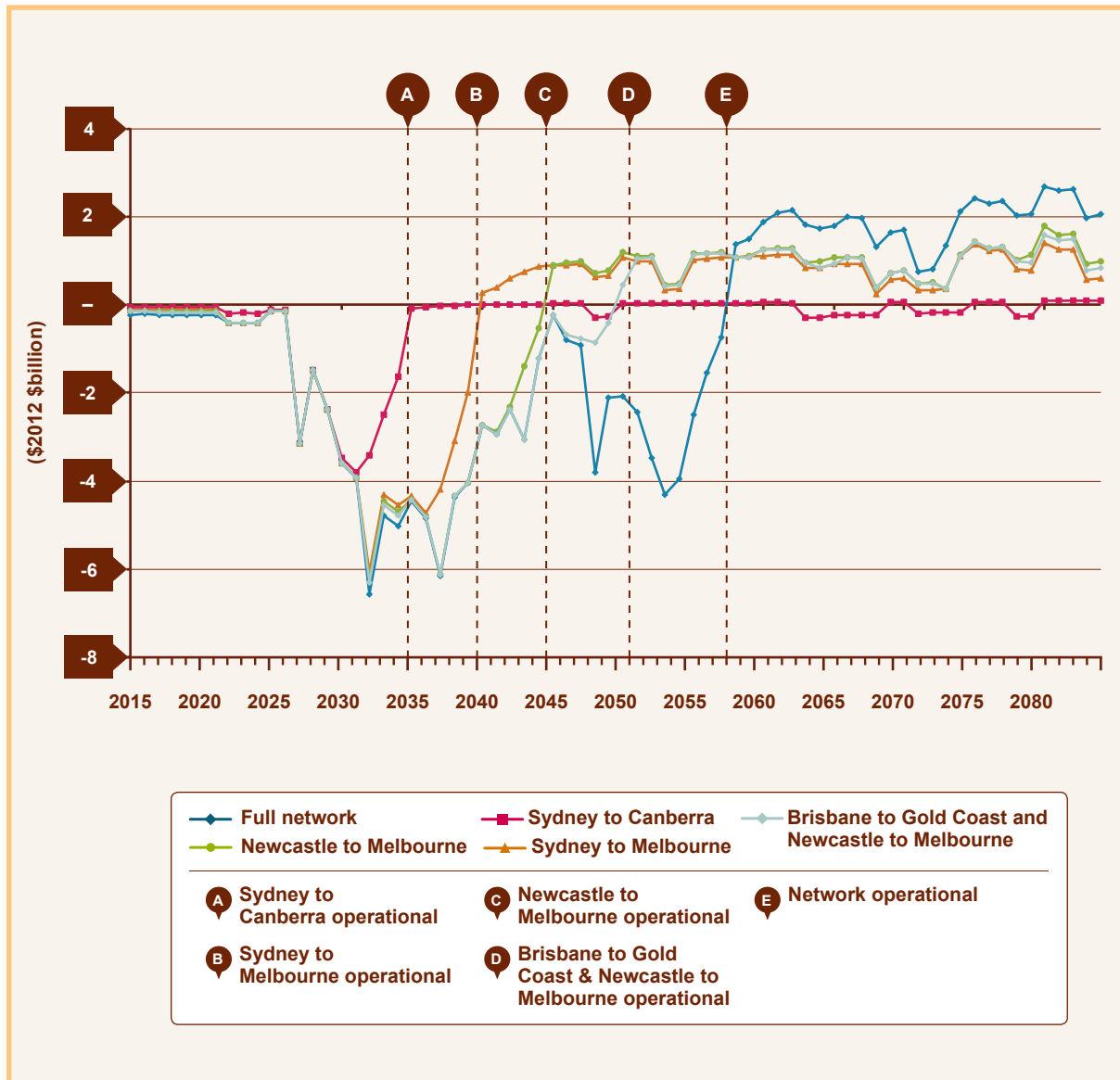
Figure ES-12 HSR program risk-adjusted project cashflows per year (\$2012, \$billion)



With the exception of the costs associated with accessing Sydney (as shown in **Figure ES-9**), capital costs increase broadly in proportion to the length of the HSR line being constructed. As indicated in **Figure ES-12**, extensions to the network lead to step changes in patronage and therefore are critical to the operating cashflows. For instance, completing Sydney-Canberra or Canberra-Melbourne as stand-alone segments would produce only moderate passenger demand and financial returns. When the whole line connecting Sydney-Melbourne is completed, significant additional demand would be generated

(passenger numbers at that point increase by a factor of five). Operating cashflows and returns then also improve, reflecting the growth in patronage without a correspondingly material increase in capital costs. The same benefit would be observed when the Gold Coast is connected to Newcastle and the full HSR system is in operation, resulting in a considerable uplift in demand between Brisbane, Sydney and Melbourne. The financial performance (annual cashflow) of each stage is summarised in **Figure ES-13**.

Figure ES-13 HSR program risk-adjusted cashflows per year by stage (\$2012, \$billion)



Due to the future HSR program’s expected low financial returns, significant private sector funding (debt/equity) would not be available or appropriate to finance the program. As such, a considerable commercial financing gap would exist between the total capital cost of the HSR program and the amount of financing that could be raised from the financial markets on commercial terms, based on the future HSR program operating cashflows.

Based on the detailed analysis of program cashflows, the commercial financing gap for the entire HSR program would be about \$98 billion (or 86 per cent of the total risk-adjusted capital cost) as shown in **Table ES-10**. For the Sydney-Melbourne line, the commercial financing gap would be about \$45 billion, or 92 per cent of the total capital cost.

Table ES-10 Summary of the commercial financing gap – reference case (\$2012, \$billion)

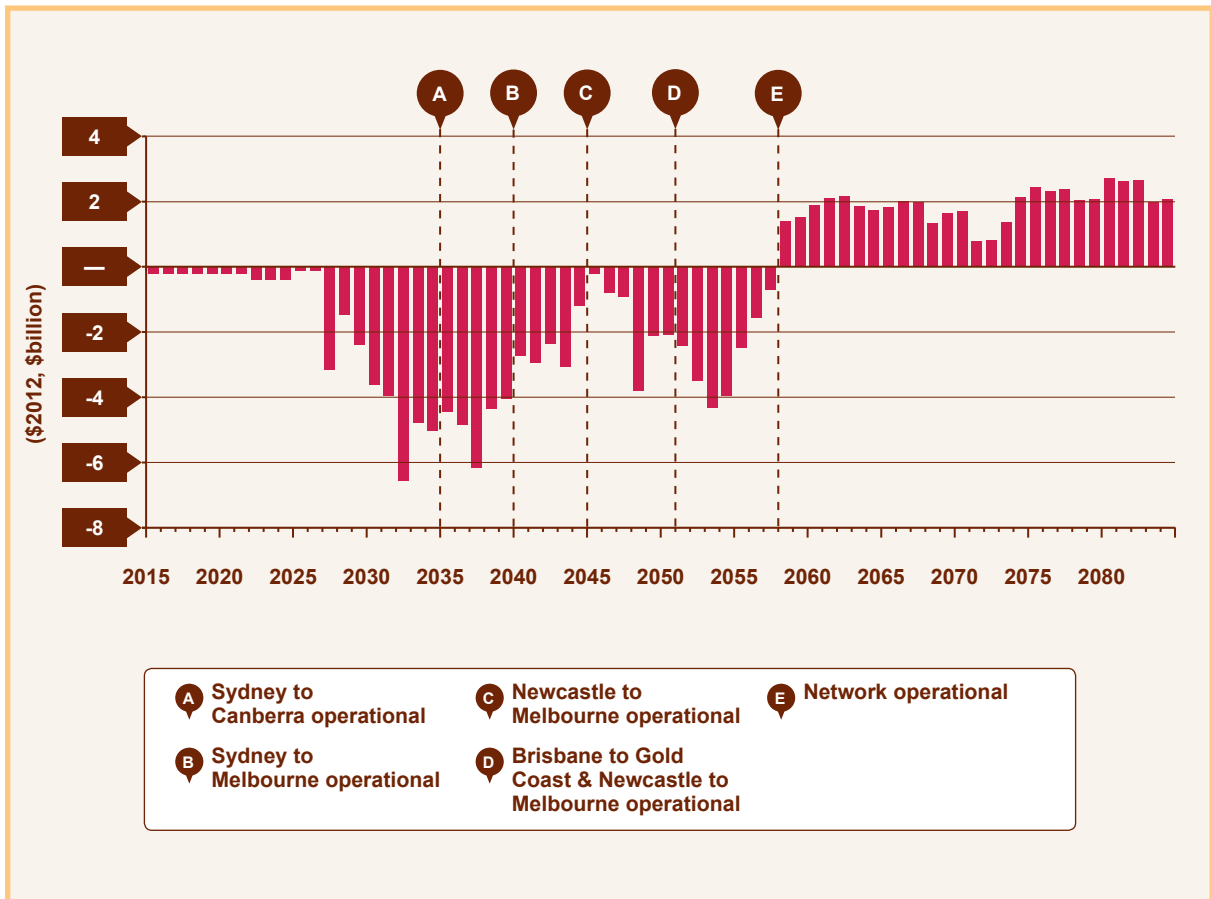
	HSR program	Sydney-Melbourne
Total capital cost	114.0	49.9
Debt carrying capacity	16.3	4.1
Commercial coverage	14%	8%
Commercial financing gap	97.7	45.7

Value capture has the potential to partially close the commercial financing gap through measures such as government land sales and capturing the incremental impact that the HSR program would have on stamp duty, developments and rates in the HSR affected zones. However, this would be a small contribution at best. It is highly unlikely that all of these measures would be implemented and the ultimate benefit that value capture might

have on closing the commercial financing gap is therefore difficult to determine at this stage.

Ultimately governments would be required to fund the majority of the future HSR program's upfront capital costs. A summary of the cashflow implications for government for the whole network is presented in **Figure ES-14**.

Figure ES-14 HSR program government cashflows (\$2012, \$billion)



Economic assessment

The study adopted a cost-benefit methodology that is conventionally applied to major transport infrastructure projects. The cost components of the analysis, including the necessary capital expenditure required to develop, construct and renew the HSR system as components wear out, depend on the proposed HSR engineering and technical specifications adopted for the preferred HSR system and on the assumed staging of network development set out in **Table ES-7**.

For the purposes of evaluation, construction of stage 1 of Line 1 (i.e. the Sydney-Canberra stage of the Sydney-Melbourne line) is assumed to start in July 2027 (start of financial year 2028).

Once constructed, the HSR system would generate a stream of economic benefits, linked to the assessment of future travel demand. In general terms, the total economic benefit of travel on HSR would depend on how much each passenger values their trip, often termed their 'willingness to pay'. This is calculated by measuring the differences in generalised trip costs when comparing the reference case (with HSR) to the base case (without HSR). Aggregating willingness to pay across all users of HSR and over time provides an assessment of the total (gross) economic value created for users of the system by the investment in a future HSR program.

Transporting passengers consumes economic resources such as labour and fuel. Because HSR could reduce demand for other modes of transport, and hence their consumption of resources, the additional resources required for HSR need to be offset against the resources avoided in other modes. The net change in resources is deducted from the gross economic value to calculate the stream of economic benefits derived from the investment in HSR.

The distribution of the net benefits between the users and the operator(s) of the HSR system is determined by the prices charged. Ultimately, prices would serve to transfer economic value from users of the system to its operators. Revenue is therefore included in the calculations (as a cost to users and a benefit to operators) to assess the relative benefits to users and operators.

The net economic benefits internal to the transport system are therefore measured by adding the two components:

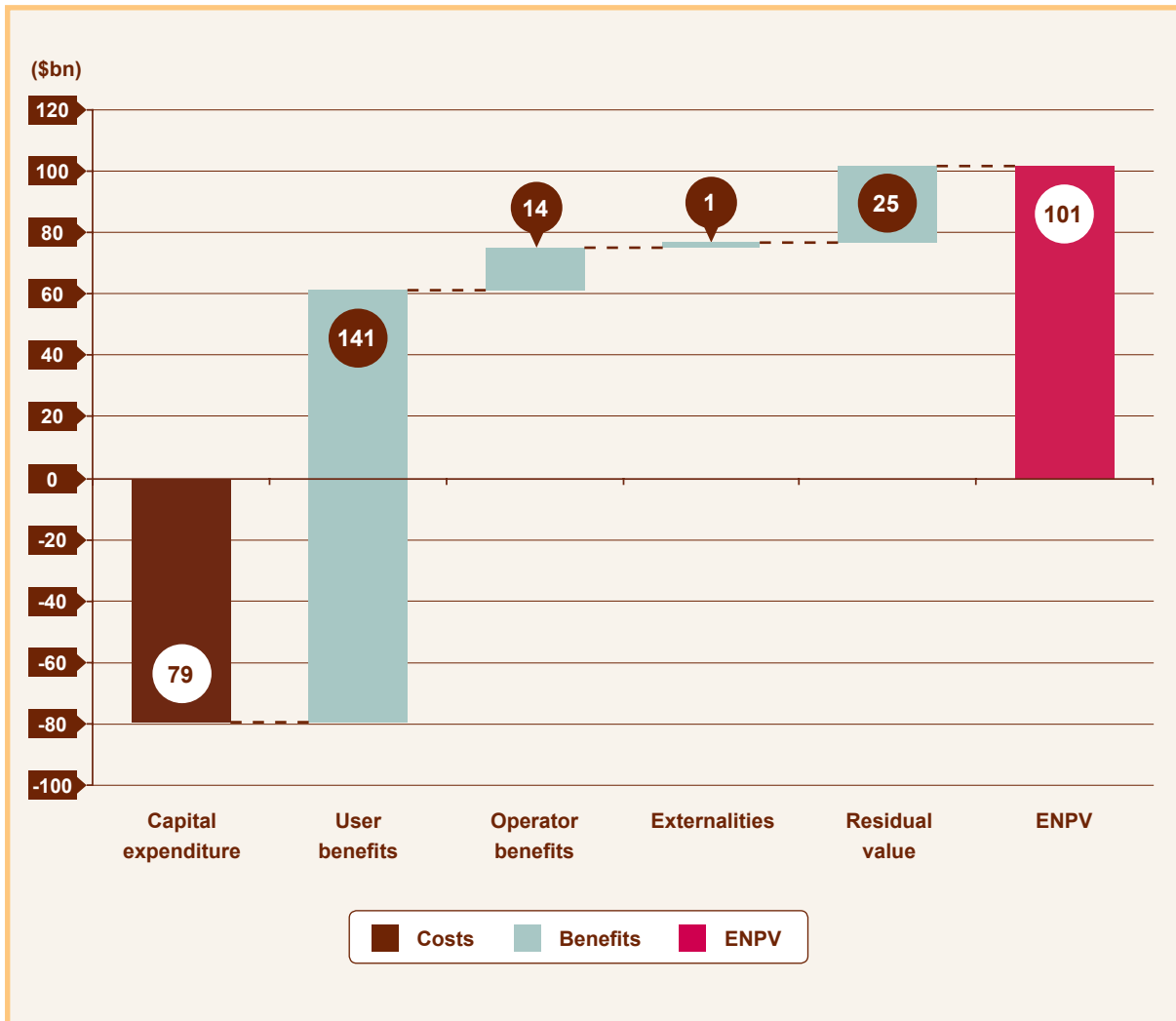
- User benefits (or consumer surplus) are calculated based on the difference between a user's willingness to pay for a service and the actual price paid.
- Operator benefits (or producer surplus) represent the difference between the price paid or revenue generated by a service and the costs associated with (or resources consumed by) operating the service. The change in operator benefits is assessed for each mode (i.e. HSR, aviation, conventional rail and coach).

In addition, there would be costs and benefits that are external to the transport system that can be measured in monetary terms and included in the cost-benefit analysis. These externalities measure the impact of HSR to the broader community, including environmental and safety impacts, decongestion benefits and any alternative avoided or deferred transport network capital expenditure. A residual value has also been included to capture the remaining value of the assets at the end of the evaluation period¹⁸. The present values of costs and benefits by category, discounted at four per cent, are shown in **Figure ES-15**¹⁹. The economic net present value (ENPV) is the sum of the present value of the economic costs and benefits, which for the program as a whole is \$101 billion.

¹⁸ A 50 year evaluation period has been adopted, commencing in 2035.

¹⁹ The discount rate converts cashflows of future costs and benefits into present day dollars to allow a comparison of costs and benefits, expressed in \$2012, and using a common base year, in this case financial year 2028, which is the assumed start of construction of the first stage.

Figure ES-15 Present value of costs and benefits for the HSR program (present value discounted to 2028, \$2012, \$billion, 4% discount rate)



The HSR user benefits dominate the economic results and account for 90 per cent of the estimated benefits (excluding the residual value). A key component is the assessment of time savings for travellers across their full journey including travel time, waiting time, check-in time and access time, with adjustments for the inconvenience of having to change modes. Travel time savings are measured using values of time based on market research conducted for this study and tested for reasonableness against conventional values used in road projects, which vary by trip purpose (e.g. business versus leisure)²⁰.

Business travellers would gain the majority of user benefits due to their higher value of time, even though they only represent about 35 per cent of the total HSR travel market, as shown in **Table ES-11**.

20 Austroads, *Guide to Project Evaluation*, 2012.

Table ES-11 User benefit estimates by market segment (present value discounted to 2028, \$2012, \$billion)

	Business users	Leisure users	Total
Short regional	1.7	7.4	9.1
Long regional	31.3	27.1	58.4
Inter-city	60.6	12.6	73.2
Total	93.6	47.1	140.7

The summary results for the reference case predict that an investment in the preferred HSR program would generate an economic internal rate of return (EIRR) of 7.6 per cent and an economic cost-benefit ratio (EBCR) of 2.3 using a four per cent

discount rate²¹. A seven per cent discount rate has also been tested and would reduce the ENPV to \$5 billion and the EBCR to 1.1, as shown in **Table ES-12**; although marginal, the estimated economic benefits remain positive.

Table ES-12 Summary economic indicators for the HSR program (present value discounted to 2028, \$2012, \$billion)

	4% discount rate	7% discount rate
Total costs	79.3	58.9
Total benefits	180.6	63.8
EIRR	7.6%	7.6%
ENPV	101.3	4.9
EBCR	2.3	1.1

Sydney-Melbourne is the strongest performing line, with an estimated EIRR of 7.8 per cent, as shown in **Table ES-13**. It has an estimated positive ENPV of \$69 billion and an EBCR of 2.5 when measured on a stand-alone basis.

Table ES-13 Summary economic indicators for Sydney-Melbourne (present value discounted to 2028, \$2012, \$billion)

	4% discount rate	7% discount rate
Total costs	46.5	38.9
Total benefits	115.7	45.3
EIRR	7.8%	7.8%
ENPV	69.3	6.5
EBCR	2.5	1.2

Note: Totals do not add up exactly due to rounding.

21 The EIRR represents the discount rate that makes the net present value of all economic cashflows equal to zero. The higher the EIRR the greater the net economic returns achieved by a project relative to its capital resource costs and if EIRR is greater than the discount rate, then the project would deliver a positive net economic benefit.

The incremental economic results for each additional stage of the preferred HSR program are set out in **Table ES-14**. The results support the preferred staging of the HSR program, with Sydney-Melbourne delivering an estimated EIRR of 7.8 per cent. The subsequent northern stages

from Newcastle-Melbourne and Brisbane-Gold Coast add little incremental economic value on a stand-alone basis (i.e. ENPV does not materially change) and the results suggest they would not be undertaken unless the intention were to complete the line connecting Brisbane and Sydney.

Table ES-14 Incremental economic impacts for each additional stage of the HSR program (present value discounted to 2028, \$2012, \$billion)

	Future HSR program				
	Sydney- Canberra	Sydney- Melbourne	Newcastle- Melbourne	Brisbane- Gold Coast & Newcastle- Melbourne	Network complete (i.e. Brisbane- Melbourne)
Year operations commence	2035	2040	2045	2051	2058
Total costs*	22.2	46.5	58.6	64.3	79.3
Total benefits	20.4	115.7	126.7	126.7	180.6
EIRR	3.8%	7.8%	7.3%	7.1%	7.6%
ENPV	-1.7	69.3	68.1	63.9	101.3
EBCR	0.9	2.5	2.2	2.0	2.3

* Costs include rolling stock and asset renewal costs.

Overall, the results of the analysis present a positive economic case for the introduction of HSR. Forecasts were prepared for the reference case (i.e. with HSR) which was part of the central case for evaluation purposes. The reference case reflects a range of long-term assumptions and expectations, including:

- Strong growth in the base travel market over the 52 years to 2065 (travel on the east coast will more than double from 153 million trips to 355 million trips).
- No significant increase in aviation capacity in the Sydney basin. This results in increased delays and the inability of passengers to travel at preferred times, consistent with assumptions in the Joint Study on Aviation Capacity for the Sydney Region²². Assumed additional aviation capacity in Sydney has the effect of reducing the estimated EIRR for the HSR program as a whole from 7.6 per cent to 7.1 per cent and reducing the EBCR from 2.3 to 2.1. Additional aviation capacity also reduces the financial return from 0.8 per cent to 0.3 per cent.

- HSR fares would be structured to be comparable to and competitive with alternative modes of transport for both business and leisure purposes. HSR fares have been set to be competitive with air fares on the main inter-capital routes on the east coast, trending downwards over time by 0.5 per cent per year to 2015 and remaining constant thereafter, consistent with the forecast reduction in real air fares. Car operating costs increase over time due to a forecast real increase in the cost of fuel (13 per cent real increase by 2065 after allowing for forecast improvements in fuel efficiency).
 - If HSR fares were increased by 30 per cent, the EIRR for the program as a whole would reduce to 7.4 per cent. However, the financial return would improve from 0.8 per cent to 2.3 per cent, with operating cashflows becoming positive three years earlier in 2038.
 - If HSR fares were increased by 50 per cent, economic returns would fall further but HSR would still produce substantial net economic gains, with an EIRR of 7.2 per cent and an EBCR of 2.1 (at a four per cent discount rate). The financial return would improve further to three per cent.

Competitive aviation response

The study predicts that over half the 83.6 million HSR trips forecast in 2065 would be diverted from air, which would have a significant impact on aviation markets.

Airline services are mobile in the sense that there are few significant sunk capital costs in servicing particular routes and assets can be quickly redeployed to other routes. Airlines operating along key regional and inter-capital routes across the east coast of Australia already compete strongly against each other, and fare levels of many fare classes have declined over time, which suggests that airfare levels are already highly competitive on major routes.

It is not expected that airlines would respond to HSR competition by reducing their fares on a sustained basis. Rather, it has been assumed that airlines would quickly reduce capacity, either by reducing frequencies or aircraft sizes, to locations within the HSR corridor where there is significant passenger diversion to HSR. This assumption is consistent with overseas experience where, following the introduction of HSR, the airline response has generally been to reduce services on the competitive route.

Airlines do not control all of the components of an end to end journey by air that influence the relative competitiveness of air travel and HSR travel. Most important of these are the cost of accessing the airport, its location relative to HSR stations and airport capacity. Nevertheless, to the extent that airlines are able to innovate in ways that have not been anticipated in this study, it could have an impact on actual HSR patronage.

A low demand/high cost sensitivity was developed that included a range of alternative assumptions which in combination result in a set of circumstances unfavourable to HSR. The low demand/high cost scenario includes:

- No aviation capacity constraints in Sydney.
- A 30 per cent increase in pre-risk capital costs.
- Low population growth and low economic growth.
- A 50 per cent increase in HSR fares.

While the combination of these assumptions may be unlikely, the results of the analysis provide a useful basis for comparison and an understanding of the economic performance of the HSR program. The combination of assumptions significantly reduces the economic return generated by the future HSR program from 7.6 per cent to 3.8 per cent. The impact on the financial return is, however, modest with the higher costs offset by the large fare increase.

The economic and financial results were tested against a range of sensitivity tests, with the results summarised in **Figure ES-16** and **Figure ES-17**:

- The low growth scenario assumes lower economic and population growth (relative to the reference case) resulting in lower overall demand for transport and thus lower demand for HSR. It assumes per capita GDP growth rates are assumed to be 0.3 per cent per year lower than the reference case, and population growth is assumed to be 51 per cent between 2010 and 2065, compared to 72 per cent in the reference case.
- The high growth scenario assumes that the Australian economy experiences strong growth into the future (high GDP growth), with high population growth. This scenario results in higher overall demand for transport and thus higher demand for HSR. Per capita GDP growth rates are assumed to be 0.3 per cent per year higher than in the reference case, and population growth is assumed to be 103 per cent between 2010 and 2065, compared to 72 per cent in the reference case.
- Higher (+30 per cent and +50 per cent) HSR fares.
- An aggressive competitive aviation response which results in a 50 per cent reduction in fares for two years.
- Additional aviation capacity within the Sydney region, which removes the negative effects of travel time on flights to/from Sydney from the reference case, and assumes there is no unmet demand.
- Additional aviation capacity within the Sydney region, combined with 30 per cent increase in HSR fares.
- Low demand and high costs (described above).
- Mode choice model sensitivities (including alternative specific constants (ASCs), access/egress weighting and values of time).
- Higher (+30 per cent) capital and operating costs.
- Lower (–10 per cent) capital and operating costs.

Figure ES-16 Impact of alternative assumptions on the economic results (EIRR)

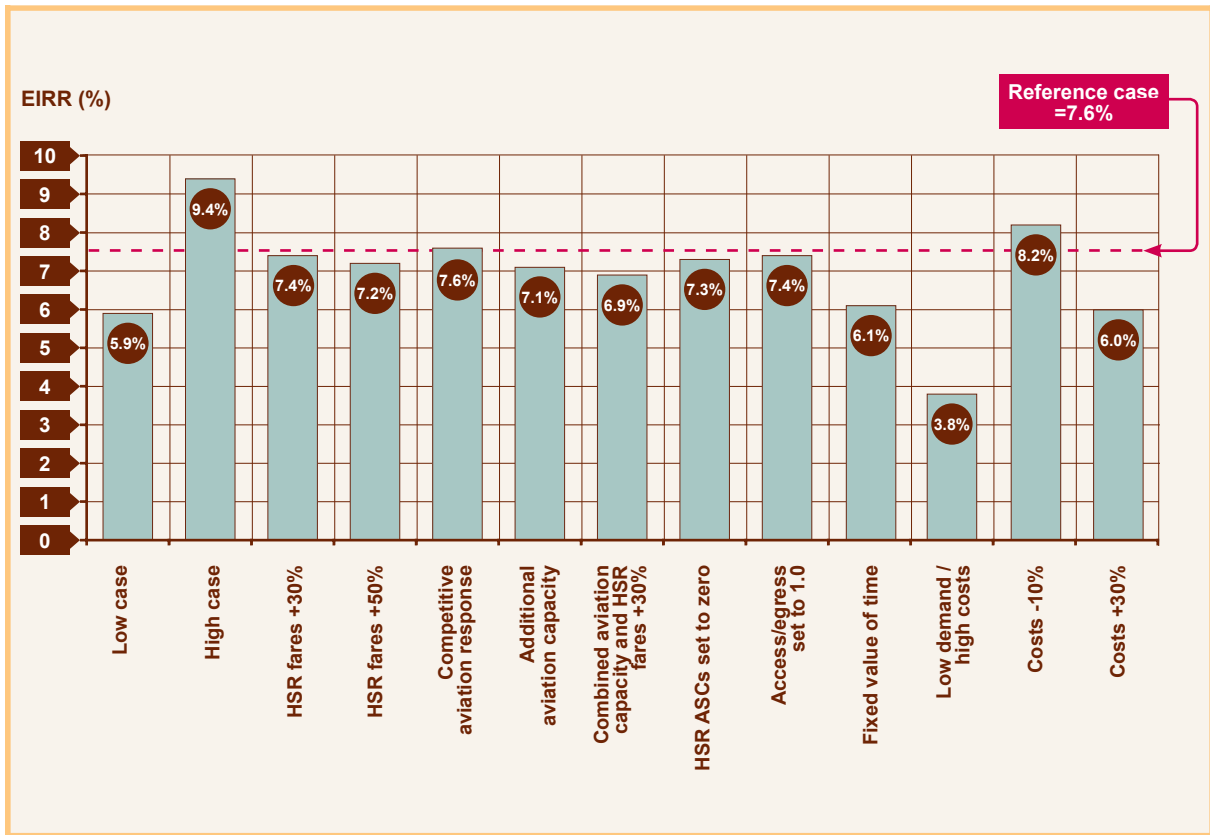
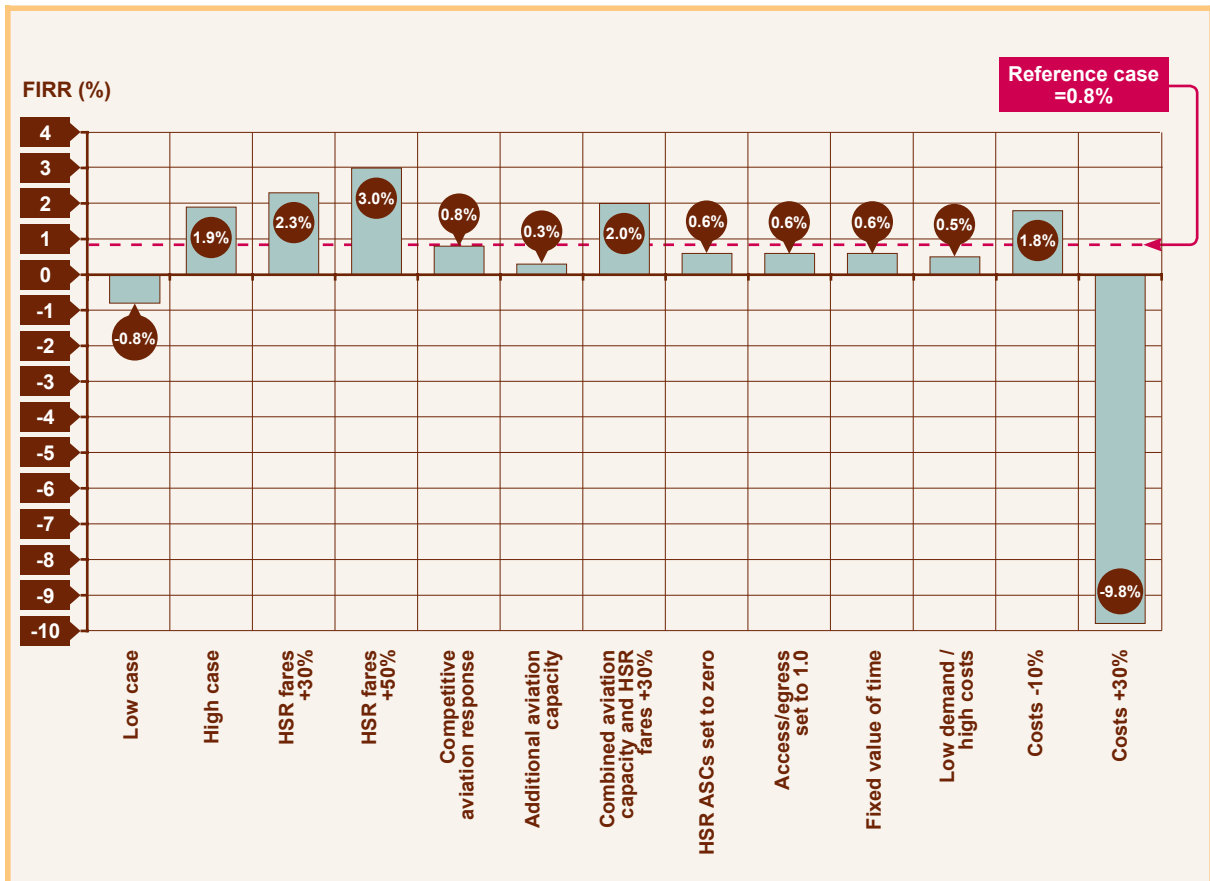


Figure ES-17 Impact of alternative assumptions on the financial results (real FIRR post tax)



Environmental and social assessment

A strategic environmental assessment framework, consistent with Australian Government guidelines, was developed and its key principles incorporated into the selection of the preferred alignment and station locations to reduce the potential for negative environmental impacts should there be a decision to proceed with HSR.

A preliminary strategic assessment of the environmental and social aspects of a HSR system on the east coast was undertaken for three reasons:

- To ensure that environmental factors were integrated into the development of the HSR system, including decisions about the corridor selection, alignment, station locations and design features.
- To ensure that the overall HSR system is consistent with principles of ecologically sustainable development.
- To identify important environmental and social issues to be further investigated and assessed in the implementation phases, should a decision be made to proceed with HSR.

The assessment of the environmental impacts of HSR was integrated into the evaluation of alignment options and station options, using a Geographic Information System (GIS) toolkit to identify potential ecological and heritage interactions and land use planning constraints and opportunities associated with the various options. These evaluations were combined with other considerations, such as engineering parameters, constructability, cost and user benefits to determine the preferred alignment and station locations.

The preferred HSR alignment and stations were selected to avoid, wherever possible, significant impacts on communities and ecological and heritage resources. Residual impacts would be managed by mitigation strategies developed during the concept and detailed design phases of HSR development, should a decision be made to proceed with HSR. This is a standard practice for large infrastructure projects. Where necessary, offsets for natural environments could also be used.

In addition, the assessment of environmental issues associated with HSR has addressed noise and vibration, energy use and carbon emissions/greenhouse gas considerations, the implications of climate change, and the promotion of ecologically sustainable development (ESD). Additional detailed investigations would be required across each of these disciplines, should governments decide to proceed with HSR, to minimise the environmental impacts and maximise potential positive outcomes.

The social impacts have been canvassed through theme-based case studies into three key areas identified through research and stakeholder consultation:

- a. Workforce and community development.
- b. Access to health and other public services.
- c. Tourism, recreation and social inclusion.

The case studies highlight that HSR could potentially have a range of both positive and negative impacts.

Broader impacts of HSR

Impacts on regions

International evidence demonstrates that HSR can contribute to, but is not always a cause of, regional development. Implementation of HSR would significantly improve accessibility between capital cities and regional centres and would provide the potential for significant regional economic development. However, the extent to which regional towns and cities served by HSR take advantage of that potential would depend on:

- Supportive and aligned regional development policies at the Commonwealth, state and local levels.
- The availability and appropriate application of investment.
- Metropolitan and regional planning policies that encourage and support new development in regional centres with HSR stations.
- The timing of HSR opening in relation to broad economic trends.

Robust and pragmatic planning would be required to determine how these initiatives should be developed and what outcomes should be pursued. In part, they are associated with the nature and scale of the proposed HSR network and require forecasting responses and conditions many years into the future. They are also uncertain, however, because they would require responses from outside the transport sector. They would need businesses to change how they operate, investments to switch to new locations, and tourists to change their travel patterns.

An investment of the magnitude and nature of HSR could also have unintended consequences and impacts, such as causing small regional cities to lose jobs and residents to nearby regional centres with HSR stations. These negative impacts would need to be managed through effective regional development policies, early and careful planning to position local businesses for change, and appropriate human and capital investment in complementary assets.

To gain positive and sustained benefits from HSR, regional communities along the corridors would need to follow deliberate strategies. HSR is not a panacea for regional development but, when coupled with appropriate strategies and plans, it could have a positive impact on regional communities over time.

In examining the potential impacts of HSR, the inherent uncertainties need to be acknowledged. However, with proactive and positive responses from key stakeholders, the implementation of HSR could result in improvements in regional productivity, changes to tourist spending patterns and, for regions closer to the capital cities, changes to commuting patterns. Emerging international evidence suggests that wider economic impacts at the regional level may be generated by regional accessibility improvements, though quantitative estimates of these are considered neither sufficiently certain nor robust for inclusion in the main economic assessment.

Impacts on cities

HSR could have wider economic impacts on cities through its impact on effective employment density, that is, by bringing places of residence and employment closer together by a reduction in travel times. Benefits can then arise in a number of ways:

- It is easier to match workers to specific vacancies and to find employees with appropriate skills.
- It enables greater specialisation of supply, leading to more efficient production of goods and provision of services.
- It leads to knowledge spill-over (i.e. greater opportunities for formal and informal contact through increased accessibility).
- Employees have a greater choice of jobs.
- There is more competition between companies and between individuals.

As the HSR system is constructed, accessibility to major cities from areas such as the Central Coast (to Sydney) and the Gold Coast (to Brisbane) would improve, allowing employers to access a larger labour pool and providing employees with a wider choice of employers. Internationally, positive economic benefits have been attributed to such impacts, so called agglomeration benefits, and included in the quantitative assessment of the benefits of investments in transport infrastructure. However, as noted above, because of the uncertainty of these effects in the current context, no adjustments to the economic returns have been made for them in this study.

Impacts on the national economy

Although the majority of benefits of HSR would accrue to users of the system, HSR would have a positive net impact on the size of the national economy, with GDP estimated to be 0.1 per cent higher relative to the baseline in 2085.

HSR would also raise the overall level of investment in Australia. In 2036, HSR investment would represent 0.8 per cent of aggregate investment in the economy, and would average around 0.4 per cent during the construction period as a whole. The assumption that HSR would be financed domestically means that, to accumulate

the required HSR capital stock, some of Australia's pool of investment would be channelled into HSR instead of elsewhere. This investment substitution effect produces a negative impact on the economy, since it assumes that investment would be diverted away from sectors with a higher financial return than would be achievable for HSR (which is projected to achieve only a 0.8 per cent financial rate of return on capital invested), lowering Australia's average return on investment. Other things being equal, and in the absence of higher productivity benefits generated by HSR, this would lower consumption and GDP. However, business travel time savings generated by HSR are estimated to increase labour productivity, which over the long term drives gains in GDP, offsetting the negative investment impacts.

The investment impacts of HSR would be different if it were assumed to be financed by borrowing from foreign sources. There would be less crowding out of higher return capital, but costs involved with servicing the foreign debt would be incurred.

Real consumption is estimated to decrease during the construction of HSR (until around 2056). Post 2056, real consumption begins to increase relative to the baseline as benefits start to flow from the operation of HSR. As investment in HSR tails off and productivity gains flow from the operational phase, resources can be redirected to other investment uses and to consumption, and national income (moving closely with GDP due to the assumption of domestic financing) begins to increase and move above the baseline.

Similarly, the investment substitution effect means that HSR would impact each of the Australian states in different ways. All else being equal, an increase in investment in one state, for example, would result in a reduction in the level of investment across the remaining states. In the case of HSR, the impact on each state reflects the strength of investment in and operation of HSR, and the concentration of industries that compete for HSR inputs within each state.

Based on these assumptions, NSW/ACT is expected to be the primary beneficiary state from HSR due to the substantial investment it receives.

The expansion in NSW/ACT's GSP would come at a cost to the other states, which would share the burden of reduced investment in other sectors. Productivity gains are also expected to be concentrated in NSW/ACT, although there would still be sufficient gains in Victoria and Queensland to yield a positive GSP impact.

The construction of HSR draws labour into NSW/ACT and away from other states. The assumed constraint on labour supply means that the bulk of the expansion in construction sector labour requirements in NSW/ACT would have to be offset by contractions in other sectors, leading to varying impacts on employment by state similar to impacts on GSP by state, but with less intensity.

While beyond the scope of the modelling, alternative funding arrangements involving a different sharing of the financing of HSR would clearly alter the pattern of gains and losses in different regions.

Implementing a future HSR program

Roles of the public and private sectors

The Australian Government, ACT Government and relevant state governments would need to have a central role in the development of HSR. This would be due both to its strategic nature and to the fact that the Australian public would have to fund most of the infrastructure. Governments would own the infrastructure and would have an obligation to ensure that it was efficiently and effectively provided and used.

With an initial capital cost in excess of \$100 billion, a future HSR program would be one of the largest infrastructure programs ever undertaken in Australia. Its size would challenge the resources of the supplier industry, both domestically and globally, with only a limited number of organisations having the financial capacity and depth of skills and resources available to compete for the likely size of works packages. To achieve value for money, governments would need to carefully package and stage the procurement to ensure competitive bids were achieved for

each package. Government would need to retain some of the risks around the integration of the component parts, but these risks could be mitigated through rigorous technical oversight.

Governments would retain an ongoing role in the stewardship of the HSR sector after construction, to ensure the objectives and economic benefits of the HSR program were achieved. This role would involve providing oversight of the delivery of HSR services against agreed price and service quality metrics, while being careful to avoid constraining the market agility and innovation of those managing the transport services. Governments would also be responsible for safety and environmental compliance.

The private sector should be closely involved in a broad range of roles:

- Design and construction of components of the HSR infrastructure network under contract to governments.
- Development of station precincts in partnership with the relevant government.
- Supply of rolling stock (train sets) and the signalling and communications systems.
- Control and operation of HSR trains to deliver high standard transport services to the public.
- Maintenance of the HSR system.

Development of HSR stations, and associated commercial opportunities, would offer an opportunity for private finance. A public-private partnership model is envisaged for greenfield station developments, with the private sector partnering with the relevant state or territory government for CBD station developments.

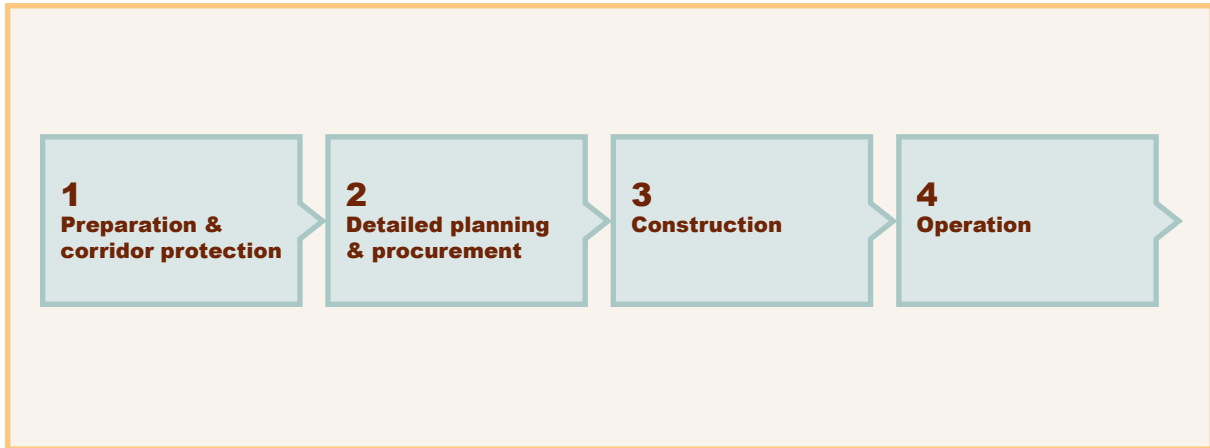
Under the preferred model, HSR train services would be contracted to a private sector operator through one or more concession arrangements. There would be separate concessions for Line 1 and Line 2, each being a combined exclusive concession for inter-capital express and regional services on that route, although a single operator would not necessarily be precluded from operating both concessions. The concession holder(s) would operate the train services, control the movement of trains through the network and maintain the HSR network.

The preferred model for Australia has common elements with many of the world's HSR lines, although overall it is perhaps closest to the Japanese model for new HSR lines. In Japan, a single state-owned entity (JRJT) is responsible for the development and strategic management of the HSR network, but operation of train services, control of the movement of trains and maintenance of lines is carried out by (mainly) private sector train operating companies serving particular high speed routes on an exclusive basis, for which they pay JRJT a fee for use of the line.

Delivering the public sector components of a future HSR program

If adopted, a future HSR program would be developed in discrete phases, starting with initial feasibility studies and investigations, leading on to construction and operation of the HSR system. Four separate phases can be identified, as illustrated in **Figure ES-18**.

Figure ES-18 Four phases of the HSR program



The first phase in a future HSR program would be a preparation and corridor protection phase, which would precede a formal commitment to build the HSR system. This phase would provide the necessary policy foundation for the procurement, construction and operation of a future HSR program. It would require alignment between the participating governments on the program objectives, mechanisms and timeframes for resolving issues, and the delivery of enabling regulation or legislation.

The proposed model for pursuing multi-jurisdictional agreements of the type needed to support the HSR program is to adopt a ‘gated approach’ using a series of formal agreements. Each formal agreement in the process would need to be in place prior to progressing to the next stage, ensuring alignment of governments at critical milestones. The first gate would be a Memorandum of Understanding (MoU) between the Australian, ACT and state governments to formalise the engagement on the HSR program and to set out the responsibilities of the parties, the process to be followed and the timelines for resolving issues. Subsequent gates would involve formal inter-governmental agreements (IGAs), first to protect an HSR corridor and later to develop and implement a stage or stages of HSR.

Once there is a mandate to implement a preferred HSR system, a publicly-owned HSR development authority (HSRDA) would be created to develop, procure and integrate the HSR system, including procuring and owning the required land. A single coordinating authority, with appropriate professional management expertise, would be required to effectively and efficiently progress the detailed planning required to develop and procure an HSR system (the HSRDA would later evolve into an HSR development and management authority in the operational phase, and would prepare and manage train operations concessions). The HSRDA could be owned jointly by the Australian Government, ACT Government and relevant state governments.

Next steps

If it were decided that the case for HSR on the east coast of Australia has sufficient merit for further government action to be taken, there are a number of immediate next steps in the process that could lead to a decision to protect the HSR corridor and possibly to a decision to implement HSR.


The immediate next step following completion of the HSR study is to confirm the Australian government's interest in continuing the necessary preparatory works to inform a formal ministerial decision to proceed.

Following a decision to proceed, an MoU would be signed to allow planning and development work, including corridor protection, to commence. Governments would need to commit resources and funding to the development and delivery of the arrangements under the MoU.

The MoU would initiate a number of activities, including site investigations necessary for corridor protection and preparation of the IGA to protect the HSR corridor. The aim of the IGA would be to formalise the commitment to the protection of the HSR corridor by rezoning, resuming, purchasing or holding land within the corridor.

A blurred landscape photograph. The foreground is a vibrant green field, possibly a meadow or agricultural land. The background features a clear blue sky and a large, dark, blurry shape that could be a tree or a distant structure. The overall image has a motion blur effect, giving it a sense of movement and depth.

1

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1

Introduction

Population and employment growth will continue to challenge the capacity of existing transport networks and public infrastructure along the east coast of Australia over the coming decades¹. Travel on the east coast of Australia is forecast to grow steadily at around 1.8 per cent per year over the next 20 years, increasing by approximately 60 per cent by 2035². By 2065, travel on the east coast will have more than doubled, from 152 million trips in 2009 to 355 million trips³.

A strategic study of the implementation of a High Speed Rail (HSR) network on the east coast of Australia (the study) was announced by the Minister for Infrastructure and Transport, the Hon Anthony Albanese MP, in August 2010. This strategic study investigates whether HSR could play an effective role in helping to meet future travel demand. It is anticipated that the study will inform the Australian Government's, and state and territory governments', consideration of the next steps for HSR⁴.

1 Australian Bureau of Statistics (ABS) mid-range population projections (cat. no. 3222.0) estimate that between 2011 and 2050, the population will grow by 37 per cent in NSW, 49 per cent in Victoria and 80 per cent in Queensland.

2 Based on forecast population and income (GSP/capita) growth. See **Chapter 2** for detailed discussion on the forecast travel market.

3 Growth in the base travel market on the east coast comprising inter-regional and inter-city trips and excluding commuting and other local travel. The base travel market is forecast to grow at 1.8 per cent per year from 2009 to 2035, 1.5 per cent per year from 2035 to 2050 and 1.0 per cent per year from 2050 to 2065. See **Chapter 2** for more details.

4 High Speed Rail Study Terms of Reference, Department of Infrastructure and Transport, 21 October 2010.

The first phase of the study, which was published in August 2011:

- Provided an assessment of the likely range of costs.
- Identified potential corridors and stations.
- Estimated the potential future market demand for HSR.
- Considered potential social and regional impacts.

In November 2011, the Department of Infrastructure and Transport (the Department) appointed the AECOM Consortium⁵ to undertake phase 2 of the study. This second phase builds on the first phase, but is considerably broader and more detailed in its objectives and scope, and has therefore refined many of the phase 1 estimates.

The second phase of the study has examined in more detail the issues surrounding the potential introduction of HSR and has considered alternative technologies, corridors, alignments and station locations to design a preferred HSR system for the east coast of Australia. Phase 2 has also included a comprehensive economic, financial, environmental and social appraisal of the preferred HSR system, including a rigorous assessment of potential future demand, together with an appraisal of alternative institutional and governance arrangements that would support the implementation of HSR.

1.1 Background to HSR

1.1.1 What is HSR?

HSR is generally defined as a purpose-built, fixed-track mode of transport, capable of speeds of at least 250 kilometres per hour, usually over long distances. It typically offers services between major cities, occupying the same travel market as aviation, but also provides opportunities for intermediate stops in regional areas. HSR can also provide capacity for fast commuter rail services from outer metropolitan areas to city centres.

Originating in Japan in the 1960s, HSR systems now operate in 14 countries: Japan, Italy, France, Germany, Spain, Switzerland, the three Benelux countries (Belgium, Netherlands, Luxembourg), China, United Kingdom, Korea, Taiwan and Turkey. The rapid increase of HSR in recent decades is evidenced by the increase in total global kilometres of HSR track, from just over 1,000 route kilometres in 1980, to more than 15,000 route kilometres in 2011⁶. The growth in HSR is illustrated in **Figure 1-1**.

Most HSR systems operate on purpose-built tracks at maximum speeds of between 250 and 300 kilometres per hour, with some more recent systems operating in excess of 300 kilometres per hour. Services in Spain and France have commercial operating speeds of 310 kilometres per hour and 320 kilometres per hour, respectively⁷. All HSR systems currently in operation are based on electric traction using traditional steel wheels on rails, but with a range of track and train technology options⁸. While most HSR services run on dedicated HSR tracks, some HSR trains also use short sections of conventional tracks at lower speeds, such as at entries to cities or extending from a dedicated line.

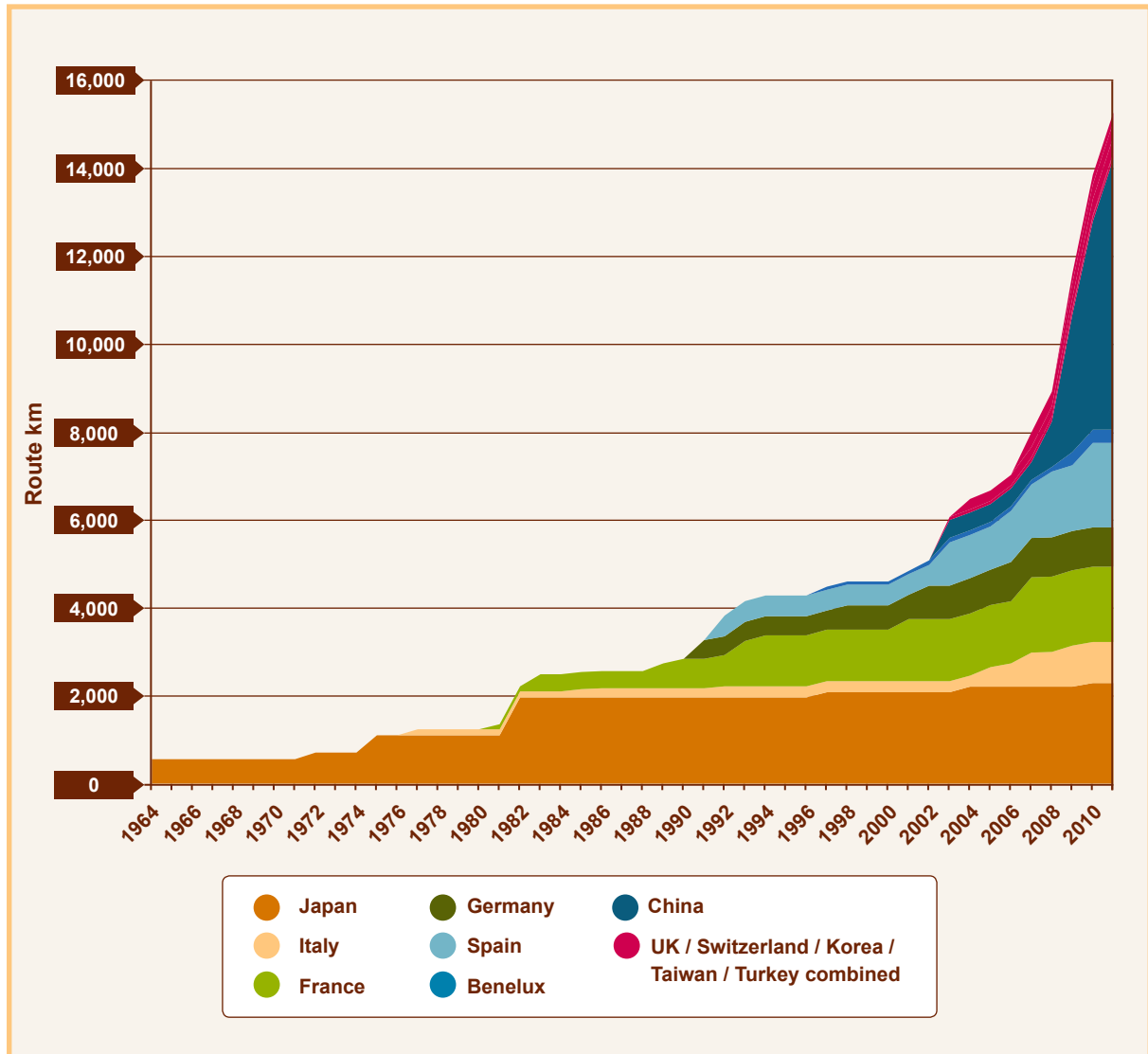
5 Comprising AECOM, Grimshaw, KPMG, SKM, ACIL Tasman, Booz & Company and Hyder.

6 Derived from The World Bank, *High speed rail: the fast track to economic development?*, 2010 (updated).

7 Commercial operating speed is the maximum operating speed in commercial service.

8 Maglev or magnetic levitation technology systems are excluded from this definition of HSR.

Figure 1-1 Growth in route kilometres of HSR (1964-2011)



Source: World Bank⁹.

1.1.2 Why people choose HSR

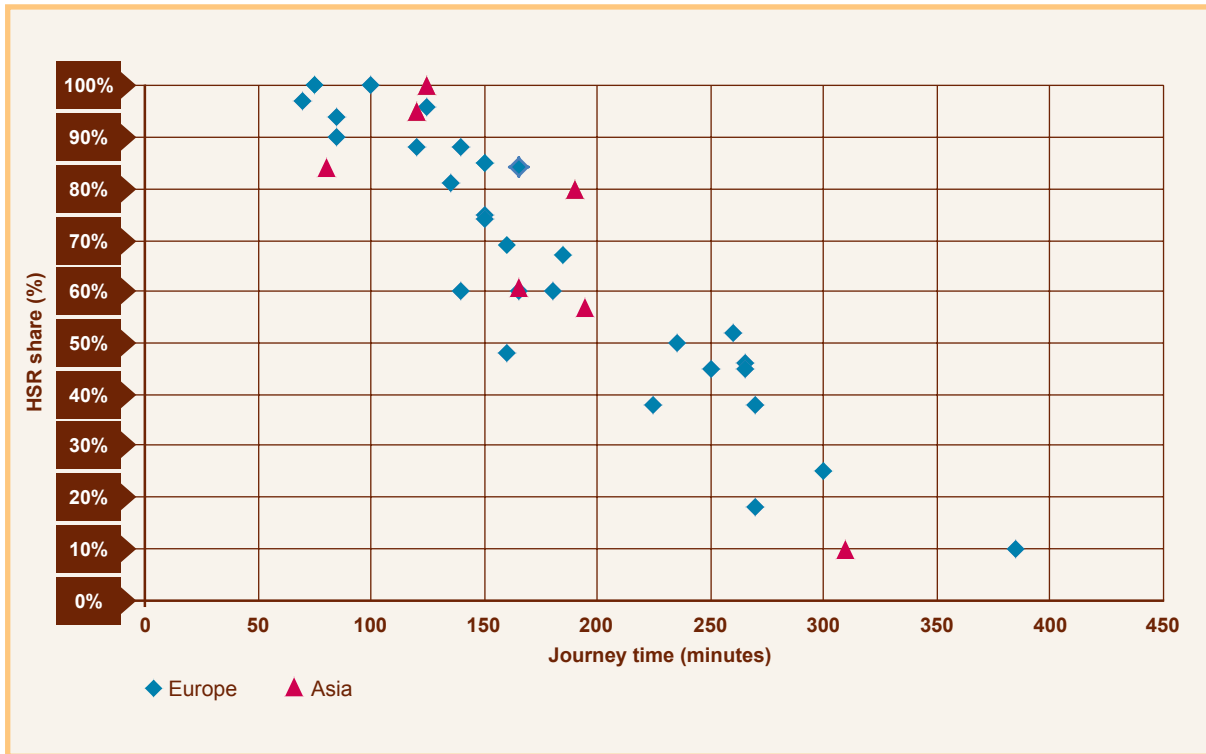
According to a paper prepared for the European Community (EC) on the effectiveness of HSR in relation to its competitiveness with air, based on a review of eight European HSR routes, the main factor driving HSR market share (as long as rail had a competitive service frequency) was the

rail journey time¹⁰. The time required for airport check-in and other procedures prior to departure was considered part of the journey time, and the absence of these procedures on HSR was seen as a competitive advantage.

⁹ The World Bank, loc. cit.

¹⁰ Steer Davies Gleave (for the European Commission), *Air and Rail Competition and Complementarity*, 2006.

Figure 1-2 Relationship between journey time and market share for HSR



Source: Compilation of international data from Steer Davies Gleave, Arup-TMG and Nash¹².

Figure 1-2 presents international data showing that the shorter the HSR journey time, the higher its market share. Each point represents a city to city journey time and HSR share, based on data on operating HSR services collected and provided in the EC report, the Arup-TMG East Coast Very High Speed Train Scoping Study (VHST) and Nash¹¹. Further detail is provided in **Appendix 1A**.

Beyond door-to-door journey time, international research shows that a range of other factors also influence people's choice of travel mode:

- The convenience of accessing one mode versus another (for example, journey times to airports versus journey times to an HSR station).
- Price and ticket conditions, including the availability of alternative lower-priced modes such as bus (coach) and car.

- Reliability and punctuality, particularly considering current congestion at airports and on motorways in some countries.
- On-board service quality (although this may be becoming less important as common service attributes begin to appear on both air and HSR services in some markets)¹³.

1.2 Approach to the study

The purpose of phase 2 is to advise the Minister for Infrastructure and Transport on 12 matters ('the study objectives'). Six interrelated technical modules, as illustrated in **Table 1-1**, combine to address these study objectives in two parts:

1. Definition of the preferred HSR system for the east coast of Australia.
2. Appraisal of the preferred HSR system.

¹¹ Arup and TMG (unpublished, for the Department of Transport and Regional Services), *East Coast Very High Speed Train Scoping Study Phase 1 – Preliminary Study Final Report*, November 2001.

Nash, *HSR Overseas experience Report, High Speed Rail Study Phase 1*, 2011.

¹² *ibid.*

¹³ Steer Davies Gleave (for the European Commission), *loc. cit.*

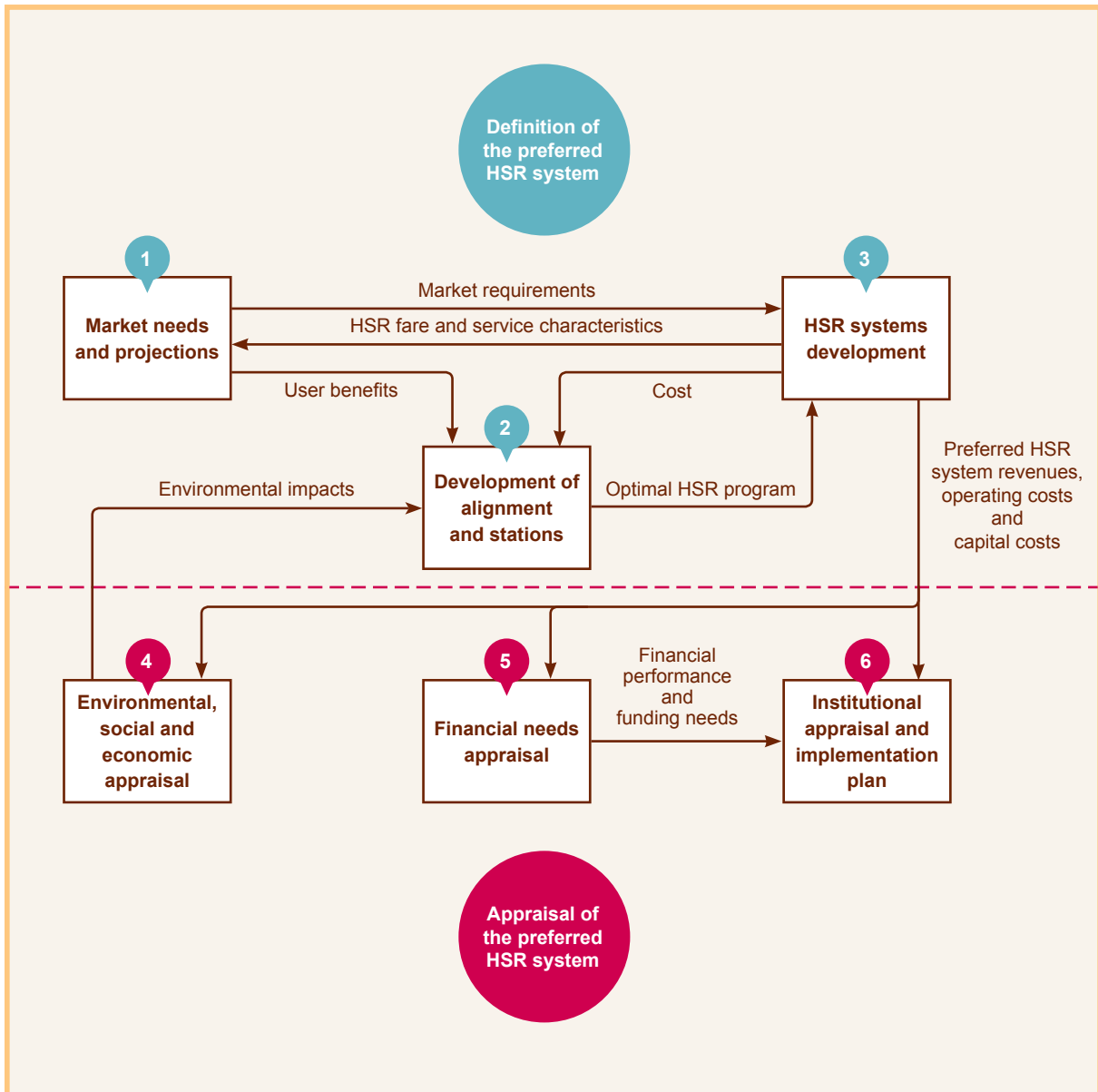
Table 1-1 Phase 2 study modules

Module		Study objectives
System definition		
1	Market needs and projections	Projected travel demand in the east coast corridor.
2	Development of alignment and stations	The preferred HSR system, including corridor, alignment, transport products and system specifications.
		The optimal HSR program for staging the physical construction and provision of services on the preferred HSR system.
3	HSR systems development	HSR system alternatives that could best serve the projected travel market effectively, and the aggregate and segmented travel demand and market shares that could be served by each.
System appraisal		
4	Environmental, social and economic appraisal	The specific environmental, social and economic impacts of the recommended HSR program, their effect on community groups, and the overall net cost or benefit of those impacts to Australia.
		The nature, extent and value of any opportunity created for an integrated HSR/corridor regional development concept.
		The nature and cost of any complementary access projects and their contribution to achieving the assessed performance of the HSR program.
5	Financial needs appraisal	The financing needs, financial performance and commercial viability of the HSR program.
		Any commercial financing gap and ways of funding and financing such a gap, including through public-private financing and funding partnerships.
		The key risks to the HSR program and its successful performance, the implications of these risks and possible mitigation measures, if any.
6	Institutional appraisal and implementation plan	The most appropriate institutional framework for governance, planning, procurement, construction, operation and regulation of the HSR program.
		An effective implementation plan for creating the recommended institutional framework and delivering the HSR program and for securing, if merited, an integrated HSR/corridor regional development concept.

The modules and their associated interrelationships are shown in **Figure 1-3** with the arrows indicating the module interdependencies (i.e. the key information that passes between the modules).

The approach taken in each module is described further.

Figure 1-3 Phase 2 modules and interdependencies



1.2.1 Definition of the preferred HSR system

Module 1 - Market needs and projections

Demand models were developed to forecast the likely future travel market on the east coast of Australia and the potential future demand for HSR, based on the likely attractiveness of travel via a future HSR system compared to travel via alternative modes. The first year of HSR operations

was designated as 2035 for assessment purposes, and a long-term horizon of 50 years was adopted, consistent with Australian Transport Council (ATC) guidelines.

For the purposes of demand modelling, the base year was 2009 and three forecast years were established (2035, 2050 and 2065) for which detailed forecasts were developed. Forecasts without HSR (the 'base case') and with HSR (the 'reference case') were then derived for each year of

the evaluation period. Demand for intermediate years (between 2035 and 2065) was derived by interpolation, and for years through to 2085 by extrapolation.

Primary market research was undertaken to support the development of the demand models and to define various inputs to the appraisal (such as the value of time for travellers).

HSR fares were modelled on a per kilometre basis (incorporating a ‘flagfall’ and a distance component) and set such that they were broadly comparable with corresponding forecast air fares on the Sydney-Melbourne and Brisbane-Sydney air routes. Access costs such as taxi fares, airport and station parking charges and metropolitan bus and rail fares were assumed to remain constant in real terms.

Forecasts were prepared for the reference case (i.e. with HSR) as part of the central case for evaluation purposes, and for a range of sensitivities. An assessment was made of the potential inter-city and regional markets for HSR, broken down by business and leisure travel. In addition to forecasting inter-capital and regional travel, potential demand for high speed commuter services was investigated in two corridors – Newcastle-Sydney and Brisbane-Gold Coast. Newcastle-Central Coast-Sydney is likely to be the biggest commuter market on the HSR network. Under fare assumptions consistent with conventional commuter services (i.e. with subsidies), there would be a demand for these services. However, these services would not contribute to the financial performance of HSR, nor would they be the source of any significant incremental economic benefit in the cost-benefit analysis of HSR. Commuter demand was therefore excluded from the demand forecasts in **Chapter 2** and the financial and economic appraisals in **Chapters 7** and **8**, although it was allowed for in the capacity planning.

Module 2 – Development of alignments and stations

The development of alignment and station location options had to be compatible with delivering the necessary system performance to meet market

needs while also ensuring the environmental, social and economic sustainability of the system. A large number of alternative alignments (up to 50 for each regional alignment section) and station locations were tested, with the preferred alignment and station locations selected based on a balance of construction and operating costs, user benefits (e.g. relative journey times) and environmental considerations.

Regional station locations were selected on the basis of potential demand. Similarly, stations on the periphery of the capital cities (other than Canberra) were selected on the basis of their accessibility to the potential market.

A strategic environmental assessment framework, consistent with Australian Government guidelines, was developed and its key principles incorporated in the selection of the preferred alignment and station locations to reduce the potential for negative environmental impacts. The findings of the assessment are reported in **Appendix 5C**.

Rationale for tunnelling

Journey times that are competitive with other forms of transport are key for HSR if it is to secure a sustainable market share and reliable revenue base. International experience shows that HSR journeys of less than three hours tend to attract over 50 per cent share of the travel market. This is illustrated in **Figure 1-2**.

To realise these competitive times, HSR in Australia, because of the long distances between centres, must be able to achieve an average operating speed of more than 250 km per hour. This is reliant on track geometry that is capable of accommodating these speeds. Existing road and rail alignments were not constructed for these speeds and their geometry is inadequate. Were HSR to follow existing transport corridor alignments, speed restrictions would be necessary, with an associated increase in the transit time of the service, to the extent that it would not be competitive, particularly in serving the long distance inter-city travel market.

In densely populated areas, the track geometry required to achieve speeds of 250 kilometres per

hour would make a surface alignment highly disruptive, would require extensive land acquisition (and associated costs), and would result in noise impacts, community severance and poor visual amenity to a large number of people, particularly when passing through the middle and inner suburbs of the capital cities.

Tunnelling was therefore considered, in addition to where it was required by the terrain, in locations where no dedicated surface route providing the required operating speed could be created without unacceptable dislocation and/or environmental costs.

Module 3 – HSR system development

The design of the preferred HSR system was based on the premise that any future HSR system would need to become an effective component of future integrated transport networks on the east coast¹⁴. A central consideration was the need to ensure that the HSR would deliver an effective and affordable transport solution that was attractive to customers. To achieve this, HSR fare and service characteristics, such as end-to-end journey times, would have to be competitive with alternative modes, particularly air travel.

For the purposes of the demand assessment and appraisal, average fares for HSR business and leisure travel were designed to be competitive with, and comparable to, air fares on the main inter-capital routes, after taking into account relative access times and costs. For example, the reference case assumes the average HSR single (one-way in \$2012) economy fare between Sydney and Melbourne in 2065 would be \$141 for a business passenger and \$86 for a leisure passenger. This variation reflects the tendency for passengers travelling for business to pay more for a ticket than those travelling for leisure (a result of the booking methods used, the higher tendency of business travellers to purchase flexible tickets, and the tendency to travel at peak times). The corresponding average air fares (one-way in \$2012) in 2065 were estimated as \$137 and \$69 respectively. In practice, a range of fares

would be offered, targeted to market segments and influenced by seat utilisation patterns and competitive pressures, as is currently the case with the airlines, where current air fares paid for inter-city business travel can vary from the overall average by as much as 65 per cent. Sensitivity tests also considered average fares up to 30 per cent and 50 per cent higher, as well as 50 per cent lower in the context of a price war with the airlines.

For inter-capital markets, reliable HSR transit times of up to three hours between the city centres (Sydney-Melbourne and Brisbane-Sydney) were considered competitive with air travel, once all journey components (such as travel time, waiting time, check-in time, access time and interchanges) were taken into account. These target transit times were then used to define the HSR system requirements for maximum and average operating speeds and reliability.

This in turn required a technical assessment of likely HSR technologies, with the technical components of the system – including the track type and geometry, power supply, signalling and the train itself – all combining to deliver the desired HSR system performance.

The technical components of the system, combined with the preferred alignments and station locations, then determined the cost of constructing a future HSR system. Cost components were developed from Australian unit costs and benchmarked against international HSR systems, taking account of a range of manufacturers' delivered costs for existing HSR systems and reflecting the use of proven HSR system technology (such as train control and power supply systems) and train sets already in service, and readily available. No new technology was assumed.

Indicative service plans, including service types (inter-capital express services and regional services with intermediate stops) and service frequencies required to meet projected demand, were developed and used to inform the assessment of operating costs and the required number of train sets.

14 Department of Infrastructure and Transport, *Request for tender for the second phase of a strategic study into the implementation of a high speed rail network on the east coast of Australia*, Part A: Statement of Requirements, Canberra, 2011.

1.2.2 Appraisal of the preferred HSR system

The appraisal of the preferred HSR system first required an understanding of the likely future travel market, including consideration of likely future travel options without HSR (the base case), and the alternative future with an investment in HSR (the reference case). By comparing the base case with the reference case, the incremental costs and benefits of a future HSR system are able to be assessed.

Development of the base case

The long-term horizon for the study required assumptions and forecasts extending well beyond existing transport and land use plans of the relevant jurisdictions. Therefore, a set of assumptions was developed to reflect the likely future without HSR, based for the most part on existing policy settings. These assumptions were then reviewed to ensure that, when extrapolated over an extended period of time, they did not result in implausible outcomes.

The base case assumes that, without HSR, travellers on the east coast will continue to rely on existing modes of transport:

- Aviation will remain the primary means of transport for long distance interstate (and some inter-regional) trips.
- Road-based travel and private vehicle usage will remain the primary mode for connections with and between regional centres.
- Public transport will play an increasingly important role in meeting travel demand within cities served by conventional rail and bus transport.

For road and rail modes, the base case assumes that governments will continue to augment supply by providing infrastructure and services to meet demand. For aviation, given the uncertainty around the future of airport capacity in the Sydney region, the base case assumes that there will be no additional investment in airport capacity in the Sydney basin and that airport service levels within the Sydney region will become increasingly constrained.

As outlined within the recent Australian/NSW Government Joint Study into Aviation Capacity in the Sydney Region (hereafter referred to as the Joint Study), demand for aviation services in the Sydney region is expected to double to 88 million passenger trips per year by 2035, and then double again by 2060¹⁵. Sydney (Kingsford Smith) Airport does not have the capacity to meet the expected demand, leading to:

- Slower and more unreliable air journey times as airlines and airports are faced with higher levels of congestion.
- An increasing requirement for air passengers to shift their travel time because of a lack of capacity at their preferred travel time.
- An increasing number of travellers who are forced to travel by other means or who do not travel at all (otherwise known as unmet or suppressed demand).

The Joint Study's projection has added complexity to the modelling of the base case to take account of some of the constraints at Sydney Airport. Given the likely significance of this projection, a sensitivity analysis was developed and tested which allowed for additional aviation capacity in Sydney and removed the effects of unplanned delays from the demand modelling.

Development of the reference case

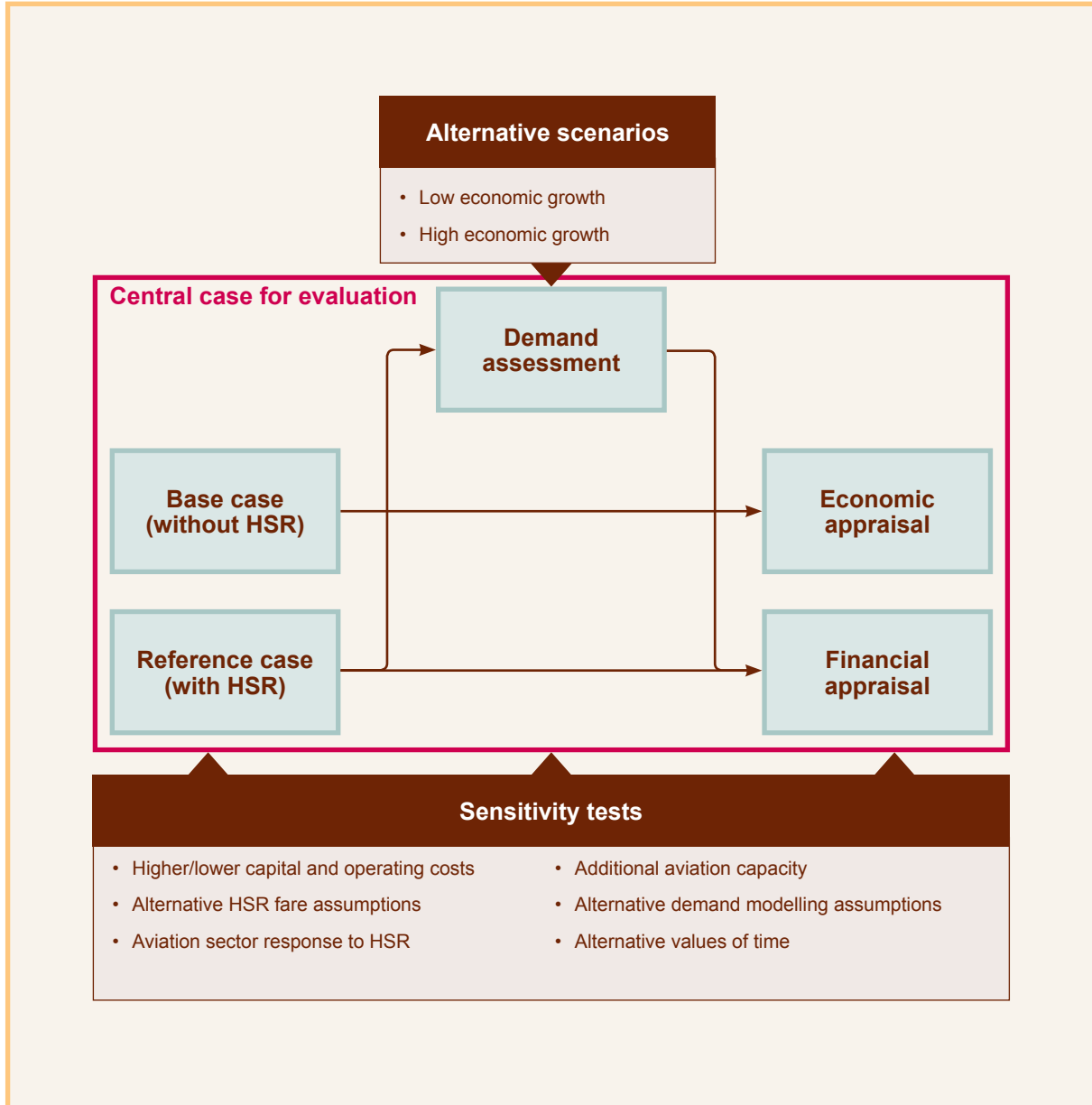
For the purposes of appraisal, a reference case was developed as part of the central case for evaluation and comparison against the base (without HSR) case. The reference case incorporates the primary assessment of future demand, revenues, operating costs and capital costs for the preferred HSR system.

Sensitivity analysis

Reflecting the inherent uncertainty of assumptions that underpin the appraisal of long-term infrastructure programs, the appraisal was complemented by a number of alternative scenarios and sensitivity tests, as illustrated in **Figure 1-4**.

15 Australian Government and NSW Government, *Joint Study on aviation capacity in the Sydney region*, Canberra, 2012.

Figure 1-4 Phase 2 alternative scenarios and sensitivity tests



In this context, a *scenario* is a projection based on a set of internally consistent assumptions and parameters, in this case, variations to the reference case that represent an alternative outcome.

Sensitivity tests are generally variations to a single assumption or parameter, to assess their importance to the modelling and its outputs. In this study, some sensitivity tests have varied more than one assumption.

Two alternative economic scenarios were developed, one unfavourable and one favourable to HSR:

- The ‘low growth’ scenario assumes lower economic and population growth (relative to the reference case). This scenario results in lower overall demand for transport and thus lower demand for HSR. Per capita GDP growth rates are assumed to be 0.3 per cent per year lower than the reference case, and

population growth within the study area is assumed to be 51 per cent between 2010 and 2065, compared to 72 per cent in the reference case.

- The 'high growth' scenario assumes that the Australian economy experiences strong growth into the future, with high population growth. This scenario results in higher overall demand for transport and thus higher demand for HSR. Per capita GDP growth rates are assumed to be 0.3 per cent per year higher than in the reference case, and population growth within the study area is assumed to be 103 per cent between 2010 and 2065, compared to 72 per cent in the reference case.

In addition to the two alternative economic scenarios, several sensitivity tests were developed that assessed the impact of alternative assumptions and forecasting model parameters on the economic and financial results. The tests undertaken assessed the effects of:

- All HSR fares increased by 30 per cent with a corresponding decrease in HSR demand.
- All HSR fares increased by 50 per cent with a corresponding decrease in HSR demand.
- Competitive pricing between HSR and aviation when the line opens between Sydney and Melbourne, with both air fares and HSR fares assumed to be reduced by 50 per cent for two years.
- Additional aviation capacity within the Sydney region, which removes the negative effects of travel time on flights to/from Sydney from the reference case, and assumes there is no unmet demand.
- Additional aviation capacity within the Sydney region, combined with 30 per cent increase in HSR fares.
- Setting the alternative specific constant (ASC) within the demand model to zero. The ASC quantifies the preference for HSR as a travel mode relative to air for inter-city and long regional trips, and relative to rail for short regional trips, over and above the measurable improvements in level of service.

- Applying a weighting of 1.0 to the time taken to access and egress the principal mode of travel, compared to the weighting of 1.4 used in the reference case. This reduces the benefits of HSR in comparison to air travel, but increases the benefits of HSR in comparison with car travel.
- Lower values of time. Given the long time horizon for the assessment of HSR, growth in the values of time over the evaluation period was considered appropriate. However, economic evaluation of rail and road projects in Australia does not usually use real increasing values of time in appraisal, and this test assumed fixed values.
- Low demand and high costs, leading to a set of circumstances that is unfavourable to HSR. This test combined additional aviation capacity in the Sydney region, a 30 per cent increase in pre-risk capital costs, low growth scenario and a 50 per cent increase in HSR fares.
- Higher (+30 per cent) capital and operating costs.
- Lower (-10 per cent) capital and operating costs.

Economic results for all the sensitivity tests were presented using both a four per cent discount rate (the reference case assumption) and an alternative rate of seven per cent. Some sensitivities, such as higher fares, have a positive impact on the financial results but a negative impact on the economic results (with higher fares, fewer people use the system). These trade-offs were explored through the appraisal.

Finally, in addition to the growth scenarios and the sensitivity tests outlined above, alternative staging assumptions were tested to determine the preferred staging for the HSR program. The following changes in the assumed timing of HSR development were assessed:

- Accelerated roll-out, bringing the construction timeline forward by five years.
- Deferred roll-out, pushing the construction timeline back by five years.

Module 4 - Environmental, social and economic appraisal

An assessment of the environmental impacts of HSR was integrated into the evaluation of alignment options and station options using a Geographic Information System (GIS) toolkit that identified sites of ecological and heritage value along the HSR alignment options. These assessments were combined with other considerations, such as engineering parameters, constructability, cost, and user benefits, to determine the preferred alignment and station locations. In addition, the assessment of environmental issues associated with HSR addressed noise and vibration, energy use, carbon emissions/greenhouse gas considerations, the implications of climate change, and the promotion of ecologically sustainable development.

The likely social impacts of a future HSR program were identified through case studies into three key areas based on research and stakeholder consultation:

1. Workforce and community development.
2. Access to health and other public services.
3. Tourism, recreation and social inclusion.

Insights from the case studies were used to outline the potential social impacts of a future HSR system.

A standard Cost Benefit Analysis (CBA) was undertaken to provide a comprehensive assessment of the costs and benefits to users and operators of HSR over the evaluation period from 2035 to 2085. It included an assessment of externalities, such as environmental impacts, accident cost savings and decongestion benefits. The CBA establishes the overall economic merit of a future HSR program and guides decisions on the optimal staging of the HSR program.

The CBA was undertaken in real 2012 terms, (expressed as '\$2012') utilising a discount rate of four per cent with a base year of 2028. A discount rate of seven per cent was also tested. Where necessary, costs and benefits for earlier years have been escalated to \$2012 using the Consumer Price Index (CPI).

The construction of a new HSR system to help meet future travel demand would influence the future development of cities and regions, as well as where people choose to live and work. The appraisal of HSR therefore also considered the opportunities for future urban and regional development, and the implications for the way transport systems might evolve and develop to meet future demand.

Module 5 - Financial needs appraisal

Financial modelling of the reference case was undertaken to assess the potential financing needs, financial performance and commercial viability of the HSR program over the evaluation period from 2035 to 2085, having regard to the proposed staging of the preferred HSR system.

Future costs and revenues were expressed in \$2012 prices discounted to financial year 2028, the assumed commencement of main construction compatible with starting operations in 2035. Air fares were reduced in real terms by 0.5 per cent per year until 2015 and held constant thereafter, consistent with the assumptions about air fares in the Joint Study. Labour-related operating costs were assumed to increase in real terms by 0.2 per cent per year, with actual real wage increases offset by productivity improvements. Fuel prices were assumed to increase in real terms, although much of the increase would be offset by efficiency improvements. Future budgetary impacts for governments were assessed based on the projected future cash flows, which incorporated allowance for risk.

Module 6 – Institutional appraisal and implementation plan

Appropriate governance and institutional arrangements would need to be established to ensure that, if adopted, the HSR program is subject to proper public oversight, is effectively and efficiently delivered, and meets its objectives. Specific governance arrangements were developed, having regard to the multi-jurisdictional nature of a future HSR program and the potential role of the public and private sectors.

An implementation plan was developed for the preferred HSR system that took account of the staging analysis, the economic and financial appraisals and the proposed governance and delivery model for HSR. The plan also considered additional preparatory work required by governments before any formal decision to proceed with the construction of an HSR system.

1.2.3 Optimism bias and how it is addressed

International experience of major infrastructure projects has found there is a tendency for project costs to be under-estimated, and traffic projections and benefits over-estimated, compared to actual outcomes¹⁶. Some major greenfield infrastructure projects in Australia (e.g. a number of privately financed toll road projects)¹⁷ have similarly suffered from over-estimated traffic projections. These major projects may be described as having suffered from an ‘optimism bias’.

To mitigate the risk of optimism bias in this study, a number of safeguards were adopted:

- Specific surveys of the Australian travel market were conducted to test the validity of international experience in the Australian context.
- The results of the Australian demand analysis were assessed against actual international

travel demand outcomes. The results were also subjected to independent peer review¹⁸.

- The average prices assumed to be charged for travel on HSR were market-based and derived from analysis of what would be necessary to compete with air travel in particular. The fares took into account both current and projected fares and costs for other modes, principally aviation and car.
- The infrastructure construction cost estimates were developed using Australian observed unit rates wherever possible, in a bottom-up process, and benchmarked against recent domestic and internationally observed rates.
- The physical and environmental constraints of proposed alignments were built into the route selection process to avoid areas where there is a high risk of cost escalation.
- Technology systems (such as train control and power supply systems) and rolling stock cost estimates were based on known technologies that are currently in use and took account of a range of manufacturers’ delivered costs elsewhere.
- Train operating costs were estimated from an indicative operating plan, using unit cost rates, reflecting Australian markets.
- A risk assessment was undertaken to arrive at risk-adjusted cost and revenue estimates.
- A wide range of sensitivity tests were undertaken to assess the impact that alternative assumptions would have on the CBA results, including higher and lower capital cost estimates and higher and lower demand forecasts.

16 Flyvbjerg, Holm, and Buhl, How (In) accurate Are Demand Forecasts in Public Works Projects? The Case of Transportation, *Journal of the American Planning Association*, Vol. 71, No. 2, Spring, 2005, pp. 131-146.

17 Bureau of Infrastructure, Transport and Regional Economics (BITRE), *Review of Traffic Forecasting Performance: Toll Roads*, 2011. GHD, *An investigation of the causes of over-optimistic patronage forecasts for selected recent toll road projects*, 2011, http://www.infrastructure.gov.au/infrastructure/public_consultations/patronageforecasting.aspx.

18 The Institute of Transport Studies, University of Leeds, UK.

1.3 Structure of the report

The remainder of this report is organised as follows:

Chapter 2

Discusses the future travel market in the east coast corridor.

Chapter 3

Describes the preferred HSR system, including the transport products proposed to serve the travel market, the system specifications, operations and maintenance facilities, and system-wide greenhouse gas and noise impacts.

Chapter 4

Presents the preferred HSR route, with conclusions on alignments and station locations.

Chapter 5

Presents the proposed HSR stations in more detail, describing in particular how HSR would be integrated with the major capital city termini.

Chapter 6

Defines the possible staging for implementing an HSR system, with a focus on the first stage.

Chapter 7

Presents the capital and operating costs of HSR, discusses the commercial performance of the preferred HSR system and summarises the financial performance and risk.

Chapter 8

Presents the economic appraisal of the preferred HSR system using a conventional CBA and discusses the likely flow-on effects to the broader economy.

Chapter 9

Presents an appraisal of regional development effects and opportunities.

Chapter 10

Identifies potential governance and institutional structures and the regulatory mechanisms required for delivery of an HSR program.

Chapter 11

Presents potential delivery structures for an HSR system, discussing the roles of the public and private sectors and strategies for procurement and packaging.

Chapter 12

Presents an implementation plan for the delivery of a future HSR program.

The report is supported by appendices, organised as follows:

Group 1 – Travel markets.

Group 2 – Preferred HSR system.

Group 3 – Preferred HSR alignment.

Group 4 – Cost and program.

Group 5 – Environmental, social and economic appraisal.

Group 6 – Commercial appraisal.

Group 7 – Procurement, institutional appraisal and implementation plan.

The responses to individual study objectives can be found in the chapters and appendices listed in **Table 1-2**.

Table 1-2 Location of responses to the phase 2 study objectives

Study objectives	Response
The projected travel market in the east coast corridor.	Chapter 2 Group 1 appendices
HSR system alternatives that could serve the projected travel market effectively and the aggregate and segmented travel demand and market shares that could be expected to be attained by each.	Chapter 3 Group 1 and 2 appendices
The preferred HSR system including corridor, alignment, transport products and systems specifications.	Chapters 3, 4 and 5 Group 2 and 3 appendices
The optimum HSR program for staging the physical construction and provision of services on the preferred HSR system.	Chapter 6 Appendix 4A
The specific environmental, social and economic impacts of the recommended HSR program, their incidence on community groups, and the overall net cost or benefit of those impacts to Australia compared to the base case.	Chapters 4, 8 and 9 Group 5 appendices Appendices 4B and 4C
The nature, extent and value of any opportunity created for an integrated HSR/corridor regional development concept.	Chapter 9
The nature and cost of complementary access projects and their contribution to achieving the assessed performance of the HSR program.	Chapter 5
The financing needs, financial performance and commercial viability of the HSR program.	Chapter 7 Group 6 appendices
Any commercial financing gap and ways of funding and financing such a gap, including public-private financing and funding partnerships.	Chapter 7 Group 6 appendices
The key risks to the HSR program and its successful performance, the implications of these risks and possible mitigation measures, if any.	Chapter 7 Appendix 6C
The most appropriate institutional framework for governance, planning, procurement, construction, operation and regulation of the HSR program.	Chapters 10 and 11 Appendix 7A
An effective implementation plan for creating the recommended institutional framework and delivering the HSR program and for securing, if merited, an integrated HSR/corridor regional development concept.	Chapter 12 Appendix 7B



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2

Travel markets

2.1 Introduction

As described in **Chapter 1**, phase 2 of the study involved the development of models to forecast the likely future travel market on the east coast of Australia and the potential future demand for HSR compared to travel via alternative modes.

The demand forecasts were fundamental to the appraisal of the alternative alignments and station options for the preferred HSR system. They were also critical inputs to the appraisal of the economic and commercial performance of the preferred system, and were used in the appraisal of the regional development effects and opportunities.

This chapter describes how the current travel market was evaluated and provides an overview of the current situation. It also outlines the future travel market in the east coast corridor, both with and without HSR (the reference case and base case respectively), and provides the strategic context for a discussion of a future HSR program.

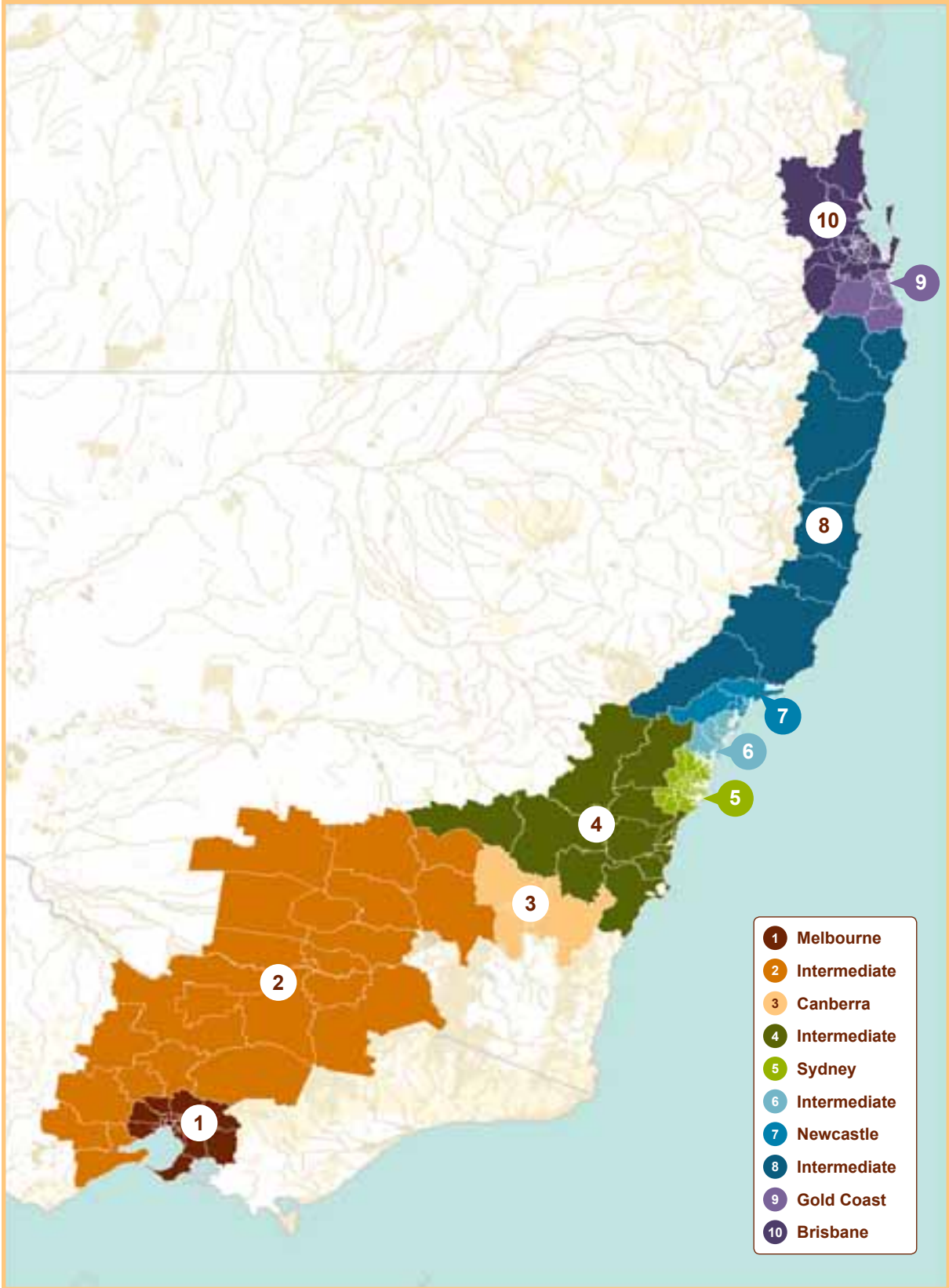
2.1.1 Study area

The study area for the demand forecasting is illustrated in **Figure 2-1**. It encompasses the preferred HSR corridor from phase 1, crossing three states and one territory (Queensland, New South Wales (NSW), Victoria and the Australian Capital Territory (ACT)), and extending approximately 1,700 kilometres from end to end.

To allow closer analysis of travel demand within the corridor, particularly within metropolitan areas where it was necessary to differentiate between potential HSR station locations, the study area was divided into ten sectors and 167 zones.

The 167 zones are based on ‘statistical local areas’ (SLAs) and are thus consistent with standard employment and population data. They are also consistent with the zone systems used in metropolitan transport models and have been designed to allow ready analysis of potential HSR stations. The ten sectors into which they have been aggregated for presentational purposes represent the six largest cities and the four ‘intermediate’ areas between these cities.

Figure 2-1 Study area for the demand forecasting showing the geographical subdivision into 10 sectors and 167 zones



2.2 Approach

The data used in the forecasts was independently verified wherever possible and benchmarked against international experience. In addition, a conservative view was adopted wherever there were uncertainties in the forecasting process.

The demand forecasting addressed the following key questions:

- What are the main markets in the east coast corridor that HSR could potentially serve?
- What is the size of these markets and how are they split between the alternative transport modes (car, rail, coach and air)?
- How would the travel markets grow in the future?
- What would be the potential for diversion from current transport modes to an HSR network?
- How sensitive would the level of that diversion be to HSR performance and to the alternative future scenarios?

These questions were addressed as follows.

Estimates of inter-capital and regional travel along the east coast corridor for each transport mode were derived from existing travel data for the east coast collected by the National Visitor Survey (NVS), an ongoing survey of domestic travel undertaken by Tourism Research Australia (TRA), and verified against independent data including a special survey of inter-urban traffic patterns.

Past studies and specific analyses of trends in air and car travel along the east coast enabled the forecasts of growth in the travel market to be related to the expected future increase in east coast populations and income.

Forecast demand would be derived from two sources: diversion from existing modes of transport to an HSR service, and the 'induced' travel that would also result (i.e. new trips made by people taking advantage of the improved accessibility offered by the introduction of HSR). The forecasts of diverted and induced demand were based on international multimodal modelling practice and informed by a stated preference (SP) survey of travel behaviour carried out specifically for the study.

The SP survey was used to gauge travel behaviour by asking people to indicate what their preference would be, rather than determining this information through observation of actual behaviour.

As discussed in **section 1.2.1**, the demand forecasts exclude HSR commuter services.

2.3 Current travel market

2.1.2 Journey numbers

The size of the current travel market on the east coast was estimated from the NVS, which takes account of business and non-business travel, excluding commuting. A sample of nearly 150,000 day and overnight trips formed the basis of the current market estimate, taken from 11 years of NVS surveys (2000 to 2010) and annualised to a number for 2009, the year adopted during phase 1 of the study. Trips greater than 50 kilometres within the study area ending in one of the major towns or cities (Brisbane, Gold Coast, Newcastle, Sydney, Wollongong, Canberra and Melbourne) were included.

Some travel was omitted because it covered only a short distance, or would be best served by car, implying that few such journeys would be likely to transfer to HSR. This included all travel wholly within each of the intermediate areas, other than that to and from Wollongong. A small proportion of the omitted longer trips could use HSR, and to this extent, the HSR forecasts are conservative. Trips to and from places external to the study area were also excluded.

The estimate of the 2009 east coast travel market is approximately 152 million trips per year. The total number of journeys in both directions in 2009 between each of the ten sectors shown in **Figure 2-1** is summarised in **Table 2-1**. The excluded trips referred to above are shown by an X in the table.

Table 2-1 Total travel market for 2009 ('000 trips per year)

Sectors	Brisbane	Gold Coast	Intermediate	Newcastle	Intermediate	Sydney	Intermediate	Canberra	Intermediate	Melbourne	Total
Brisbane	X	18,780	2,920	280	240	3,780	580	560	500	2,480	
Gold Coast		X	3,340	200	180	1,880	400	160	340	1,200	
Intermediate			X	2,960	X	5,160	220	240	X	440	
Newcastle				X	3,020	6,900	980	220	140	320	
Intermediate					X	12,400	300	260	X	220	
Sydney						X	23,880	4,640	1,860	6,300	
Intermediate							2,640*	2,500	160	700	
Canberra								X	1,120	1,240	
Intermediate									X	35,180	
Melbourne										X	
Total											151,780

* Trips of over 50 kilometres between Wollongong and the remainder of the intermediate area in which it is included.

The greatest demand in the study area, as represented by the number of trips within and between sectors, was for relatively short trips between the capital cities and adjacent sectors. For example, in 2009:

- Approximately 35 million trips were made between Melbourne and the intermediate area between Melbourne and Canberra.
- Approximately 24 million trips were made between Sydney and the intermediate area between Sydney and Canberra.
- Approximately 19 million trips were made between the Gold Coast and Brisbane.

Trips between the capital cities (that is, with their origin in one capital city and destination in another) are smaller in comparison, although are comparable in terms of passenger kilometres due to the long distances involved. Examples are:

- Over six million trips were made between Sydney and Melbourne.
- Almost four million trips were made between Sydney and Brisbane.

2.3.1 Journey types

Six journey types were differentiated, defined by length and purpose (business or non-business), shown in **Table 2-2**. The shares of travel for each transport mode by journey type are shown in **Table 2-3** (trips) and **Table 2-4** (person travel kilometres). Overall, air travel accounted for 13 per cent of trips, almost evenly split between business and other purposes. Car travel accounted for 78 per cent of trips and rail for six per cent. In both cases a minority of the journeys were for business. Coach travel accounted for three per cent of trips.

The air share of the long distance journeys to and from the main cities was very high for both trip purposes (79 per cent for non-business and 96 per cent for business). Conversely, for the regional trips, car accounted for most travel in the corridor (over 85 per cent), especially for the shorter journeys.

Table 2-2 Journey type used for market segmentation

Journey type	Description	Purpose
Inter-city	Journeys over 600 km between the main towns and cities*	Business
		Non-business
Long regional	All regional journeys \geq 250 km	Business
		Non-business
Short regional	All regional journeys < 250 km	Business
		Non-business

* The six main towns and cities based on population in the corridor were Brisbane, Gold Coast, Newcastle, Sydney, Canberra and Melbourne. Sydney-Canberra sits within long regional. Brisbane-Gold Coast and Newcastle-Sydney sit within short regional.

Table 2-3 Distribution of east coast travel market by mode of transport and purpose for 2009 (trips)

Purpose	Mode of transport				Total trips ('000s)
	Air	Car	Rail	Coach	
Inter-city					
Business	96%	4%	0%	0%	6,930
Non-business	79%	19%	1%	1%	11,280
Long regional					
Business*	42%	55%	2%	2%	4,160
Non-business	15%	76%	4%	5%	19,960
Short regional					
Business	0%	91%	7%	2%	9,440
Non-business	0%	90%	7%	3%	100,010
Total trips ('000s)	20,500	118,000	9,100	4,200	151,780
Total trips (%)	13%	78%	6%	3%	100%

* Total does not add up exactly to 100% due to rounding.

Table 2-4 Distribution of east coast travel market by mode of transport and purpose for 2009 (person travel kilometres)

Purpose	Mode of transport				Total person travel kilometres (millions)
	Air	Car	Rail	Coach	
Inter-city					
Business	96%	4%	0%	0%	7,166
Non-business	81%	17%	1%	1%	12,582
Long regional					
Business	56%	41%	2%	1%	2,248
Non-business*	29%	64%	4%	4%	10,252
Short regional					
Business*	1%	91%	7%	2%	1,184
Non-business	0%	90%	7%	3%	11,742
Total person travel kilometres (millions)	21,313	21,505	1,406	951	45,174
Total person travel kilometres (%)	47%	48%	3%	2%	100%

* Total does not add up exactly to 100% due to rounding.

For the calculation of person travel kilometres on each mode, a single common measure of zone-to-zone distance is used.

2.3.2 Verification of travel market estimates

Achieving an accurate estimate of the travel market size is critical to achieving reliable demand forecasts. It is therefore very important to independently verify the estimate.

Travel surveys involving contacting people at their homes can be subject to biases and uncertainties, and it is consequently good practice to compare the results of such surveys with independent travel demand data relating directly to the relevant transport modes.

Existing information is commonly used, such as counts of road traffic and ticketing data for public transport passengers. Such data was drawn on for

this study, supplemented by a major car number plate survey specifically undertaken to verify the car travel market. The following sections explain the processes undertaken to verify the travel market estimates derived from the NVS.

Air and rail travel

Reliable independent information based on rail and air ticketing data was obtained from the Bureau of Infrastructure, Transport and Regional Economics (BITRE)¹ for air travel and CountryLink² for rail travel. The data gained from these sources was compared with the travel market estimates for air and rail shown in **Table 2-5** and **Table 2-6**. For the relatively small numbers of rail trips, the travel market estimates closely matched the CountryLink values.

1 BITRE is part of the Department of Infrastructure and Transport.

2 CountryLink is part of the government-owned Rail Corporation NSW, and provides regional and interstate passenger rail services in NSW, Queensland, the ACT and Victoria.

Table 2-5 Annual rail trips by route for 2009

Route	Travel market estimate (NVS)	Total volume observed (CountryLink)	Difference
Sydney-Melbourne	68,000	75,000	-9%
Brisbane-Sydney	26,000	27,000	-4%
Sydney-Canberra	53,000	55,000	-4%

The travel market estimates for air were lower than BITRE's total air passenger counts, partly because transfer passengers were included in the BITRE counts but not fully represented in the travel market estimates. The proportion of transfers on some of the key domestic routes was obtained from global airline ticketing database MIDT (Marketing Information Data Transfer), as shown in **Table 2-6**. Transfer passengers account for much of the difference between the market estimates and the counts. The evidence from these independent data sources suggested that the market estimates of non-transfer air passengers on these routes were reasonable, albeit slightly conservative, the exception being the two Gold Coast routes, where the market estimate underestimated the observed air demand³.

Table 2-6 Air trips between major cities by route for 2009 (millions)

Route	Travel market estimate (NVS)	Total volume observed (BITRE) ⁴	Difference	Estimated transfer % (MIDT)
Sydney-Melbourne	5.5	7.1	-23%	15%
Brisbane-Sydney	3.3	4.3	-24%	22%
Brisbane-Melbourne	2.3	2.7	-14%	9%
Gold Coast-Sydney	1.4	2.1	-31%	17%
Gold Coast-Melbourne	1.1	1.6	-31%	0%
Canberra-Melbourne	0.9	1.1	-21%	12%
Sydney-Canberra	0.6	1.0	-45%	36%

Car travel and the number plate survey

The diversion of car travel to HSR was expected to account for a significant proportion of HSR demand, so verification of the car travel market was important. However, the traditional source of car travel market validation data, traffic counts, could not provide an effective basis for validation, because medium and long distance car travel,

which is the market for HSR, could not be distinguished from other trips.

A large-scale number plate matching survey was therefore commissioned between Sydney and Melbourne to provide independent data that could be used to validate the car travel market estimates derived from the NVS. The survey used specialised

³ The sensitivity testing described in **section 2.9** specifically addressed the implications of these conservative market estimates.

⁴ BITRE, aviation statistics, 2009.

video equipment to record number plates over a 24 hour period for five days, from Wednesday 7 to Sunday 11 December 2011 inclusive, capturing northbound traffic at six locations along the Hume Highway between Seymour in Victoria and Campbelltown in NSW. Overall, 289,888 vehicles were observed. More detail on the number plate matching survey can be found in **Appendix 1C**.

Table 2-7 compares six demand flow estimates for light vehicles in the corridor between Melbourne and Sydney derived from the number plate survey with equivalent estimates from the NVS data. 'Light vehicles' include Austroads classes 1 and 2 (two axle vehicles up to 5.5 metres with or without towing a caravan, trailer, boat, etc.) and

includes cars, utility vans, light vans, bicycles and motorcycles.

The overall volume of traffic was similar for the two sources, but there were variations for the different journeys. The largest variation was for the longest car journeys between Sydney and Melbourne, where the survey along the Hume Highway would have missed trips which had taken the coastal route via the Princes Highway or the inland route via the Olympic Way, as well as some trips involving stopovers. For the other, shorter, journeys, which are more important for estimating car diversion to HSR, the NVS estimate of the car travel market on each of these journeys was consistent with the number plate survey estimates.

Table 2-7 Comparison of estimates of light vehicle travel market by route for 2009 ('000 annual vehicles) – NVS data and number plate survey

Journey	NVS estimate	Number plate survey*
Melbourne-Albury	626	493
Melbourne-Canberra	203	163
Melbourne-Sydney	528	259
Albury-Canberra	61	81
Albury-Sydney	85	71
Canberra-Sydney	2,201	2,639
Total	3,704	3,705

* Total does not add up exactly due to rounding.

The outstanding differences in demand estimates at the monitoring sites were due to a combination of the data uncertainties associated with the surveys, and the inherent uncertainties in the comparison of two such different surveys. Consequently, the sensitivity testing (described in **section 2.9**) makes allowance for uncertainties in the market estimates, including those associated with current car travel demand.

More discussion on the current travel market can be found in **Appendix 1B**.

2.4 Future travel market

The second stage in the demand forecasting was to estimate what the travel market would look like in the future, were an HSR program not pursued. This required assumptions to be made about growth in population and the economy, and about the future transport system without HSR. These assumptions are referred to as the base case, and its characteristics are discussed in the next section (**2.4.1**).

This is followed in **section 2.4.2** by a discussion of the forecast travel demand in the context of these base case conditions.

2.1.3 Base case

The base case assumes no HSR throughout the evaluation period, with specific forecasts being prepared for 2035, 2050 and 2065. It is in four parts:

- Population and employment forecasts based on state and ABS projections⁵.
- Road and public transport level-of-service scenarios, which take into account the expected future transport infrastructure.
- Aviation scenarios, an important element of which is the future aviation capacity for Sydney (the base case assumes that there will be no second Sydney Airport).
- Economic scenarios, covering economic growth and the future costs of transport, upon which the travel demand growth forecasts in the study area also depend.

The defining characteristics of the base case are discussed below, with more detail provided in **Appendix 1F**.

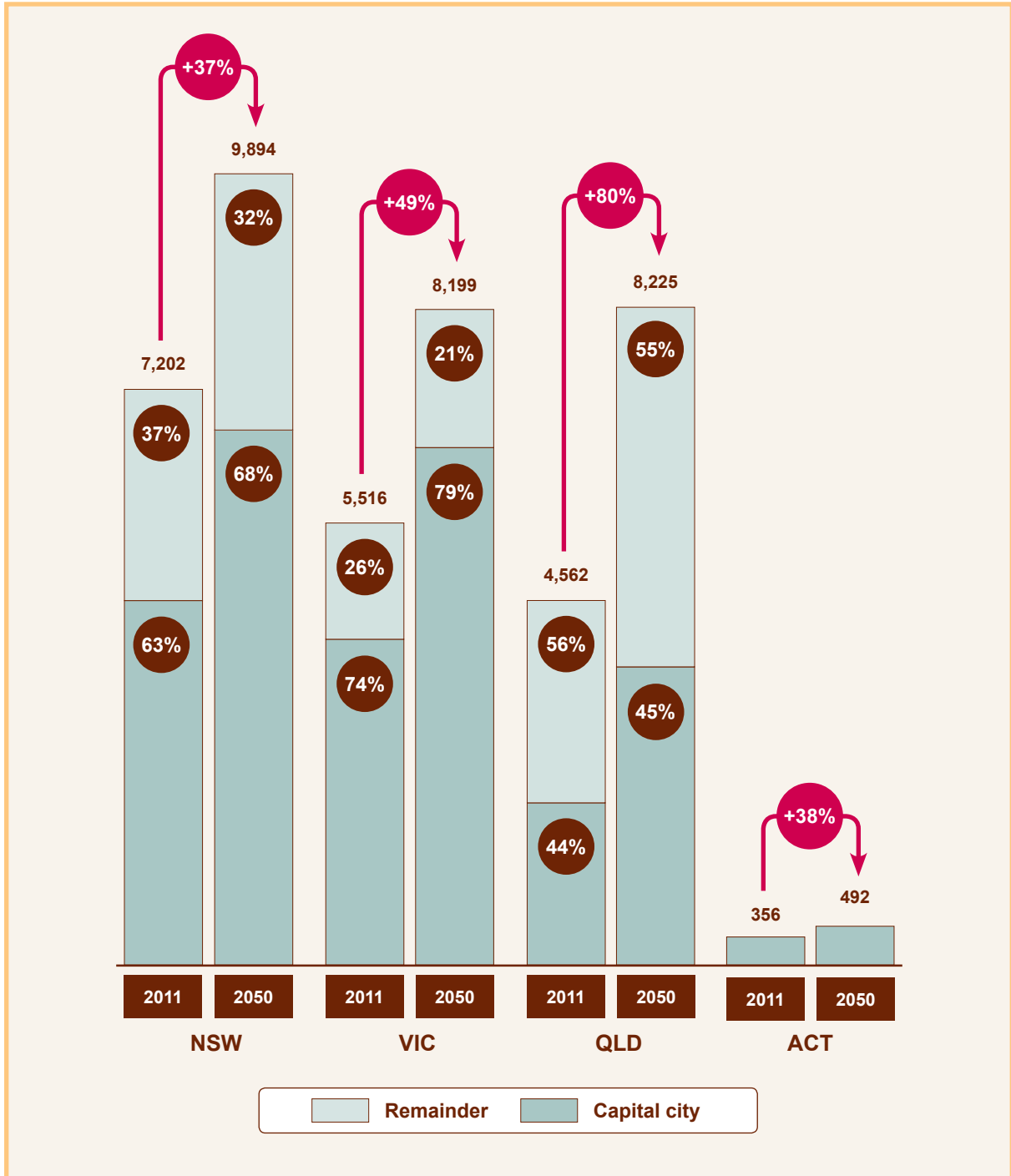
Population and employment forecasts

As illustrated in **Figure 2-2**, population growth was forecast for all states and major cities along the east coast. Sydney and Melbourne would continue to house the majority of each state's population (around 68 per cent and 79 per cent respectively). Brisbane would also continue to house a significant proportion of Queensland's population (45 per cent).

State forecasts of city centre employment growth were used to the extent that data was available. Beyond the state projection periods, it was assumed that city centre employment growth to 2065 would be the same as the overall population growth of the metropolitan area.

5 For a complete list of population and employment forecasts data sources, see **Appendix 1F**.

Figure 2-2 Forecast population growth along the east coast ('000)



Source: ABS⁶.

6 ABS, Population Projections Australia 2006 to 2101, catalogue no. 3222.0 (mid-range projections).

Road and public transport levels of service

Forecast level-of-service data for future journeys by road and public transport in the Sydney region and the metropolitan areas of Brisbane and Melbourne was obtained from the state transport departments. The information was derived from the state transport models and included future infrastructure and service improvements⁷.

The information was used to estimate access and egress times to HSR stations and the airports and also for estimating the journey times for the metropolitan component of regional road journeys.

Outside the metropolitan areas, the level of service by road, rail and coach was assumed unchanged from 2009 levels, on the basis that future infrastructure investment would maintain the current inter-urban transport levels of service.

Aviation scenarios

The base case assumes no second Sydney Airport, although aviation passenger capacity is assumed to increase with greater flight frequencies and increasingly larger aeroplanes. Based on the Joint Study and BITRE aviation forecasts, domestic air service frequencies at Sydney Airport were assumed to increase by 36 per cent between 2009 and 2035, and remain constant thereafter when the airport has reached capacity. For services which do not use Sydney Airport and would therefore not be capacity-constrained (such as Brisbane-Melbourne), the increases in frequency assumed were larger: 60 per cent, 80 per cent and 100 per cent in 2035, 2050 and 2065 respectively. Air fares were assumed to continue to decline until 2015 (by 0.5 per cent per year) and then remain constant in real terms through the forecast period, consistent with the Joint Study⁸.

International experience⁹ supports the following conclusions regarding the response of airlines to competing HSR services:

- Air services are likely to be curtailed or withdrawn where HSR services offer a competitive transport alternative.
- Full service carriers (FSCs) will continue to support their network strategies on major inter-city routes, albeit with smaller aircraft, but they may reduce service frequencies on low yield routes.
- Low cost carriers (LCCs) are likely to respond by transferring services to more profitable routes.
- A reduction in the air market size following the introduction of HSR may serve to increase competition between FSCs and LCCs for some major inter-city routes, and ultimately put some downward pressure on air fares.

It is not expected that airlines could, or would, respond to HSR competition by reducing their fares on a sustained basis. Rather, it has been assumed that airlines would quickly reduce capacity, either by reducing frequencies or aircraft sizes, to locations within the HSR corridor where there is significant passenger diversion to HSR¹⁰. This assumption is consistent with overseas experience where, following the introduction of HSR, the airline response has generally been to reduce services on the competitive route. For example, Air France responded to the completion of the Paris-Marseille HSR TGV route by reducing services and EasyJet exited the route. In Japan there has been some limited price competition from the airlines on competing routes to the Shinkansen, although arguably the Japanese domestic airline market was less competitive than Australia's is now.

7 State transport models are: the Sydney Strategic Travel Model (STM) held by the Bureau of Transport Statistics, Transport NSW; the Victorian Integrated Transport Model (VITM) held by the Department of Transport, Victoria; the Brisbane Strategic Transport Model – Multi-Modal (BSTM-MM) held by the Modelling, Data and Analysis Centre, Department of Transport and Main Roads, Queensland.

8 *ibid.*

9 For example, the Eurostar services across the English Channel, the Paris-Marseille TGV service and the HSR services in China.

10 It is likely that any reduction in capacity will be redeployed to routes outside the HSR corridor.

Airlines operating along key regional and inter-capital routes across the east coast of Australia already compete strongly against each other, and fare levels of many fare classes have declined over time, which suggests that airfare levels are already highly competitive on major routes.

The sensitivity tests reported in **section 2.9** include tests of the impacts on the HSR forecasts of variations in both air and HSR fares, including one scenario in which air fares are reduced by 50 per cent for two years.

The demand at Sydney Airport was 37 million passengers per year in 2010. According to the Joint Study, by around 2035 the airport is expected to be at capacity¹¹. Subsequent passenger demand would exceed the available capacity and, increasingly, some journeys would not be catered for. The Joint Study estimated that, after this point, there would be longer delays (on average an 11 minute increase in unexpected delays) due to reduced reliability, and a reduced ability of passengers to travel at their preferred times, with higher fares being used to spread peak demand, equivalent to an average seven per cent increase in aviation fares. These assumptions have been maintained in the reference case.

Additionally, the sensitivity of HSR demand to the impacts of additional aviation capacity in the Sydney region was tested. This test assumed that, even if an additional airport was built to cater for inter-city air traffic, Sydney Airport would remain the preferred destination for most flights which would compete with HSR, because of its proximity to the centre of Sydney and its well-developed supporting infrastructure. This could not be easily replicated by a new airport in any other feasible identified location. As a result, Sydney Airport would remain near to capacity in terms of slot utilisation, but without the previously assumed penalties relating to unreliability and the unavailability of preferred departure times.

Economic scenarios

Economic projections were underpinned by gross domestic product (GDP) and gross state product (GSP) projections based on the '3Ps' methodology used in the Australian Government's Intergenerational Report (IGR) 2010¹². This methodology assumes that trend growth rates over the forecast horizon to 2065 are a function of **population, productivity** and labour force **participation**, as determined by ABS demographic assumptions and state treasury economic assumptions.

Real Australian GDP growth over the period to 2065¹³ is projected to average 2.5 per cent per year. This is composed of average annual real GDP per person growth of 1.5 per cent and average annual growth in the total population of one per cent. This compares with the average of the past two decades of 3.1 per cent per year, during which there was stronger average growth in real GDP per person of 1.8 per cent and faster average growth in the total population of 1.4 per cent each year.

Real GSP growth rates in the east coast corridor to 2065 are projected to vary by state and territory, from an average of 1.9 per cent per year for the ACT to 2.9 per cent per year for Queensland. Real GSP per capita is forecast to grow from an average of 1.1 per cent for the ACT to 1.5 per cent for Victoria and Queensland.

Fuel price is an important factor in people's private vehicle travel decisions and in influencing public transport fares. The base case assumes fuel prices continue to increase in real terms, driven by crude oil prices, although this increase will be at least partly offset by improved fuel efficiency from advances in technology. A summary of the parameters that will impact on the future cost of travel is given in **Table 2-8**, and discussed further in **Appendix 1F**.

11 Australian Government and NSW Government, loc. cit.

12 Australian Government, *Australia to 2050: future challenges*, January 2010.

13 Growth beyond 2065 is extrapolated for commercial performance and economic appraisal in accordance with rates given in **Appendix 5A**.

Table 2-8 Base case economic parameter assumptions

Economic parameter	Assumption
GSP/capita	Forecast to grow on average 1.1% to 1.5% per year in real terms to 2065 in the corridor, varying by state.
Air fares	Decline by 0.5% per year in real terms from 2012 to 2015, then constant. This is consistent with the Joint Study ¹⁴ .
HSR fares	Follow the same trend as air fares. Base HSR fare structure reflects that of air fares.
Standard inter-urban/country rail fares	From 2011, a real increase of 55% by 2035, then a gradual increase to 2065 (a 65% increase over 2011).
Coach fares	From 2011, a 3% real increase by 2065.
Vehicle operating costs	From 2011, a 13% real increase by 2065.
Airport/station parking charges	Constant in real terms in \$2012.
Taxi fares	Constant in real terms in \$2012.
Local metropolitan bus and rail fares	Constant in real terms in \$2012.

The HSR fare structure is similar to that for air, with two components: a fixed flagfall and one varying directly with distance. On the key routes, Sydney-Melbourne and Brisbane-Sydney, where HSR would be competitive with air travel, HSR fares have been modelled to be comparable to, and competitive with, inter-city air fares. However, to compete effectively on shorter routes where HSR's primary competitor is car, the flagfall has been set lower than the comparable air figure, with a correspondingly higher distance component. As a result, modelled HSR fares are typically lower than modelled air fares for shorter regional journeys, and higher than air fares for longer journeys (e.g. Brisbane-Melbourne).

Table 2-9 outlines the comparative fares across selected routes. In practice, a range of fares will be offered on each route based on seat utilisation, booking flexibility and other factors, as is the case with air fares.

Table 2-9 Selected reference case fares for 2065 (\$2012 price levels)

From	To	Travel distance (km)	Leisure fare	Business fare
Brisbane	Newcastle	662	\$71	\$117
Brisbane	Sydney	797	\$83	\$136
Brisbane	Canberra	1,077	\$125	\$205
Brisbane	Melbourne	1,621	\$169	\$277
Newcastle	Sydney	134	\$31	\$52
Newcastle	Canberra	415	\$73	\$121
Sydney	Canberra	280	\$42	\$69
Sydney	Melbourne	824	\$86	\$141
Canberra	Melbourne	651	\$71	\$117
Albury-Wodonga	Melbourne	284	\$42	\$70

Unlike air fares, the HSR fares structure has a strong relationship with journey distance as is the case for travel by car, with which HSR competes for the shorter journeys along the east coast corridor. For example, HSR leisure fares for Sydney-Canberra journeys are far lower than air fares and therefore much closer to (but still higher than) the cost of the equivalent car journey.

For business travel by car, the vehicle operating costs per person (allowing for the average group size) are broadly similar to the assumed HSR fares over most distances. For typical non-business journeys, the HSR fare is about \$20 to \$30 per person higher than the perceived cost per person of travel by car at the average occupancy; for single-person occupancy, however, HSR is generally comparably priced or cheaper.

Access costs such as taxi fares, airport and station parking charges, and metropolitan bus and rail fares, also influence transport mode choice. These access costs have been assumed to remain constant in real terms.

2.4.1 Forecast travel demand

Forecasts for travel demand have been produced for 2035, 2050 and 2065, with travel for intermediate years being derived by interpolation and for years through to 2085 by extrapolation.

The travel market for future years was forecast by factoring the 2009 base travel market by the estimated rates of growth in travel demand. The growth in travel demand from 2009 has been based on two main factors, future population growth and income growth, as measured by GSP per capita¹⁵. This methodology is based on techniques used by BITRE. The growth in travel demand was proportional to the average population growth forecast for the origin and destination zones of each journey. It was also related to the growth in income (GDP per capita), with the degree of income sensitivity (or elasticity¹⁶) being determined separately for air, rail and coach travel, based on data from previous studies and supplemented, for air, by additional analyses of aviation trends.

¹⁵ The further influence of transport accessibility and prices on the balance of overall travel demand between the transport modes has been forecast separately through the mode choice forecasting procedures, described in **section 2.5**.

¹⁶ 'Income elasticity' is a measure of the extent to which the demand for a good or service is altered by a change in income. A high measure of elasticity indicates a commodity that is likely to be in higher demand as income increases (e.g. luxury goods), while a low measure of elasticity suggests that demand for the good or service is not significantly influenced by income (e.g. staple foods).

There was limited evidence about the sensitivity of the growth in medium and long distance car travel to income growth. This was sufficiently important that further information was sought through a specific analysis of the trends in light vehicle traffic flow on the major inter-city highways in the corridor. Traffic count data describing the trends in light vehicle traffic volumes at 56 sites on the Hume and Pacific Highways over the two decades to 2011 was assembled. This demonstrated that rural light vehicle traffic had grown, on average, by approximately 2.7 to 3.0 per cent per year over the past two decades across rural sections of the Hume Highway in Victoria and NSW, and on rural sections of the Pacific Highway in NSW.

A comparison with published ABS population statistics for the same period shows average annual population growth rates of 1.0 per cent, 1.1 per cent, 1.2 per cent and 2.1 per cent in NSW, Victoria, the ACT and Queensland respectively – very much less than the traffic growth rates in the corridor. Over the same period, income (GDP per capita) has increased by 1.8 per cent per year on average and car fuel prices by 4.6 per cent per year on average.

Relationships were estimated between the growth in rural light vehicle traffic at 56 sites and the growth in per capita GDP, population and changes in fuel prices, allowing for the impacts of network changes in the corridor. The analysis confirmed that car travel demand grows significantly with income, and an appropriate elasticity of car travel demand to income growth was identified.

The resulting set of income elasticities on which the demand forecasting was based are given in **Table 2-10**. As short distance travel is likely to be less sensitive to income growth, the conservative assumption was made that the income growth elasticities for short regional journeys were lower (by 50 per cent). The travel demand elasticities were assumed to mature (i.e. reduce) through time, the rate of maturing for air being consistent with the Joint Study¹⁷. In the absence of evidence on maturation rates of the car, coach and rail demand elasticities, a faster maturation rate (implying a reducing growth rate) has been used, again as a conservative assumption.

Table 2-10 Income elasticities of various travel modes

Year	Air	Car		Rail/Coach	
		Inter-city / long regional	Short regional	Inter-city / long regional	Short regional
2009	1.00	0.80	0.40	0.57	0.28
2035	0.88	0.62	0.31	0.44	0.22
2050	0.82	0.54	0.27	0.38	0.19
2065	0.76	0.46	0.22	0.33	0.16

For the base case scenario, as a result of the assumed growth in population and income, the travel market (without HSR) is forecast to grow at approximately 1.9 per cent per year to 2035, then 1.4 per cent per year to 2050 and a further 1.1 per cent per year to 2065.

By 2065, without HSR, the total corridor demand would have more than doubled, from 152 million trips in 2009 to approximately 355 million trips in 2065. The total future travel markets for 2035, 2050 and 2065 are summarised by sector in **Table 2-11** to **Table 2-13**.

17 Australian and NSW Governments, loc. cit.

Table 2-11 Total travel market forecast for 2035 without HSR ('000 trips per year)

Sectors	Brisbane	Gold Coast	Intermediate	Newcastle	Intermediate	Sydney	Intermediate	Canberra	Intermediate	Melbourne	Total
Brisbane	X	33,540	4,620	520	430	6,960	1,040	1,100	970	5,080	
Gold Coast		X	5,440	390	340	3,680	750	320	680	2,540	
Intermediate			X	4,240	X	8,140	320	400	X	790	
Newcastle				X	4,320	9,780	1,400	360	230	600	
Intermediate					X	17,560	390	420	X	420	
Sydney						X	33,580	7,810	3,010	11,820	
Intermediate							3,620	3,660	240	1,290	
Canberra								X	1,670	2,400	
Intermediate									X	58,330	
Melbourne										X	
Total											245,150*

*The total does not exactly match the sum of the cells due to rounding.

Table 2-12 Total travel market forecast for 2050 without HSR ('000 trips per year)

Sectors	Brisbane	Gold Coast	Intermediate	Newcastle	Intermediate	Sydney	Intermediate	Canberra	Intermediate	Melbourne	Total
Brisbane	X	42,410	5,640	670	580	9,550	1,370	1,500	1,320	7,300	
Gold Coast		X	6,360	500	450	4,940	960	420	910	3,550	
Intermediate			X	4,690	X	9,760	370	480	X	1,020	
Newcastle				X	4,870	11,120	1,580	430	270	780	
Intermediate					X	20,710	440	520	X	570	
Sydney						X	38,700	9,720	3,760	16,150	
Intermediate							4,000	4,200	280	1,710	
Canberra								X	1,980	3,240	
Intermediate									X	72,000	
Melbourne										X	
Total											301,780*

*The total does not exactly match the sum of the cells due to rounding.

Table 2-13 Total travel market forecast for 2065 without HSR ('000 trips per year)

Sectors	Brisbane	Gold Coast	Intermediate	Newcastle	Intermediate	Sydney	Intermediate	Canberra	Intermediate	Melbourne	Total
Brisbane	X	51,200	6,610	840	750	12,570	1,730	1,960	1,680	9,890	
Gold Coast		X	7,160	610	570	6,360	1,190	530	1,140	4,740	
Intermediate			X	5,020	X	11,320	420	560	X	1,260	
Newcastle				X	5,340	12,290	1,740	490	310	970	
Intermediate					X	23,750	480	630	X	730	
Sydney						X	43,420	11,660	4,460	20,930	
Intermediate							4,300	4,680	320	2,130	
Canberra								X	2,240	4,130	
Intermediate									X	81,660	
Melbourne										X	
Total											354,760*

*The total does not exactly match the sum of the cells due to rounding.

2.5 Forecasting the impacts of the preferred HSR system on east coast travel demand

Following from the first and second stages of the demand forecasting procedures (i.e. evaluation of the current travel market, and forecasting of travel demand without HSR (the base case)), the third stage was to estimate the impacts of the preferred HSR system (the reference case) on the levels of travel demand assumed in the base case. These impacts would be twofold: a transfer of demand from existing modes of transport to HSR, and an overall increase in travel demand resulting from the improved transport accessibility (referred to as induced demand).

The general approach to the demand forecasting, which is described below, was based on international practice.

2.5.1 Structure of the east coast travel demand forecasting procedure

The structure of the east coast travel demand forecasting procedure is illustrated in **Figure 2-3**. At the top level is the base case market estimate, described above, to which is added a process for forecasting the induced travel demand. At the second level, the travel market is allocated to three groups of modes: car, 'fast' mass transport (air and HSR), and 'slow' mass transport (conventional rail and coach). In the third level, the 'fast' mass transport demand is allocated between HSR and air. Up to this point, the model structure is very similar to that used in the previous Australian HSR studies.

The further components (shown as red boxes in **Figure 2-3**), relate to additional features developed specifically for this study. Two additional levels

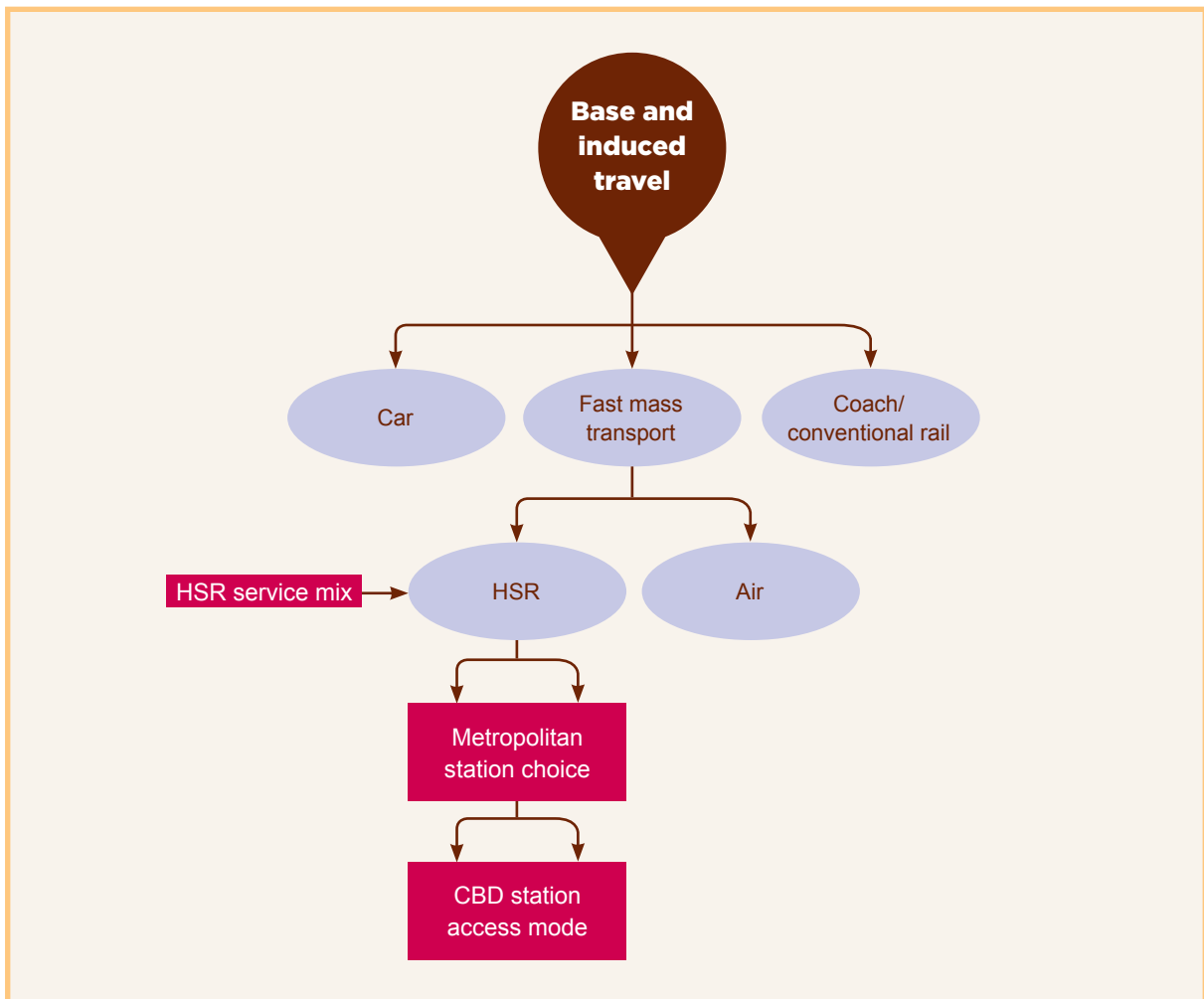
were added to the model to assist in making decisions on the locations of city centre and peripheral park-and-ride stations. These deal with metropolitan station choice, and were used to forecast the preference of HSR users for alternative station locations, making allowance for the modes of transport that would be available for travel to and from the stations.

The additional service mix model deals with the pattern of HSR services along the HSR line. Both inter-capital express services (e.g. non-stop Brisbane-Sydney and Sydney-Melbourne) and inter-capital regional services (e.g. between Brisbane and Sydney and Sydney and Melbourne, with varying stopping patterns at regional stations

along the way) would operate (see **Chapter 3**). This model was used to allocate HSR passenger demand between the different services available, and to capture the effect that a mix of HSR services would have on the HSR demand forecasts.

The procedure also drew on international evidence to allocate appropriate values to the parameters used in this model. This evidence is referenced and discussed in **Appendices 1D** and **1E**. Additionally, to confirm that the demand forecasts reflect Australian travel choice behaviour and are appropriately sensitive to the attributes of the HSR service, an SP survey on the impacts of HSR was carried out in the east coast corridor and the results incorporated in the demand forecasting procedures.

Figure 2-3 Transport modelling methodology summary



2.5.2 Stated preference survey

SP surveys can be used where evidence on travel choice behaviour cannot be obtained in real life. For example, where a new transport mode such as HSR is being considered, SP survey techniques provide a means of exploring how people making relevant journeys would react to the availability of HSR.

The objectives of the SP survey for this study were to investigate the key model parameters, which determine:

- The overall sensitivity of transport mode shares to changes in transport service characteristics (the scaling parameters).
- How sensitive mode shares are to transport prices (the ‘values of time’).
- The choice of station and mode of station access.
- The extent of preference (or otherwise) for HSR, beyond the measurable improvements in level of service (journey times, service frequencies, fares, access and egress), referred to as ‘alternative specific constants’ (ASCs)¹⁸.

This survey followed international practice, in that people making relevant journeys within the east coast study area were identified and presented with hypothetical scenarios in which an HSR service would provide their journey. They were then asked to choose between their existing transport mode and HSR. Each survey respondent was presented with nine different scenarios in which the competitive position of HSR relative to their current mode was varied. More than 2000 people were surveyed.

Formal statistical analysis of travel choice data obtained from SP surveys provides considerable information on how people weigh up the different aspects of each transport mode in choosing between the alternatives.

The design of the SP survey was informed by local focus groups and a pilot survey, and also took note of both the previous Speedrail study and the SP survey undertaken for a recent United Kingdom HSR study¹⁹.

The survey sample was drawn from residents of two major cities (Melbourne and Sydney), two large population centres (Canberra and Newcastle) and two regional towns (Albury and Wagga Wagga) who had recently travelled to selected destinations in the corridor.

Survey sample quotas were defined according to home area, purpose, journey length and mode. Further details of the survey design are provided in **Appendix 1D**.

Statistical analysis of survey results

Statistical analysis of the SP survey results yielded information about the following:

- Segmentation and sub-markets: the SP analysis confirmed the general structure of the model, based on (a) business and non-business; and (b) a division by distance into short regional, long regional, and inter-city.
- Mode choice hierarchy (the overall model structure pictured in **Figure 2-3**): the survey findings supported the model assumption that HSR is most similar to the air mode, and that these two modes should therefore continue to be represented in a lower level in the hierarchy. In addition, the analysis strongly supported station choice and access being the two lowest levels in the hierarchy.
- Values of time (which determine the influence of transport costs): the study’s derived values of time (shown in **Figure 2-14**) were well supported in the SP analysis; higher values of time for longer journeys were found in the previous Australian studies and with international experience²⁰.

18 An alternative specific constant (ASC) represents factors that are not able to be explicitly included in an evaluation (e.g. an aversion to flying and a preference for HSR because it is easier to do work on the train: evidence on the preferences for different modes is reported in **Appendix 1A**).

19 Rand Europe, Modelling demand for long-distance travel in Great Britain, stated preference surveys to support the modelling for high-speed rail, 2011.

20 See for example: Abrantes and Wardman, Meta Analysis of UK Values of Time: an Update (Transportation Research A), 2001 and other evidence reviewed in **Appendix 1D** including the Speedrail and Very Fast Train Studies.

Table 2-14 Derived values of time (\$2012/hr)

Purpose	Distance		
	Short regional	Long regional	Inter-city
Business	38	81	57
Non-business	9.5	20	14

In accepted modelling practice, SP analysis should not be directly used for a demand model because individuals' stated preferences may not match their actual behaviour. Instead, SP analysis should be re-scaled using data relating to actual choices (termed 'revealed preferences'). This has been done using the NVS data. Further detail is given in **Appendix 1D**.

Other survey findings

In addition to the results of the statistical analysis, the survey provided a number of insights into the likely response to an HSR service. Interest among respondents was generally favourable. HSR was considered to be an attractive travel option, and many respondents chose HSR in all scenarios presented, while some of those who never chose it in relation to their current journey still said that they would consider it for other journeys. Rail passengers were most likely to switch to HSR, followed by air passengers. There was less response from existing car travellers, many of whom have reasons other than time and cost for choosing to travel by car.

Survey results indicated that HSR was seen as a good choice for journeys to the large centres such as Melbourne, Brisbane and the Gold Coast, and also for those living in the regional areas. Consideration of possible locations for HSR terminals in the capital cities suggested that existing major CBD terminals were strongly preferred because of their proximity to where people start and end their journeys, and their access to connecting transport services to distribute passengers throughout the metropolitan areas. Those living in the major cities preferred central stations to other locations, especially locations that did not have both good public transport and

parking available. This was less of a concern for those living in the regional areas.

Model outputs

The final stage in the forecasting procedures was the development of model outputs to inform the development of the HSR corridor and alignment, and the appraisal processes.

Model output templates provide both summary and detailed analyses of the model forecasts for all appraisals, including corridor travel demand, HSR trips, trip kilometres, revenues and user benefits, the impacts on other modes, the modes of access to every HSR station and passenger loadings on individual HSR services. Forecasts are provided for the year 2065, when the appraisal assumes that the full HSR program would be implemented. The commercial and economic appraisal provided in **Chapters 7 and 8** takes account of the staged delivery of HSR described in **Chapter 6**. The growth in HSR demand arising from the staged implementation is also shown in **section 2.7**.

Following the introduction of new transport infrastructure and services, there is typically a delay in achieving the forecast demand levels, as travellers adapt to the availability of a new transport facility. This is referred to as the ramp-up period.

Ramp-up on toll roads is typically expected to be achieved within two years and this is reported to be true of some HSR services (e.g. many of the French TGV services). But for other HSR services, it has taken longer: the Thalys service between Paris, Brussels, Cologne and Amsterdam, and the Tokaido service in Japan, are both reported to have experienced ramp-up of demand over five years²¹.

21 Refer to **Appendix 1E** for the detailed evidence.

Many European and Japanese HSR services were developed in corridors that already had high levels of rail demand, which is likely to shorten the ramp-up period. This would not be the case along the east coast of Australia; therefore, a more conservative five-year ramp-up profile for the HSR service was adopted (**Table 2-15**). This assumes

that, in the first year after opening, just 40 per cent of the potential demand would be achieved, with the full potential demand being achieved in the fifth year. This profile was applied to each new stage of the HSR system in the commercial and economic appraisal.

Table 2-15 HSR ramp-up assumption: the proportion of the potential demand achieved in each of the first five years after opening

Year				
1	2	3	4	5
40%	55%	75%	90%	100%

2.6 Verification of the demand forecasting procedures

This study has placed an emphasis on benchmarking the HSR demand forecasts against international evidence. This is particularly important given the evidence that some past demand forecasts for other HSR lines have proved to be optimistic. This section presents the benchmarking evidence comparing the HSR demand forecasts²² with international experience.

For consistency with the independent evidence, unlike the final HSR forecasts presented later in this chapter, the HSR forecasts used for these comparisons assume Sydney Airport is not capacity-constrained.

2.6.1 Benchmarking the comparative air to HSR mode shares against international experience

Considerable evidence has been assembled in the international literature on the impacts of HSR on inter-city air travel in Europe, Japan and Korea²³. How the total combined HSR/air market is shared between the two modes has been the focus of much research and commentary.

In **Figure 2-4**, the international statistics are represented by the blue dots, which show the HSR shares of the combined air/HSR travel markets on selected routes. For HSR journey times less than two hours, this is typically over 80 per cent, whereas if HSR journey times exceed 4.5 hours, the HSR share falls below 30 per cent.

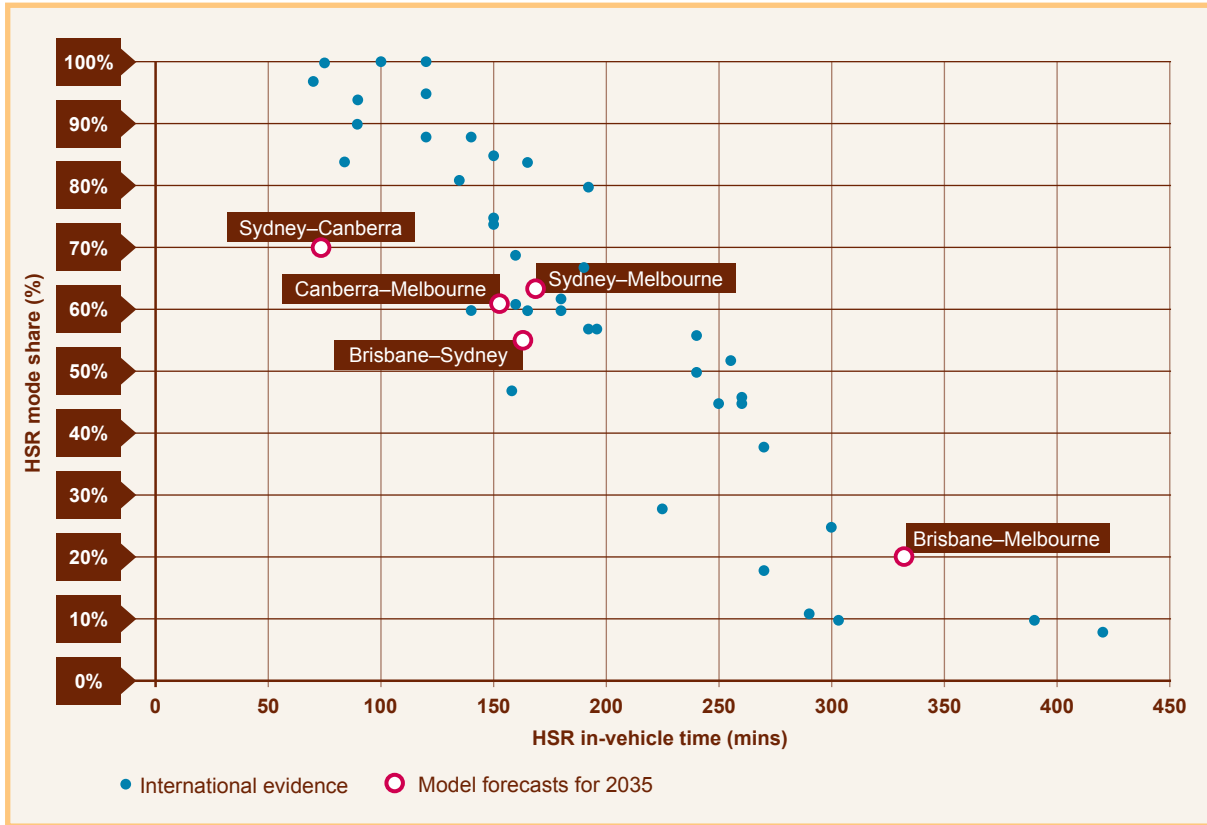
The inter-city forecasts for this study for 2035 are shown in the figure as red circles.

The strong consistency of the east coast forecasts with international experience is evident. The forecasts for Brisbane-Melbourne are at the high end of the range for journeys over five hours, while Sydney-Canberra is lower than the expected range for journeys less than two hours, but this is largely explained by the relatively high proportion of passengers transferring to connecting flights, which are assumed in the forecasts not to divert to HSR.

22 The full HSR line from Brisbane to Melbourne is assumed in these comparisons.

23 For details see **Appendix 1A**.

Figure 2-4 HSR share of combined HSR/air travel market, comparing the final model forecast for 2035 with international evidence²⁴



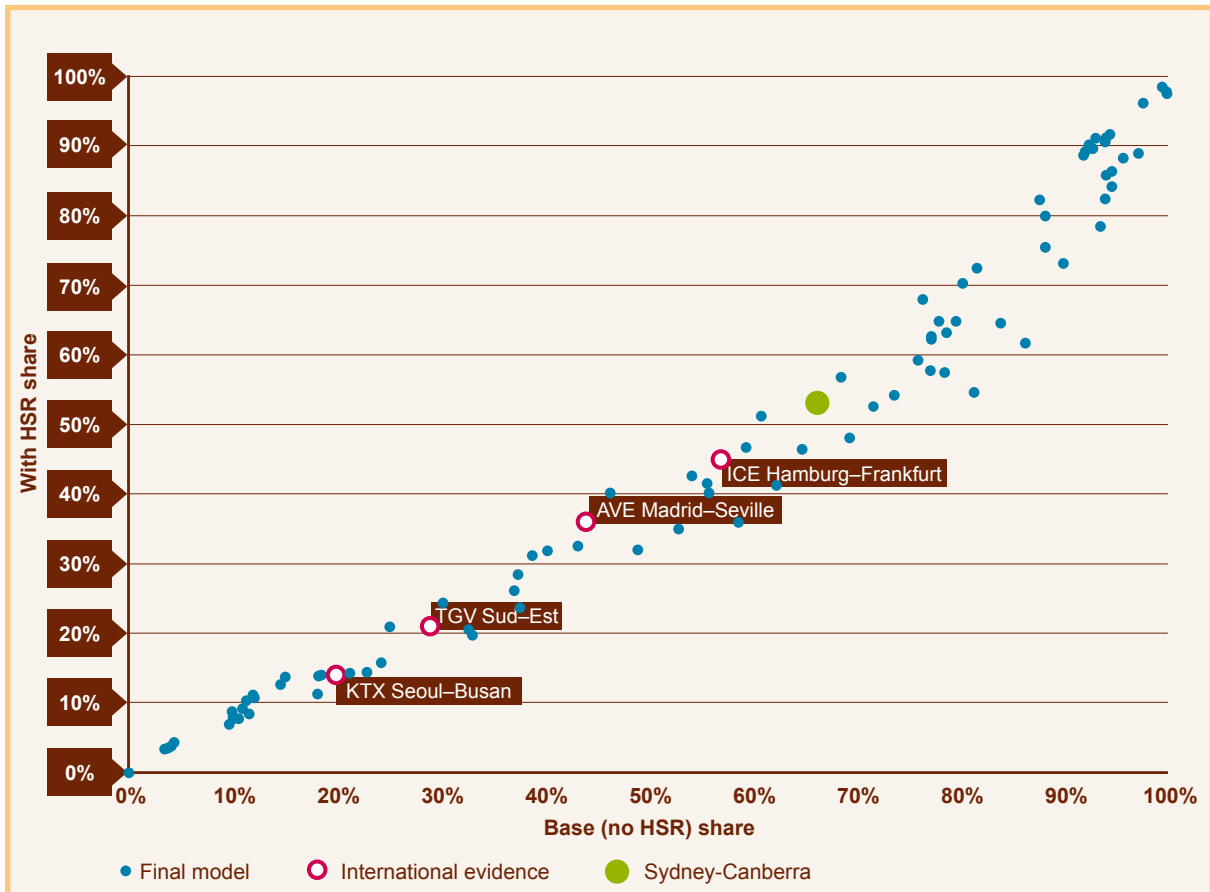
2.6.2 Consistency of the forecast transfer from car to HSR with international experience

In transport demand forecasting, estimates of the diversion from car to other transport modes such as HSR are subject to uncertainties, principally because there are many reasons why the private vehicle is chosen for journeys other than simply journey time and cost. Once the HSR service is introduced, car trips are forecast to divert to HSR as illustrated in **Figure 2-5**, where the blue dots refer to trips between the ten sectors in the east coast study area (shown earlier in **Figure 2-1**).

For each pair of sectors, the forecast car mode share in the east coast corridor in 2035 in the reference case (with HSR) is plotted against the car mode share in the base case (without HSR). For example, one dot is highlighted in green. This is the sector pair concerning the travel between Sydney and Canberra. Without HSR the car mode share is 66 per cent, and this reduces to 53 per cent with HSR, as shown.

²⁴ For consistency with the international data, the east coast HSR forecasts in this figure assume that Sydney Airport is not over-capacity and encompass the full air demand on these routes by making an allowance for the air transfer trips not specifically modelled in this study.

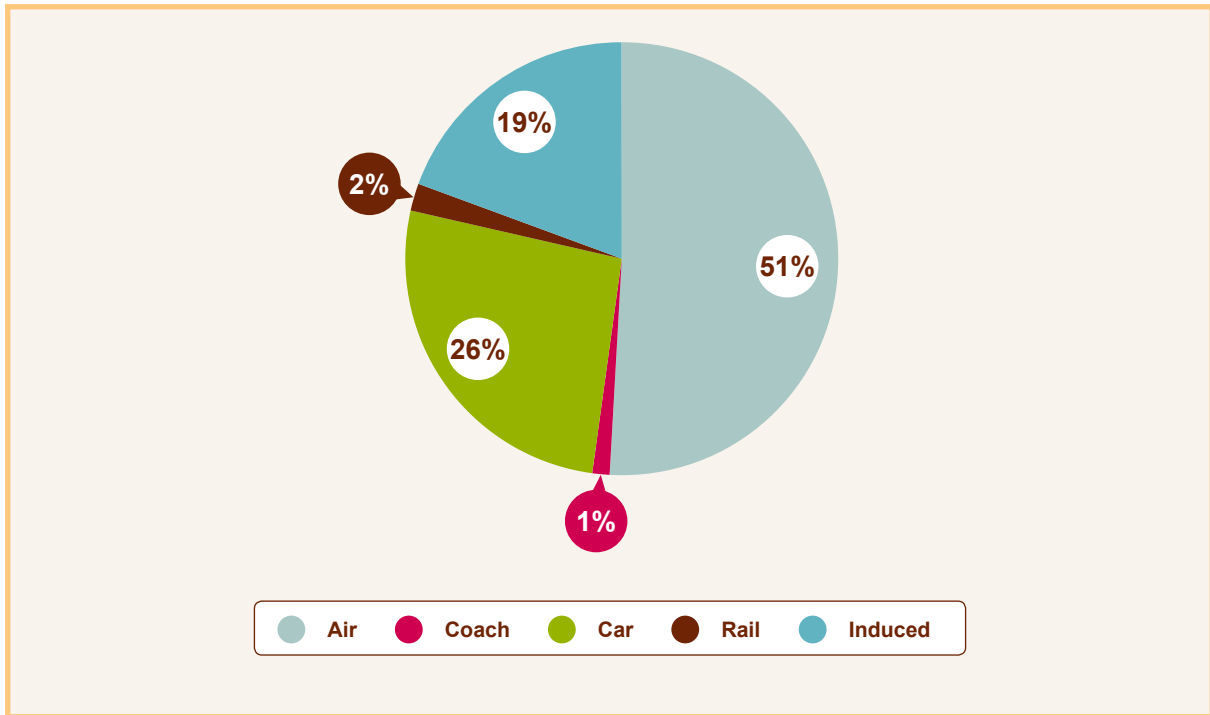
Figure 2-5 Mode transfer from car to HSR, comparing the forecast for 2035 with international evidence



It is evident that the car mode share in the 2035 base case varies greatly between the very long journeys, for which the car is rarely used, to the shorter journeys, which are largely made by car. The reduction in the car mode share varies between very little to about 20 percentage points. For Canberra to Sydney trips, the car mode share reduces by 13 percentage points.

The limited international evidence on the effect of HSR on the car share of travel is also included in the figure, and the particular HSR service is identified (represented by red circles). It is again clear that there is considerable consistency, providing support for the forecast of diversion from car provided by the east coast demand forecasting procedures.

Figure 2-6 Source of HSR travel demand in 2035 (trips)



2.6.3 Consistency of forecast induced HSR travel with international experience

The various sources of HSR demand are presented in **Figure 2-6**. Trips diverted from air account for 51 per cent of HSR passengers; 26 per cent are forecast to divert from car travel. The next largest component is induced travel. Overall, 19 per cent of HSR trips are forecast to be induced; international experience²⁵ suggests that the most common range of induced travel on HSR is 20 to 30 per cent, so these forecasts are on the conservative side of this range.

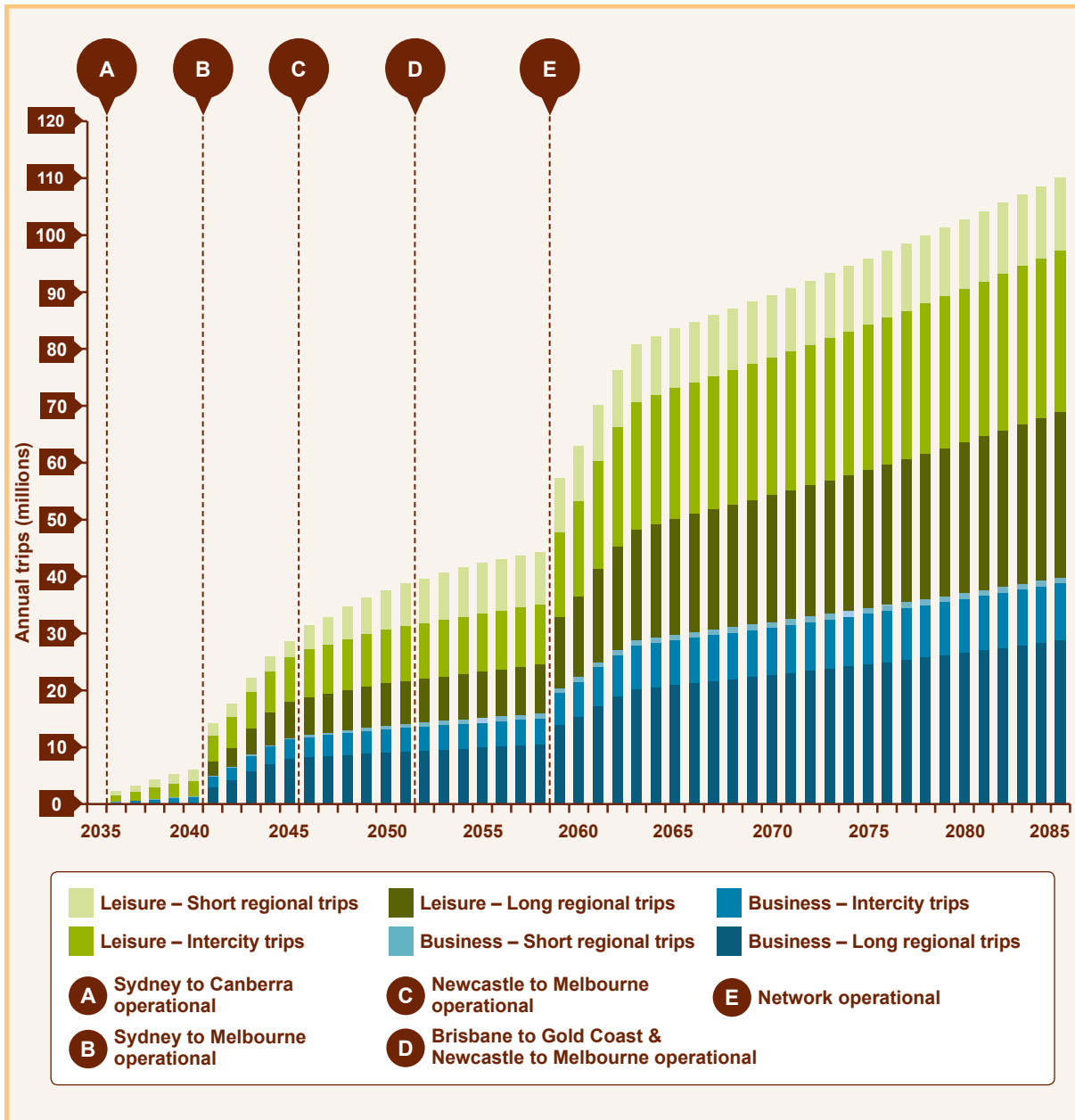
2.7 The forecasts for the preferred HSR system

The final forecasts for the preferred HSR system (the reference case) are summarised in this section. Unlike the verification forecasts in **section 2.6**, these allow for the impacts of aviation congestion in Sydney.

The preferred HSR system would be implemented over a period of decades, as described in **Chapter 6**. By 2065, under the reference case assumptions, the HSR network is forecast to attract 83.6 million passenger trips per year, as illustrated in **Figure 2-7**.

25 Presented in **Appendix 1E**.

Figure 2-7 Reference case demand forecasts for HSR by market segment



Subsequent forecasts and analysis in this chapter are presented for the year 2065, when the preferred HSR system would be complete and fully ramped up.

All forecasts presented here assume the complete HSR network between Brisbane and Melbourne. Associated with this demand is an estimation of the benefit to users of the HSR system, adopted in the economic appraisal and presented in **Chapter 8**.

The HSR demand forecasts for 2065 are given in **Table 2-16**. HSR demand for business and non-business purposes is forecast to be 83.6 million passengers. The HSR passenger kilometres are those travelled on the train and are measured in terms of track length between stations. This is distinct from HSR person travel kilometres (in **Table 2-20**), which are based on zone-to-zone distances.

Table 2-16 Travel demand for 2065

Total travel market with HSR ('000s trips)	HSR travel market	
	HSR trips ('000s)	HSR passenger kilometres (billion)
388,690	83,600	53.1

Table 2-17 shows the breakdown by sector of the forecast east coast travel market in 2065 with a full HSR system in place. The forecasts are larger than

those in **Table 2-13** because the induced travel leads to a higher total travel demand forecast with HSR.

Table 2-17 Total travel market matrix for 2065 with HSR ('000 trips per year)

Sectors	Brisbane	Gold Coast	Intermediate	Newcastle	Intermediate	Sydney	Intermediate	Canberra	Intermediate	Melbourne	Total
Brisbane	X	52,740	7,620	1,100	1,010	16,220	2,210	2,260	1,970	10,450	
Gold Coast		X	7,720	800	810	7,390	1,380	580	1,350	4,800	
Intermediate			X	5,540	X	13,810	500	720	X	1,600	
Newcastle				X	5,440	13,350	1,850	610	390	1,040	
Intermediate					X	25,840	500	760	X	1,000	
Sydney						X	45,270	13,690	5,300	26,950	
Intermediate							4,350	4,880	350	3,060	
Canberra								X	2,550	4,890	
Intermediate									X	84,020	
Melbourne										X	
Total											388,690*

*The total does not exactly match the sum of the cells due to rounding.

The equivalent breakdown of the 83.6 million HSR passengers is given in **Table 2-18**. The HSR share of the total travel demand is given in **Table 2-19**. The HSR mode share of the shorter journeys is forecast to be low, typically five to 15 per cent, and to reach its maximum for the inter-city journeys (Sydney-Melbourne 70 per cent, Sydney-Brisbane 67 per cent). For other long journeys, HSR is forecast to account for 25 to

44 per cent of the market. Overall, the HSR mode share is forecast to capture 22 per cent of the travel market. Infrastructure need is more directly related to trip kilometres and, when measured this way, HSR accounts for 40 per cent of the forecast travel market in the east coast corridor. **Table 2-20** shows the breakdown by the east coast market sectors; the distance measure used for all modes is the car travel distance.

Table 2-20 Distribution of east coast travel market by mode of transport and purpose for 2065 (person travel kilometres)

Purpose	Mode of transport					Person travel kilometres (millions)
	HSR	Air	Car	Rail	Coach	
Inter-city						
Business	63%	35%	2%	0%	0%	32,157
Non-business	40%	50%	10%	0%	0%	49,831
Long regional >250 km						
Business	60%	17%	22%	0%	1%	8,283
Non-business*	41%	11%	44%	1%	2%	32,578
Short regional <250 km						
Business	5%	1%	87%	6%	1%	2,510
Non-business	5%	0%	86%	6%	3%	25,654
Total person travel kilometres (millions)	59,928	40,912	46,316	2,156	1,702	151,014
Total person travel kilometres (%)	40%	27%	31%	1%	1%	100%

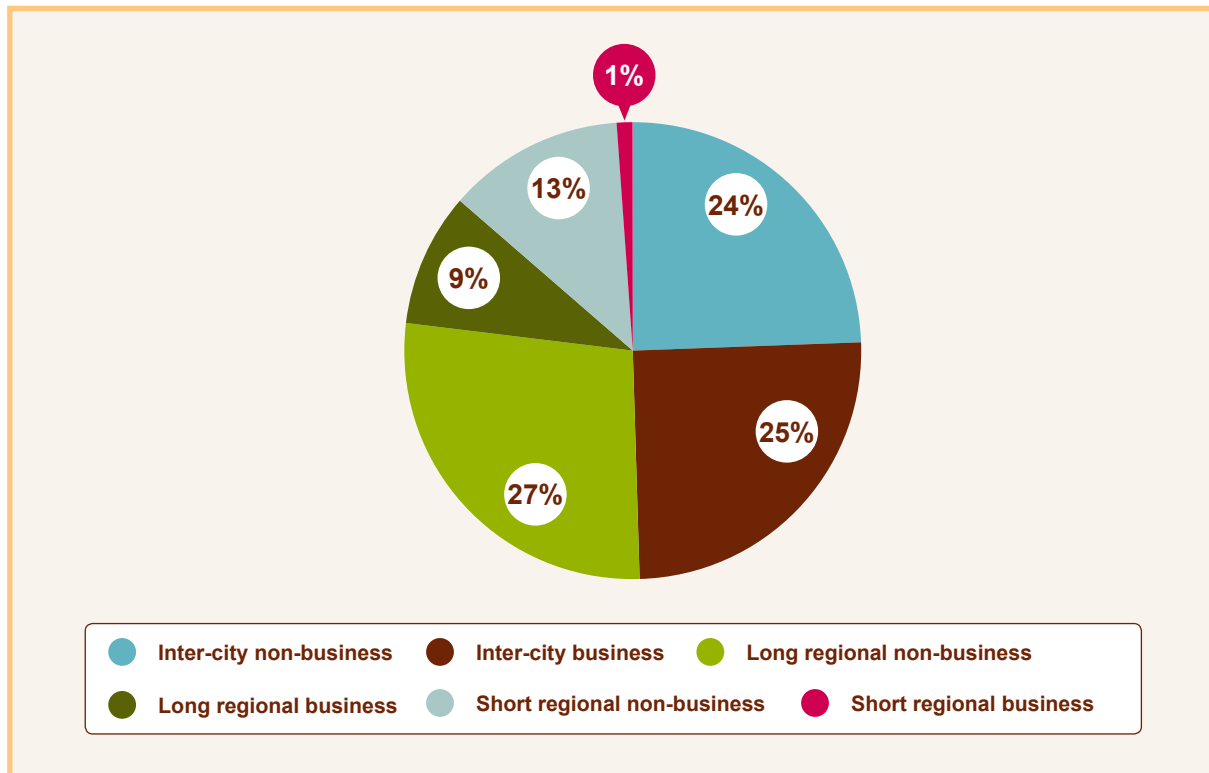
*Total does not add up exactly to 100% due to rounding.

For the calculation of person travel kilometres on each mode, a single common measure of zone-to-zone distance is used (unlike the measure of HSR passenger kilometres in **Table 2-16**, which uses the distance on the rail line).

2.7.1 HSR demand forecasts analysed

The overall contributions to HSR demand by purpose and distance segments are summarised in **Figure 2-8**. Business travel accounts for 35 per cent of HSR demand, with inter-city business travel accounting for most of this. Only 14 per cent of HSR demand comprises short regional trips.

Figure 2-8 Source of HSR travel demand (trips) in 2065 by journey type



Note: Total does not add up exactly to 100% due to rounding.

The sources of HSR demand (the diversion from each mode and induced trips) are detailed in **Figure 2-9** and **Figure 2-10** by trip purpose and distance segment respectively. Overall, 55 per cent of HSR trips are diverted from air, 23 per cent are diverted from car and 19 per cent are induced.

The diversion from air is higher for business travel (66 per cent), while the diversion from car is higher for non-business travel (30 per cent). For inter-city travel, the largest component of HSR demand (75 per cent) is diverted from air. This would be expected, as air is the main current mode for such journeys. Similarly, the car is currently the main mode for short regional travel, and the diversion from this mode accounts for 72 per cent of short regional demand on HSR.

There is some diversion from rail only for short regional trips (ten per cent), and less induced travel for short regional trips. In the former case, this is because rail is only significant in the base market for short regional journeys and, in the latter case, it indicates that in general HSR does not provide a large improvement in accessibility over private car for the shorter journeys.

Within modelling limitations, the forecasts imply that by 2065, HSR could attract 40 per cent of inter-city air travel on the east coast and 60 per cent of regional air travel (primarily long regional). Specifically, on the major routes directly served by HSR (i.e. Sydney to Melbourne, Brisbane and Canberra), over 50 per cent of the air travel market could be attracted to HSR. HSR would also attract a share of the significant growth in road traffic expected over the subsequent decades.

Figure 2-9 Source of HSR travel demand (trips) in 2065 by trip purpose

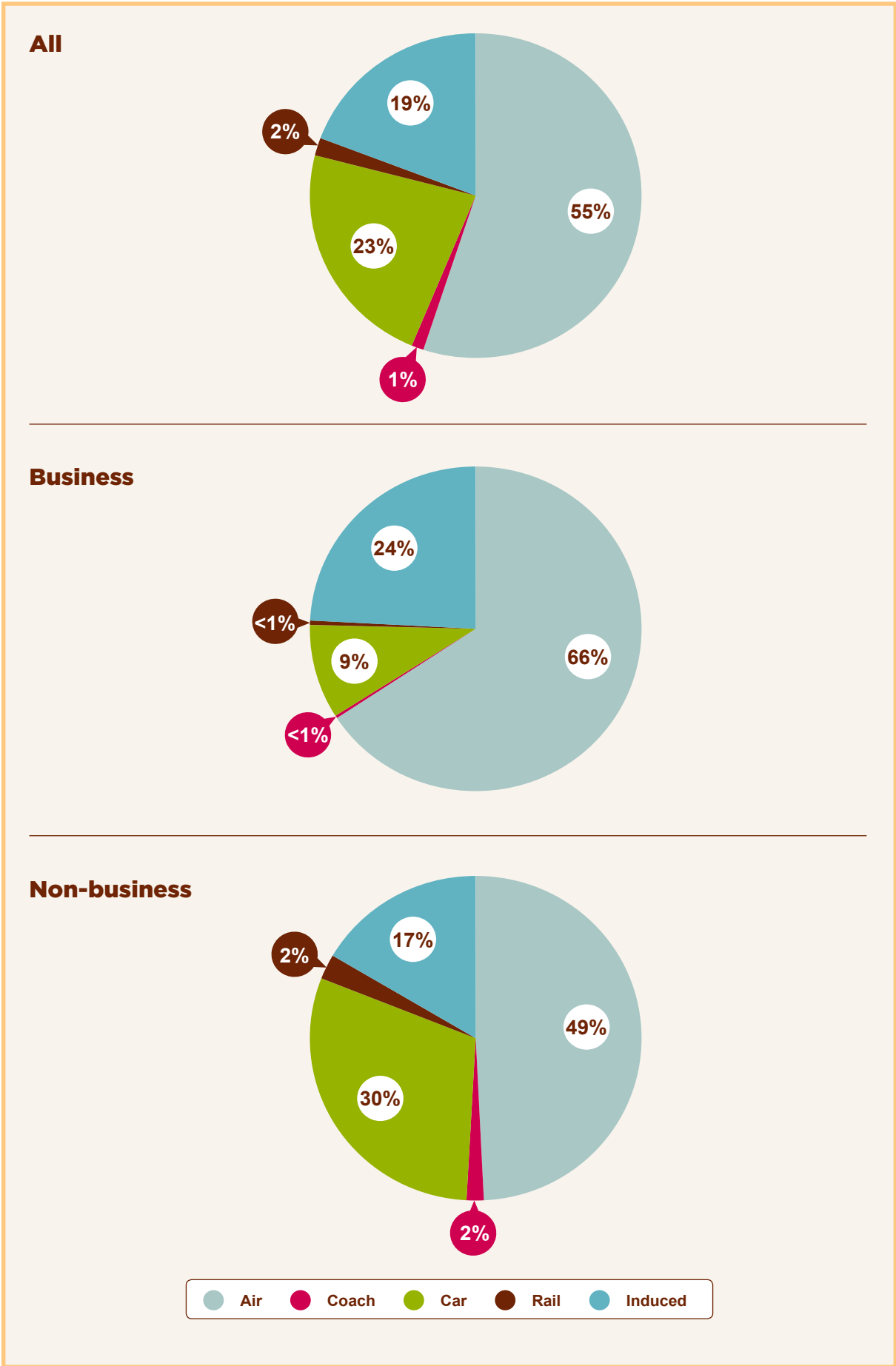
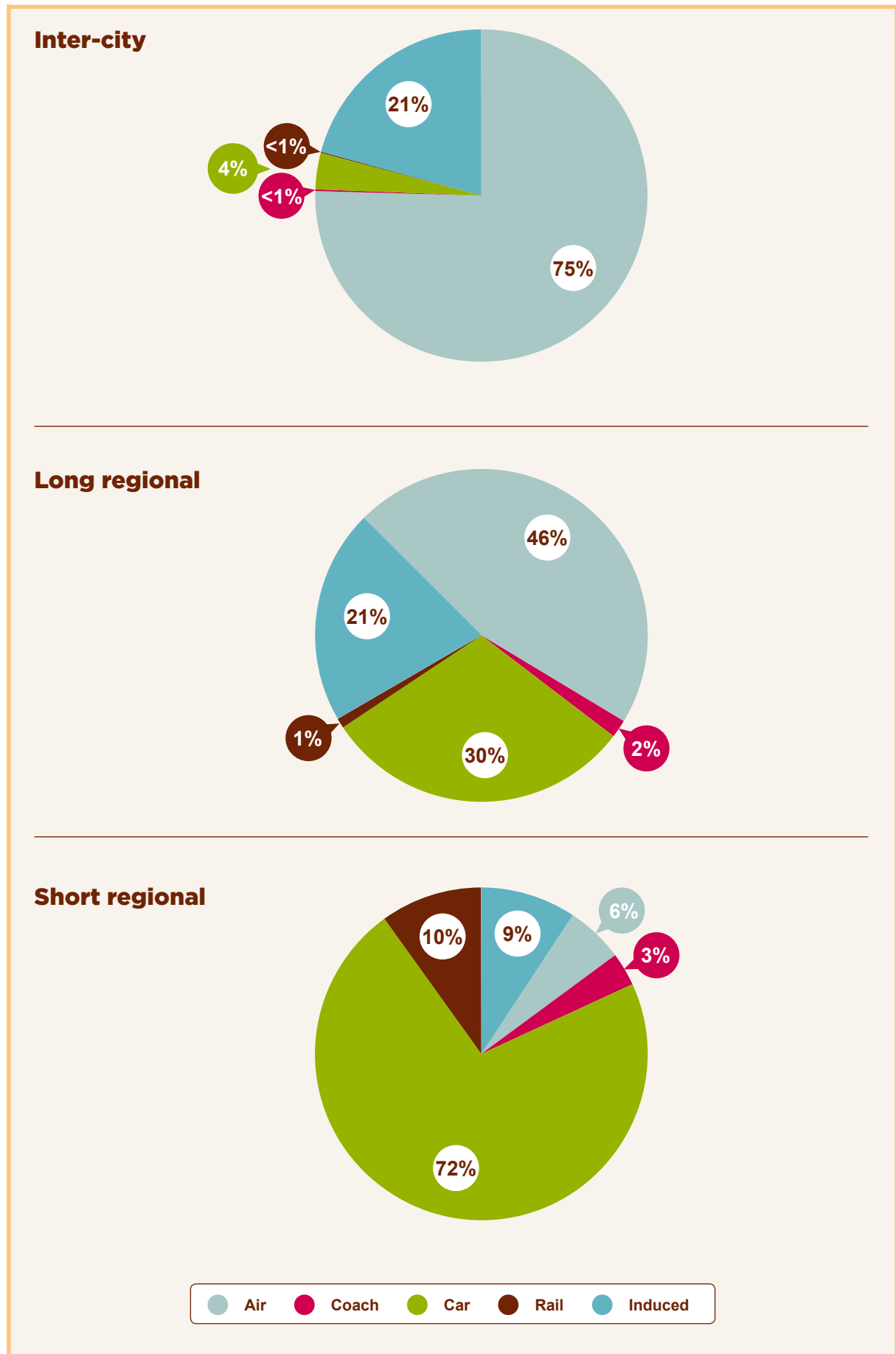


Figure 2-10 Source of HSR travel demand (trips) in 2065 by distance segment



Note: Inter-city total does not add up exactly to 100% due to rounding.

HSR would offer improvements in transport service over other modes of transport.

Figure 2-11 provides an indication of the relative competitive features of HSR in relation to the demand forecasts²⁶.

One of the principal benefits of HSR over air travel is that it provides direct services between city centres, rather than stopping the service on the metropolitan periphery for passengers to continue to their final destination by other means (similar to the experience of air passengers arriving at an airport). This benefit is estimated to account for around 23 per cent of demand.

The second principal benefit of HSR is its high speed and therefore shorter journey times, which together account for 51 per cent of HSR demand. Thirty-one per cent is accounted for by the high speed of 300 kilometres per hour (this benefit has been estimated by testing the impact of reducing the HSR service speed to a much slower speed of 100 kilometres per hour), while 20 per cent is attributable to this lower speed still being considerably faster for shorter distance rail journeys than conventional rail lines because of its limited stops. It also provides a very large improvement in service frequencies, connectivity and rail times for medium and longer journeys.

The differential time required at an airport, related to check-in and security requirements and the time taken to traverse the airport, is estimated to account for around ten per cent of HSR demand.

The avoidance of congestion at Sydney Airport in the base case accounts for about eight per cent of HSR demand.

The forecasts assume that some travellers would have a preference for HSR over and above the level-of-service benefits. This benefit, estimated from the SP survey, accounts for approximately seven per cent of HSR demand.

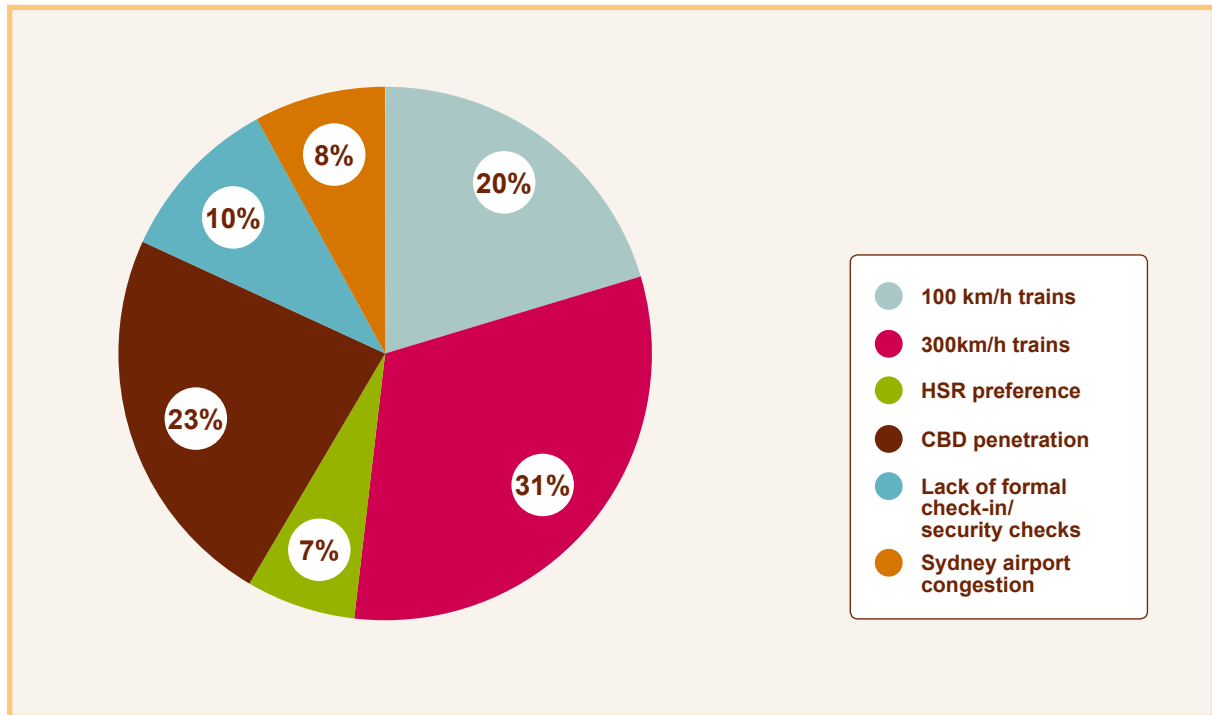
Thus the majority (about 75 per cent) of the HSR demand is estimated to arise from its high speed, frequent, direct fast rail services and city centre accessibility due to the central stations. Additionally, there are demand contributions arising from the projected future congestion at Sydney Airport, HSR's lack of formal check-in and security checks, and traveller preferences.

Growth in the total market and changes in base case assumptions over time are also significant influences on the forecast HSR demand.

Travel demand growth rates in the east coast corridor are projected to be greater for the longer distance journeys. From 2009 to 2065, overall demand growth rates for inter-city, long regional and short regional journeys are 2.2 per cent per year, 1.6 per cent per year and 1.4 per cent per year, respectively.

26 This type of analysis can only be done indicatively.

Figure 2-11 Source of HSR travel demand by HSR competitive characteristic



Note: Total does not add up exactly to 100% due to rounding.

The effect of market trends on HSR demand can be illustrated by considering a forecast for the year 2009, assuming the preferred HSR system was complete. Applied to 2009 conditions, the HSR system is forecast to attract 27 million passengers per year. The forecast of HSR patronage is 83.6 million passengers in 2065, an implied growth rate of two per cent per year over the 2009 patronage estimate, in part reflecting the growth of the longer distance travel market which is served by HSR.

Figure 2-12 shows the demand forecasts at HSR stations along the route (i.e. the number of passengers boarding and alighting at each station) in 2065. Sydney's Central station, at the heart of the east coast network, would cater for the most passengers, followed by stations at Melbourne, Brisbane and Canberra. Passengers transferring between the north and south sections of the HSR

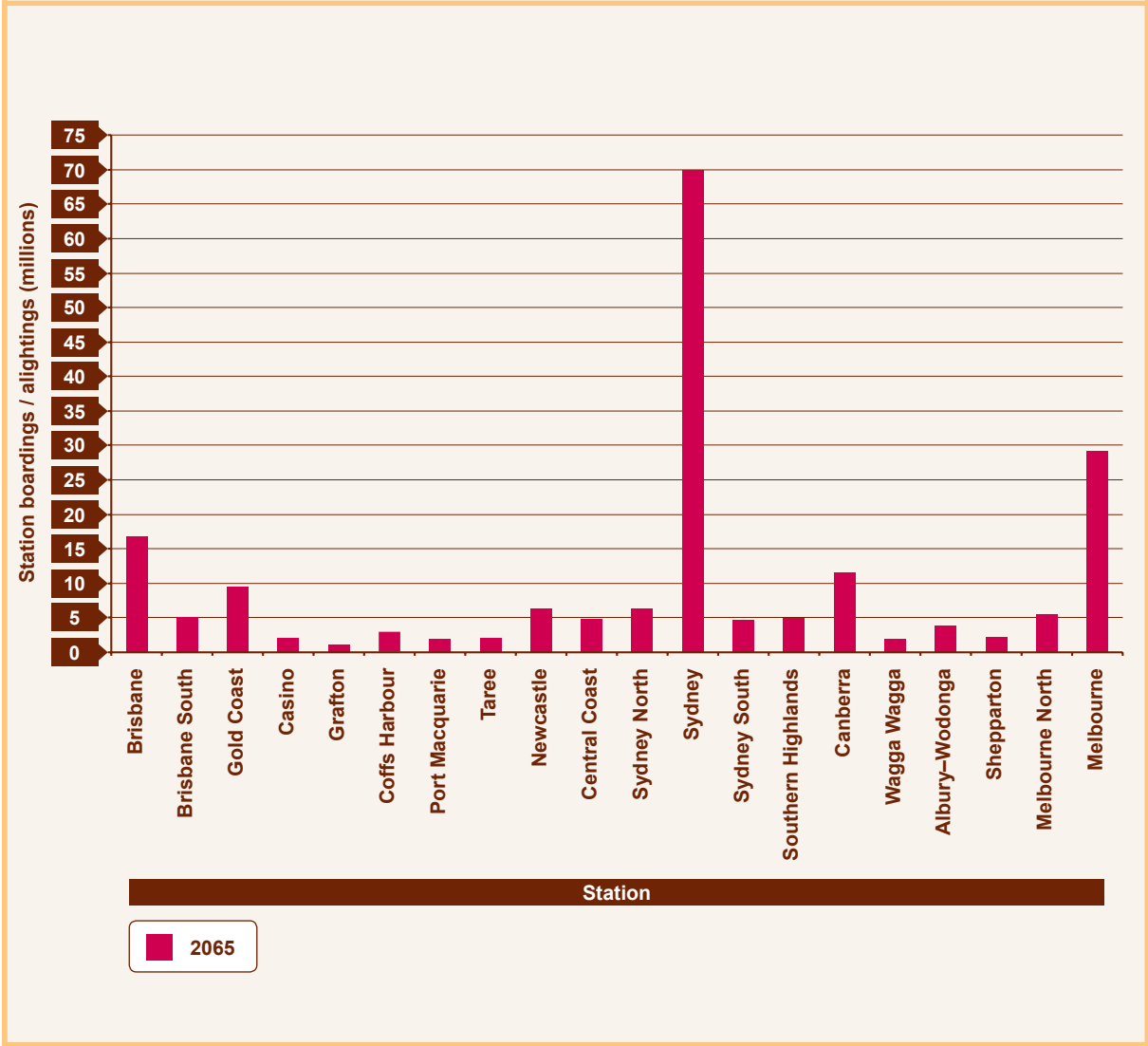
line at Central station in Sydney would account for about 21 per cent of all HSR passengers at Central²⁷. The peripheral stations to the three major cities would also attract a proportion of the HSR demand; primarily city residents (rather than visitors) who would access the stations by taxi, private car or rail.

Of the regional stations, Gold Coast and Newcastle would attract significant numbers of passengers. Almost 50 per cent of HSR passengers would either board or alight at the regional stations²⁸, split broadly equally between residents of the regional areas and city residents travelling to the regional areas.

²⁷ These are included in the Sydney boarding and alighting station totals, each interchange counting as two trips: one alighting on arrival at the station and one boarding on departure. Interchanging passengers therefore account for around 21 per cent of the passenger total, but around 34 per cent of boardings and alightings at Sydney.

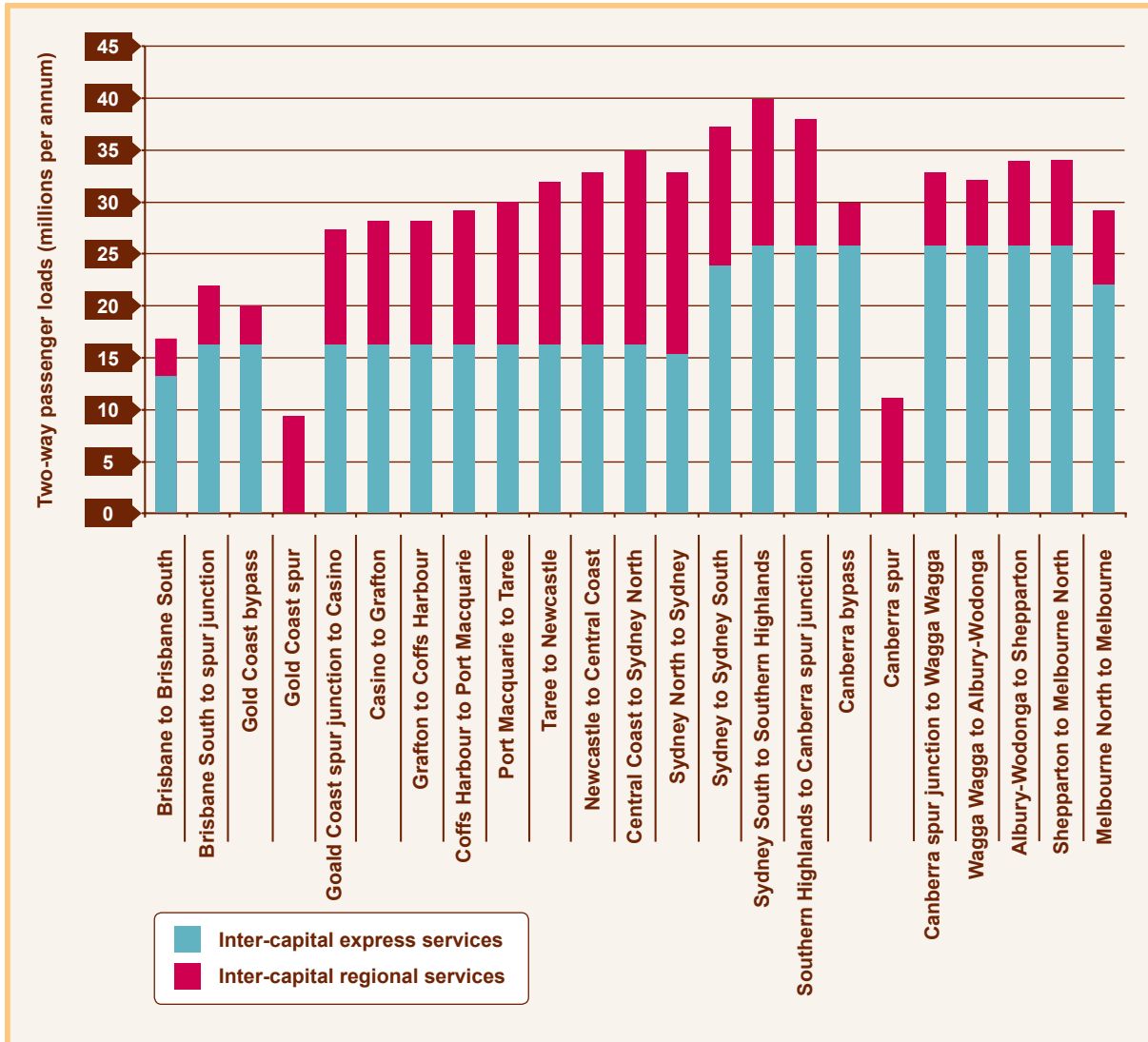
²⁸ The regional stations are all stations other than the four city centre stations and the four city peripheral stations: Melbourne, Melbourne North, Canberra, Sydney South, Sydney, Sydney North, Brisbane South and Brisbane.

Figure 2-12 HSR demand by station in 2065 (boardings and alightings)



The HSR line loadings for 2065 are given in **Figure 2-13**. Between each adjacent pair of stations there are multiple HSR services. The figure shows the total number of passengers on all services, with the highest loadings on the line south of Sydney to Melbourne.

Figure 2-13 HSR line loadings in 2065



2.8 Sensitivity testing

In forecasting the impacts of a new mode of transport over 50 years in the future, the inherent uncertainties must be recognised (and indeed are evident in the experience of other HSR forecasts). The risks and uncertainties associated with the HSR demand forecasts have therefore been evaluated in a risk analysis and a series of sensitivity tests.

2.8.1 Overall risk for the commercial appraisal

Long-term forecasts for new transport projects as far ahead as 2065 are subject to uncertainty in terms of future scenario characteristics and of the proportion of the travel markets they would win. A review of these risks in relation to HSR concluded that the key uncertainties related to:

- The description of the future scenarios: population growth, GSP per capita growth and alternative air fare scenarios²⁹.

29 The range of air fares used in these tests was that used in the Joint Study. In these tests, it is assumed that the HSR fare strategy would be to maintain its competitive position against air fares. Consequently, the changes in air fares are assumed to be matched by commensurate changes in HSR fares.

- The demand forecasts: uncertainties in the estimates of current travel demands, the projections of growth, and the forecasts of the travel demand share that would be attracted to HSR.

There are other risks; for example, the potential further investment in airport capacity and the level of HSR fares, which relate to government policy and HSR pricing policies and are not encompassed in this overall analysis but which have been the subject of individual sensitivity tests.

The levels of uncertainty about these risk factors were combined to provide an overall range of uncertainty around the 2065 demand risk due to these specific factors, as shown in **Table 2-21**.

The tests suggested that there is a 95 per cent chance that actual HSR demand in 2065 will be between 22 per cent less than the forecast and 32 per cent greater than the forecast. This is known as the ‘95 per cent confidence range’. The asymmetry of this range reflects the conservative assumptions that have been made in the reference case, as illustrated in **Figure 2-14**.

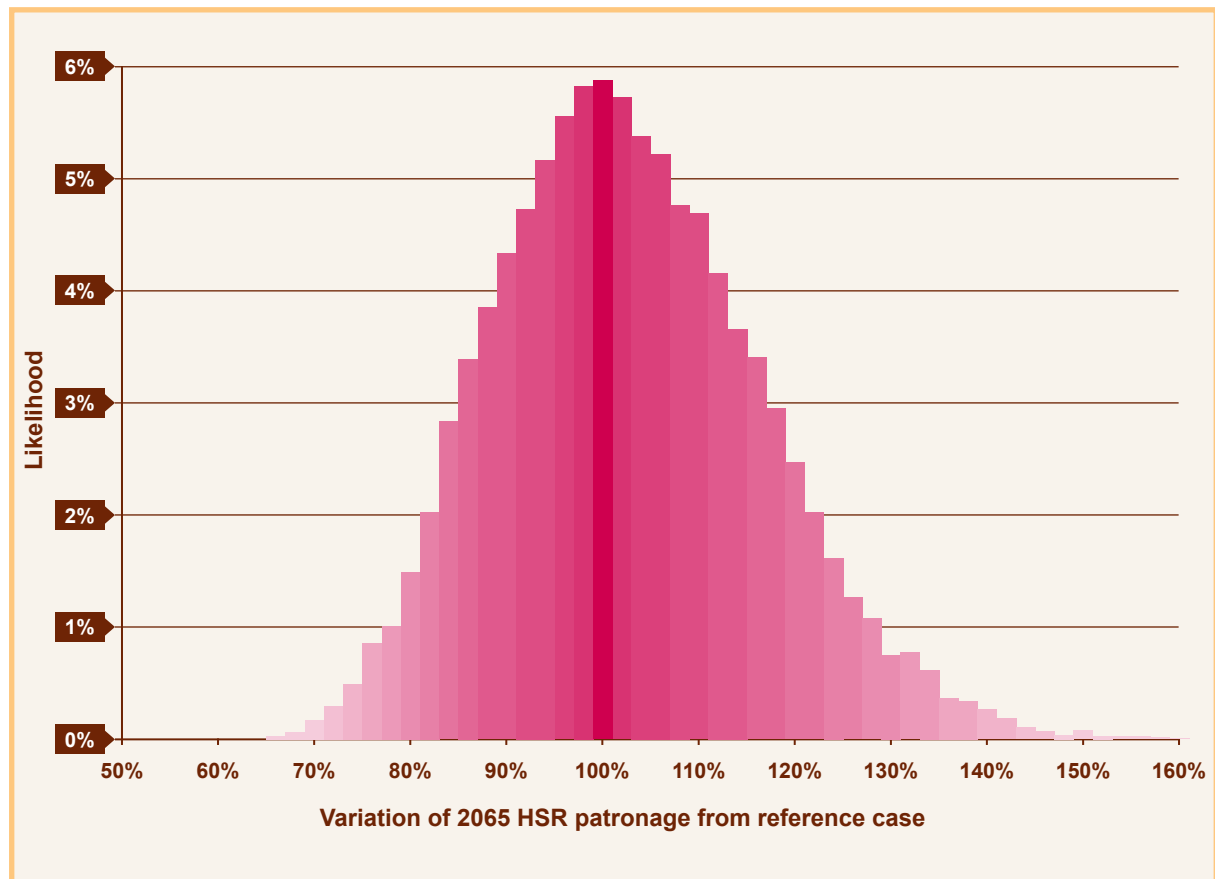
Table 2-21 Overall range of uncertainty around the 2065 HSR demand forecasts (relative to the reference forecast)

Risk profile	
Most likely*	95% confidence range**
+3%	-22%/+32%

*The variation from the base forecast due to an asymmetric risk distribution.

**The range within which there is a 95 per cent chance that the outcome will lie.

Figure 2-14 Overall distribution of HSR demand for 2065



2.1.4 Scenarios and sensitivity tests

In addition to the overall risk analysis, the low and high growth scenarios were tested and a range of individual sensitivity tests were run to illustrate specific uncertainties.

The 'low case' represented a combination of the low population and low economic growth scenarios, while the 'high case' combined the high population and high economic growth scenarios³⁰.

The sensitivity tests were as follows:

- A high HSR fares scenario (a 30 per cent higher fare³¹ and a 50 per cent higher fare than assumed in the reference case).
- Additional aviation capacity that assumes there is no unmet aviation demand in the Sydney region.
- A combined test with additional aviation capacity and HSR fares +30%.
- Tests involving variations to the demand forecasting procedures:
 - HSR ASCs set to zero (these are the preferences for HSR relative to air for inter-city and long regional trips, and relative to rail for short regional trips, over and above the measurable improvements in level of service).
 - An access/egress weighting of 1.0 (in the reference forecasts a weighting of 1.4 is used).
 - Increased scaling parameters for regional trips. The higher the scaling parameters, the greater the sensitivity of the HSR forecasts to differences in the costs of travel for HSR and competing modes.
- A fixed value of time after 2035 (in the reference forecasts the values of time increase with income).
- A low demand combined scenario in which the low growth, additional aviation capacity and 50 per cent higher HSR fare yield scenarios were combined.

As shown in **Figure 2-15**, the sensitivity tests produced a range of demand forecasts in 2065 from a 45 per cent reduction to 46 million passengers, to a 33 per cent increase to 111 million passengers, from the reference case of 83.6 million passengers.

The forecasts shown in **Figure 2-15** were most sensitive to the low and high scenarios of population and economic growth. The HSR fares increases of +30 per cent and +50 per cent also impacted significantly on HSR demand.

The low combined scenario linking low population and economic growth with greater aviation capacity and higher HSR fares therefore resulted in the largest decline in HSR demand, of 45 per cent.

The effects of the model sensitivity tests were relatively minor, with only the removal of the HSR ASCs having a significant impact on demand (a decline of seven per cent).

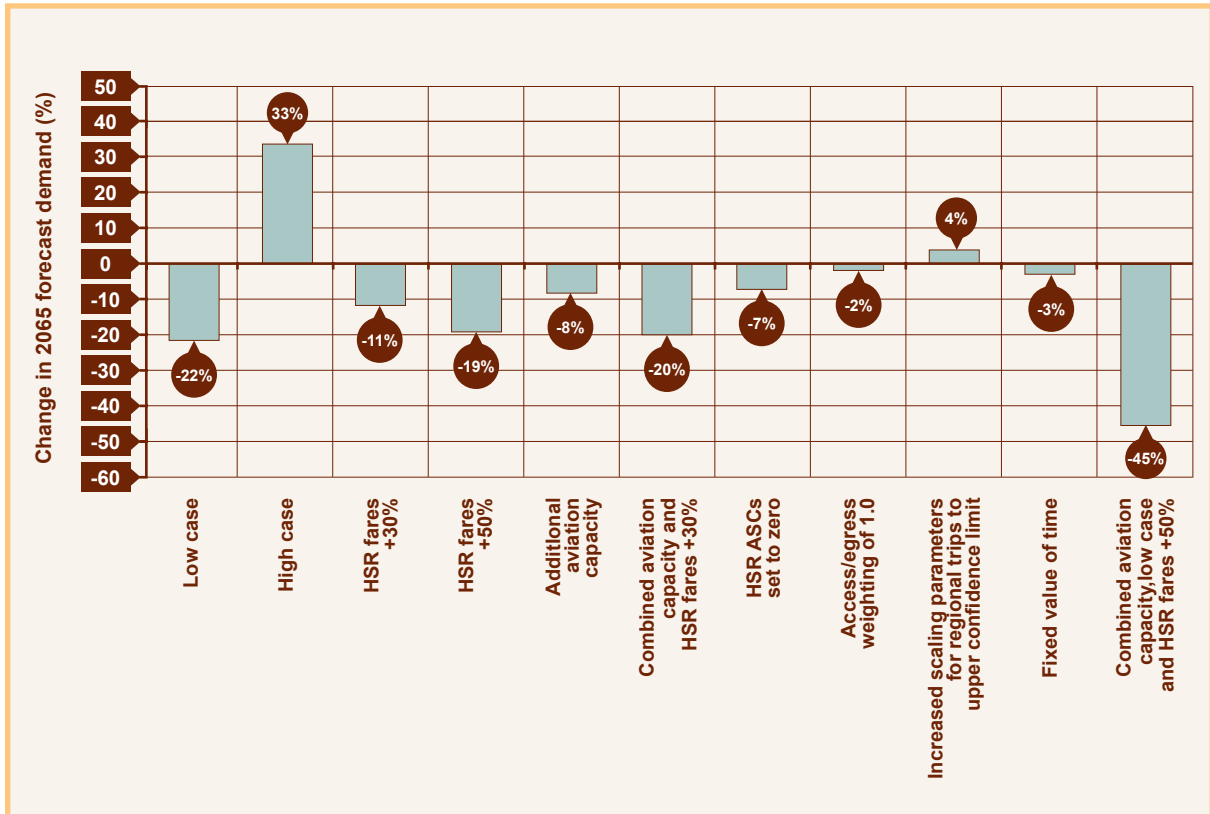
Increasing the scaling parameters required a compensating adjustment to the ASCs to reproduce the mode shares observed in 2009. The net effect was a small increase in forecast HSR demand.

The impact on user benefits of the demand changes arising from the sensitivity tests is reported in **Chapter 8**.

30 In the financial risk analysis, the population and economic growth uncertainties were assumed to be uncorrelated.

31 This is a larger fare variation than that used in the Joint Study and the financial risk analysis.

Figure 2-15 Impacts of the sensitivity tests on HSR demand for 2065



2.9 Conclusion

The demand forecasting provides the following picture of the likely impact of this new mode of travel on the east coast market:

- A fully functional HSR network, under the reference case assumptions, is forecast to attract 83.6 million passenger trips by 2065.
- Alternative assumptions produce forecasts of between 46 million and 111 million passenger trips.
- Sydney-Melbourne is the largest market segment for HSR, with 18.8 million passenger trips in 2065.
- The next largest is Brisbane-Sydney, with 10.9 million passenger trips, followed by Sydney-Canberra with 5.2 million passenger trips.
- About half of the HSR demand would be diverted from air travel and about a quarter from car. Most of the rest would be new trips.

The demand forecasting has addressed the five key questions raised at the beginning of this chapter:

What are the main markets in the east coast corridor that HSR could potentially serve?

The total travel market in the study corridor amounted to 152 million trips of more than 50 kilometres in 2009. Of these, there were just over 18 million inter-city trips, of which almost 40 per cent were for business and most (85 per cent) were made by air. There were another 24 million trips of more than 250 kilometres (long regional trips), of which 17 per cent were for business and the majority (72 per cent) were made by car. The remaining shorter distance trips (between 50 and 250 kilometres) accounted for most of the 2009 travel market (109 million trips).

The 2065 HSR patronage forecast is 83.6 million passengers, of which:

- 18.8 million passengers per year travel between Sydney and Melbourne (22 per cent of total forecast HSR demand).
- 10.9 million passengers per year travel between Brisbane and Sydney CBD and peripheral stations (13 per cent of total forecast HSR demand).
- 5.2 million passengers per year travel between Sydney CBD and peripheral stations and Canberra (six per cent of forecast HSR demand).

What is the size of these markets and how would they be split between the alternative transport modes (car, rail, coach and air)?

In 2009, the car was used for 78 per cent of the journeys, air travel accounted for 13 per cent, rail for six per cent and coach for just three per cent. Air travel was most important for the inter-city and very long regional trips, while rail served specific corridors, mainly local to the major metropolitan areas.

If travel is measured in terms of passenger kilometres, inter-city and long regional travel in 2009 accounted for more than 70 per cent of passenger kilometres. Air and car travel carried broadly equal proportions of the travel, accounting for 95 per cent of total passenger kilometres travelled.

These estimates of the size of the modal travel markets were verified against independent data, including specially collected road traffic surveys.

How would the travel markets grow in the future?

This travel market in the east coast corridor is expected to increase substantially in future: by over 60 per cent by 2035, by 100 per cent by 2050 and by more than 130 per cent by 2065.

The methodology used for these travel growth projections was verified against historic growth data and informed by a special analysis of the growth rates for inter-urban car traffic.

What would be the potential for diversion from current transport modes to HSR?

Without HSR, over 90 per cent of these journeys would have to be catered for by air and private car, subject to the transport capacity being available. Constructing an HSR system would provide additional capacity in the corridor, and would provide a new, alternative mode of transport that the evidence suggests would attract a significant market share.

Using proven technology, HSR could deliver city centre to city centre journey times of less than three hours between Brisbane and Sydney, and between Sydney and Melbourne. As a result, nearly 22 per cent of trips and nearly 40 per cent of passenger kilometres in the corridor in 2065 were forecast to be attracted to HSR. The provision of direct connections between the city centres is a significant component of the attractiveness of such services, and this may become even more highly valued as travel congestion in cities continues to increase in the coming decades.

Together with other market attributes of the HSR service, these journey times would allow it to compete effectively with air travel.

By 2065, HSR could attract 40 per cent of inter-city air travel on the east coast and 60 per cent of regional air travel (primarily long regional). On the three main sectors, Sydney-Melbourne, Sydney-Brisbane and Sydney-Canberra, HSR could attract more than 50 per cent of the air travel market.

Regional demand would represent a significant component of total HSR demand (about 50 per cent of trips), since for many regional areas the private car currently represents the only realistic transport option for accessing large parts of the corridor.

How sensitive would the level of that diversion be to HSR performance and to the alternative future scenarios?

The provision of HSR as a new travel option to capital cities and regional centres along the east coast would also lead to people choosing to make more journeys in the corridor to take advantage of the improved transport accessibility provided by the HSR services. Achievement of the average operating speed of 300 kilometres per hour and corresponding journey times accounts for 51 per cent of the forecast HSR demand.

The forecast diversion to HSR and the consequent induced travel were validated against the independent evidence of the impacts of HSR in other countries. Additionally, alternative growth scenarios were tested with low growth generating 22 per cent less, and high growth 33 per cent more, HSR demand when compared to the reference case.



3

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3

Service and operations

3.1 Introduction

This chapter describes the development of the services required for the preferred HSR system (derived from an understanding of the travel market provided in **Chapter 2**) and how the system would be operated. It includes discussion of:

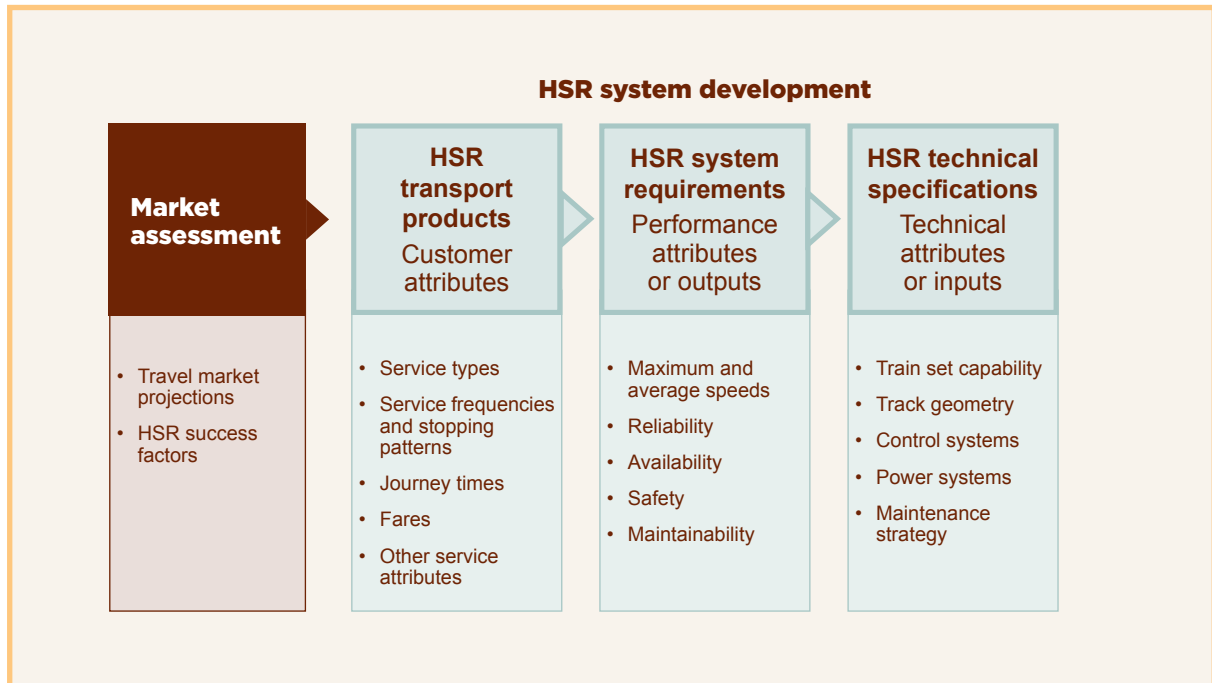
- Transport products – the types of HSR services to be delivered by the preferred HSR system. The services are defined by the journey time and frequency to be offered, the fares and other significant customer amenities such as WiFi access, business class, wheelchair accessibility and in-carriage luggage storage.
- System requirements and technical specifications – technical and/or performance specifications for infrastructure, equipment and systems capable (or likely to become capable, with anticipated technological developments) of delivering the recommended HSR transport products.

This chapter describes how the transport products, system requirements and technical specifications of the preferred HSR system were developed in response to the travel market assessment presented in **Chapter 2**. The process is illustrated in **Figure 3-1**.

This chapter describes:

- The key attributes of HSR products internationally and summarises the results of stated preference (SP) surveys undertaken for this study.
- A service pattern that provides sufficient capacity to serve the HSR demand forecast in **Chapter 2**.
- Requirements and technical specifications for track, power supply, train control, rolling stock including the required fleet size, depots and maintenance facilities that would deliver the service.

Figure 3-1 HSR system development



- The system-wide greenhouse gas and noise emissions that would arise from the operation of HSR.

The requirements and specifications for the HSR stations specifically are discussed in **Chapter 5**.

In developing the preferred system, this chapter seeks to answer the following questions:

- What types of services would best serve the forecast HSR demand?
- What is the expected journey time and frequency of services between HSR stations?
- What requirements – in terms of speed, reliability and availability – would deliver the desired journey time and frequency?
- What would be the technical specification of the infrastructure to deliver these requirements?
- How would the preferred system be operated and maintained?
- What would be the system-wide impacts of HSR in terms of greenhouse gas emissions and noise, and how could they be mitigated?

3.2 Transport products

The transport product is defined as the type and configuration of transport services, in planning terms, to be delivered by an HSR system, including market context, pricing strategy and level, the train service frequency/timetable to be offered, and other significant customer amenities.

The transport product translates the demand for HSR identified in the market analysis into the requirements for rolling stock and infrastructure, as shown in **Figure 3-1**.

Further detail on transport products is contained in **Appendix 2A**.

3.2.1 Market research and commercial considerations

Development of the market needs and commercial context of a potential HSR service on the east coast of Australia was based on market research in Australia for this study and previous studies of HSR, complemented by a review of international experience in countries where HSR is already operating.

Australian market research

To develop an appreciation of the likely response of the Australian customer to the introduction of an HSR service in a competitive east coast travel market, two sources of analysis were employed – research undertaken for the Speedrail study between 1993 and 2000¹ and the SP survey undertaken for this study (described in **Chapter 2** and **Appendix 1D**).

Speedrail was a major study of the feasibility of an HSR link between Sydney and Canberra operating at up to 320 kilometres per hour. The Speedrail study market research included in-depth interviews and focus groups to identify consumer preferences and perceptions of existing travel modes and HSR. This research indicated that the perceived advantages of the service included speed, convenience, reliability and the ability to work on the train. Potential disadvantages included fare levels, the need to ‘keep to a schedule’ and to travel in groups, and the need for a car at a destination to complete the journey.

The SP survey, and the initial focus groups that preceded it, investigated why people would or would not choose to use HSR and what they would value most about HSR. More than half the travellers interviewed in the SP survey (travelling by air, car and standard rail) did not consider that there were any current alternative modes possible for their present journey. However, given a journey in the study area that would be served by HSR, 81 per cent responded that they would consider using such a service. Most of those who would not consider HSR were car users, with inconvenience and the need for a car at the destination the main reasons cited. These findings were consistent with the Speedrail study.

International evidence on HSR transport products

Research undertaken by consultant SDG for the European Community (EC) in 2006 reviewed the effectiveness of HSR and its competitiveness with air travel on eight European routes, including London-Paris (distance approximately 500 kilometres), Madrid-Barcelona (distance approximately 620 kilometres) and Paris-Marseilles (distance approximately 780 kilometres)². This data suggested that the main determinant of market share, as long as HSR had a competitive service frequency, was the rail journey time. The time required for check-in and other procedures prior to departure was considered part of the journey time, and the considerably easier access to HSR services was perceived to be an advantage.

A study by Nash broadly concurred with the EC report³. Nash found that journey time, reliability, accessibility of stations (particularly city centre stations), airport check-in times (and waiting times generally), competitive fares, yield management⁴ and seat reservations systems were all cited as factors influencing customer choice. A review of the competitive environment for HSR also found that journey times were critical⁵. Business travellers on HSR sought an uninterrupted journey (with the ability to work on the train), quality of service and a service frequency that allowed passengers to ‘turn up and go’⁶. Fares, accessibility and check-in requirements were also cited as influences on mode choice.

1 Sinclair Knight Merz, *Technical Note 1*, Speedrail focus group discussions, 1998.

2 Steer Davies Gleave, *Air and Rail Competition and Complementarity*, European Commission, 2006.

3 Nash, *HSR Overseas experience report*, *High Speed Rail Study Phase 1*, 2011.

4 In this context, yield management is the strategy by which the travel industry maximises profit by varying prices for the same product, e.g. offering discounts on seats when it appears they will otherwise remain unsold.

5 Segal, *High Speed Rail – The Competitive Environment*, European Transport Conference, 2006.

6 ‘Turn up and go’ refers to high frequency public transport services where passengers do not need to look up a timetable as waiting time between services is short.

Summary of required service attributes

Based on the Australian market research and international analysis, a successful HSR service would require:

- Competitive journey times.
- High standards of on-board comfort and convenience.

These service attributes would need to be complemented by:

- Convenient station access/egress arrangements.
- Convenient timetabling (frequencies and service patterns).
- An appropriate fare structure (including availability of discount fares on undersold services).

These service attributes defined the requirements of a successful HSR system, which in turn established the technical specifications to deliver a successful system. These are discussed in the following sections.

3.2.2 Service planning

A guiding principle of the HSR study is that HSR must be successful in meeting travel needs in Australia's competitive transport market. The primary demand for HSR services would be for travel to and from the east coast capital cities. The 2065 HSR patronage forecast is 83.6 million passengers, of which:

- 18.8 million passengers per year would travel between Sydney and Melbourne CBD (22 per cent of total forecast HSR demand).
- 10.9 million passengers per year would travel between Brisbane and Sydney CBD (13 per cent of total forecast HSR demand).
- 5.2 million passengers per year would travel between Sydney CBD and peripheral stations and Canberra (six per cent of forecast HSR demand)⁷.

Sydney would be the hub of the HSR network serving the east coast of Australia to the north and south:

- 34 per cent of all HSR trips would have an origin or destination at Sydney North, Sydney or Sydney South stations.
- 21 per cent of all HSR trips would have an origin or destination at Melbourne North or Melbourne stations.
- 13 per cent of all HSR trips would have an origin or destination at Brisbane or Brisbane South stations.
- Seven per cent of all HSR trips would have an origin or destination at Canberra station.

In 2065, 72 per cent of all potential HSR trips originating in the north coast of New South Wales are forecast to have a destination in one of the four capital cities (Brisbane, Sydney, Canberra or Melbourne). For the regional communities between Canberra and Melbourne, 96 per cent of all potential trips would have a destination in one of the capital cities. The demand suggests the HSR system should facilitate:

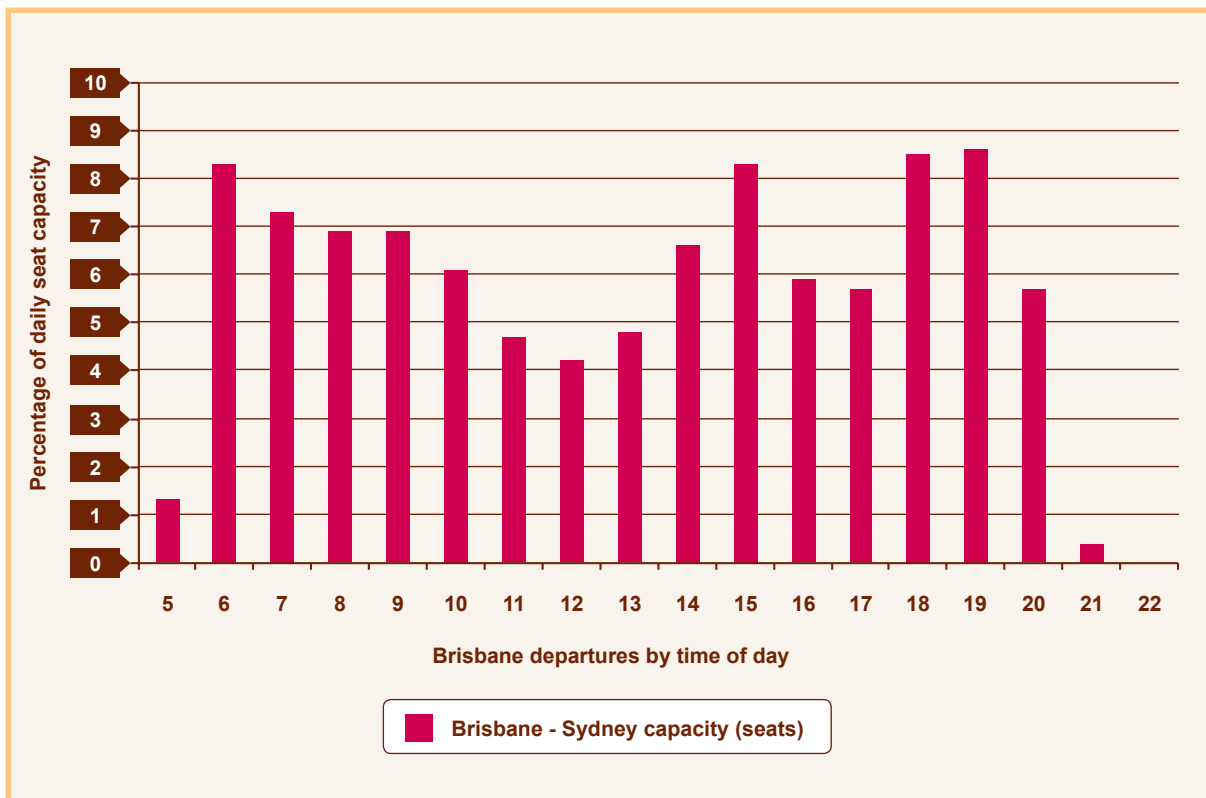
- High speed travel between the capital cities on the east coast. This would be achieved through inter-capital express services. These would provide non-stop services between Brisbane and Sydney, Sydney and Canberra, Sydney and Melbourne, and Canberra and Melbourne. Some of these inter-capital express services may also call at city peripheral stations.
- High speed travel between regional communities and the capital cities. As the demand forecasts show, the capital cities are the primary destination for passengers using regional HSR stations and inter-capital regional services are primarily designed to provide regular high speed links between regional stations and at least two capital cities. Regional services would also facilitate travel between regional stations, although some inter-regional movements with low demand may require passengers to change from one service to another at an intermediate station to complete their journey.

⁷ These are station-to-station movements and vary slightly from the zone-to-zone movements presented in **Chapter 2**.

The service plans and frequencies (and assumed train sizes) were derived from the HSR demand forecasts. The plans were designed to ensure the average utilisation of each service was 90 per cent in the peak hours and at least 60 per cent over the operating day (these percentages are referred to as ‘loading factors’), while maintaining the supply of HSR capacity so that it matched forecast demand with attractive service frequency.

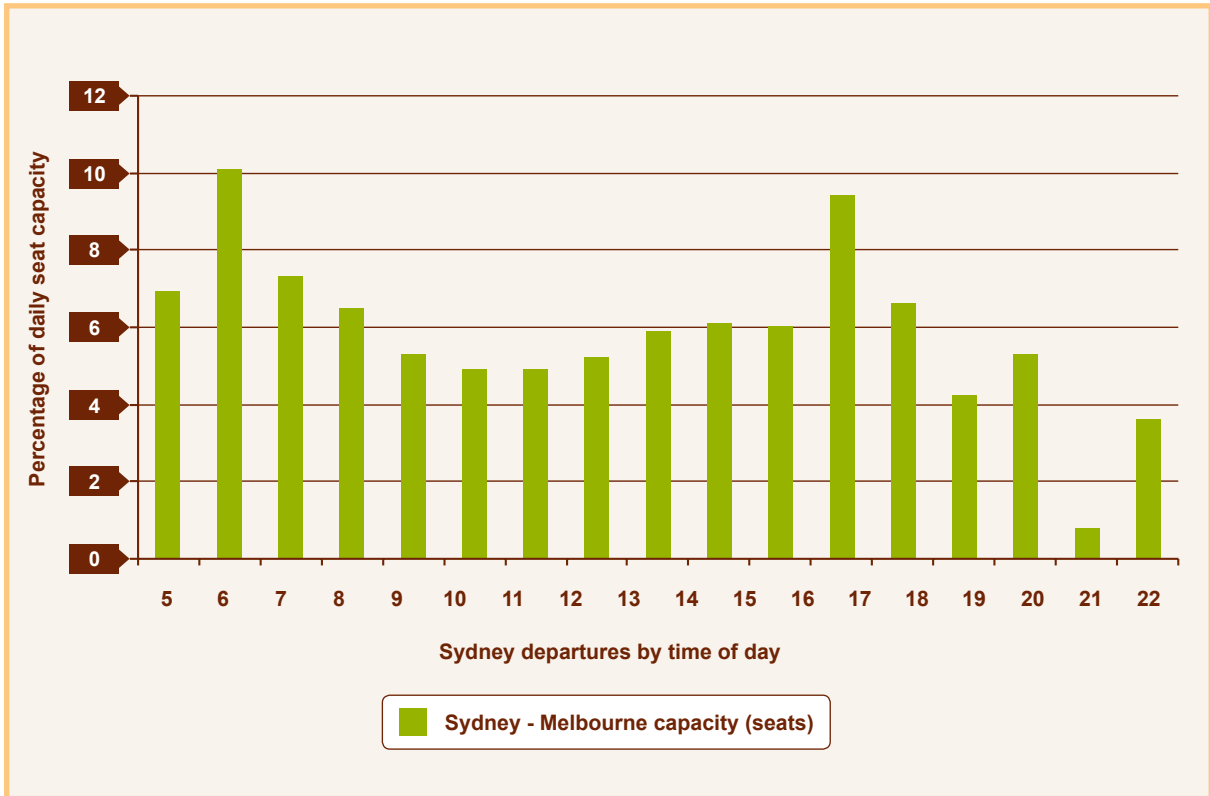
The HSR service pattern is expected to match the capacity profile in the corridor. For comparison, the 2011 inter-capital aviation market for three selected inter-capital air routes, drawn from Qantas profiles for scheduled domestic flights on a Friday, is shown in **Figure 3-2**, **Figure 3-3** and **Figure 3-4**. These figures show the average weekday seat capacity (expressed as a percentage of the total seat capacity on the route that day) at hourly intervals over a year.

Figure 3-2 Brisbane-Sydney Qantas air services weekday capacity profile



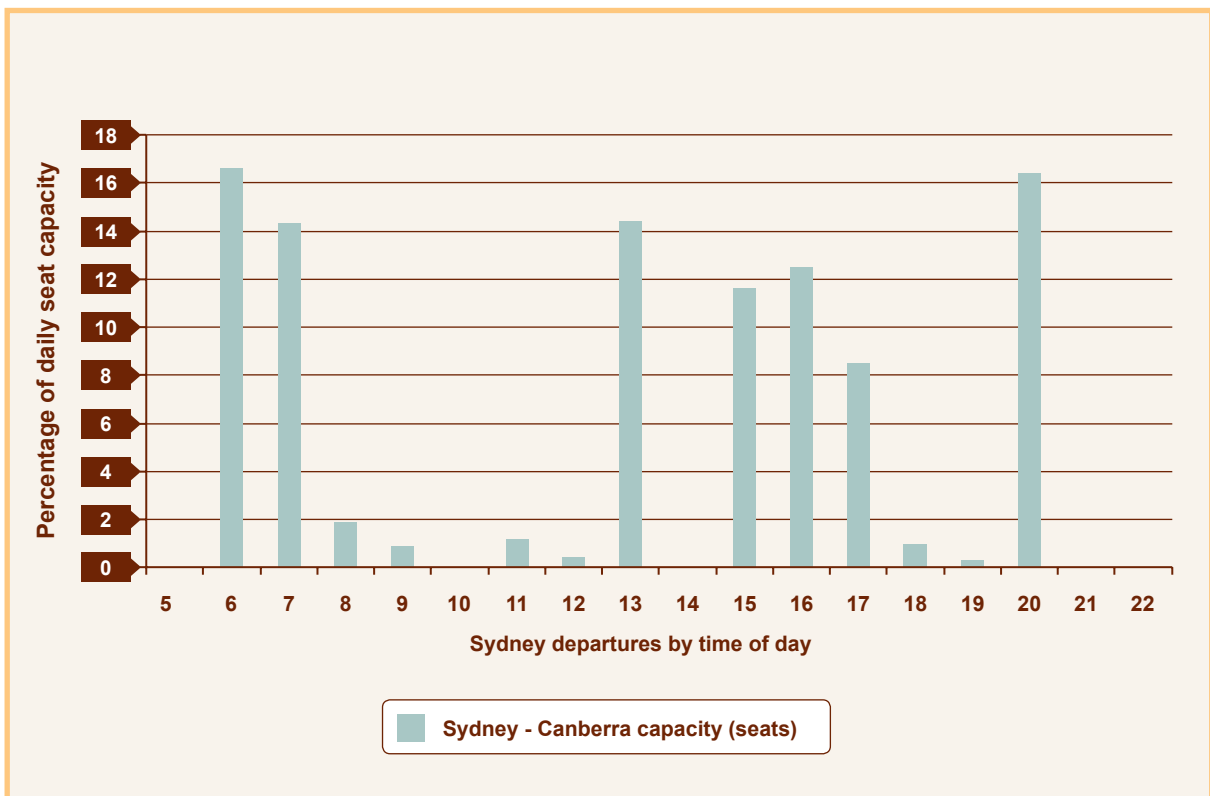
Source: BITRE, 2011

Figure 3-3 Sydney-Melbourne Qantas air services weekday capacity profile



Source: BITRE, 2011

Figure 3-4 Sydney-Canberra Qantas air services weekday capacity profile



Source: BITRE, 2011

Along with departure times, the time of arrival at a destination is important to consider in a comparison of HSR and air travel. For HSR to be competitive, the arrival times need to be comparable between the two modes, so that an equivalent or shorter journey time by HSR is not undermined by less frequent services or a longer experience at the beginning or end of the journey, for instance to travel from an HSR station to a final destination.

The morning departure pattern in each case indicates peak arrivals in the destination CBD (after allowing for airport to city transfers) of 8am to 10am. The afternoon and evening profiles are slightly extended and differ between the routes shown, most likely as a result of airline passengers transferring between flights. In these three examples, the evening demand extends to destination city centre arrivals up to as late as 11pm.

Data was also collected on travel time for car trips in the corridor, using number plate matching at selected sites to identify the longer distance car trips in the market to be served by HSR. This information is discussed in **Chapter 2**. Observations of northbound travel on the Hume Highway between Melbourne and Sydney show departure times from an overnight low of less than two per cent of daily traffic per hour, building up in the hours before 6am. Departures in each hour between 10am and 8pm are broadly in the range between five per cent and seven per cent of daily trips depending upon the trip length, implying destination arrivals up to midnight and beyond.

Given these market characteristics, the HSR operation would need to be available for approximately 18 hours per day, with services typically starting after 5am and finishing before midnight at the destinations. This would allow HSR passengers to arrive at the start of the working day, without having to start their journey unacceptably early in the morning, and provide a range of opportunities up to 8.30pm to leave after the business day and still arrive at their destination before midnight. The number of trains operated would vary between weekdays and weekends – and potentially also between days of the week – in response to day-to-day travel demand variations.

This pattern of operation is consistent with international experience. A review of the current timetables for HSR operations overseas (Eurostar between the United Kingdom and France, and Thalys between France, Belgium and Holland, and Taiwan) shows that:

- Eurostar (Paris/Brussels-London) journey times are typically two to 2.5 hours. Services are operated between 5:30am and 11.30pm. Friday is the busiest day of the week and weekend service levels are about 70 per cent of weekday service levels.
- Thalys (Paris-Brussels-Amsterdam) journey times are typically 1.5 to 2.5 hours, but some trips also operate to/from places off the HSR route with longer journey times. Services are operated between 6am and 11pm. Friday is the busiest day of the week and weekend service levels are about 80 per cent of weekday levels.
- Taiwan High Speed Rail (Taipei-Taichung-Zuoying) journey times are typically 1.5 to two hours. Services are operated between 6:30am and midnight. Friday is the busiest day of the week and weekend services are about 20 per cent higher than Monday to Thursday service levels.
- A shutdown period is needed every night in order to undertake essential maintenance and maintain the reliability targets.

To develop service plans for the east coast of Australia, the following assumptions were used based upon experience of HSR systems internationally:

- Average peak-hour loading factor (percentage of seats occupied) of 90 per cent.
- Overall average loading factor of 60 per cent.
- Load factors over individual sections of line not to exceed 100 per cent (i.e. no passengers are assumed to need to stand).
- Peak-hour demand of 1.5 times the average hourly demand.

- Two standard train configurations have been assumed, to maintain operational flexibility for inter-capital express and inter-capital regional services.
- Peak hour demand will be accommodated to some extent by a larger train capacity, so that expected service levels are only 1.3 times the daily average.

HSR services would operate for 18 hours per day, with a slightly shorter operating day on Sundays. Travel times between Brisbane/Gold Coast and Sydney and between Sydney and Melbourne are less than three hours for the inter-capital express services and up to 3.5 hours for the inter-capital regional service. This means that the last trains of the day travelling the full length of the northern or southern routes would need to depart by 8.30pm. Later trains could depart to terminate at an intermediate station, such as Canberra from Sydney or Melbourne.

There are 16 hours of the day during which HSR trains could depart Brisbane/Gold Coast, Sydney or Melbourne to travel the length of the HSR lines. HSR services to/from Canberra, because of their shorter trip times, could offer departures over 17 hours and still complete their trips before the end of the operating day.

Indicative required service patterns

The HSR service frequencies have been determined to match the forecast demand. Inter-capital express services would mainly operate non-stop between the CBD stations, although some services would make one call at one of the city peripheral stations to offer a non-stop service between the peripheral station and the destination capital.

Generally, two service patterns have been developed for inter-capital regional services between capital cities. A regional service would need to be operated at least once every two hours, so that the minimum level of service at any

regional station would be an inter-capital regional train every two hours (travelling between two capital cities). For example, the minimum service level at Taree would be a regional train every two hours to Brisbane and every two hours to Sydney.

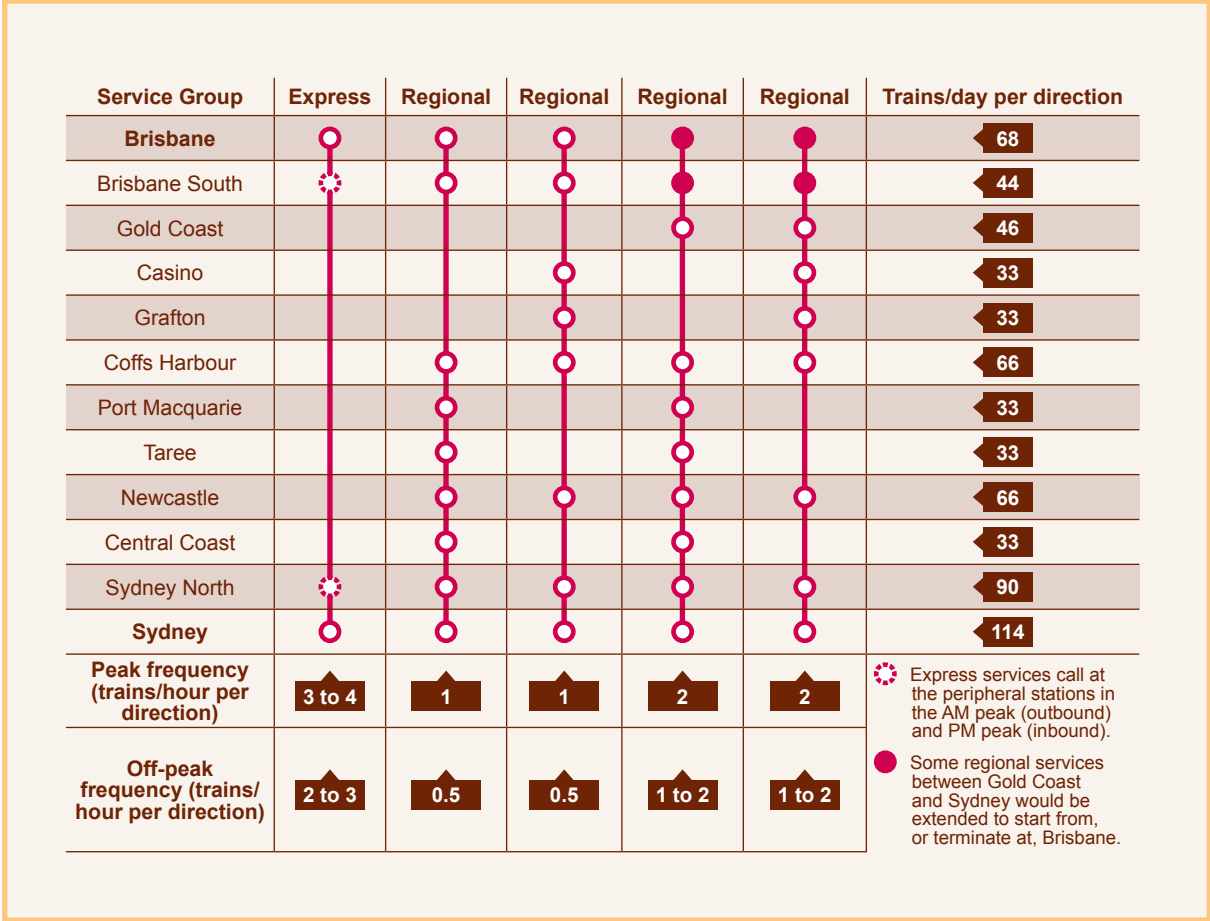
One intermediate station between Brisbane and Sydney and one between Sydney and Melbourne would be served by all inter-capital regional services. This would allow passengers travelling between regional stations to do so with, at most, one change of train. South of Sydney, the selected station could be Wagga Wagga, so a passenger wanting to travel from the Southern Highlands to Shepparton could change trains at Wagga Wagga with only a short wait between services. The equivalent station north of Sydney could be Coffs Harbour. Although the demand forecasts suggest that the number of passengers making such trips will be comparatively small, the facility could be offered without significant impact on the trips between regional stations and capital cities.

No HSR trains would operate non-stop through Sydney. Passengers travelling from stations north of Sydney to stations south of Sydney would have to change trains at Sydney Central.

The actual timetable to be operated for inter-capital express and regional services would be determined by the operator on a commercial basis. However, it is assumed that a regular interval service of HSR trains would run at the same time each hour of the trip pattern's operation. This has operational advantages and would also make the HSR service easier to market to prospective passengers. The timetables for Eurostar, Thalys and Taiwan HSR all show these regular interval characteristics.

The indicative stopping patterns between Brisbane-Sydney and Sydney-Melbourne are shown in **Figure 3-5** and **Figure 3-6** respectively.

Figure 3-5 Brisbane-Sydney indicative stopping patterns in 2065



The typical 2065 service patterns shown in **Figure 3-5** were developed to provide sufficient capacity to accommodate the forecast peak period demand and comprise:

- Two one-stop inter-capital express services per hour for Brisbane-Sydney, calling at either Brisbane South or Sydney North city peripheral stations.
- One or two non-stop inter-capital express services per hour for Brisbane-Sydney.
- An hourly inter-capital regional service calling at Brisbane South, Coffs Harbour, Port Macquarie, Taree, Newcastle, Central Coast and Sydney North.

- An hourly inter-capital regional service calling at Brisbane South, Casino, Grafton, Coffs Harbour, Newcastle and Sydney North.
- Two regional services per hour for Gold Coast-Sydney calling at Coffs Harbour, Port Macquarie, Taree, Newcastle, Central Coast and Sydney North.
- Two regional services per hour for Gold Coast-Sydney calling at Casino, Grafton, Coffs Harbour, Newcastle and Sydney North.

Figure 3-6 Sydney-Melbourne indicative stopping patterns in 2065

Service Group	Express	Regional	Regional	Express	Regional	Express	Regional	Trains/day per direction
Sydney	○	○	○	○	○			130
Sydney South	⊗	○	○	⊗	○			94
Southern Highlands			○		○			40
Canberra				○	○			38
Canberra						○	○	19
Wagga Wagga		○	○					35
Albury-Wodonga		○					○	25
Shepparton		○					○	25
Melbourne North	⊗	○	○			⊗	○	75
Melbourne	○	○	○			○	○	111
Peak frequency (trains/hour per direction)	5	1	1	1	2	1	0.5	⊗ Express services call at the peripheral stations in the AM peak (outbound) and PM peak (inbound).
Off-peak frequency (trains / hour per direction)	4	0.5	0.5	1	1	0.5	0.5	

The typical 2065 service patterns shown in **Figure 3-6** were developed to provide sufficient capacity to accommodate the forecast peak period demand and comprise:

- Two non-stop inter-capital express services per hour for Sydney-Melbourne.
- Three one-stop inter-capital express services per hour for Sydney-Melbourne, calling at either Sydney South or Melbourne North city peripheral stations.
- An hourly inter-capital regional service calling at Sydney South, Wagga Wagga, Albury-Wodonga, Shepparton and Melbourne North.
- An hourly inter-capital regional service calling at Sydney South, Southern Highlands, Wagga Wagga and Melbourne North.
- One inter-capital express service per hour, calling at Sydney South, for arrival in Canberra between 8am and 10am.

- Two inter-capital regional express services per hour for Sydney-Canberra, calling at Sydney South and Southern Highlands.
- One inter-capital express service per hour for Canberra-Melbourne, calling at Melbourne North to provide Melbourne arrivals between 8am and 10am.
- At least one inter-capital regional service for Canberra-Melbourne, calling at Wagga Wagga, Albury-Wodonga, Shepparton and Melbourne North.

The mix of business and leisure travellers on the HSR services would be determined by the service pattern and also by the pricing strategy adopted by the operating company. For this analysis, it has been assumed that the peak services match the business arrival and departure times and that off-peak service levels are broadly constant over the operating day. Peak service hourly demand is assumed to be 1.5 times the average hourly

demand, but in the peak hours, service levels are only 1.3 times the daily average hourly service levels, reflecting the higher load factors assumed to apply to peak train operations.

The HSR service would build up in stages to the 2065 service pattern, as described in **Chapter 6** and as shown in **Figure 3-7**:

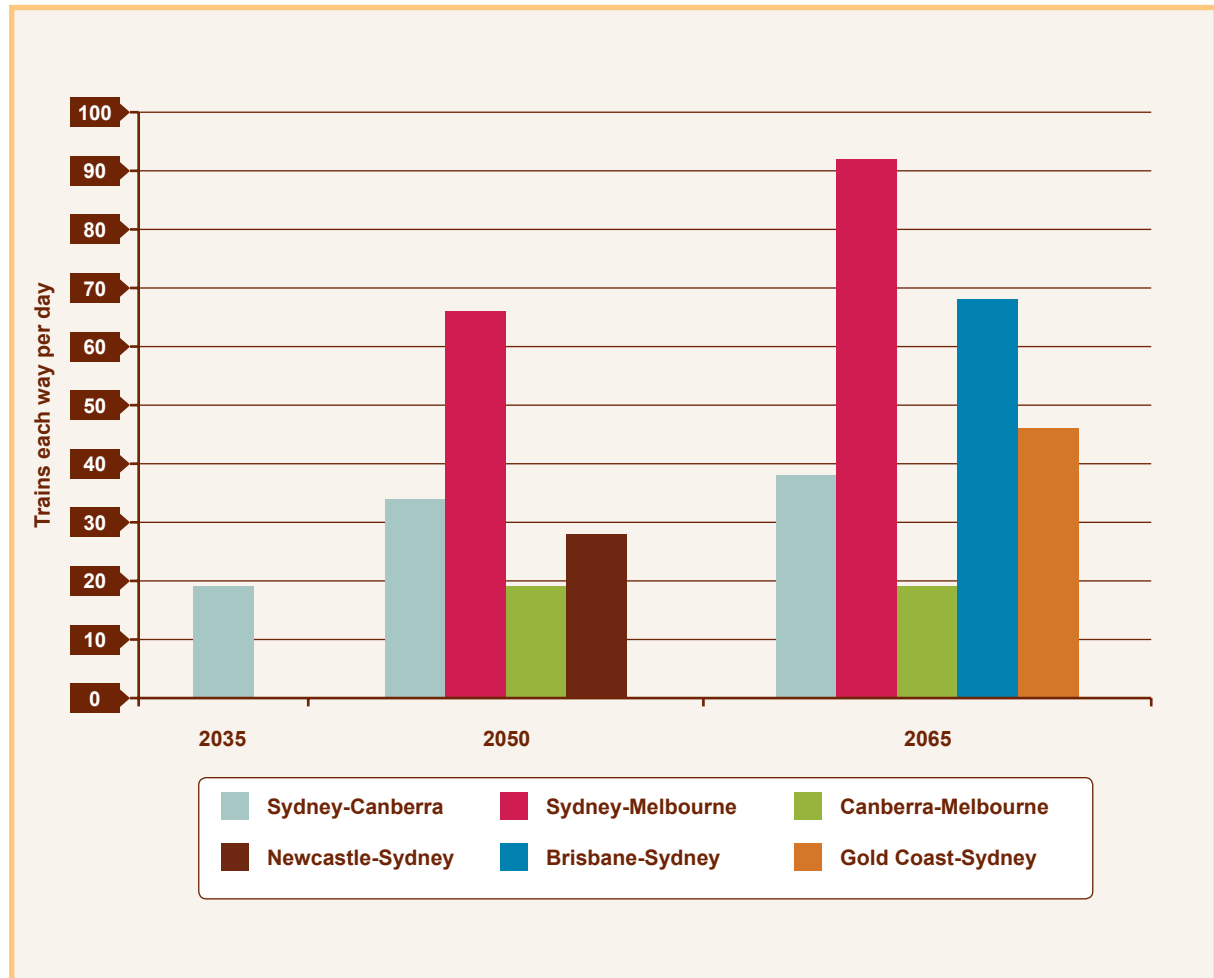
- In 2035, with HSR services operating between Sydney and Canberra and still in the ramp-up phase, total forecast HSR demand is 2.3 million passengers per year, of which 1.3 million (57 per cent) would be travelling from Sydney Central to Canberra or vice versa. In 2035, HSR services would be operated between Sydney and Canberra on an hourly basis throughout the day with additional inter-capital express services in the peak period to accommodate this demand – a total of 38 trains per day.
- In 2050, with HSR services operating Newcastle-Sydney, Sydney-Canberra, Sydney-Melbourne and Canberra-Melbourne, total forecast HSR demand is 39.2 million passengers per year, of whom 11 million would be travelling between Sydney and Melbourne CBD stations (28 per cent of total forecast HSR patronage). The 2050 service pattern would be:
 - 66 trains each way per day between Sydney and Melbourne, of which 48 would be intercapital express services.
 - 34 trains each way per day between Sydney and Canberra.
 - 19 trains each way per day between Canberra and Melbourne.
 - 28 trains each way per day between Newcastle and Sydney.

The demand at regional stations is also predominantly focused on travel to the capital cities. For example, the 2065 forecasts show:

- For Grafton, 38 per cent of passengers would be travelling to Sydney and 44 per cent to Brisbane/Gold Coast.
- For Newcastle, 47 per cent of passengers would be travelling to Sydney and 25 per cent to Brisbane/Gold Coast.
- For the Southern Highlands, 59 per cent of passengers would be travelling to Sydney, 23 per cent to Melbourne and two per cent to Canberra.
- For Albury-Wodonga, 69 per cent of passengers would be travelling to Melbourne, 12 per cent to Sydney and six per cent to Canberra.

The regional stations to be served by HSR are described in **Chapter 4**.

Figure 3-7 Future daily HSR service patterns



3.3 System requirements

This section describes the key system requirements, namely system operating speed, reliability and availability⁸.

3.3.1 Speed

The demand forecasts presented in **Chapter 2** indicate that, internationally, HSR can achieve a 50 per cent or higher share of the air/rail market when journey times are about three hours or less. Achieving this journey time for HSR trips between the capital cities on the east coast of Australia would therefore be a principal factor in defining the required operating speed of the railway. This definition is necessary as it determines the design speed, which in turn determines the geometric parameters of the system.

To achieve a journey time of three hours between Sydney-Melbourne and between Brisbane-Sydney would require operating speeds of up to 350 kilometres per hour. This would enable the train to attain an average speed of approximately 300 kilometres per hour for the overall journey, after allowing for negotiation of the terrain and operating environment between these cities. This capability would be consistent with the latest practice for HSR systems being planned and implemented, for example, in the USA, Italy and China.

The design speed for the HSR system infrastructure would exceed the maximum operating speed, to allow for later improvements in rolling stock that may be able to operate safely at higher speeds. The maximum design speed for this system would be 400 kilometres per hour.

⁸ A fuller description of the requirements is provided in **Appendix 2B**.

3.3.2 Reliability and availability

The infrastructure will, during its whole life cycle, need to meet requirements concerning reliability, availability and maintainability.

International benchmarking experience suggests that 99.7 per cent of planned journeys are achievable on a closed HSR system, as demonstrated for the Taiwan HSR, which has services that achieve departures within one minute of the timetabled schedule, and within five minutes on arrival⁹.

Conversely, where HSR services share infrastructure with conventional passenger and freight trains, the service availability diminishes considerably, due to a variety of operational, reliability and maintenance factors.

The existing rail infrastructure in and around Brisbane, Sydney and Melbourne is currently operating close to capacity. The option to superimpose the HSR train requirements on top of the predicted services anticipated to be operating in future on the existing infrastructure is considered impractical. The geometry of existing infrastructure would require very significant modification to allow HSR operational speeds to be attained. This is discussed in **Chapter 4**.

To achieve the required journey times and reliability, the HSR system would require dedicated infrastructure for the entire system. A system mixing HSR services with conventional passenger and freight rail services on shared infrastructure would not be capable of delivering competitive HSR journey times at the required level of service reliability.

Freight services have not been included in the service planning. International experience demonstrates that the only freight carried on dedicated HSR networks is transported in vehicles similar to high speed passenger rolling stock. 'Light freight' trains carrying items such as high-value, parcel-type goods may have some potential, although there would be some additional cost involved to cater for these services. Additionally, freight services on the HSR line would have

ramifications for speed and also for track wear from heavy haulage. Overall, this opportunity is minor when compared to the HSR passenger services and has not been considered as part of the preferred HSR system. The removal of any conventional passenger train services due to the introduction of HSR could, however, relieve capacity on the conventional rail network for additional freight operations.

3.3.3 Safety

The entire railway would need three metre-high security fencing on both sides to prevent access by persons and animals. Provision for this, and its electronic surveillance, has been made in the costs. Suitable track crossings for stock and fauna, either by underpasses or bridges, are also provided for in the costs. Specific crossings for fauna, including for arboreal mammals such as gliders, would be designed at the detailed stage when accurate information on fauna corridors would be available.

3.4 Technical specifications

3.4.1 Technical components

An HSR system comprises a number of technical components that combine to determine system performance. These components include:

- Track infrastructure.
- Tunnels.
- Power supply and transmission.
- Train control and communications systems.
- Rolling stock.
- Stations.
- Operations and maintenance facilities.

In selecting the technical components for a potential HSR system on the east coast, proven wheel-on-rail technology, which is already in service internationally, has been specified to ensure that the system achieves the defined requirements. Magnetic levitation, or 'maglev', technology is not proposed for the Australian east coast HSR. The text box below presents the arguments considered.

⁹ The recently completed HSR railway in Taiwan reports achievement of reliability targets of 99.7 per cent and above (*Taiwan High Speed Rail Annual Report 2011*).

Magnetic levitation (maglev)

Maglev is a rail system that uses magnets to suspend, guide and propel vehicles along a fixed track, rather than the mechanical methods used for conventional and HSR train systems. The first commercial system began operating at Birmingham International Airport (United Kingdom) in 1984, running at 40 kilometres per hour, but it closed 11 years later due to maintenance problems and costs. More recently, two new prototype systems operating at higher speeds have been commissioned in Japan and China. The Chinese system (opened in 2004) operates at up to 400 kilometres per hour (and is designed for 500 kilometres per hour) over a 30.5 kilometre shuttle line between Shanghai and Pudong Airport. The base system cost about US\$1.2 billion to build – approximately twice the anticipated average capital cost per kilometre of wheel-on-rail HSR.

While maglev could potentially offer greater speeds and therefore shorter journey times for HSR than conventional systems, it has a number of disadvantages, including:

- **Construction:** No existing maglev routes are over 30.5 kilometres long and the challenges of building a 1,700 kilometre route are likely to be significant. Maglev is almost certainly more costly to build than a conventional HSR system, with total costs very difficult to estimate with precision.
- **Maintenance:** The long-term maintenance issues and associated costs are also largely unknown. While the mechanical aspects of maintenance have improved in recent years, the civil and general infrastructure maintenance and repair costs will only materialise after a minimum operating period of 20 years.
- **Practicality:** A study commissioned by the British Government (United Kingdom Government White Paper, *Delivering a Sustainable Railway*, 24 July 2007) rejected maglev for future planning, concluding that maglev is not proven for anything other than short-distance ‘airport people-mover’ or shuttle-type operations, and that when development risk is taken into account, it could cost between four and five times more than conventional HSR.
- **Operations:** Maglev cannot currently be used at multi-platform stations, which would be required at all major city stations, as it cannot run on conventional rail tracks.

There are clearly major technological and cost risks in adopting maglev and it was not considered as part of the preferred HSR system.

3.4.2 Track infrastructure

Track geometry

HSR requires a specific and demanding set of parameters governing track geometry and track type. The geometry needs to maintain the comfort of passengers while enabling the train to travel at high speed. This is ensured by restricting the degree of horizontal and vertical curvature of the track and limiting how much vertical acceleration/deceleration is permitted. A comparison of the geometries required for conventional rail and HSR is provided in **Chapter 4**.

Parameters and track types for existing HSR systems in Europe, China, Taiwan and Japan as well as for proposed HSR systems in the United Kingdom, California and Norway were considered in the system selection process. The standards adopted are described in **Appendix 2B**. The alignment would generally be twin track, except at stations where additional tracks will be required.

Regional and city-peripheral stations would have two additional tracks to serve platforms. This would improve the safety and amenity of these stations by allowing non-stop trains to bypass the station itself. Approaches to terminal stations would have extra tracks to provide sufficient capacity and access to all HSR platforms (for illustrations see **Chapter 5**).

Track gauge

The proposed gauge (1,435 millimetres) is the standard used on HSR networks throughout the world. Using a standard gauge would enable procurement of standard rolling stock and other equipment, thereby minimising the risk and additional cost associated with new prototypes.

Track type

There are two generic choices of track structure type: ballast and slab track. Traditionally, a track structure consists of the rails and sleepers with top and bottom ballast (typically crushed stone). With slab track, the track structure comprises a series of concrete slabs with the rails either embedded in it or fastened to it, instead of fastened to sleepers embedded in ballast.

Ballasted track has the advantage of being relatively quick to install and can be maintained by a fleet of specialist plant. However, the nature of ballast track means that the track can and will move under load, which results in the need for ongoing maintenance to restore the line and level and for the ballast to be cleaned or replaced. There is some experience (French TGV) where the use of ballast at high speed (more than 300 kilometres per hour) has been found to produce fine particles which are deposited on the rail surface and cause damage to train wheels.

With concrete slab track systems, the ballast is replaced by a rigid concrete slab track, which transfers the load and provides track stability. Slab track systems require little routine maintenance. Consequently, fewer possessions of the track are required, increasing the availability of the track for running trains. An inspection regime is necessary, but, because the track is fixed in position, there is no requirement for regular realignment of the rails. Concrete slab track is used by the Japanese HSR network and increasingly throughout mainland Europe as well as in China.

The recommendation for Australia is for the use of slab track.

Many slab track systems require less construction depth than the equivalent ballasted system. Embedded rail systems and resilient base plate track types require the least depth. The reduced construction depth means reduced dead load on structures such as bridges, making their construction less costly. Slab track is fixed in position and will not move out of line or level under load. Concrete slab track also offers a greater degree of track bed stability than ballasted track, meaning that higher running speeds are achievable. Resilience is introduced into the track system by means of pads, bearings or springs, depending on the type of slab system.

Slab track can be designed to suit particular requirements and to meet the required performance criteria in terms of noise and vibration. Within each generic system, the resilient components can be selected to optimise the balance between acoustic performance and rail stability.

An estimate of design life for traditional ballasted track is around 15 years, after which the ballast requires renewal. This is a noisy and time-consuming activity if performed during non-operational hours and, given the long lengths of track involved, would require a large labour force working continuously. A concrete slab track is typically constructed with a design life of at least 60 years and can be designed to withstand a temperature range of –10 to 50 degrees Celsius.

Although the capital cost of slab track systems is usually higher than the equivalent ballasted track (about 20 to 30 per cent higher initial outlay), the long design life and minimal maintenance requirement for slab track systems means that overall their whole life cost is lower than that of traditional ballasted track.

Slab track has been used successfully on a number of HSR projects around the world, as shown in **Table 3-1**.

Table 3-1 International examples of slab track use

Project	Country
Shinkansen	Japan
High Speed Line HSL-Zuid	The Netherlands
Cologne-Frankfurt High Speed Line	Germany
Nuremberg-Ingolstadt High Speed Line	Germany
Taiwan High Speed Railway	Taiwan
Eje Atlantico	Spain
TGV Méditerranée	France
Channel Tunnel Rail Link Phase II	United Kingdom

3.4.3 Tunnels

Chapter 4 contains a summary of the rationale for tunnelling on sections of the alignment. This section discusses the various configurations and construction methods that could be applied, although the actual configuration of each tunnel would only be determined at a more detailed stage of design.

Tunnel configurations

HSR tunnel configurations are commonly:

- Single bore double track tunnels (e.g. Japan, Taiwan, shorter tunnels in Spain).
- Twin bore single track tunnels (e.g. Germany, and longer tunnels in Spain and the United Kingdom).

The use of a third tunnel for services/emergency egress has also been adopted on some systems (e.g. Brenner Base, Channel Tunnel), but is more relevant to tunnels without practical locations for intermediate access.

The following components need to be accommodated within a tunnel:

- Rail track form.
- Rolling stock structure gauges.
- Emergency egress (i.e. walkways).
- Emergency and operations access.
- Traction power supply.

- Signalling and communications.
- Tunnel utilities (including the possibility of utilising tunnels for non-HSR services).
- Tunnel ventilation.
- Tunnel lining/support.

In addition to the above space-proofing considerations for HSR, the tunnel would need to be sized to meet aerodynamic pressure requirements.

Recently constructed tunnels in Europe and Asia show a strong correlation between the free tunnel area and train speed. As the speed increases, so does the tunnel area required to minimise adverse pressures and shockwaves. These effects are calculated from what is termed a free area ratio. In order to minimise the impacts of pressure (comfort, train structural strength and fatigue) and energy consumption (friction), tunnels are built progressively larger to accommodate increases in operational speed. The free ratio is the proportion of the unfilled, or 'free', tunnel cross-sectional area relative to the occupied (train cross-sectional profile). Other effects associated with changes in free area ratio include noise, heat generation and energy efficiency.

For the purposes of this study, the various types of tunnel were developed for costing before establishing an average cost per kilometre for use in the alignment model (Quantm) and the capital cost estimate (see **Appendix 4B**).

Tunnel construction

Tunnels would normally be constructed by tunnel boring machines or mined tunnel techniques, depending on ground type. Because of their disruptive effects at ground level (requiring any structure above to be demolished and land to be occupied for long construction periods), cut-and-cover tunnels would only be constructed in exceptional circumstances, for example at the final approach to Central station in Sydney, as the tunnels emerge to the surface.

Tunnel boring machines would achieve faster production rates and economies of scale in longer tunnels compared with the other techniques, but are restricted to circular tunnel shapes of constant size. While the relatively high capital cost and long manufacturing time of tunnel boring machines makes them expensive and impractical over short lengths, they are well suited to the full range of ground and groundwater conditions expected throughout the study area.

Shorter tunnels are usually more economical when constructed by mined tunnel techniques, due to the lower capital costs of plant. Over longer tunnels, the additional work cycles required in these methods make them less competitive unless multiple excavations can be established.

3.4.4 Power supply and transmission

The traction power supply system is the railway electrical distribution network used to provide energy to high speed electric trains. It comprises three types of traction power facilities – traction power substations, switching stations, and paralleling stations, in addition to connections to the overhead contact system and to the traction return and grounding system.

A 2 x 25 kilovolt (KV) autotransformer feed configuration has been proposed for the traction electrification system. Although 1 x 25kV traction power supply systems have been used successfully for electrified main line railway for many years, 2 x 25kV autotransformer feed systems have become the modern standard for main line electrification, especially for HSR.

In total, there are more traction power facilities required for a 2 x 25kV autotransformer feed system than for a 1 x 25kV system, but there are fewer substations, with their associated HV utility circuits, HV transformers and HV switchgear. The electromagnetic interference emitted due to the load current in the catenary system and running rails is considerably reduced. For the Australian HSR, for the purpose of cost estimation it has been assumed that the track power supply would be provided by two 25 kilovolt 50 hertz auto transformers every ten kilometres with traction power feeder stations typically every 60 kilometres.

All trains have been assumed to use regenerative braking to reduce traction power requirements by eight to ten per cent. This is shown and quantified in **Appendix 2B**.

HSR power demand from the national power grid

It is estimated that HSR power demand would progressively increase from approximately 540 megawatts in year 2035 to approximately 820 megawatts in year 2050, and would require approximately 1,800 megawatts from the national power grid along its length by 2065. The 2035 HSR power demand of 540 megawatts compares to the current total national generation capacity of 72,000 megawatts, in effect less than one per cent of the current grid capacity. A similar percentage is estimated by 2065. While the HSR system would be a significant user of electricity, it is estimated to consume a small overall percentage within the likely growth of the national electricity supply system.

3.4.5 Train control and communications systems

A bi-directional transmission-based train control system would be specified throughout the length of the route, providing the ability for trains to continue to operate at full line speed, in either direction, on either track without having services interrupted by unscheduled disruptions. The operation of the railway would be controlled from an operations control centre, with an identical standby control centre located in close proximity

to allow for the transfer of operational staff if required. As Sydney would be at the hub of the HSR operation, it has been assumed that both control centres would be in Sydney. There is no need for the centres to be physically located on the railway so precise locations have not been specified.

3.4.6 Rolling stock

A large number of high speed trains are in service around the world. Several well known international suppliers of rolling stock have trains in their current product range that meet the requirements of a 350 kilometre per hour operational speed for the express services.

There are a number of high speed trains designed to provide a variety of customer amenity options, such as a choice between business class and economy, catering and WiFi. Business class would offer more space and a higher level of comfort and amenity to the passenger, including 'at seat' catering.

Trains would be typically 200 metres long at the commencement of operation, increasing over time in accordance with market requirements¹⁰. The longest train set envisaged for the east coast market in this study is 300 metres, and all city terminal stations have been specified to accommodate trains of this length. **Table 3-2** lists some of the items required for the rolling stock.

3.4.7 Operations and maintenance facilities

Operations facilities

The HSR would be operated from one of two management control centres (one main and one standby) located in Sydney. The control centre would contain all the operational functions including:

- Management of train operations.
- Signalling and train movement control.
- Electrical control.
- Management of service disruption.
- Management of operational incidents.
- Management of customers (and other members of the public) and operational staff.
- Management and maintenance of fleet.
- Management of infrastructure, the infrastructure controller, plant and premises.
- Management of accidents, major incidents, emergencies and other reportable incidents.

The operation of the main and standby control centres is not analysed in this study. There are options for the use of these facilities to be used in dual operating mode (i.e. one line operated from each centre) with the ability for competitive operation of the two lines and possibly to provide better continuity in the event of an emergency transfer of control.

¹⁰ Different suppliers have different configurations and number of cars to create a train set. The passenger capacity has therefore been specified, not the number of cars.

Table 3-2 High speed express rolling stock specification

Item	Requirement
Design life	30 years
Standards	European Technical Specification for Interoperability or equivalent ¹¹
Recyclability	98% of train to be recyclable following disposal
Modular design	Facilitating future-proofing for layout flexibility
Maintainability	A design that facilitates ease of maintenance
Train reliability	200,000 km/technical breakdown
Fleet size	2035 – 6 x 200 m sets 2050 – Combination of 34 x 200 m sets and 25 x 300 m sets (59 in total) 2065 – Combination of 72 x 200 m sets and 56 x 300 m sets (128 in total)
Maximum operating speed	350 km/h
Braking system	Electrical regenerative braking to improve energy efficiency
Configuration	Business and economy class Comfortable seating for all classes Catering facilities Toilet in each carriage Wheelchair-accessible carriage entrance on each train set WiFi and power sockets available for all classes Luggage storage in each car Passenger information provided in all cars
Train length	200 m and 300 m
Seating capacity	520 seats (200 m sets) and 780 seats (300 m sets)
Security	In line with current operational domestic HSR railways, no specific security measures are assumed at the stations. Passenger assistance and CCTV in all cars
Seat reservation	Automatic system to be provided for each seat

Maintenance facilities

Based on the current evaluation of maintenance stabling for the train fleet, it has been determined that the following facilities are required:

- Two main maintenance depots and stabling yards located close to both the Newcastle and Canberra stations (at Lenaghan and Goulburn

respectively), capable of undertaking heavy maintenance activities and each with adequate stabling for the respective stations.

- One stabling yard close to each of the Brisbane, Sydney and Melbourne stations (at Greenbank, Holsworthy and Craigieburn).

¹¹ Specifications adopted by the European Commission to ensure interoperability of the trans-European rail system. They relate to infrastructure, energy, rolling stock, control and signalling, and maintenance and operation.

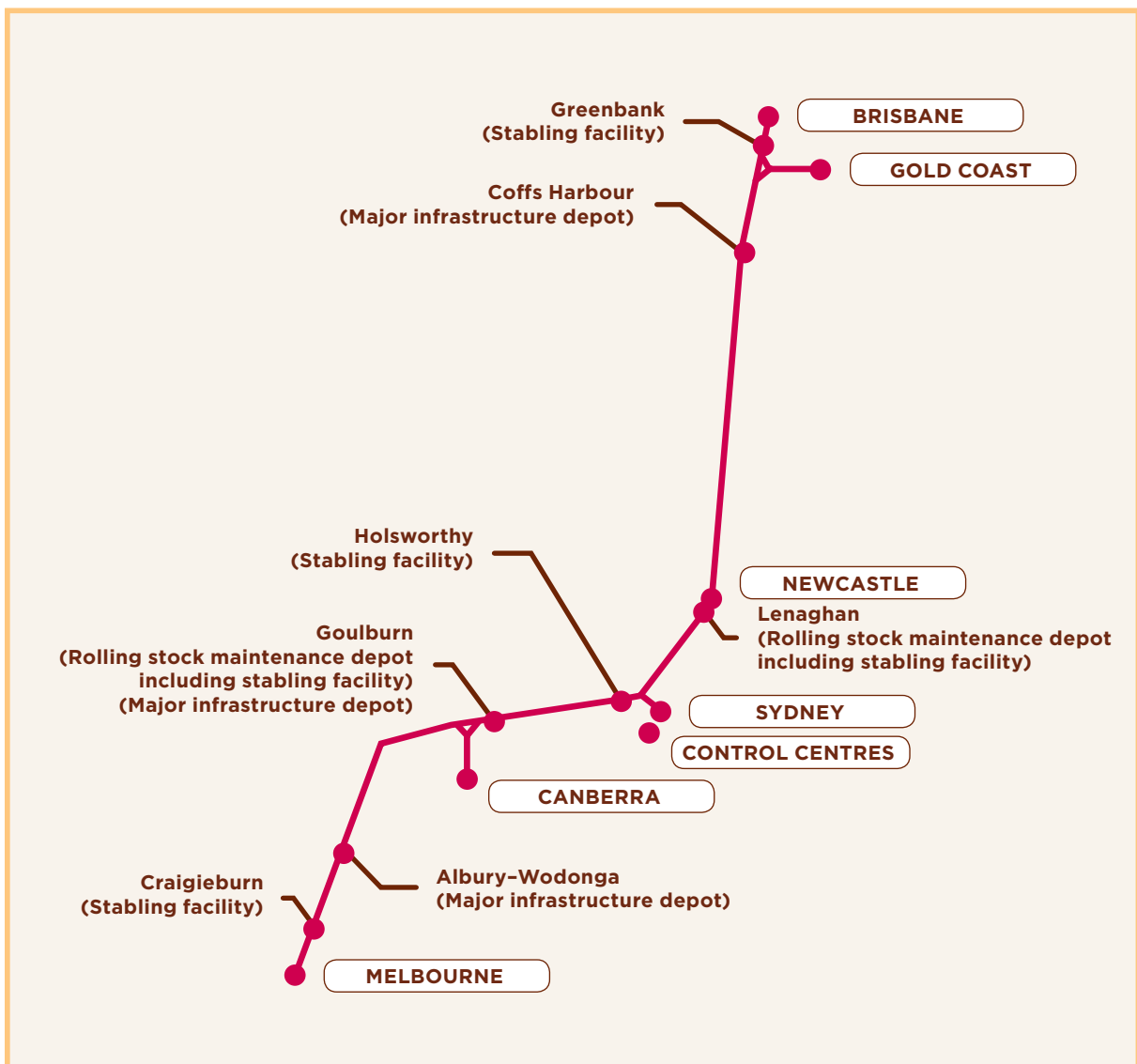
The configuration for maintenance depot and stabling yard locations has been established and addresses the productivity, reliability and availability of the HSR fleet. A segmented approach to the system has been taken to accommodate the distribution of trains on the network during peak service operation. These segments are:

- Brisbane-Newcastle (including Gold Coast).
- Newcastle-Sydney.
- Sydney-Canberra.
- Canberra-Melbourne.

The busiest segments would be Sydney-Canberra and Newcastle-Sydney. Locating a depot close to the segment with highest service frequency would reduce the movement of empty trains and provide increased operational flexibility in managing the fleet to return trains to the depot for maintenance.

Figure 3-8 shows the location of depots and stabling facilities.

Figure 3-8 Location of depots and stabling facilities



3.5 System-wide environmental impacts during operation

The construction, operation and maintenance of the preferred HSR system would generate greenhouse gas and noise emissions. This section describes how estimates of these emissions were derived and the measures available to mitigate their impact.

3.5.1 Greenhouse gas emissions

According to the Greenhouse Gas Protocol¹², the Intergovernmental Panel on Climate Change (IPCC) and Australian Government GHG accounting and classification systems, GHG emissions are reported as tonnes of carbon dioxide equivalent (t CO₂-e), categorised into three ‘scopes’:

- Scope 1 emissions, also called ‘direct emissions’, are generated directly by the project, e.g. emissions generated by the use of diesel fuel by construction equipment onsite.
- Scope 2 emissions, also referred to as ‘indirect emissions’, are generated outside the project’s boundaries but provide energy to the project, e.g. the use of purchased electricity from the grid.
- Scope 3 emissions include all indirect emissions, other than those included in scope 2, associated with upstream or downstream activities, e.g. emissions associated with the extraction, production and transport of purchased construction materials.

This study has considered all emissions, although scope 3 estimates were derived through benchmarking of other studies as some of the information necessary to calculate them was unavailable. Scope 1 and scope 2 emissions associated with the construction of HSR and subsequent infrastructure renewal (through the use of electricity, fuel and materials and the clearance of vegetation) amount to 11.4 million tonnes of CO₂-e. The majority of this is attributable to the diesel fuel consumed by construction vehicles associated with earthworks, together with the power consumed during tunnelling operations. Further detail is provided in **Appendix 5G**. Benchmarking of scope 3 emissions suggests they usually account for 50 to 80 per cent of overall construction emissions. This would mean total construction emissions of 22.8 to 57.1 million t CO₂-e.

Operation and maintenance of the preferred HSR system would consume energy and generate GHG emissions over the life of the infrastructure, primarily in relation to the consumption of electricity to run the trains. However, the HSR system would also enable passengers to switch from more GHG-intensive modes of transport (e.g. air travel), which would produce countervailing reductions.

To determine the actual GHG impacts of HSR, the initial step was to derive emission factors for electricity and each fuel type used by the non-HSR modes from which trips are diverted. These were derived for this study using energy and carbon content parameters from the Australian Treasury¹³ and the National Greenhouse Accounts (NGA) Factors¹⁴, taking into account projected changes in the parameters over the study period. Full details are provided in **Appendix 5G**.

12 World Business Council for Sustainable Development (WBCSD) and World Resources Institute (WRI), 2004, *Greenhouse Gas Protocol*.

13 Australian Treasury, 2011, *Strong Growth, Low Pollution – Modelling a Carbon Price*, Commonwealth of Australia, Canberra.

14 DCCEE, 2012, *National Greenhouse Accounts Factors July 2012*, Canberra.

The emission factors were then combined with forecast fuel consumptions and occupancies for air, road and rail to derive unit emissions per passenger kilometre over the evaluation period.

Table 3-3 shows the average emissions per passenger kilometre of each mode, calculated from the total operational emissions and passenger kilometres for each mode over the operational period. It illustrates that coach and HSR travel have the lowest emissions per passenger kilometre, while aviation and business car use have the highest emissions. Note the emissions totals for HSR include the operation of both the infrastructure and trains, whereas the emissions for other modes comprise only the operation of the vehicles (aircraft, coaches, trains).

The extent to which HSR would change the level of GHG emissions was then calculated by combining the number of passengers expected to divert from each of the non-HSR modes with the unit emission rates included in **Table 3-3**.

Table 3-4 and **Figure 3-9** compare the difference in emissions between the base case (without HSR) and the reference case (with HSR). The reduction in emissions as the result of modal diversion are shown in green in **Figure 3-9**, while the new emissions associated with HSR construction and operation, and from suppressed aviation demand in Sydney, are shown in red. There is a net increase in emissions in the reference case of approximately 22 million tonnes of CO₂-e over the assessment period from 2035-2085. The costs associated with these emissions are included in the economic appraisal provided in **Chapter 8**.

The overall increase in emissions is influenced significantly by the assumption in the reference case that there is no additional aviation capacity in Sydney. This lack of additional aviation capacity suppresses growth in travel in the study area, which reduces growth in GHG emissions in the base case (with no HSR). Where HSR provides greater opportunity for travel, by meeting this suppressed demand and through induced demand, overall emissions increase. This is in spite of the emissions per passenger kilometre travelled declining, as HSR has lower emissions per kilometre than most other modes.

Table 3-3 Operational emissions per passenger kilometre 2035-2085

Transport Mode	Emissions (Mt CO ₂ -e)	Passenger km (billion)	Emissions per passenger km (tonnes CO ₂ -e / 1000 pkm)
Aviation ⁽¹⁾	197	1,765	0.112 ⁽²⁾
Coach	3	171	0.018
Car – business	18	186	0.097
Car – leisure	93	1,613	0.058
Rail	6	166	0.036 ⁽³⁾
HSR	56	1,981	0.028

(1) Doubling of aviation emissions (due to radiative forcing) applied.

(2) Includes allowance for impact of non-CO₂ gases released at altitude (see **Appendix 5G**).

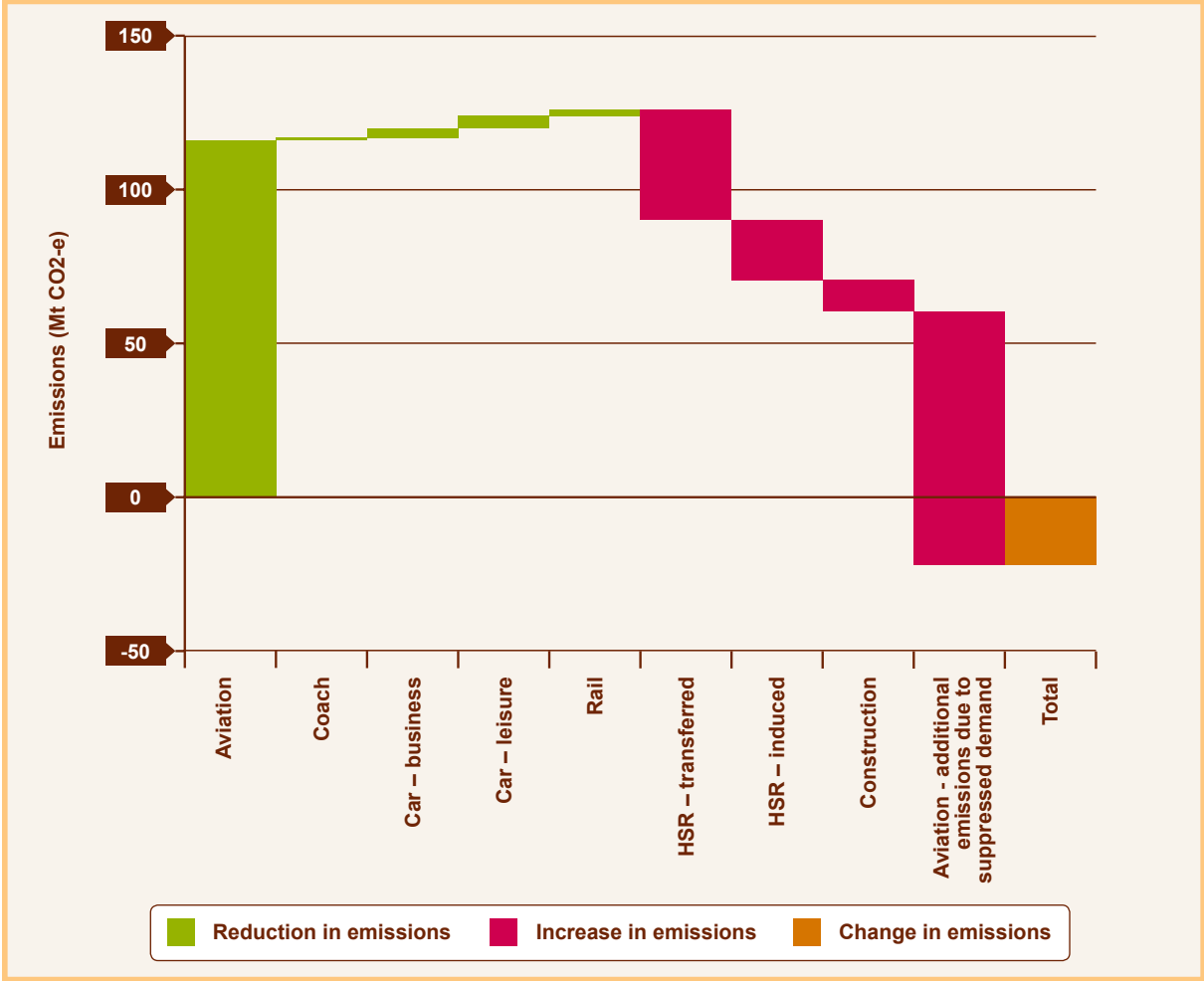
(3) Estimate for non-urban rail services which would be directly affected by HSR.

Table 3-4 Total emissions over evaluation period (million tonnes CO₂-e)

Emissions source	Base case (No HSR) (Mt CO ₂ -e)	Reference case (with HSR) (Mt CO ₂ -e)	Change (Mt CO ₂ -e)
Aviation	232	116	-116
Aviation – additional emissions due to suppressed demand in Sydney	-	81	81
Coach	4	3	-1
Car – business	21	18	-3
Car – leisure	97	93	-4
Rail	9	6	-3
HSR – transferred	-	35	35
HSR – induced	-	21	21
Construction	-	11	11
Total	362	384	22

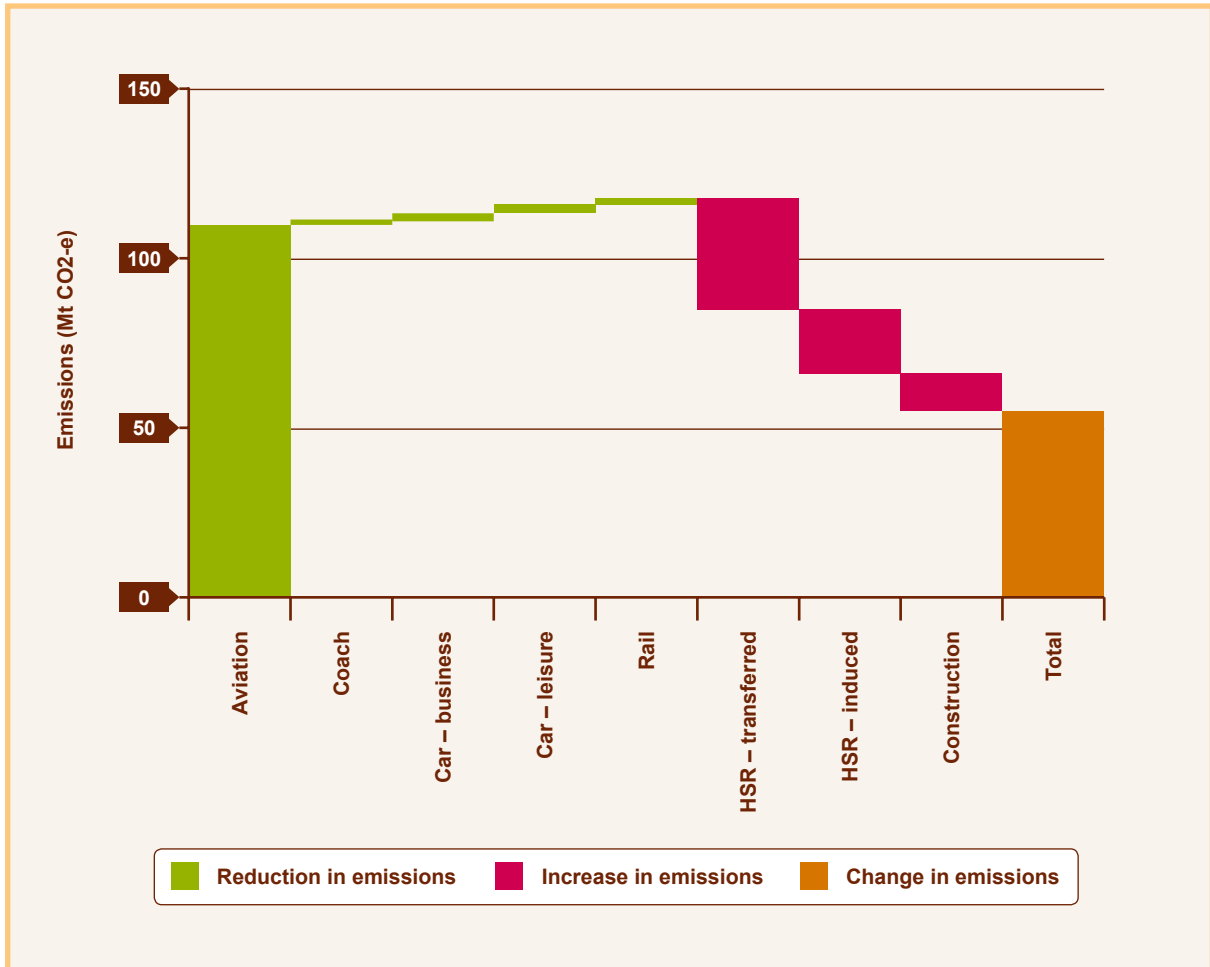
Notes: Totals may not sum due to rounding differences.

Figure 3-9 Savings in GHG emissions arising from the operation of HSR in the reference case



Note: Positive numbers denote a reduction in emissions, while negative numbers denote an increase.

Figure 3-10 Savings in GHG emissions arising from the operation of HSR in the additional aviation capacity sensitivity test



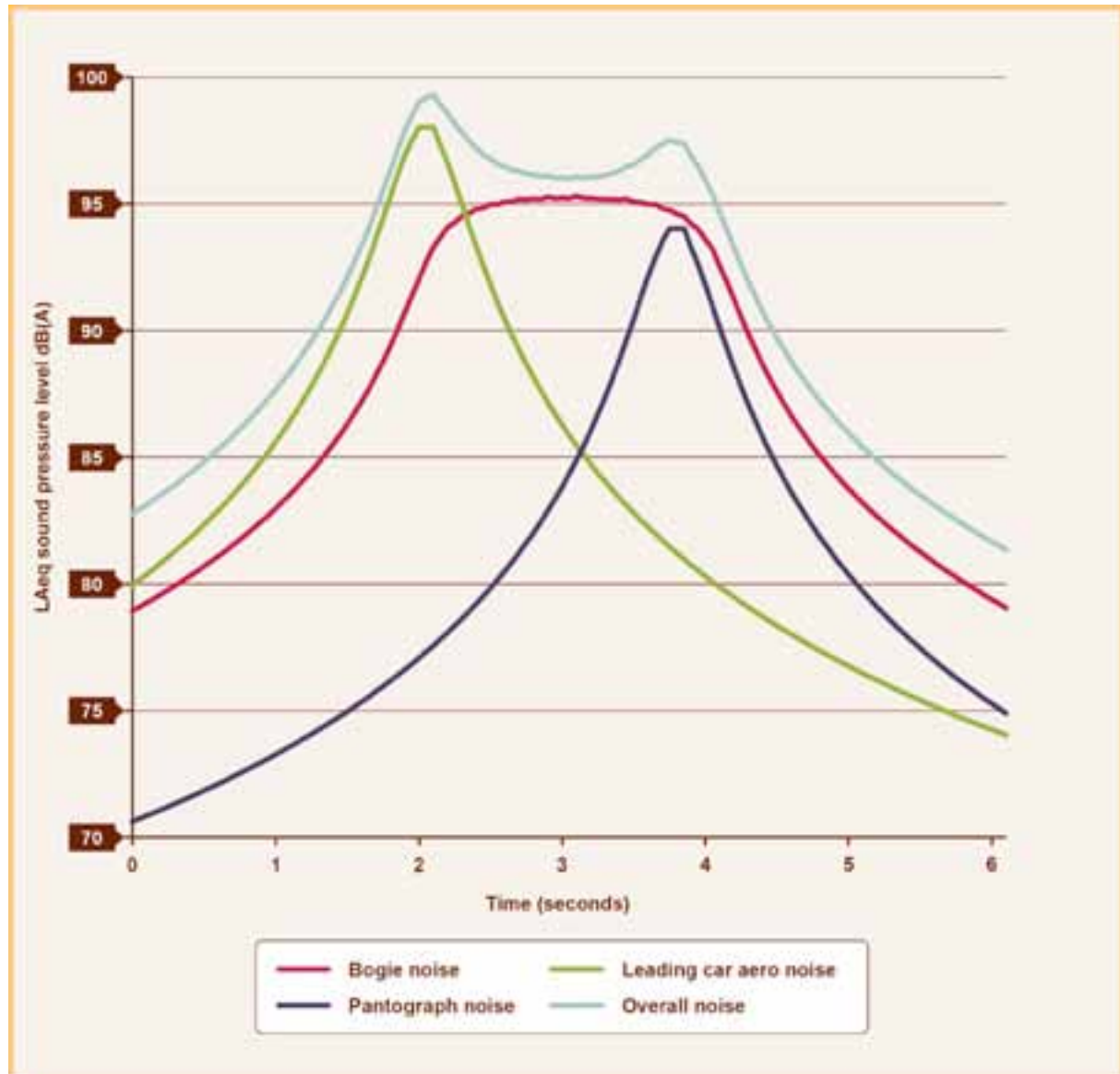
Note: Positive numbers denote a reduction in emissions. In this scenario, there are also additional emissions from aviation travel which are larger than the net reduction shown.

The impact of assuming additional aviation capacity in Sydney is shown in **Figure 3-10**. Under this scenario, it is assumed that there is sufficient aviation capacity within the Sydney region to meet demand, i.e. there is no suppressed demand. The emissions in this scenario, without HSR, are therefore higher, as there is more travel by air than in the constrained scenario. The overall outcome is a net reduction in GHG emissions of approximately 55 million tonnes of CO₂-e over the assessment period from 2035-2085, due to travel shifting from air to HSR. Emissions per passenger kilometre are lower with HSR than in the additional aviation capacity base case.

Appendix 5G outlines 13 sensitivity tests in addition to the aviation capacity test, and documents their estimated impact on GHG emissions. These show that HSR only results in reduced overall GHG emissions compared with the base case where aviation capacity in Sydney is assumed to be unconstrained.

There would also be emissions associated with the construction of additional aviation capacity in the unconstrained aviation sensitivity tests, but these would apply both without and with HSR and were not included in the calculations.

Figure 3-11 Noise levels for an HSR train operating at 350kph



3.5.2 Noise

An individual HSR train would be slightly louder than an existing passenger train operating on Australia's rail network today, although given its greater speed the duration of the noise impact of a single HSR train would be shorter. However, the frequencies of HSR trains described in **section 3.2** are significantly greater than current service levels, leading to a potentially greater noise impact overall. An assessment of the noise that would be generated by the HSR service was therefore

undertaken to establish the mitigation that would likely be required. The cost of the mitigation is included in the commercial and economic appraisals provided in **Chapter 7** and **Chapter 8**.

Two types of operational noise generated by HSR were assessed:

- Airborne noise emitted by moving trains across open space.
- Groundborne or regenerated noise transmitted through the ground arising from the passage of moving trains on the trackform.

Airborne noise

Recent research¹⁵ reviewing the noise sources associated with high speed rail defined the following components, all contributing to the overall noise levels:

- Bogie noise, created by the wheel/rail interaction.
- Aerodynamic noise from the front of the train.
- Aerodynamic noise emitted from the pantographs providing electrical power to the train.

Figure 3-11 illustrates how the different types of noise contribute to the overall noise levels for a train travelling at 350 kilometres an hour in a rural area. The calculations are based on the slab track design assumed for the preferred HSR system, and the noise levels are those received at a point 25 metres from the centre line of the HSR track.

Airborne noise is measured in dB(A) units. L_{Aeq} is the equivalent continuous noise level. For HSR airborne noise, the noise peaks arising from all the trains in a given period are combined to define an L_{Aeq} .

The period used for assessment of daytime noise in Australian noise standards is 15 hours. The $L_{Aeq(15hr)}$ standard in NSW and Victoria is 60dB(A) and this was adopted for the assessment of mitigation requirements on the high speed rail study.

HSR trains are assumed to operate between 5am and 11pm and within that the 'daytime' period for noise assessment was assumed to be 7am to 10pm. The assessment was undertaken using train frequencies between Sydney and Canberra, the most intensively used section of the HSR system, which would carry the highest number of HSR trains per hour.

Noise emissions from HSR trains were plotted against distance from the track with and without mitigation. The assessment was repeated for urban areas, assuming a lower operational speed of 250 kilometres per hour, and also for 'urban' and 'transitional' areas on the approaches to towns and cities.

The results are provided in **Table 3-5**, which shows the distance from the centreline of the railway at which compliance with the adopted standard is achieved.

Table 3-5 Noise compliance offset distances

Scenario	Compliance offset distance
Rural area	230 m
Transition area with 2 m mounding	70 m
Transition area with 3 m mounding	51 m
Urban area with 2 m noise wall, 7 m from track centreline	25 m
Urban area with 2 m noise wall, 4 m from track centreline	21 m
Urban area on viaduct with 2 m noise barrier	21 m

Note 1: Rural areas have been assumed to comprise predominantly single storey receivers (e.g. dwelling, office, school).

Note 2: Urban areas have been assumed to comprise predominantly two storey receivers.

Note 3: Viaduct has been assumed to be predominantly elevated, resulting in a similar height as a second storey receiver.

15 K. Nagakura & Y Zenda, Prediction Model of a Wayside Noise Level of Shinkansen, 2004.

P Bellingrad et al, *Experimental Study of Noise Barriers for High Speed Trains*, 2012.

C Mellet et al, 'High Speed Train Noise Emission: Latest investigation of the aerodynamic/rolling noise contribution', *Journal of Sound and Vibration*, 2006.

DJ Thompson et al, *Application of a Component-Based Approach to Modelling the Aerodynamic Noise from High-Speed Trains*, 2012.

The results summarised in **Table 3-5** indicate that the indicative offset distances at which receivers would be affected range from 21 metres to 230 metres, depending on the location and noise mitigation provided. Noise barriers would be required for all built-up areas to ensure that receivers were not adversely affected. Mitigation for receivers in sparsely populated areas would generally comprise architectural treatments such as mechanical ventilation, upgraded doors and window seals. While further investigation of specific measures would be required at a later stage if an HSR were progressed, this assessment shows that appropriate noise mitigation could be included in the design to ensure that impacts comply with adopted standards. The measures required to achieve this outcome are included in the HSR capital cost estimates provided in **Chapter 7**.

Regenerated noise

Regenerated noise is created when vibrations produced by trains running in tunnels travel up through the ground and into buildings, causing flat surfaces in the building to vibrate. The vibration is not generally strong enough to be felt, but may create an audible noise inside the building.

The analytical procedure used to predict rail related vibration and regenerated noise relies on empirical data for input parameters such as train vibration levels, track attenuation and vibration attenuation through ground.

Mitigation for ground borne noise requires variation to the types of fastener used to connect the track with the pad on the slab track upon which it rests. A variety of fasteners and pads could be employed dependent on the specific location, but the offset distance required at 250 kilometres per hour (the maximum tunnel speed) varies from less than five metres to 57 metres, depending on the form of mitigation adopted. This indicates that HSR could be designed to ensure that sensitive receivers are not adversely affected by regenerated noise. The same measures are predicted to provide sufficient mitigation potentially arising from ground-borne vibration as well as regenerated noise.

3.6 Conclusion

The east coast travel market that HSR would attract is heavily influenced by the capital cities, which would be either the origin or destination of the majority of HSR travel. Furthermore, travel between the state capitals would be particularly strong and with the continued growth forecast over the evaluation period, would require trains 300 metres long operating four to five times during peak hours by 2065.

This leads to the definition of two types of product. Inter-capital express services would connect the state capitals with journey times less than three hours, which as shown in **Chapter 2**, internationally has led to HSR attracting market shares in the region of 50 per cent. These services would stop only at peripheral stations on the outskirts of metropolitan areas to pick up the outbound city resident market. Additionally, inter-capital regional services would connect the state capitals with more frequent stops at regional population centres.

The required journey times and frequency of these services could be provided through a twin-track wheel-on-rail system using technology proven on other HSR systems currently in operation overseas. This would assist with managing system cost and enable procurement of components from currently available sources. It would not, however, rule out adoption of further developments, for instance in the next generation of signalling technology, during the period of further planning that would be required for an Australian HSR program.

The preferred HSR system between Brisbane and Melbourne would be a substantial operation that would require a fleet of some 128 trains by 2065. Sydney would be the hub of the preferred HSR system and would be the location of the HSR operations centre. With services operating to the north and south, maintenance facilities would be required to serve both lines. Locations at Lenaghan (near Newcastle) and Goulburn (between Sydney and Canberra) have been identified as suitable for these facilities.

HSR would generate lower GHG emissions per passenger kilometre than other modes from which demand would divert, i.e. aviation and the private car. In the reference case, the circumstances of 'no expansion of airport capacity in the Sydney region' result in a preferred HSR system that would generate an overall net increase of 22 million tonnes of CO₂-e over the period from 2035 to 2085. In the aviation capacity sensitivity test there is less potential for aviation capacity released through diversion of some journeys to HSR to be taken up by aviation demand not previously catered for. The outcome of the sensitivity test is a net reduction in GHG emissions of about 55 million tonnes of CO₂-e over the period from 2035 to 2085, associated with the introduction of HSR.

The impact of noise emissions from HSR operations has been considered to develop noise mitigation for an HSR system that would be compliant with the adopted noise criteria. Adequate mitigation for both noise and vibration could be included in the design of a future HSR program to ensure that compliance is achieved for affected receivers. The mitigation has been included in the capital cost estimates.

A blurred landscape featuring a large white number '4' centered in the middle. The background consists of a green field in the foreground, a brownish-green field in the middle ground, and a blue sky with dark, horizontal cloud streaks in the upper portion. The overall image has a motion blur effect.

4

The background of the page is composed of several diagonal stripes in various shades of teal, ranging from light to dark. The stripes run from the top-left towards the bottom-right. The bottom-right corner of the page is white, where the number '4' is located.

4

Alignment and station locations

4.1 Introduction

This chapter describes the development of the preferred HSR alignment between Brisbane and Melbourne. It includes an explanation of how the corridors, which encompass the broad range of potential alignments previously identified in phase 1 of the study, have been developed and assessed to arrive at a preferred alignment and station locations for the capital cities and regional areas. The objective of the alignment options evaluation process was to select the most sustainable alignment based on the assessment criteria which included potential user benefits, engineering, cost and social and environmental values.

The chapter is structured as follows:

- **Section 4.2** outlines the methodology for selecting the preferred alignments and station locations.
- **Section 4.3** introduces the preferred alignments and station locations.
- **Sections 4.4 to 4.11** present the options along the route from north (Brisbane) to south (Melbourne) and explain the choice of the preferred alignments and stations.

The chapter is supported by several technical appendices:

- **Appendix 3A** details the evaluation criteria and methodology applied to a range of options.
- **Appendix 3B** describes the preferred alignment.
- **Appendix 3C** discusses the land requirements for implementing the preferred alignment.
- **Appendix 3D** contains detailed maps of the preferred alignment.

In determining the preferred alignment and station locations, the study considered the following questions:

- How could the value of each option be maximised to meet the travel demand?
- To what extent did each option avoid significant adverse environmental impacts?
- How successfully did each option minimise the need to acquire private property?
- How well did each option support land use planning strategies where feasible?
- To what extent did each option contribute to the aim of limiting construction risks, including impacts on existing railway operations and major roads?

4.2 Methodology for selecting the preferred HSR alignment and station locations

Alternative alignments and station locations were analysed and compared to select the preferred HSR alignment.

The analysis considered the costs, user benefits, accessibility, environmental and social impacts of each alternative, as well as the associated risks during construction. These criteria are briefly explained below. Full details can be found in **Appendix 3A**.

User benefits were calculated based on travel time, convenience and fares, all expressed in monetary terms over the appraisal period. In evaluating station locations, user benefits are measured as the relative costs of travel in accessing different stations. In selecting alignment alternatives, the benefits are measured as the relative value of travel time and cost savings or penalties using one alignment or another.

Accessibility in the capital cities, and particularly the relative proximity of each station option to other interconnecting transport modes (for example metropolitan rail, bus and tram services), were assessed qualitatively, using a range from

low to high. In regional areas, station locations were selected with regard to ease of access from motorways or major roads.

Environmental and social impacts of HSR alignment and station location options were considered through a strategic environmental assessment framework, based on the Australian Government's indicative strategic endorsement criteria¹. These criteria were derived from the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and included:

- Protection of the environment, in particular, matters of national environmental significance (MNES).
- Promotion of ecologically sustainable development.
- Promotion of the conservation of biodiversity.
- Demonstrated adaptation to reasonable climate change scenarios.
- Protection and conservation of heritage.

The strategic environmental assessment focused on identifying preliminary strategic considerations rather than project-level impacts. For instance, the maps in **Appendix 3D** illustrate the preferred alignment, but at this strategic stage, elements such as corridor boundaries are not exact and it is therefore not possible to estimate the precise impacts on specific properties. Should a decision be made to proceed with HSR, more detailed site surveys and specific geotechnical, environmental and engineering investigations will form part of the detailed design phase, in consultation with property owners.

Comparative cost estimates for the alignments were developed by applying unit prices to estimated quantities and distances for each of the cost components (e.g. tunnels, bridges and other civil works):

- Unit costs for the stations and for each of the major civil infrastructure elements of the alignments were built up from preliminary design specifications and benchmarked against recent domestic and international

1 Department of Sustainability, Environment, Water, Population and Communities, *Guide to Undertaking Strategic Assessments*, 2011.

examples. Unit prices for many of the non-civil infrastructure elements were based on recent HSR projects and similarly benchmarked.

- Operating costs were captured in the appraisal either through the proxy of train transit time/route length comparisons, or as a specific item where they provided material differentiation between route options (e.g. in Canberra, the through option would add 13 minutes to the non-stop travel time between Sydney and Melbourne compared to the direct route between Sydney and Melbourne which is possible with a spur option to Canberra).

Experience has shown that certain issues regularly lead to problems in meeting cost or time targets in major infrastructure works.

Construction risk (or constructability) was assessed on a scale from ‘very easy’ to very difficult’, taking into account not only variability in construction complexity, but also the likely interfaces with, and impacts on, third parties such as the need to provide noise barriers in some areas and fauna and stock crossings. Although the estimated ease of construction has a bearing on the construction cost estimate, it should be noted that additional issues may emerge during detailed design or implementation phases, which can affect the constructability assessment.

4.2.1 Generation of options for urban alignments and station sites

The location of city centre stations is one of the key influences on the demand for HSR services. In turn, the preferred location of city centre stations is a key determinant in the location of the urban alignment, since the preferred alignment is typically that which best serves the preferred station location, taking into consideration the cost of constructing each alignment. Shortlists of potential city centre station sites were identified using the following guidelines:

- Stations to be located close to existing railway stations or transit interchanges.
- Stations at surface level were preferred over subsurface or elevated stations.

- Station sites to avoid areas of environmental or heritage significance, and be sensitive to community and residential areas and current local land use.
- To make use of existing transport infrastructure wherever possible.

The following factors were considered in generating potential urban alignments:

- Existing and planned future rail and road corridors were examined for their suitability to allow a design speed of 250 kilometres per hour from the urban periphery to the city stations. This is considerably faster than conventional train speeds, which typically have design speeds of 80 kilometres per hour (or less) in inner urban areas and 115 kilometres per hour in outer suburbs.
- The horizontal curves required to accommodate these higher speeds mean that even the use of existing transport corridors for viaducts would require significant property acquisition to straighten them to accommodate the wide curves necessary for the HSR design speed. The additional cost of this land, and the complexity of the associated grade-separated junctions at existing overbridges, makes a viaduct more expensive than tunnelling in urban areas, but with none of the environmental shielding that tunnels ultimately provide. Tunnels have been proposed in most urban areas because of the lack of suitable rail corridors that could meet the HSR alignment and of suitable land to establish a new surface (or viaduct) corridor for HSR. New surface level corridors in urban areas are generally limited to undeveloped land, large areas of parkland or recreational reserves, or government-owned land, as the additional cost of procurement of developed land tends to make surface alignments even more expensive than tunnelling, but with the added environmental impacts.
- Where surface alignments and viaducts are not viable, the impact of geology, flooding, natural features (water body crossings, high ground), existing tunnels and suitable portal locations on tunnelling options was considered.

Demand analysis showed that having peripheral, as well as city centre, stations can increase the benefits of HSR by allowing capital city residents, in particular, to access the HSR without having to travel to the central city station. These benefits are maximised at locations which are well connected to the urban transport network. Potential peripheral station sites were identified using the following criteria:

- Fit with the preferred urban alignments.
- Sustainability impacts and land use planning constraints.
- Connectivity with the current and future planned urban transport networks.

Figure 4-1 shows the required geometry for an HSR alignment superimposed on the existing Bankstown line rail corridor. This HSR alignment through an urban area is designed to meet a design speed of 250 kilometres per hour. The tighter curves used on existing conventional inner suburban railways allow for travel at up to 80 kilometres per hour.

The disparity in the curves means that for HSR, either at surface or on viaduct, simply widening the existing rail corridor is not feasible. Any tightening of the curve on the HSR alignment would result in a lower operating speed, longer journey time and reduced user benefits. The new HSR corridor would require property acquisition, and would cut through existing communities and developments.

Figure 4-1 shows the minimum corridor width (30 metres), not including the additional width required for embankments or cuttings necessary to maintain the smooth vertical alignment required for HSR. Where the existing rail corridor is straight enough to accommodate the HSR alignment, it would still need to be widened, by procuring and clearing adjacent land, to create the 30 metres required for two dedicated HSR tracks. The rail corridors approaching Melbourne are one exception; in some cases the corridor is wide enough to accommodate HSR tracks, although the existing tracks would most likely need to be shifted within the corridor to accommodate the new HSR tracks. Where this is feasible, the preferred alignment utilises these existing corridors.

A surface alignment would still require every road or rail crossing to be grade separated, resulting in the additional impacts of overbridges or underpasses. Overbridges would need to pass at least seven metres above the HSR tracks. Even if the new surface alignment were constructed on viaduct, communities along the alignment would be bisected, with consequent social dislocation. There would also be challenges where a viaduct crossed motorways, rail corridors or any highly-skewed crossings. This height separation would have a significant visual impact in a metropolitan environment.

Comparative costs for in tunnel, on viaduct or at surface, between the two points of the alignment shown on **Figure 4-1**, are shown in **Table 4-1**. **Appendix 4B** contains detail on the source of the costs used.

Table 4-1 shows that tunnelling can have a significant cost advantage (\$171 million per kilometre against \$230 million per kilometre for viaduct and \$252 million per kilometre for surface) in densely populated cities. In these areas, a surface alignment would require extensive property acquisition (at significant cost), and would result in community severance and dislocation of businesses and suburbs.

An additional advantage of tunnelling is that the tunnels could be more direct to the station, resulting in a shorter route than alignments on viaduct or at surface, further increasing user benefits of HSR over conventional rail. Combined with the reduction in environmental and community impacts, tunnelling was the preferred alignment solution in the urban areas.

Figure 4-1 Required geometry of HSR alignment, superimposed on the Bankstown line rail corridor

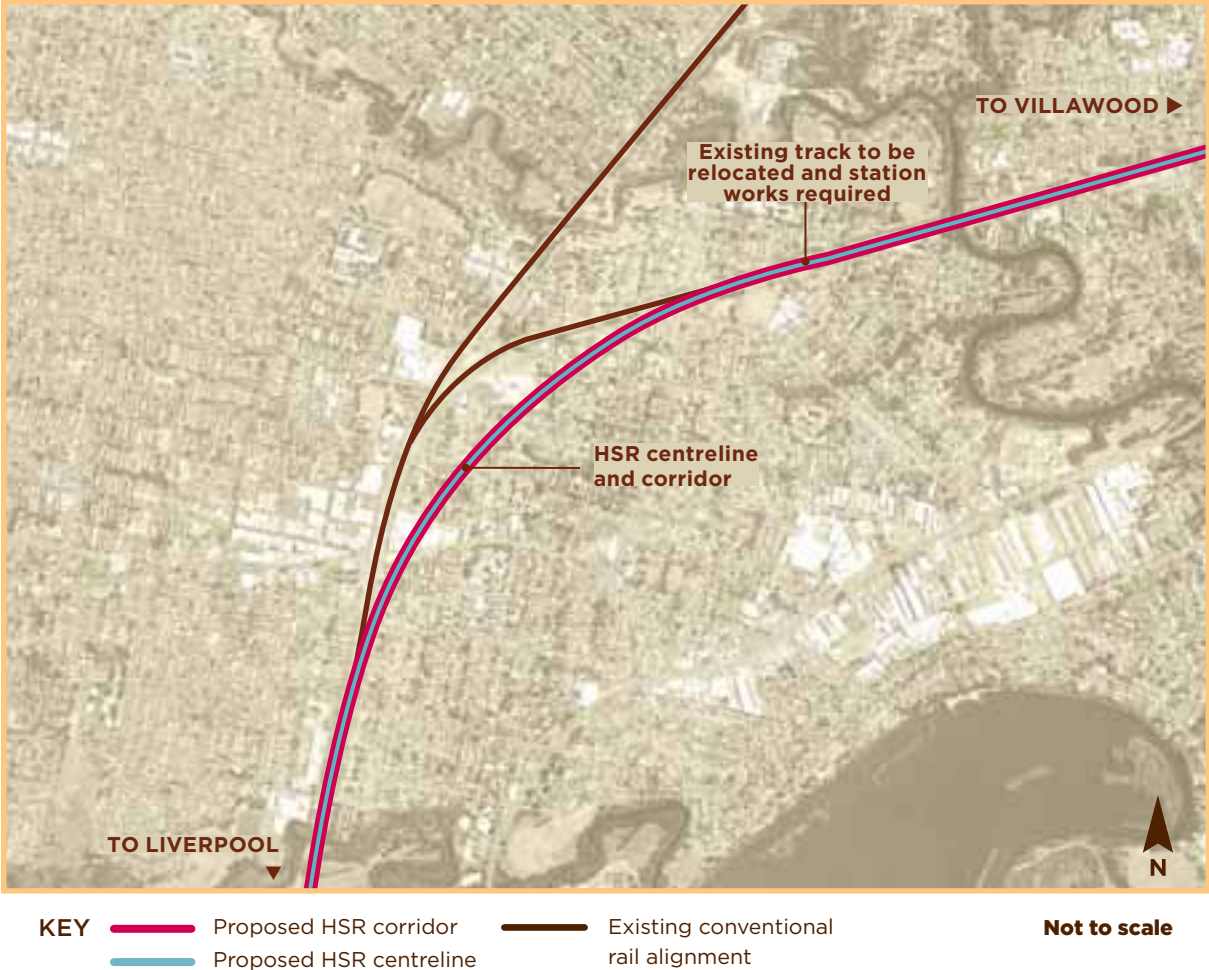


Table 4-1 Cost comparison for tunnel, on viaduct or at surface, between the two points shown on **Figure 4-1** (\$2012, \$million per km)

	Tunnel	Viaduct	Surface
Tunnels	170	-	-
Structures	-	105	80
Earthworks	-	13	13
General civil works	-	14	24
Permanent way	*	10	10
Signals and communications	*	5	5
Power	*	8	8
Land	1	75	112
Total	171	230	252

* These three items are included in the tunnels cost of \$170 million per km

4.2.2 Selection of the preferred urban alignments and station locations

The shortlists of alignments and stations were compared to identify those that best met the criteria. Alignments and stations were assessed using 'pair-wise' comparisons, in which two options were compared and the lesser performing option excluded from further assessment. This process was repeated until it yielded a single preferred option. The criteria for selecting the preferred city centre stations, alignments (both urban and regional) and peripheral station locations were:

- Access time and user benefits.
- Capital cost and relative construction complexity.
- Sustainability impacts and land use planning constraints.

Further discussion of these criteria and a constructability matrix are provided in **Appendix 3A**.

4.2.3 Generation of regional alignments and station locations

The demand modelling found that patronage on HSR was relatively unaffected by the precise siting of regional station locations. A prime consideration for determining how best to approach and serve regional towns was to avoid the impact of a high speed line through their centres. The frequency of trains passing (as many as 20 per hour in 2065), with the majority travelling at maximum speed (as only a proportion would actually be stopping), would create significant visual and environmental impacts on adjacent properties.

The creation of a suitable corridor to permit trains to travel through regional towns at speed would result in the demolition of a significant number of properties and realignment of any transecting roads, unless the route was tunnelled (at considerable additional cost). Even a viaduct crossing a town would have considerable negative impacts in terms of community severance, noise and visual amenity.

Alignments were therefore chosen to avoid the regional town centres but, where possible, to approach the outskirts of the towns, where property development is less dense and there is good accessibility by road. Regional stations were then identified on the preferred regional alignment and evaluated to balance local user benefit and environmental and social impacts.

4.2.4 Selection of the preferred regional alignments and station locations

Regional alignments

The study area was divided into seven sections for the purposes of appraisal:

- Brisbane-Grafton.
- Grafton-Port Macquarie.
- Port Macquarie-Twelve Mile Creek².
- Twelve Mile Creek-Sydney.
- Sydney-Goulburn.
- Goulburn-Albury-Wodonga.
- Albury-Wodonga-Melbourne.

Alignment planning software³ was used to generate up to 50 potential alignments of approximately 50 to 100 kilometres in length within each section that met particular topographical, environmental, geological, hydrological and cost constraints. These were then subject to progressive pair-wise comparison, with the two best performing and lowest cost alignments in each section being compared against the assessment criteria. This process continued in each section until only one alignment along the corridor remained – the preferred alignment.

Regional stations

HSR stations need to be located where the alignment is flat and straight. Given this constraint, the following guidelines were used to identify potential regional station sites:

- Good access from the regional road network.
- Proximity to population centres and growth areas.
- Proximity to other regional transport infrastructure, i.e. regional airports or rail stations.
- Avoidance of significant geographical constraints, such as flood plains or steep topography.
- Avoidance of other areas of significance, such as environmental or heritage areas or large infrastructure features.

The preferred regional station sites were selected on the basis of the following criteria:

- Accessibility.
- Sustainability and consistency with land use planning and regional planning strategies.
- Capital cost.
- Constructability.

More detail on the development and evaluation of alignments is provided in **Appendix 3A**.

Regional centres to be served

The market demand analysis indicated that there was significant demand from regional centres, both now and in future, based on population forecasts. Approximately 55 per cent of HSR trips are forecast to start or end their journey at a peripheral or regional station. Station locations were chosen along the preferred alignment on the basis of being able to serve the largest possible regional population.

2 North of Newcastle.

3 Quantm, provided by Trimble Planning Solutions.

Figure 4-2 presents regional centres within the study area and their population forecasts at 2036, with potential station locations highlighted in red⁴.

While demand may exist in the regional centres, it does not necessarily follow that each regional centre should have its own HSR station, for the reasons outlined below.

The demand forecasts indicated that generally a regional centre with a population greater than 50,000 in 2036 could support a station⁵. While stations have been generally proposed at these centres, in some cases, a single regional centre with insufficient population for a station may draw on a larger population from surrounding districts and therefore also be identified as a preferred station location. Similarly, others with a population greater than 50,000 may be able to access a nearby station in the surrounding area, for example:

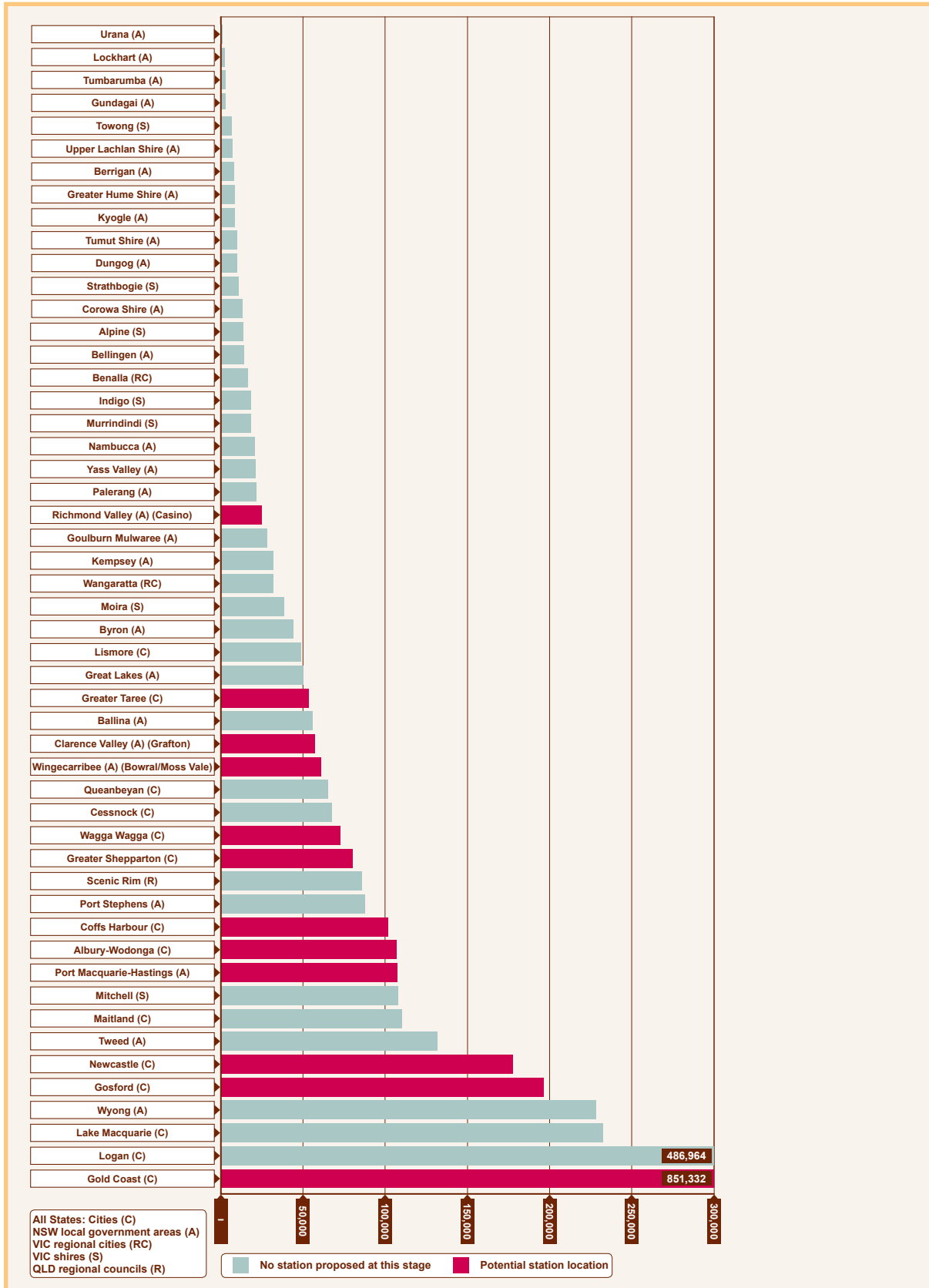
- Fringe metropolitan areas, such as Logan (Brisbane) and Mitchell Shire (Melbourne) would be served by the peripheral station or by the city centre station in each city.
- An HSR station located at Newcastle could serve the population centres of Maitland, Cessnock and Port Stephens. Lake Macquarie, with a forecast population of approximately 230,000 in 2036, could support an HSR station of its own; however, with the dispersed nature of the population and an HSR station at Newcastle, the population of Lake Macquarie could be served by the Newcastle and Central Coast stations.
- A Central Coast HSR station could serve both Gosford and Wyong, and also meet some of the travel demand from Lake Macquarie.
- The Far North Coast area of Lismore, Ballina, Byron and Casino could be served by one regional station, as the forecast combined population for the area in 2036 is 175,000⁶. The station location was also influenced by the preferred alignment south from Brisbane.
- The Great Lakes area could be served by a station at Taree, but could also be served by a Newcastle regional station.
- Queanbeyan could be served by the Canberra terminal station and the Gold Coast Terminal station could serve the nearby areas of the hinterland and Tweed.

4 ABS, loc. cit.

5 Towns served by regional stations on international HSR networks vary in size, but are generally above 50,000. The number of regional centres would mean an average distance between stations for the Brisbane-Sydney-Canberra-Melbourne sectors of approximately 100 km. This is greater than the average distance between stations on the Taiwan HSR (50 km), the Seoul-Busan line (65 km) and the Beijing-Shanghai line (60 km), but less than on the Madrid-Barcelona line (125 km).

6 ABS, loc. cit.

Figure 4-2 Forecast regional populations along the preferred alignment (2036)



Source: ABS, Census Data by LGA, 2010

4.3 Overview of the preferred HSR alignment and station locations

The alternative corridors, alignments and station locations described in this chapter were analysed and compared to select a preferred east coast HSR alignment that would be environmentally and economically sustainable. This section summarises the preferred alignment, which is illustrated in **Figure 4-3**.

Further details of the alignment selection for each sector are discussed in **sections 4.4 to 4.11**.

4.3.1 Brisbane-Sydney

From a new HSR station in the footprint of the existing Transit Centre adjacent to Brisbane's Roma Street station, the HSR alignment would run south in a tunnel beneath the existing Ipswich Line and emerge at St Lucia before crossing the Brisbane River and running on a viaduct along the Oxley Creek floodplain to Greenbank. A Brisbane peripheral station would be located just south of the M2 Motorway, west of Paradise Road.

From Greenbank, the alignment would follow an inland corridor via Beaudesert, including a series of tunnels beneath the Border Ranges at the Queensland/NSW border. The Gold Coast would be served by a spur line from near Beaudesert, including a four kilometre tunnel beneath Mount Tamborine to an HSR station adjacent to the existing conventional rail station at Robina. The route would continue south of Beaudesert in tunnel underneath the World Heritage Gondwana Rainforest in the Border Ranges National Park, pass Casino to the west, and stay east of the Great Dividing Range passing Grafton, Coffs Harbour, Port Macquarie and Taree to Newcastle.

The section from Beaudesert to Newcastle has a number of major structures including a seven kilometre viaduct across the Clarence River floodplain to the east of Grafton, a 2.5 kilometre tunnel beneath the Boambee State Forest to the southwest of Coffs Harbour, a five kilometre viaduct across the Wilson River floodplain to the northwest of Port Macquarie, a 15 kilometre viaduct across the Manning River floodplain to the east of Taree and a two kilometre tunnel beneath the Myall Lakes Ramsar Wetlands between Taree and Newcastle.

Avoiding built-up areas, including Wyee, Wyong and Ourimbah to the east and steeper topography to the west, the alignment would broadly follow the F3 Freeway corridor south of Newcastle into Sydney. This would include long lengths of tunnel (including a 6.5 kilometre tunnel north and a series of smaller tunnels south of the Hawkesbury River) and a high level crossing of the Hawkesbury River, on a bridge adjacent to the F3 Freeway crossing at Mooney Mooney.

Regional stations would be located west of Casino (along the Bruxner Highway), southeast of Grafton (adjacent to Grafton Airport), southwest of Coffs Harbour (west of the Pacific Highway), west of Port Macquarie (west of the Oxley Highway/Pacific Highway interchange), southeast of Taree (along Old Bar Road), west of Newcastle (east of the F3 Freeway) and at the Central Coast (north of the F3 Freeway/Pacific Highway interchange at Ourimbah).

The alignment into Sydney from the north would be in tunnel, generally following the Northern Line towards Homebush, then eastwards generally following the Western Line before terminating at Central station. A Sydney North peripheral station would be located adjacent to the conventional rail station at Hornsby.

Figure 4-3 Preferred HSR alignment and station locations



Note: The map shows 16 of the 20 proposed stations but omits the peripheral stations which would not be discernible at the scale shown.

4.3.2 Sydney-Melbourne

Exiting Sydney to the south, the route would be in tunnel from Central station to around Holsworthy and then predominantly at surface level to the east of Glenfield, Minto and Campbelltown. A Sydney South peripheral station would be located at the northern end of the Department of Defence land at Holsworthy, accessed via the M5 Motorway and Moorebank Avenue.

The preferred alignment would then broadly follow the Hume Highway corridor, passing through the Southern Highlands and heading inland toward Yass. The alignment would deviate from the Hume Highway corridor in places to minimise adverse impacts on residential areas, such as Mittagong, Bowral and Moss Vale, as well as environmentally sensitive areas and water supply catchment areas.

Canberra would be served via a spur line to an HSR station on Ainslie Avenue near Civic. The spur alignment would connect to the HSR alignment near Gunning. On the approach to Canberra it would run parallel to the Majura Parkway and then deviate to the west, in a 3.6 kilometre tunnel under Mount Ainslie towards Civic.

From Goulburn the main route would continue west through Yass, skirt the Brindabella Ranges and deviate north and west from the Hume Highway corridor to serve Wagga Wagga and then on to Albury-Wodonga. West of Albury-Wodonga, the alignment would also deviate from the Hume Highway corridor to avoid the hills northwest of Albury and to minimise noise and severance impacts on the community. From here, the preferred alignment would head towards Shepparton, past Seymour and broadly follow the Hume Freeway corridor toward Craigieburn.

The alignment into Melbourne would be at surface level via Craigieburn to Roxburgh Park, then via the Upfield Line corridor in tunnel from Gowrie to Southern Cross station. A Melbourne peripheral station would be located just north of the M80 Western Ring Road, west of the Hume Highway at Campbellfield.

The Sydney-Melbourne route has comparatively few major structures, the longest being a three kilometre viaduct across the Murrumbidgee River floodplain to the east of Wagga Wagga and a two kilometre viaduct across the Murray River floodplain to the west of Albury-Wodonga. Aside from the 3.6 kilometre tunnel under Mount Ainslie, there would be three other tunnels, each less than two kilometres in length.

Regional stations would be located in the Southern Highlands (adjacent to Mittagong Airport), east of Wagga Wagga (adjacent to Wagga Wagga Airport), west of Albury-Wodonga (north of the Hume Freeway/Murray Valley Highway interchange), and east of Shepparton (along the Midland Highway).

Twenty stations are proposed, with the capital city stations located in the central business districts (CBDs). The locations of the other stations vary and are explained in sections **4.4 to 4.11**.

The proposed stations are:

- Brisbane CBD
- Brisbane South
- Gold Coast
- Casino
- Grafton
- Coffs Harbour
- Port Macquarie
- Taree
- Newcastle
- Central Coast
- Sydney North
- Sydney CBD
- Sydney South
- Southern Highlands
- Canberra CBD
- Wagga Wagga
- Albury-Wodonga
- Shepparton
- Melbourne North
- Melbourne CBD

4.4 Brisbane-Grafton (including the Gold Coast)

4.4.1 Brisbane

Overview

Brisbane is Australia's third largest capital city with a population of approximately two million people and employment at over one million, generating nine per cent of Australia's gross domestic product. Population and employment forecasts indicate a population for metropolitan Brisbane of almost three million by 2031, with employment of around 1.5 million⁷. By 2056, the population is predicted to reach around four million people⁸. The surrounding region is also expected to grow rapidly. The Brisbane local government area (LGA) and ten other surrounding LGAs together constitute the South East Queensland (SEQ) region, which is expected to have a population of six million by 2056, with strong growth on the Sunshine Coast to the north, in Toowoomba to the west and on the Gold Coast to the south⁹.

The long-term infrastructure policy for the city is set out in Brisbane City Council's *Brisbane Long Term Infrastructure Plan 2012-2031*¹⁰. This identifies a series of actions to deliver infrastructure strategies for transport and other services for the metropolitan area and key employment and commercial districts, including the Brisbane CBD. The *South East Queensland Regional Plan 2009-2031* and *Connecting SEQ 2031* outline the Queensland Government's land use and transport plans to support the growth in the SEQ region¹¹.

In Brisbane, congestion and insufficient capacity already affect the performance of the rail network.

The *Connecting SEQ 2031* plan foreshadows a number of new rail lines, including Cross River Rail and extensions to northwest Brisbane, light rail on the Gold Coast, an inner Brisbane subway and further expansion of the bus rapid transit (BRT) network¹². However, to date the planning strategies for Brisbane have not taken into account the possibility of HSR.

Strategic planning context and issues

The planned growth of Brisbane and the SEQ region will continue along existing developed corridors along the coast, as well as inland corridors towards and beyond Ipswich to the west and towards Beaudesert to the south. The *South East Queensland Regional Plan 2009-2031* maintains the existing urban footprint but identifies sufficient land to accommodate a projected population of 4.4 million people and their employment and economic development needs up to 2031, albeit in a more compact urban form¹³. The plan sets out specific growth management policies aimed at achieving urban consolidation and encouraging infill and redevelopment in established urban areas¹⁴.

The area between Brisbane and the Gold Coast includes continuous residential development from Coomera to the Gold Coast, as well as many natural and constructed waterways.

Environmental planning context and issues

The entry points into Brisbane feature a mix of well-vegetated tablelands (including Mount Tamborine) in the hinterland to the Gold Coast, and undulating land predominantly used for agriculture and rural small holdings within a valley that includes Beaudesert, south of Brisbane.

7 Brisbane City Council, *Brisbane Economic Development Plan 2012-2031*, 2012.

8 ABS, Census Data by LGA, 2011.

9 *ibid.*

10 Brisbane City Council, *op. cit.*

11 Department of Infrastructure and Planning, *South East Queensland Regional Plan 2009-2031*, 2009.

Department of Transport and Main Roads, *Connecting SEQ 2031 – An Integrated Regional Transport Plan for South East Queensland*, 2011.

12 *ibid.*

13 Department of Infrastructure and Planning, *op. cit.*, p. 8.

14 *ibid.*, p. 9.

The Greenbank Military Training Area occupies a key location south of Brisbane. This Defence site has environmental and heritage values in addition to being an important training base, which Defence has advised will be required for long-term military use.

The coastal urban areas from Brisbane to the Gold Coast are framed to the west by the upland hinterland of Mount Tamborine and Tamborine National Park and State Forest. Additional natural areas between Brisbane and Beaudesert include Buccan Conservation Reserve, Plunkett Conservation Park and the Burnam Range. To avoid direct impact on these areas of high conservation value, a tunnel under Tamborine National Park would be constructed.

The Brisbane region includes a number of major rivers and creeks (including the Brisbane, Logan, Bremer and Albert Rivers and Oxley Creek) that meander through wide valleys and floodplains as they travel to the coast. These waterways and their floodplains contain areas of ecological and heritage significance, including a number of key vegetated areas that are mapped as essential habitat under Queensland's *Vegetation Management Act 1999*, in addition to the nationally-listed Threatened Ecological Community Swamp Tea-tree (*Melaleuca irbyana*)¹⁵. At the strategic level of this study, detailed assessment of each of these areas was not possible; however, their presence was considered in the choice of alignment to minimise potential impacts on them. Specific mitigation measures would be designed at the concept design phase when the detailed assessment of each area would be undertaken, should a decision be made to proceed with HSR.

Assessment of potential station locations

Along with the necessity to provide a new crossing of the Brisbane River, ground level access to the CBD is difficult. Phase 1 of the study identified two potential precincts for HSR stations in the centre of Brisbane:

1. At, or near, the existing station at Roma Street.
2. At South Bank.

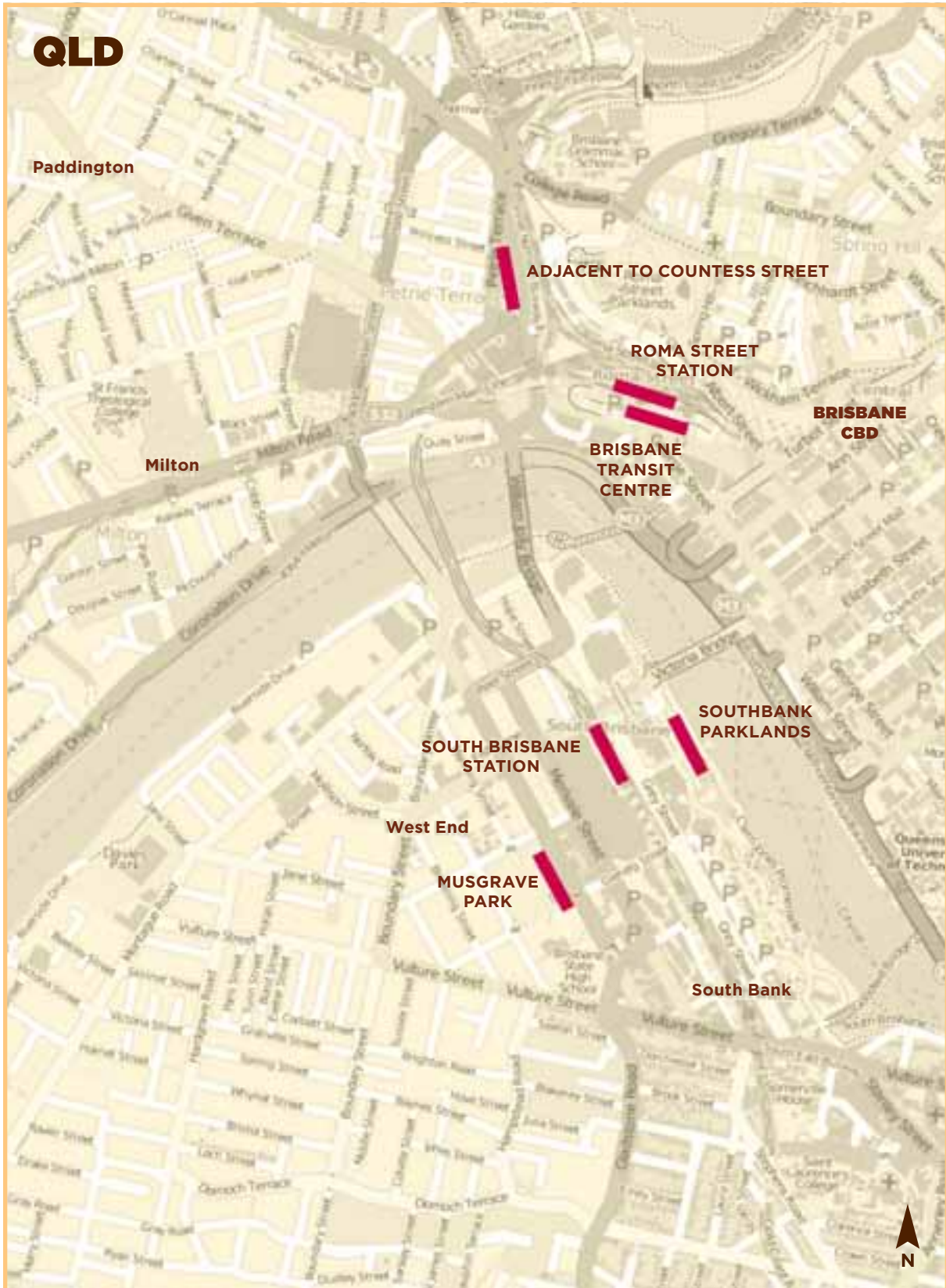
Other locations considered in phase 1 - including Bowen Hills, Fortitude Valley, Central station, Albert Street and Woolloongabba - were all ruled out due to poor accessibility or constructability. Further analysis, supported by consultation with the Queensland Government, identified three station sites at each of the two preferred precincts, namely:

- Roma Street precinct:
 - At Roma Street station.
 - A site adjacent to Countess Street.
 - At the site of the Brisbane Transit Centre.
- South Bank precinct:
 - At South Brisbane station.
 - In the South Bank Parklands.
 - In Musgrave Park.

These station sites are shown in **Figure 4-4**.

15 Essential habitat is vegetation in which a species that is endangered, vulnerable, rare or threatened has been known to occur.

Figure 4-4 Potential city centre station sites, Brisbane



KEY  Potential stations

Not to scale

Roma Street precinct

Three station sites were considered in the Roma Street precinct: at the existing Roma Street station, adjacent to Countess Street and at the Brisbane Transit Centre. All three sites provide similar user benefits but there are significant differences in cost, access and constructability.

Because the Roma Street precinct is north of the Brisbane River, a river crossing would be required for any corridor coming from the south, regardless of which site was chosen.

Roma Street station

Although the existing station at Roma Street appears to be ideal, it is on the Queensland Heritage Register, making it difficult to reconfigure for HSR operations. However, its proximity to the CBD gives it moderate to high accessibility, and it is located at a major transport interchange. This accessibility will be improved further with the proposed Cross River Rail.

Converting part of Roma Street station for use by HSR services would cost an estimated \$4.3–4.6 billion (\$4.1 billion for the urban access corridor and \$0.2–0.5 billion for the station structure). There would be additional costs associated with having to reconfigure and rebuild the existing operational railway tracks and platforms. Construction would cause significant disruption to existing rail operations, particularly given the constraints of the existing heritage station buildings, and would have an adverse impact on commuters.

Countess Street

An HSR station at the Countess Street site would have adverse impacts on existing buildings on the approach, heritage buildings associated with Victoria Barracks, and the parkland on Petrie Terrace. It would yield limited urban renewal opportunities. Further discussion of urban renewal in relation to strategically located transport infrastructure is provided in **Chapter 7** and **Appendix 3A**. It also has reduced accessibility for HSR passengers, particularly to the CBD, compared with other Roma Street station alternatives. Construction at the Countess Street site would cost an estimated \$4.35 billion (\$4.1 billion for the urban access corridor and \$0.25 billion for the station structure). HSR access to the site requires a north–south alignment, crossing the existing rail lines approaching Roma Street station from the west. Even with careful planning this would disrupt Queensland Rail services while the construction occurred.

Brisbane Transit Centre

Using the Brisbane Transit Centre site for an HSR station would provide new opportunities for urban renewal, with minimal adverse environmental and land use impacts. It would provide the opportunity to redevelop the site with an HSR station underneath, and is consistent with current and planned development in the area, such as the creation of the Justice Precinct for Civic Plaza and the improvements to public space at the western end of George Street. An HSR station at the Brisbane Transit Centre would cost an estimated \$4.47 billion (\$4.1 billion for the urban access corridor and \$0.37 billion for the station structure, excluding purchase of existing property, if required). It would also provide excellent connectivity with the proposed Cross River Rail, and largely avoid disrupting existing train services at Roma Street during construction.

South Bank precinct

Three station sites were considered at South Bank: at South Brisbane station, in the South Bank Parklands and in Musgrave Park. Despite being connected to the urban rail and BRT networks, the user benefits of sites in South Bank are lower than those in Roma Street because of the lower direct accessibility to the CBD.

South Brisbane station

South Brisbane station is on the Queensland Heritage Register. Consequently, the construction of an HSR station on this site would need to be carefully managed to avoid any negative impacts on the existing station. The site is moderately accessible, with direct connections to the urban rail and BRT network. An HSR station at this site would cost an estimated \$3.75 billion (of which \$3.5 billion is the cost of the urban access corridor and \$0.25 billion is the cost of the station structure). However, construction on this site would cause significant disruption to existing rail operations and would be severely constrained by the surrounding infrastructure environment.

South Bank Parklands

The South Bank Parklands site would require the HSR station and approaches to be elevated above flood level. This would maintain the existing road network connections, but would have major adverse impacts on the existing riverfront parkland and environment. With a pedestrian bridge over the river linking to the CBD, this site has moderate to high accessibility for pedestrians, but overall lower accessibility than the South Brisbane station site, due to its relative distance from the BRT and rail network. An HSR station at the South Bank Parklands site would cost an estimated \$3.7-3.8 billion (\$3.5 billion for the urban access corridor and \$0.2-0.3 billion for the station structure).

Musgrave Park

An HSR station at Musgrave Park would cost an estimated \$3.7 billion (\$3.5 billion for the urban access corridor and \$0.2 billion for the station structure). While developing an HSR station at Musgrave Park would be relatively simple from a constructability perspective, it is not easily accessible from the CBD, is not well served by public transport and has lower user benefits than the other options. The area is also of cultural importance for the Aboriginal people of Brisbane.

Preferred city centre station site

All of the sites in the South Bank precinct perform less favourably against the assessment criteria than those in the Roma Street precinct. The Roma Street sites have the potential to act as a catalyst for greater economic development, and are better aligned with Queensland Government planning policies than the South Bank sites. They also provide much better access and connectivity, and construction on these sites would have less impact on the environment and land use plans.

Of the options in the Roma Street precinct, the Brisbane Transit Centre is the preferred site for an HSR station. It is better aligned with local planning policies, offers the potential for redevelopment initiatives, and is likely to have fewer adverse impacts on heritage, operational and planned transport infrastructure, and on existing urban development.

The Brisbane Transit Centre is the preferred site for an HSR station in Brisbane.

Table 4-2 presents a summary of the assessment.

Table 4-2 Assessment of potential city centre station sites, Brisbane

Objective	Criteria	Roma Street precinct			South Bank precinct		
		Roma Street station	Adjacent to Countess Street	Brisbane Transit Centre	South Brisbane station	South Bank Parklands	Musgrave Park
Economics and connectivity	Difference in user benefits from Roma Street station (\$b)	-	-	-	-1	-2	-2
	Pedestrian access to CBD	High	Low	High	Moderate	Moderate - high	Low
	Public transport access (existing)	High	Moderate	High	Moderate	Low-moderate	Low
	Parking availability (existing)	Low	Low	Low	Low	Low	Low
	Proximity to residential centre	Moderate	Moderate - high	Moderate	Low-moderate	Low-moderate	Moderate
	Connectivity to arterial roads	Low - moderate	High	Low - moderate	Low	Low	Low - moderate
	Overall accessibility	Moderate - high	Moderate	Moderate - high	Low - moderate	Low - moderate	Low
Infrastructure	Capital cost (\$b) (station basic structure)	0.2-0.5	0.25	0.37	0.25	0.2-0.3	0.2
	Capital cost (\$b) (access corridor)	4.1	4.1	4.1	3.5	3.5	3.5
	Capital cost (\$b) (total)*	4.3-4.6	4.35	4.47	3.75	3.7-3.8	3.7
	Constructability**	5	4	4	5	4	1
Sustainability, land use planning & policy fit	Maintain existing land use***	4.0	3.8	4.0	4.0	4.0	3.8
	Maintain community function***	3.5	1.5	4.0	1.5	2.0	2.0
	Promote economic development***	6.0	6.0	6.0	6.0	6.0	6.0
	Summary	Slightly beneficial	Neutral	Slightly beneficial	Slightly detrimental	Slightly detrimental	Slightly detrimental
Conclusions		-	-	Preferred	-	-	-
Principal reasons for non-selection		Very difficult station constructability	Lower accessibility		Lower user benefits, low accessibility and impact on community function	Lower user benefits, low accessibility and impact on community function	Lower user benefits, low accessibility and impact on community function

*Highest cost preferred urban access corridor used for consistent comparison.

**Constructability is assessed and scored between 1 and 5, with the higher score reflecting more construction complexity.

***Sustainability, land use and policy fit is assessed and scored between 1 (highly detrimental) and 7 (highly beneficial).

Further detail is provided in **Appendix 5C**.

Potential urban access alignments

In determining the preferred HSR urban access alignment for Brisbane, the proposed Cross River Rail infrastructure scheme was examined for opportunities to share infrastructure and potential peripheral station sites. Existing rail corridors are anticipated to be fully utilised by conventional rail expansion. Any HSR alignments within, adjacent to or below existing rail and road corridors could reduce the impacts on existing inner urban development, but generally the existing geometry of these alignments is unsuitable for the speed of HSR trains.

Nine potential alignments through metropolitan Brisbane were identified to access an HSR station at the site of the Brisbane Transit Centre. Details and comparative evaluation of these can be found in **Appendix 3A**.

Preferred urban access alignment

All of the Brisbane urban access corridors are relatively similar in terms of length, travel time, sustainability merits and impacts on land use planning policy, and the user benefits of each are relatively equal. The main differentiator is the significant capital cost saving of the option via Oxley compared with the other options (between \$1.5 and \$3.7 billion).

Once an inland route via Beaudesert with a spur to the Gold Coast was selected, a number of urban access options were no longer feasible.

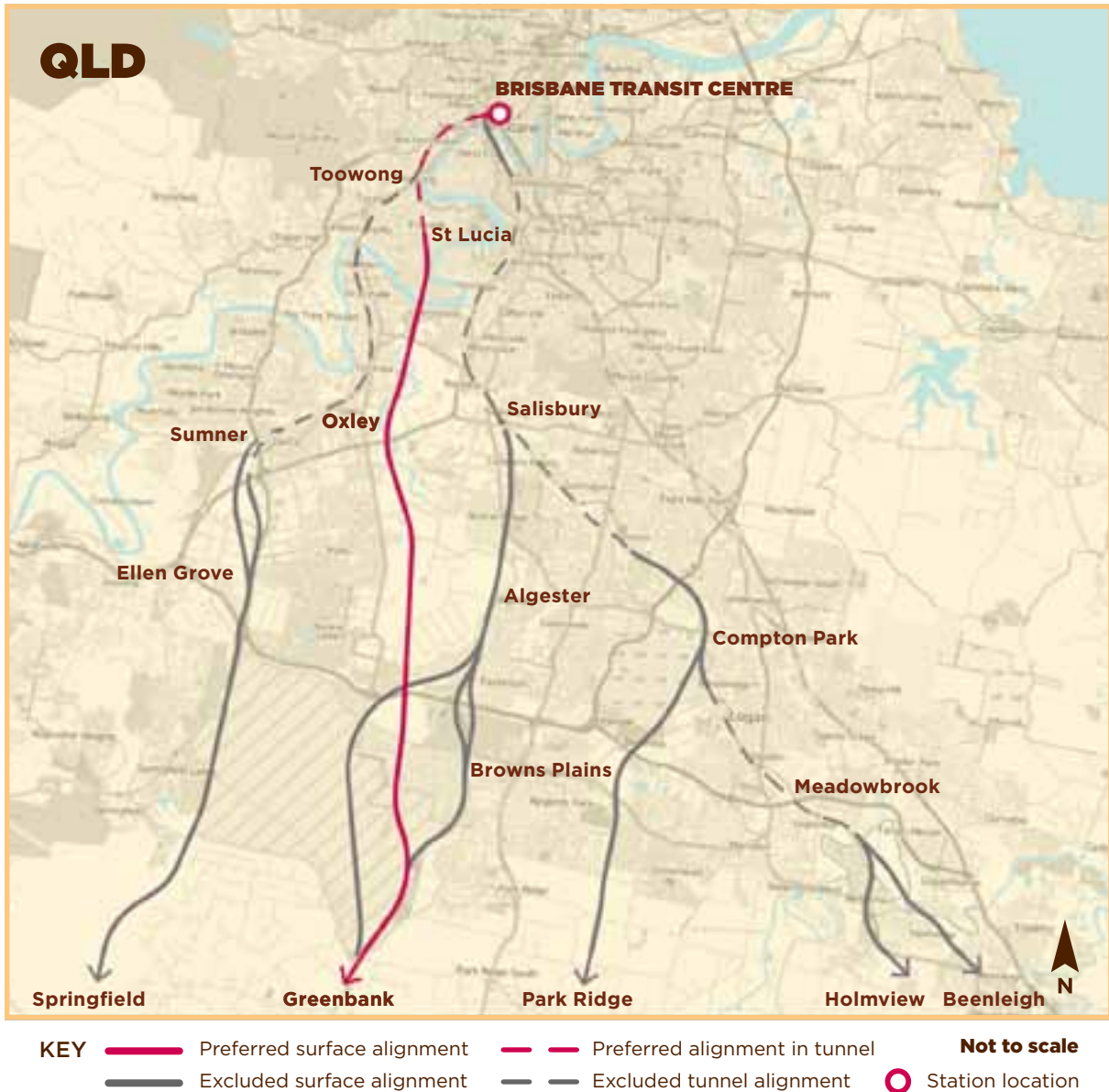
The appraisal confirmed that the alignment via Greenbank, and in particular the option via Oxley, is preferred. As this alignment includes a surface crossing of the Department of Defence land at Greenbank, two variations (presented fully in **Appendix 3A**) were also examined to determine whether a surface crossing of Defence land is the best option. These variations were:

- A tunnel under the Department of Defence land on the preferred alignment.
- A surface deviation to the east, avoiding the Department of Defence land.

The tunnel option has an increased cost of \$0.6 billion and its presence could limit Department of Defence land use. The eastern surface deviation represents a construction cost saving of \$0.2 billion (excluding land costs), but is one kilometre longer and would have significant impacts on existing residential and commercial developments. Both these options are rated more difficult to construct than the preferred option, in one case due to tunnelling through soft soils and in the second because of the interfaces between the HSR and existing rail corridor and the residential/commercial areas.

In summary, the preferred urban access in Brisbane is an alignment via Greenbank and Oxley (**Figure 4-5**).

Figure 4-5 Preferred urban access alignment, Brisbane



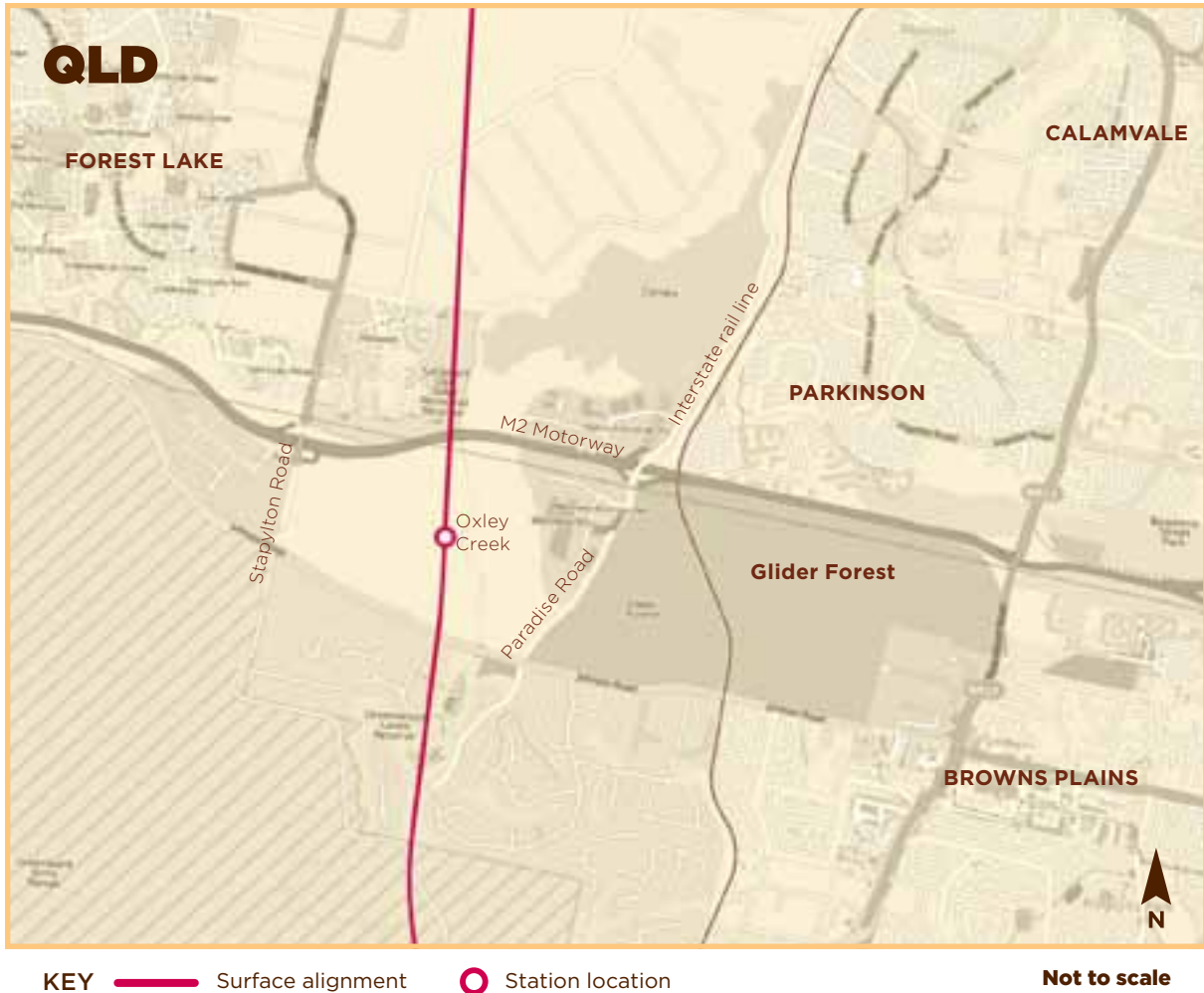
Peripheral station assessment - Brisbane

A peripheral station in Brisbane should have good connections to the regional road network as well as the regional growth areas. Two potential peripheral locations were identified, one near the M7 near Oxley and one west of Browns Plains near the M2. The selection process is described in **Appendix 3A**.

The preferred peripheral station site in Brisbane is adjacent to the M2/MR6 Logan Motorway, west of Browns Plains.

The station is located south of the motorway, west of Paradise Road, as shown in **Figure 4-6**. The site is woodland, forming part of the Glider Forest, adjacent to Oxley Creek. Road access would be provided from the motorway, via the Stapylton Road interchange. There is no urban rail access to the site (however, refer to **Chapter 5** for a discussion of a possible dedicated bus link service). The interstate rail line is located approximately two kilometres to the east but is not used for regular urban rail services at present. A peripheral station at this site would increase user benefits by \$0.9 billion.

Figure 4-6 Location of Brisbane South peripheral station site



Brisbane - preferred station sites and urban access alignment

The Brisbane Transit Centre is the preferred site for the city centre HSR station in Brisbane. This site aligns well with local planning policies and has fewer adverse impacts on heritage, operational and planned transport infrastructure and existing urban development than other sites considered. It also provides new opportunities for urban renewal and development, including above the HSR station.

The preferred access alignment to the Brisbane Transit Centre site is from Greenbank via Oxley. The cost of this alignment is approximately \$1.5 billion lower than other potential alignments, with no significant adverse impacts in terms of travel time and environmental and land use impacts.

The preferred peripheral station site in Brisbane is adjacent to the M2/MR6 Logan Motorway, west of Browns Plains.

4.4.2 Coastal vs inland corridor via Gold Coast or Beaudesert

Before the Brisbane urban alignment comparisons could be made, a decision was required to pursue either a coastal corridor via the Gold Coast or an inland corridor via Beaudesert.

The analysis showed strong demand for access to the Gold Coast, and that an alignment via the Gold Coast would generate in the order of \$10 billion more user benefits compared to an alternate alignment via Beaudesert, which would not serve the Gold Coast at all. However, an alignment through the Gold Coast would be more difficult to construct, would have a negative impact on populated and environmentally sensitive areas, and would cost \$2.7 billion more to construct

than the Beaudesert alignment. An alternative proposal of an inland alignment with a spur from Beaudesert out to the Gold Coast (without requiring a change of trains at Beaudesert) was therefore investigated.

Potential alignments within each corridor were assessed between Greenbank, a common point for the corridor alternatives to the north, and Whiporie, a common point to the south. The best performing alignments via the Gold Coast (shown in blue in **Figure 4-7**) and via Beaudesert with a spur to the Gold Coast (shown in red) were then selected for comparison.

A summary of the comparison is provided in **Table 4-3**, while the detailed appraisal of the alignments is provided in **Appendix 3A**.

Table 4-3 Comparison of alignments in the Brisbane-Whiporie corridor

Criteria	Brisbane-Grafton	
	Coastal alignment	Inland alignment, with a spur to the Gold Coast
Length (km) (Greenbank to Whiporie)	215	178
Estimated transit time (min) (Greenbank to Whiporie)	40.5	31.5
Relative net user benefits (\$b)	+0.4	0.0
Capital cost (\$b)	9.0	8.7
Constructability*	4	3
Sustainability and land use**	Not preferred	Preferred
Conclusion	-	Preferred

*Constructability is assessed and scored between 1 and 5, with the higher score reflecting more construction complexity.

**Sustainability and land use assessed on a pair-wise comparison against seven criteria.

Figure 4-7 Potential alignments in the Brisbane-Whiporie corridor



An inland alignment with a spur from Beaudesert to the Gold Coast would achieve most of the benefits at no additional cost when compared to the coastal route, while minimising the environmental and social impacts.

The inland alignment via Beaudesert with a spur from Beaudesert to the Gold Coast is the preferred alignment.

4.4.3 Regional alignment and station assessments

Overview

South of Brisbane, potential HSR alignments traverse the South East Queensland and NSW Far North Coast regions. Due to the proximity of the Great Dividing Range to the coast, this area typically contains several types of terrain, ranging from very hilly to the mountainous Lamington and Border Ranges National Parks to relatively flat coastal areas.

The population is concentrated in the larger towns and the Gold Coast. The inland towns include Beaudesert, Kyogle, Casino and Lismore, while the coastal centres include the Gold Coast, Coolangatta-Tweed Heads, Murwillumbah, Byron Bay and Ballina. The Gold Coast is densely populated, accommodating approximately 500,000 residents and a large number of tourists. It has a wide range of residential environments, including extensive low-density residential communities, canal estates and high-rise developments.

Land use away from built up areas is largely forest, rainforest and agriculture, reflecting the subtropical climate and fertile soil. The diverse agriculture includes wine, fruit and various staple crops. The area has many large waterways including the Tweed, Brunswick, Wilsons and Richmond Rivers.

South of the Border Ranges National Park the alignment passes through patchy eucalypt forest in an otherwise cleared and disturbed landscape.

Transport infrastructure includes the M1 Motorway from Brisbane to the Queensland border at Coolangatta, the Pacific Highway which runs close to the coast, and the North Coast rail line. There are several regional airports, with Gold Coast (Coolangatta) Airport being the busiest as it serves the tourist demand to the Gold Coast.

Once the inland alignment via Beaudesert, with a spur from Beaudesert to the Gold Coast, was selected as the preferred corridor, alignment options were considered for the Brisbane-Grafton section.

The Brisbane-Grafton section was divided into two sectors, the first from Greenbank to Whiporie (where the two alignment options converge) and the second in a common alignment from Whiporie to Grafton. The alignments considered are shown in **Figure 4-8**.

Figure 4-8 Brisbane-Grafton alignment options



Greenbank-Whiporie

Options were investigated to deviate the alignment to increase user benefits from a regional station location either east of Casino or east of Lismore. However, the existing rail or road corridors to access the urban areas of Casino and/or Lismore would not be suitable for an HSR alignment due to their abrupt and multiple changes in direction. The capital cost of deviating the alignment to the east of Casino exceeded the increase in user benefits. A deviation to the east of Lismore would have a significant increase in capital cost and a net user disbenefit due to the additional transit time for through passengers. Details of this comparison can be found in **Appendix 3A**.

The inland alignment via Beaudesert with a spur to the Gold Coast (shown in red in **Figure 4-8**) was identified as the preferred alignment.

Two alignments, a northern option (in blue on **Figure 4-8**) and a southern option (in red), were shortlisted for comparison. Other spur options between Beaudesert and the Gold Coast, while potentially more direct, would create more adverse sustainability and land use planning impacts, including on the Tamborine National Park, Nerang River reservoir (Advancetown Lake) and/or on the Department of Defence Canungra base between Mount Tamborine and Beechmont. Other options would also traverse longer lengths of steep terrain which would add to the capital cost.

While slightly longer than the northern option, the southern alignment option is preferred as it has fewer environmental impacts and is consistent with strategic planning objectives. The northern alignment would terminate at a station in Carrara and was discounted from further consideration on both cost and environmental grounds (see Gold Coast station assessment below, and **Appendix 3A**, for further detail).

The southern alignment (in red in Figure 4-8), terminating adjacent to the existing Robina station, is the preferred option for accessing the Gold Coast via a spur.

Whiporie-Grafton

The two shortlisted alignments for pair-wise comparison generally shared a common route between Whiporie and Grafton.

The decision to generally consider both options arose from the findings of the sustainability and land use planning appraisal, which included passing through the Banyabba State Forest and ‘high conservation value old growth forest’ listed on the National Heritage Register. Further assessment of potential impacts on these areas, and appropriate mitigation and offset measures, would be developed in the detailed assessment and design phase, should a decision be made to proceed with HSR.

The preferred alignment is an optimisation of the two alignments between Whiporie and Grafton.

Gold Coast station

The Gold Coast region is located approximately 70 kilometres southeast of Brisbane with an urban area stretching approximately 50 kilometres along the coast. It has grown significantly in recent years, and has become an important Australian tourism destination. The population of the Gold Coast was 494,500 in 2011 and is forecast to reach 850,000 in 2036 and 1.5 million by 2056¹⁶.

The biggest constraint in locating a suitable station on the Gold Coast was the potential impact on developed urban areas and planned future development, while any remaining undeveloped land would be subject to topographical constraints. Potential station locations at Carrara and Robina were assessed, with the objective of minimising impact on the urban areas while providing access to the regional road network. The location at Robina was the least constrained site, with the additional benefit of linkages with local public transport.

The alignment to the station would also have fewer adverse land use impacts than the alignment to station sites at Carrara. Options in the vicinity of

the station site were assessed, with the preferred location adjacent to the existing conventional rail station at Robina, as shown in **Figure 4-9**. The conventional rail and HSR stations would be adjacent to each other, with a walking distance of less than 40 metres between platforms.

The location at Robina has good access to the regional road network, and is close to the Pacific Highway/Robina Town Centre Drive interchange, approximately two kilometres away. Surfers Paradise would be 13 kilometres by road, Southport 18 kilometres by road and Coolangatta/Tweed Heads 25 kilometres by road.

From a land use planning and policy perspective, the *Gold Coast Planning Scheme 2003* (as amended) identifies Robina as a Key Regional Centre and a major public transport interchange¹⁷. It is strategically located to serve emerging residential communities on the western fringe of the Gold Coast. A station in this location would have synergies with the current strategic planning intent for this area.

Robina was selected as the preferred location for the HSR regional station on the Gold Coast.

Figure 4-9 Preferred Gold Coast station location



17 Gold Coast City Council, *Gold Coast Planning Scheme 2003*, version 1.2 amended November 2011.

NSW Far North Coast station

The Far North Coast region extends south from the Queensland border and incorporates the major regional centres of Tweed Heads and Lismore, coastal communities around Ballina and Byron Bay and the major towns of Casino and Murwillumbah. The region is the most biologically diverse in NSW and contains more than 20 National Parks¹⁸. The population of the Far North Coast region was 220,000 in 2011, with projections estimating the population will be 315,000 in 2036 and 328,000 by 2056¹⁹.

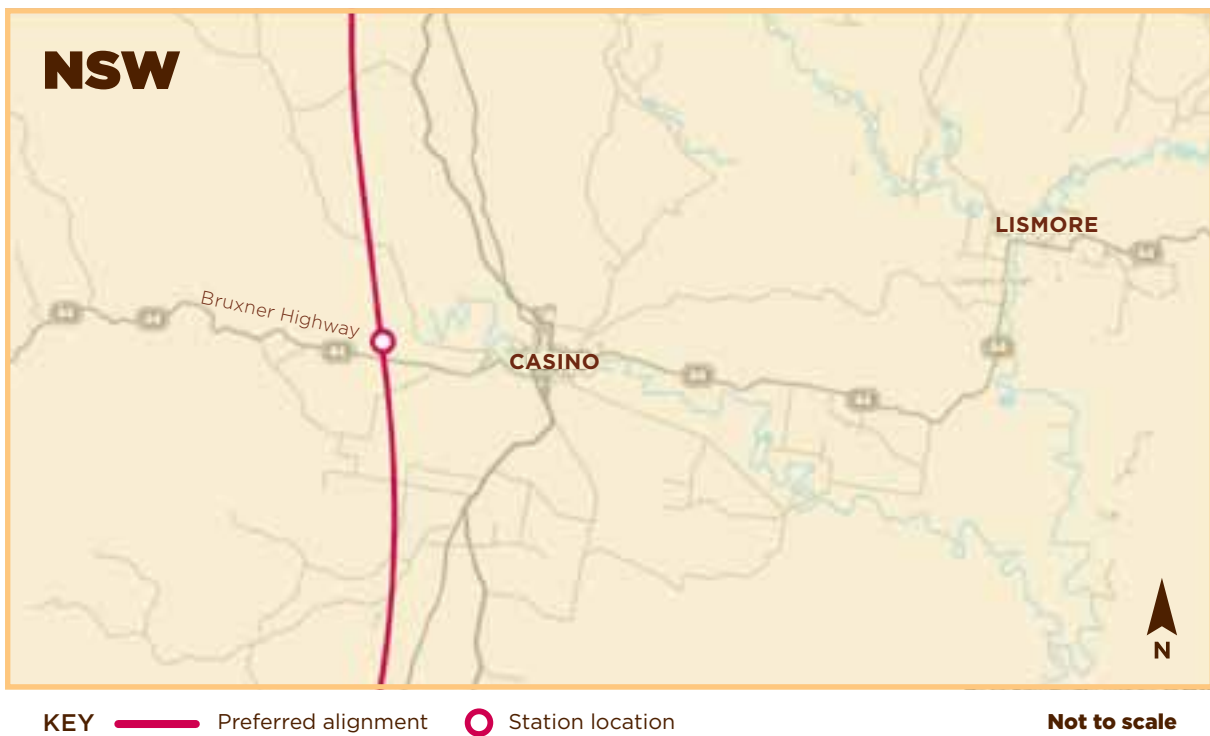
As discussed above in the context of the alignment between Greenbank and Whiporie, the preferred alignment shown in **Figure 4-10** passes to the west of Casino. Alignments that allow station options to the north and south of Casino would affect the town and require several crossings of the meandering Richmond River. Alternatives

passing to the east of Casino, allowing a station between Casino and Lismore, would attract more user benefits from Lismore and the coastal centres. However, the increased capital cost of this option relative to the preferred alignment (\$1.2 billion) was greater than the increase in user benefits (\$0.5 billion). A second option to the east of Lismore not only had larger increased capital costs compared to the preferred alignment (\$3.5 billion), but also reduced user benefits (-\$1.0 billion) due to the additional train transit time.

The preferred site for Casino station lies to the west of Casino along the Bruxner Highway.

As shown in **Figure 4-10**, this site provides good access from the regional road network. Casino, which has a regional airport and a conventional rail station, is approximately nine kilometres by road from the proposed HSR station location. Lismore is approximately 40 kilometres away by road.

Figure 4-10 Preferred Casino station location



18 NSW Department of Planning, *Far North Coast Regional Strategy*, 2006.

19 ABS, loc. cit.

4.5 Grafton-Port Macquarie

4.5.1 Overview

This section of the Mid North Coast is bounded by the Great Dividing Range to the west and the Pacific Ocean to the east. The most favourable corridors avoid the higher slopes of the range and traverse the foothills of the range down to the coastal floodplains. Acid sulphate soils are present on the floodplains and the region experiences significant flooding due to its large catchment areas. The main rivers in the area are the Clarence, Bellinger, Kalang, Nambucca, Macleay and Hastings Rivers.

The Nambucca and Macleay floodplains have been largely cleared, although small areas of Lowland Rainforest Threatened Ecological Community remain, particularly in the Bellinger and Kalang River catchments. Koala populations live in the forested areas of this section and provision would be made for koala and other fauna crossings under the alignment, including appropriate koala fencing in place of the standard fencing that would enclose the surface alignment.

Land use is generally mixed, with significant agriculture including timber and farm industries. Populations are concentrated in towns currently connected by the Pacific Highway including Grafton, Coffs Harbour, Nambucca Heads, Macksville, Kempsey and Port Macquarie. There are three potential station locations – at Grafton, Coffs Harbour and Port Macquarie.

The Grafton-Port Macquarie section was divided into four sectors: Grafton-Coramba (north of Coffs Harbour), Coramba-Charlmont (south of Coffs Harbour), Charlmont-Warrell Creek (north of Kempsey) and Warrell Creek-Port Macquarie.

The alignments assessed in this section are shown in **Figure 4-11**.

Figure 4-11 Grafton-Port Macquarie alignment options



KEY — HSR alignment options — ● Closest regional centre to potential station ○ Station location **Not to scale**

4.5.2 Regional alignment and station assessments

Grafton-Coramba

The two shortlisted alignments generally share a common route between Grafton and Coramba. Other alignment options were less direct and/or would have increased sustainability and land use planning impacts. The use of existing rail or road corridors to access the town of Grafton would not be suitable for HSR because their alignment is not suitable for the speed of HSR.

The blue alignment would have adverse impacts on housing at Ulmarra, Glenreagh and Nana Glen, and on agricultural land, state nature reserves and high conservation value old growth forests. However, it is likely to have less severe impacts than the red alignment, which would affect the existing built-up areas of Boambee and Bonville as well as potential future development, including a planned industrial expansion area in the North Boambee Valley. The blue alignment was further optimised to minimise impacts and was preferred.

In the Grafton-Coramba sector, the western alignment (shown in blue in Figure 4-11) is the preferred option.

Grafton station

Grafton is identified as a major regional centre in the Mid North Coast region of NSW. The Mid North Coast encompasses eight LGAs (Clarence Valley, Coffs Harbour, Bellingen, Nambucca, Kempsey, Port Macquarie-Hastings, Greater Taree and Great Lakes) and is a popular retirement and holiday destination. It has a variety of beaches, scenic areas, national parks and forests.

The Grafton area had a population of 49,665 in 2011, and projections indicate it will have a population of 57,284 in 2036 and 59,517 in 2056²⁰. Station options around Grafton are constrained by the Clarence River and its floodplain to the east of the town. Station zones to the north of Grafton, along Lawrence Road, and ten kilometres south of Grafton, adjacent to Grafton Airport, were identified as potential options. Any options to the north of the southern location would adversely affect creeks, while options further south or east would increase the station distance from Grafton. Options further west would increase impacts on property and the Bom Bom State Forest, as the alignment would need to be shifted to the west.

While the southern airport option is slightly further away from Grafton than the northern option, it has better access from the Pacific Highway and arterial roads and would provide better connectivity to other areas, such as Woolgoolga and Maclean (both major towns in the *Mid North Coast Regional Strategy*)²¹.

The northern zone also has potential flooding issues and soft soil, which would require extensive ground treatment to allow construction of an HSR station, and would be more costly as a result. Therefore, the southern zone near Grafton Airport as shown in **Figure 4-12** is preferred.

Land south of Grafton Airport is the preferred location for Grafton station.

20 ABS, loc. cit.

21 NSW Department of Planning, *Mid North Coast Regional Strategy*, 2009.

Figure 4-12 Preferred Grafton station location



Coramba-Charlmont

The blue and red alignments shown in **Figure 4-11** seek to avoid the hilly terrain surrounding Coffs Harbour, resulting in alignments that are approximately ten kilometres from the city centre. Other more direct alignment options between Coramba and Charlmont would be significantly more costly to construct due to the long series of tunnels required to pass through the hilly terrain.

Following the existing rail corridor through and approaching the built-up areas of Coffs Harbour and Sawtell would add approximately 13 kilometres to the overall length of the HSR alignment. This longer length, as well as the lower design speeds necessary in the built-up areas, would increase train transit time by approximately six minutes for non-stopping services compared to the blue alignment. In addition to the adverse impact on existing built-up urban areas through Coffs Harbour and Sawtell, the alignment would be close to the coastline and at risk of potential shoreline recession, coastal inundation and rising sea levels²². The use of the existing rail corridor was therefore not pursued.

Overall, the blue alignment was preferred, despite having a capital cost of approximately \$0.3 billion more than the red alignment. However, the capital cost savings on the red alignment would be largely offset by the loss in user benefits from the longer train transit time (approximately 30 seconds).

The blue alignment would have significantly less detrimental impacts than the red alignment. Both alignments would intersect several state forests and existing urban areas and villages. The blue alignment would have some adverse impacts on housing in and around the village of Upper Orara, would pass within 100 metres of Upper Orara Public School. It would also impact housing and pass within 50 metres of a school at Coramba. The red alignment would have adverse impacts on the existing built-up areas of Boambee and Bonville and impact potential future development, including a planned industrial expansion area in the North Boambee Valley²³.

The blue alignment is the preferred option from Coramba to Charlmont.

22 ABS, loc. cit.

23 NSW Department of Planning, 2009, loc. cit.

Figure 4-13 Preferred Coffs Harbour station location



Coffs Harbour station

Coffs Harbour is identified in the Regional Strategy²⁴ as a major regional centre in the Mid North Coast region of NSW. The region had a population of 68,413 in 2011, and projections indicate this will grow to 101,800 in 2036 and 105,700 in 2056²⁵. The urban area of Coffs Harbour is constrained by the surrounding terrain. Much of the proposed growth will occur in the areas immediately adjacent to the existing urban area, into the adjacent foothills, to the south in North Boambee and Bonville.

Options northwest of Coffs Harbour around Karangi, along the coast near Coffs Harbour CBD and southwest around Boambee and Bonville were assessed, with the southwest options being preferred due to their better road access and proximity to future development. Because of the vertical gradients of the HSR alignment passing Coffs Harbour, Bonville is the closest location to Coffs Harbour with sufficient level land area to accommodate a station.

Bonville has good transport links, with bus services linking to Coffs Harbour and Sawtell centres and conventional rail stations. There is direct access to the Pacific Highway and the future urban land proposed for release in the Bonville area in the Regional Strategy²⁶. The alignment is constrained to the south by the floodplain of the Bellinger River and there is minimal scope to move the alignment east, closer to the Pacific Highway. The preferred location is approximately 15 kilometres by road from both the centre of Coffs Harbour and Coffs Harbour Airport.

The preferred station location is to the west of the Pacific Highway/Archville Station Road interchange, south of Valery-Gleniffer Road, as shown in Figure 4-13.

Charlmont-Warrell Creek

The two alignments through this sector generally share a common route. Other alignment options were either less direct or had greater sustainability and/or land use planning impacts.

24 NSW Department of Planning, 2009, loc.cit.

25 ABS, loc. cit.

26 NSW Department of Planning, 2009, loc. cit.

The preferred alignment was selected taking into consideration the findings of the sustainability and land use planning appraisal, and designed to minimise adverse impacts on Ingalba State Forest, Viewmont State Forest, Newry State Forest and Tarkeeth State Forest.

The preferred alignment is an optimisation of the two alignments generally following the same route from Charlmont to Warrell Creek.

Warrell Creek-Port Macquarie

The principal difference in the two shortlisted alignments was the deviation around the township of Kempsey, with the blue alignment passing to the east of Kempsey and the red alignment to the west. Other options to the east have a higher capital cost and are generally less direct and/or have more adverse impacts on sustainability and land use planning, principally due to their proximity to built-up areas. The blue alignment has a higher capital cost (approximately \$0.2 billion more than the red alignment). While the red alignment could adversely impact on a planned future urban area at Greenhill, the impact could be mitigated by development around the HSR alignment and offset by the capital cost saving.

The red alignment is the preferred option between Warrell Creek and Port Macquarie.

Port Macquarie station

Port Macquarie is located within the Mid North Coast region of NSW and is identified as a major regional centre in the *Mid North Coast Regional Strategy*, together with the surrounding communities of Wauchope, Lake Cathie and Bonny Hills²⁷. Port Macquarie Airport is located approximately five kilometres west of the city centre, while the conventional rail station is located at Wauchope, 20 kilometres west of Port Macquarie.

The Port Macquarie area had a population of 72,696 in 2011. This is estimated to grow to an estimated 107,600 in 2036 and 111,800 in 2056²⁸. Much of the growth will occur in the area around the Oxley Highway/Pacific Highway interchange

at Thrumster. Other growth areas are identified at Wauchope, to the south in the Lake Cathie/Bonny Hills area, and in the Kew to Laurieton corridor.

The two major constraints near Port Macquarie are the Hastings River and large areas of planned residential growth around Thrumster. These constraints make it difficult to locate a station within ten kilometres of the city centre. Potential HSR station options were identified in the Oxley Highway corridor, east and west of the Pacific Highway, to facilitate access from Port Macquarie and Wauchope, the two main population centres in the area.

The preferred station location would be to the west of the Oxley Highway/Pacific Highway interchange.

This location is approximately 15 minutes by car (ten kilometres) from the centre of Port Macquarie. The preferred location shown in **Figure 4-14** would provide good access from the regional road network, as it is adjacent to the Pacific Highway/Oxley Highway interchange. The location would also provide access from the coastal communities at Lake Cathie/Bonny Hills and Kew/Laurieton, along the Pacific Highway. Access to Port Macquarie Airport would be via the Pacific Highway and to Wauchope conventional rail station via the Oxley Highway. Bus services currently run between Wauchope and Port Macquarie and could provide access to and from the HSR station. An indication of planned future development to the west of the Pacific Highway interchange is provided in the *Mid North Coast Regional Strategy*²⁹.

From a sustainability and land use planning perspective, this location avoids any significant environmental or heritage impacts. The location is close to Port Macquarie and Wauchope, as well as the future growth area at Thrumster - which would not be adversely impacted, but could be supported, by the station. There would be opportunities to integrate the developed area to the east of the Pacific Highway with a station to the west of the Pacific Highway.

27 ibid.

28 ABS, loc. cit.

29 NSW Department of Planning, 2009, loc. cit.

Figure 4-14 Preferred Port Macquarie station location



4.6 Port Macquarie-Twelve Mile Creek

4.6.1 Overview

This section has similar characteristics to the area between Grafton and Port Macquarie, influenced by the steep topography of the Great Dividing Range and its foothills and coastal lakes and floodplains. The Cotton-Bimbang and Barrington Tops National Parks are located on the range in this section, while Myall Lakes National Park on the coast is a Ramsar Wetland³⁰.

Towns in the area include Taree, Nahiach, Bulahdelah, Forster and Karuah. Transport infrastructure includes the Pacific Highway and the North Coast Railway. Most air travel to and from the area is via the airports at Port Macquarie and Newcastle. This section contains one potential station location at Taree.

The Port Macquarie-Twelve Mile Creek section is divided into three sectors: Port Macquarie-Johns River (north of Taree), Johns River-Rainbow Flat (south of Taree), Rainbow Flat-Twelve Mile Creek (north of Newcastle)

The alignments assessed in this section are shown in **Figure 4-15**.

³⁰ The original intent of the Ramsar Convention was to protect waterbird habitats. The convention has broadened its scope to include the protection of all wetland biodiversity and the 'wise use' of all wetlands.

Figure 4-15 Port Macquarie-Twelve Mile Creek alignment options



KEY — HSR alignment options ● Closest regional centre to potential station ○ Station location **Not to scale**
— Ramsar wetland

4.6.2 Regional alignment and station assessments

Port Macquarie-Johns River

Between Port Macquarie and Kew, both shortlisted alignments pass to the east of Herons Creek. South of Kew, the alignments share a common corridor with both routes generally skirting the mountains of North Brother and Middle Brother. A more direct alignment would increase capital costs and would have adverse sustainability and land use planning impacts.

While both alignments are equal in terms of operational and infrastructure considerations, the blue alignment is preferable in terms of sustainability and land use planning outcomes, because it has less impact on existing communities and planned urban release areas than the red alignment. While both alignments impact on state forests and national parks, the blue alignment avoids a direct impact on Middle Brother State Forest (albeit by traversing part of Watson Taylor Lake). Two privately owned airfields would be affected by either alignment.

The blue alignment is preferred from Port Macquarie to Johns River.

Johns River-Rainbow Flat

The red alignment takes a direct route along this sector, whereas the blue alignment deviates to the west towards Taree town centre. Other alignment options were less direct and/or had greater sustainability and/or land use planning impacts.

The reduced train transit time (approximately 45 seconds) and the resulting additional user benefits for the red alignment effectively offset the additional capital cost (approximately \$0.3 billion) when compared to the blue alignment. The red alignment includes a very long viaduct across the Manning River Floodplain, due to the soft soil ground conditions in the lower floodplain area.

The red alignment would have less impact on Taree and settled areas in general. By comparison, the blue alignment would impact on the planned urban release area and employment area at Kundle Kundle (identified in the *Mid North Coast Regional Strategy*).

The red alignment is preferred for the section of route from Johns River to Rainbow Flat.

Taree station

Taree is located at the southern extent of the Mid North Coast region. It is nominated as a major regional centre in the Regional Strategy³¹. Taree is located to the west of the Pacific Highway, and Taree Airport is located approximately six kilometres east of the city centre. In 2011, Greater Taree had a population of 46,541. This is estimated to grow to 53,200 in 2036 and 55,300 in 2056³². A growth area is proposed north of Taree at Brimbin, and urban growth is also planned for the coastal communities at Old Bar, Diamond Beach and Hallidays Point.

The Manning River provides the greatest constraint to locating an HSR station around Taree, and its branches would necessitate multiple crossings. As a result, the alignment was moved about five kilometres to the east of Taree and the Pacific Highway. The floodplain of the Manning River would require a 15 kilometre long viaduct from just north of Old Bar Road to around Cooperook to provide flood immunity and avoid the risks of settlement due to the soft soils. A ground level station north of the viaduct would be approximately 20 kilometres by road from Taree, compared with ten kilometres for a station south of the viaduct, close to Old Bar Road. An HSR station south of Taree would also provide better access to the coastal communities of Old Bar, Diamond Beach, Forster and Tuncurry.

31 NSW Department of Planning, 2009, loc. cit.

32 ABS, loc. cit.

Figure 4-16 Preferred Taree station location



As shown in **Figure 4-16**, a station south of the proposed viaduct would provide good access from the regional road network, as it would be approximately five kilometres east of the Pacific Highway/Old Bar Road interchange. Taree has a regional airport and a conventional rail station, both of which would be approximately ten kilometres by road from the proposed HSR station. From a sustainability and land use perspective, this location avoids any significant impacts on environmental or heritage areas.

The preferred site for Taree station is south of the proposed viaduct, close to the Pacific Highway/Old Bar Road interchange.

Rainbow Flat-Twelve Mile Creek

The Ramsar Wetlands within Myall Lakes National Park are a prominent feature in this sector. Both alignments avoid major impacts on the Ramsar Wetlands. The blue alignment would pass beneath the narrowest part of the catchment of Ramsar Wetlands in a tunnel and provide a fairly direct route. The red alignment avoids the Ramsar

Wetlands and their catchment altogether, as shown in **Figure 4-15**.

Other alignment options are limited by the extent of the Ramsar Wetlands. Diverting around the Ramsar Wetlands with a route further to the west of the red alignment would add to the length of the route, train transit time and capital cost.

The capital cost of the red alignment is approximately \$1.3 billion more than the capital cost of the blue alignment, due to the greater number and additional length of tunnels required. The red alignment would also have substantially greater impacts upon state forests and rural housing than the blue alignment.

The blue alignment is preferred between Rainbow Flat and Twelve Mile Creek.

4.7 Twelve Mile Creek-Sydney

4.7.1 Overview

This section contains a large variety of landscape types. The Great Dividing Range continues southwest with the broad Hunter River floodplain and estuary to the west and north of Newcastle. Towards Sydney, the sandstone landform is dissected by the valleys and gorges formed by the Hawkesbury River and its tributaries. A chain of large coastal lakes extends from Grahamstown Lake to Pittwater, including Lake Macquarie, Lake Budgewoi and Brisbane Water with many smaller lakes and estuaries along the coastline.

This area includes Newcastle, the Hunter Valley, the Central Coast and their associated concentrations of populations, industry and tourism. Population is sparse outside these areas, reflecting the challenging terrain and extensive area of national parks, reserves and state forests.

Transport infrastructure includes the Pacific Highway, the F3 Sydney-Newcastle Freeway, and the Newcastle and Central Coast rail line between Sydney and Newcastle. The majority of air travel in the region is centred on Newcastle Airport at Williamstown. This sector contains two potential station locations – one at Newcastle and one on the Central Coast.

Twelve Mile Creek-Sydney is divided into three sectors: Twelve Mile Creek-Wyee, Wyee-Ourimbah and Ourimbah-Mount Kuring-gai.

The alignments assessed within this section are shown in **Figure 4-17**.

Figure 4-17 Twelve Mile Creek-Sydney alignment options



KEY — HSR alignment options ● Closest regional centre to potential station ○ Station location **Not to scale**

4.7.2 Regional alignment and station assessments

Twelve Mile Creek-Wyee

The red alignment passes to the east of Raymond Terrace and Grahamstown Lake, and avoids the RAAF Base Williamstown, Ramsar Wetlands to the east of Hexham (Hunter Estuary Wetlands) and the Tomago aluminium smelter. The blue alignment passes to the west of Raymond Terrace and generally between the built-up areas of Thornton and East Maitland. The two alignments share a common route south of Ryhope.

Other alignment options providing access closer to the town centre of Newcastle would require long lengths of tunnel or would significantly affect built-up areas, including through the acquisition of residential and commercial properties. While both alignments would impact on growth areas at the Wyong Employment Zone, which is a state significant area listed in NSW's *State Environmental Planning Policy (Major Development) 2005* and currently under development, the red alignment would have more adverse impacts on existing residential and industrial properties compared to the blue alignment. The blue alignment would impact on an existing urban area, an urban release area at Thornton North, and a planned freight hub to the east of Maitland.

Both alignments would traverse areas subject to potential mine subsidence over a similar length and would require special remedial works, such as grouting any voids left by mining.

The blue alignment has a \$0.4 billion lower capital cost. The red alignment extends for a further five kilometres adjacent to residential areas.

The blue alignment is the preferred option from Twelve Mile Creek to Wyee.

Newcastle station

Newcastle is the seventh largest city in Australia and the second largest urban area in NSW. The city has a population of approximately 148,535

in the LGA, and has experienced continued population growth over the past decade. The population of Newcastle is projected to grow to 177,700 in 2036 and 184,600 in 2056³³.

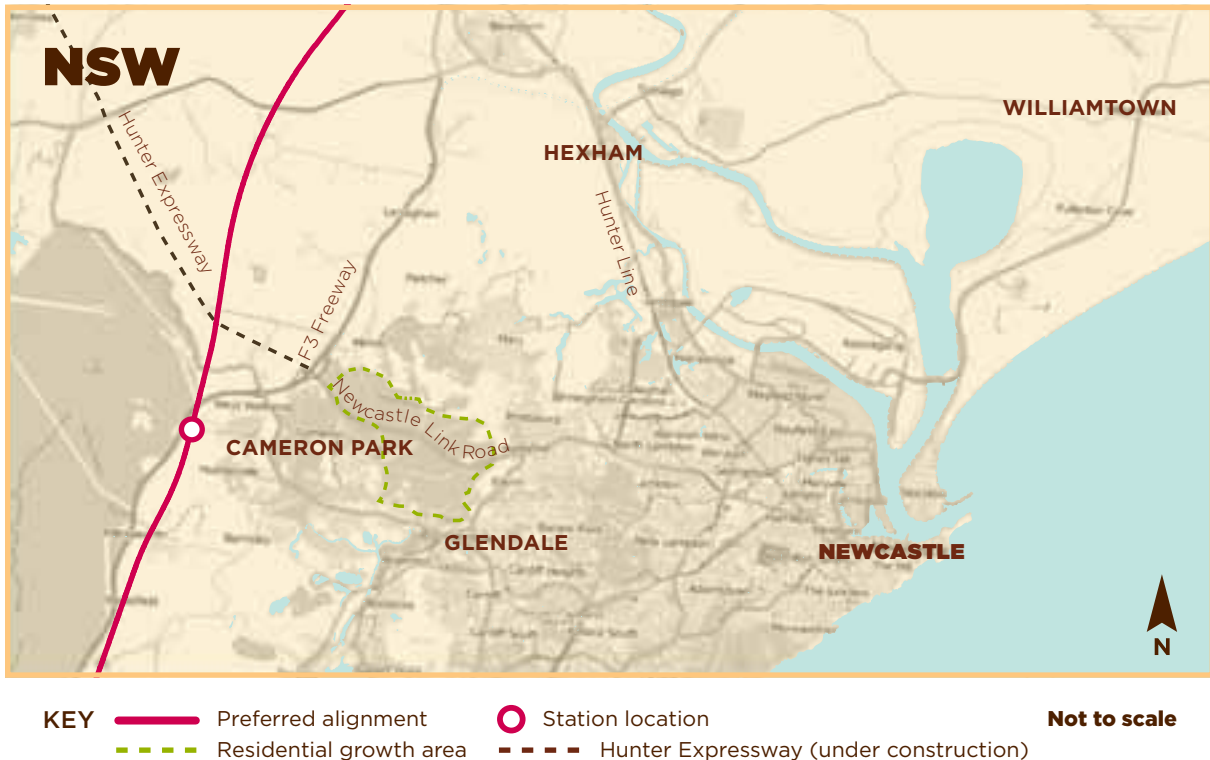
Newcastle is the world's largest coal export port and has major education and health care facilities. The regional airport, which is the major RAAF base, located to the north of the city, handles more than one million passengers every year. The Newcastle urban area extends from the city centre to the F3 corridor, including the major centres of Charlestown, Glendale, Hamilton and Mayfield, which provide services for the surrounding population and serve as employment centres. The Newcastle LGA adjoins the Lake Macquarie LGA, which encompasses the major centres of Warners Bay, Belmont and Toronto.

Potential station locations were identified close to the Pacific Highway (F3 Freeway) near Cameron Park and Hexham. Both locations offer good access to Newcastle and the Maitland region via the Newcastle Link Road and the Hunter Expressway (currently under construction) or the New England Highway respectively. Locations closer to Newcastle city centre were tested but any gain in user benefits was more than offset by the additional cost of moving the alignment.

A station near Cameron Park would better serve the population to the southwest of the Newcastle city centre and the Lower Hunter Valley via the Hunter Expressway, which is expected to open at the end of 2013. The station would also be accessible to residents in the Lake Macquarie area and northern parts of the Central Coast via the F3. Options for station locations in the vicinity of Cameron Park were investigated and a preferred location is proposed to the south of the F3 Freeway, as shown in **Figure 4-18**. It is close to the F3 Freeway/Newcastle Link Road/Hunter Expressway interchange. Newcastle city centre is approximately 20 kilometres away by road, as is Maitland.

The preferred station site for Newcastle is west of Cameron Park, adjacent to the F3 Freeway.

Figure 4-18 Preferred Newcastle station location



Wyee-Ourimbah

The two alignments in **Figure 4-17** generally share a common route, avoiding built-up areas including Wyee, Wyong and Ourimbah to the east and steeper topography to the west. Other alignment options were found to increase sustainability and/or land use impacts, mainly due to urban impacts, and/or were found to increase capital costs as the options traversed steeper topography.

The capital costs of the red alignment were approximately \$0.1 billion higher than the blue alignment. The red alignment also entailed additional adverse sustainability and land use impacts, including on sections of the Wyong Employment Zone at Halloran and North Wyong, which are currently under development and intended to be completed in the short term.

The blue alignment is the preferred alignment option from Wyee to Ourimbah.

Central Coast

The Central Coast is a highly developed region located approximately 75 kilometres north of Sydney. It comprises the LGAs of Gosford and Wyong and covers the area from the Hawkesbury River in the south to the southern shore of Lake Macquarie in the north.

Major constraints in the Central Coast area include hills, national parks and significant residential development, with built-up areas often extending to the edge of the ranges. The current population of the Central Coast is 312,186. This is expected to grow to 424,700 in 2036 and 495,400 in 2056³⁴. The population is concentrated in a number of centres that have been linked in recent years by continued residential development. The larger centres include Gosford, Wyong, Tuggerah, Woy Woy and The Entrance. The dispersed and low density nature of settlement over a large area presents challenges for locating an HSR station on the Central Coast that is easily accessible to all the populated areas.

Figure 4-19 Preferred Central Coast station location



The most accessible Central Coast HSR station zone options are located along the F3 Freeway corridor at:

- Kariong, near the Central Coast Highway interchange.
- Ourimbah, near the Pacific Highway interchange.
- Tuggerah, near the Wyong Road interchange.

The Kariong option would cater for the commercial core of the Central Coast at Gosford, strengthening its role as the main regional centre, while the Tuggerah option would provide the growing Wyong Shire with an accessible HSR station. The Ourimbah option, located between the other potential station locations, could serve the entire Central Coast population more effectively than a station located at either Kariong or Tuggerah.

A station at Ourimbah would be within a 30 minute drive of 85 per cent of the Central Coast (the combined Gosford and Wyong LGAs) population; corresponding figures for the Kariong and Tuggerah zones are 82 per cent and 69 per cent respectively. Ourimbah may also offer potential staging opportunities and/or connectivity between the HSR and urban rail networks. This is discussed further in **Appendix 3B**.

The preferred station location is north of the F3 Freeway/Pacific Highway interchange, as shown in **Figure 4-19**. The location would provide good access from the regional road network, as it is adjacent to the Pacific Highway interchange at Ourimbah. Ourimbah has a conventional rail station approximately two kilometres away by road.

Ourimbah is the preferred station option servicing the Central Coast.

Ourimbah-Mount Kuring-gai

The blue alignment in **Figure 4-17** closely follows the existing F3 Freeway on its approach to the Hawkesbury River. It includes long lengths of tunnel and a high level crossing at the Hawkesbury River, with the rail level being 35 metres above mean water level.

The red alignment has short lengths of tunnel at the north end, a tunnel under residential areas around Gosford and a long (7.5 kilometres) tunnel north of the Hawkesbury River through Brisbane Water National Park. The red alignment is predominantly within the existing rail corridor immediately north of the Hawkesbury River but would be separate from the existing rail line.

Other options to cross the Hawkesbury River were considered but all involved greater length, poor geometry resulting in slower speeds, and greater impacts on existing residential areas and national parks. A tunnel crossing of the Hawkesbury River was also investigated but not shortlisted, due to the required tunnel depth – approximately 80 metres below the water surface level – because of the mud and poor quality geology associated with the river bed. Such a tunnel would also be more than 25 kilometres long in order to reach suitable foundation material at the river crossing and then return to the surface on either side of the river.

Although the red alignment is approximately 2.5 kilometres shorter and approximately 30 seconds faster than the blue alignment, it would have greater environmental impacts, additional capital costs, poor access and would be very difficult to construct.

The red alignment would have more detrimental impacts on Brooklyn itself, where it would impact existing residential areas. It would also have a greater impact on national parks, state forests and areas of cultural significance. Parts of the red alignment are very remote and pass through difficult terrain. The capital cost of this alignment would be further increased by poor construction access, the need for marine operations (the area around the Hawkesbury River would only be

accessible by water) and the extent of additional works necessary to establish permanent access. The red alignment is also likely to require additional approvals with implications for the project timeline as well as a longer construction program.

While the blue alignment would affect Sydney Water infrastructure to the west of Brooklyn, it takes better advantage of already disturbed areas, is much more accessible and therefore would be easier to construct.

The blue alignment is the preferred route from Ourimbah-Mount Kuring-gai.

Mount Kuring-gai-Thornleigh

Further refinement was undertaken to extend the regional alignment into the urban area around Hornsby (shown as the green line in **Figure 4-20**). The green alignment has the shortest overall length of tunnel and the lowest capital cost option, but does not have a suitable station location and would also have adverse impacts on Ku-ring-gai Chase National Park. For these reasons, it was not taken forward to assessment against the red and blue options. The blue alignment passes to the west of Hornsby's commercial centre in tunnel and could include an HSR station adjoining the existing railway station at Hornsby. The red alignment is located to the immediate west of the Sydney-Newcastle Freeway and could include a station at a site currently occupied by Asquith Golf Course.

The blue alignment is favoured, largely due to the planning benefits and opportunity for urban renewal associated with a station at Hornsby. The red alignment, with a station at Asquith, would have excellent access off the Sydney-Newcastle F3 Freeway, but a station at Asquith would have less development potential than one at Hornsby. Under the *Metropolitan Plan for Sydney 2036*, Hornsby is the designated Major Centre and the primary focal point for public transport, high density housing and higher order civic, cultural, retail and economic activity for the northern part of Sydney, while Asquith is intended to remain a village³⁵. A station at Asquith would be inconsistent with this strategy.

Figure 4-20 Mount Kuring-gai-Thornleigh



The capital cost of the options is not a differentiator for this sector. The blue alignment is marginally shorter and would cost less than the red alignment. However, a station structure at Hornsby would require a deeper excavation, with associated costs. Access roads would also require upgrading.

The blue alignment is preferred from Mount Kuring-gai to Thornleigh.

Assessment of urban access alignments from the north

The assessment of city access alignments began by identifying existing or planned transport corridors, so that impacts on urban areas could be minimised by remaining within these corridors, and so that capital costs could be minimised by remaining at surface level. Current and planned projects relevant to potential HSR access routes in Sydney are listed in Table 4-4.

Table 4-4 Current and planned projects relevant to HSR access in Sydney

Project	Relevance to this study
North West Rail Link	New rail corridor and interface/connection with existing rail corridor(s), providing opportunity for shared use in new corridor and reducing potential use in existing corridors.
Epping to Parramatta rail line	New rail corridor and interface/connection with existing rail corridor(s), providing opportunity for shared use in new corridor and reducing potential use in existing corridors.
South West Rail Link (under construction)	New rail corridor and interface/connection with existing rail corridor(s), providing opportunity for shared use in new corridor and reducing potential use in existing corridors.
Southern Sydney Freight Line (completed)	New track within existing rail corridor reducing potential use by HSR.
Enfield Intermodal Terminal (under construction)	Interface/connection with existing rail corridor(s) reducing potential use by HSR.
M5 Motorway widening and corridor expansion	Road widening within an existing road corridor and new tunnel adjoining existing, reducing potential use by HSR.
M4 Motorway extension and widening	Road widening within an existing road corridor and new tunnel to extend motorway to the east towards the city, reducing potential use by HSR.
Revesby Quadruplication Project (Airport and East Hills Line) (under construction)	New track within existing rail corridor reducing potential use by HSR.
Moorebank Intermodal Terminal	Interface/connection with existing rail corridor(s) reducing potential use by HSR.
North Sydney Freight Corridor	New track within existing rail corridor reducing potential use by HSR.
CBD rail expansion and second harbour crossing	New rail corridors and interface/connection with existing rail corridor(s) providing opportunity for shared use in new corridor and reducing potential use in existing corridors.

Many of the corridors considered were unsuitable for high speed operation because of sharp curves and changes in gradient. In many where the geometry was suitable, any spare ground level capacity had already been designated for future expansion of existing facilities, including the following:

- M4 Motorway corridor to Granville – the planned widening of the M4 Motorway

included in the recent *Draft NSW Long Term Transport Master Plan* for Sydney's road network makes a ground level alignment unfeasible³⁶.

- M5 Motorway corridor – on completion of the current M5 Motorway widening, there would be minimal land available for an HSR alignment.
- East Hills Line – the East Hills Line to Glenfield will be at capacity on completion

of the Revesby Quadruplication Project (East Hills Line) currently under construction, with minimal land available for an HSR alignment, and was not carried forward.

As discussed in **section 4.2.1**, the geometry of the existing corridors limits the ability to use them for viaducts in urban areas, because they would require many deviations to smooth out the geometry to maintain design speed. This would require the acquisition of properties, with adverse social and environmental impacts and increased cost. In addition, preliminary analysis showed that bored tunnel in the Sydney urban area is often the most cost-effective construction method, due to the high cost of densely-developed land, the cost of elevated structures and the costs associated with the reduction of environmental and heritage impacts.

All the Sydney access alignments therefore include long lengths of tunnel.

Three potential alignments through metropolitan Sydney were identified to access Central station from the north: the North Shore line, the Northern line combined with the Carlingford line, and the Western line.

The three potential alignments are shown in **Figure 4-21**. The preferred alignment is shown in red and labelled 'Option 2' on the map. Those that were shortlisted, and later discarded, are shown in grey and are labelled 'Option 1' and 'Option 3' on the map and in the following discussion.

Details and comparative evaluation of these can be found in **Appendix 3A**.

Figure 4-21 Preferred urban access alignment to Sydney from the north



Preferred urban access alignment - Sydney from the north

While Option 1 (in tunnel, generally following the North Shore line) is the most direct route from the north and has the most user benefits, it would require a deep tunnel beneath the CBD and Sydney Harbour, adding significantly to the capital cost. The constructability risk of this option would be increased by potential interaction with the subsurface built infrastructure in the Sydney and North Sydney CBDs. This would mean remaining deep below the surface and approaching Central station in tunnel from the north. This in turn would result in the difficult construction of an underground five-platform station, as it would not be possible to use the existing surface platforms. The utilities infrastructure under Central station also increases the cost and/or the depth of this option.

An urban rail tunnel crossing Sydney Harbour is being considered by the NSW Government as part of the long-term transport master plan for Sydney's rail network³⁷. However, this tunnel crossing is primarily intended to be part of a Sydney mass transit network and could not be shared with HSR services without major additional cost and realignment to provide the required geometry.

Option 2 would provide the lowest cost route to Central station from the north. Both Option 2 and Option 3 (in tunnel, generally following the North Shore line to Pymble, then via a tunnel connection to the Northern line near Rhodes to Homebush, then eastwards in tunnel, generally following the Western line) would have longer travel times than Option 1 of approximately two to three minutes. These longer travel times would incur user disbenefits of between \$0.8 billion and \$1.0 billion relative to Option 1³⁸.

As the options are all in tunnel, there was no significant difference between the options from an overall sustainability, land use impact and policy perspective.

The preferred alignment to access Sydney from the north is a route travelling in tunnel, generally following the Northern line towards Homebush, then eastwards in tunnel generally following the Western line. This preferred option is shown as Option 2 in Figure 4-21.

Peripheral station assessment - Sydney North

As was identified in phase 1 of this study, the northern peripheral station zone extends from Hornsby to Epping near the M2 Motorway. The southern peripheral zone extends from Liverpool to Campbelltown, broadly along the M5 Motorway corridor. Easy interchange with the urban transport network (road and rail) is desirable to provide access between the HSR stations and urban centres within Sydney. A station at Hornsby was assessed as the main option. There are limited alternative options for a station to the north of Sydney. Much of the area surrounding the preferred alignment is residential, and a peripheral station would have significant environmental impact and would require the acquisition of properties. There are few defined centres that could accommodate an HSR station, and limited opportunities to interface with both the urban rail and road networks. Opportunities for peripheral station sites along Pennant Hills Road were reviewed, but no sites could be found that met the location criteria.

Hornsby provides access to the arterial road network via the Sydney-Newcastle F3 Freeway, which is planned to be connected to the Sydney orbital network via the M2 Motorway in the future. Road traffic access to the station site is limited by the capacity of the local road network; additional road infrastructure would be required to provide capacity for vehicles accessing the HSR car park. Good access to the urban rail network would be provided via an interchange at Hornsby station, which is served by the Northern line, North Shore line, Western line, and Newcastle and Central Coast line.

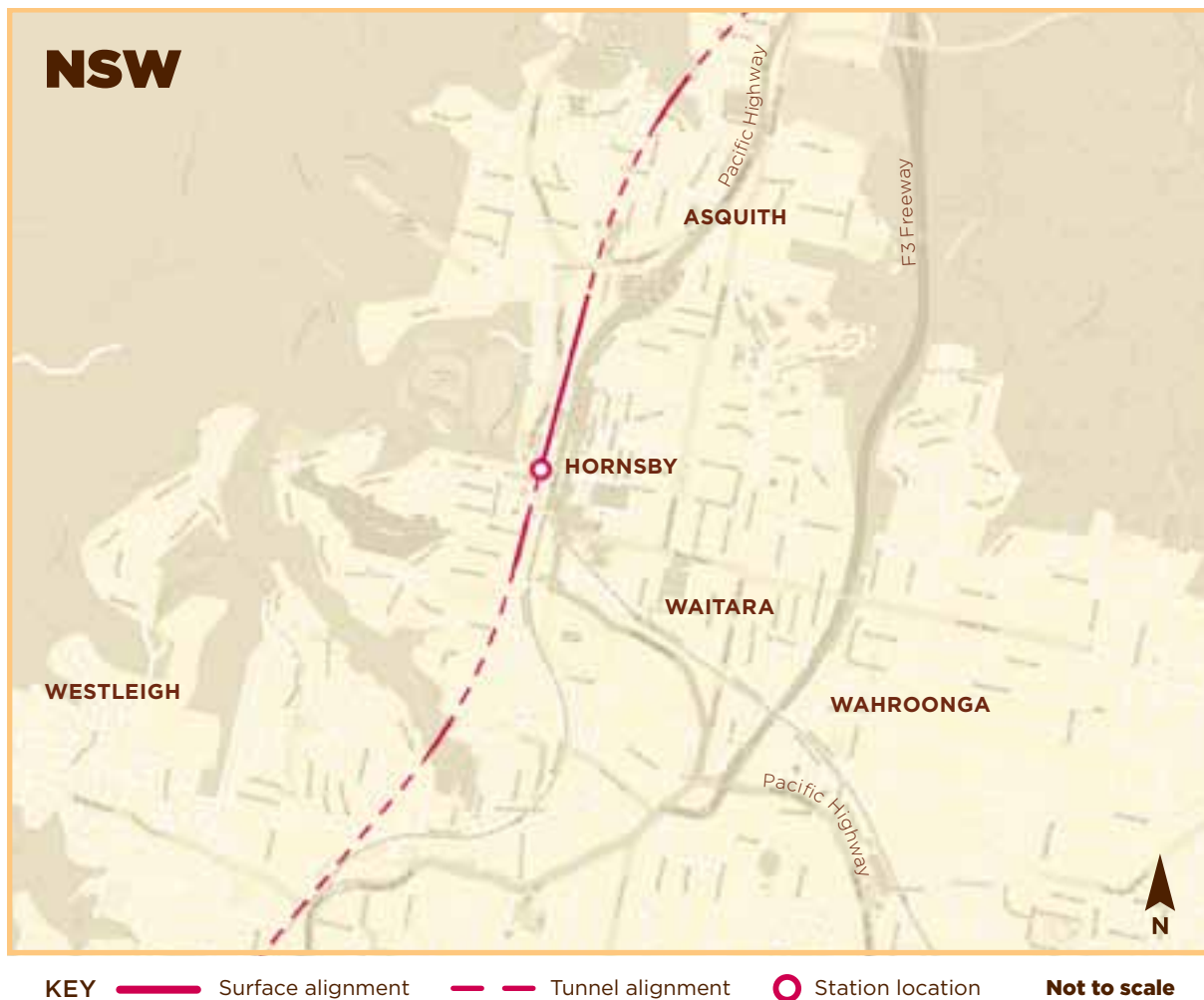
37 *ibid.*

38 User benefits are a direct function of the estimated train transit time. For the Sydney north corridor, the impact of variations in HSR running times on user benefits is estimated at about \$329 million per minute saved, for the period 2035 to 2065.

Implementing this station option would increase HSR user benefits by \$1 billion compared with not having a northern peripheral station. The preferred alignment would be in tunnel through Hornsby, requiring a below-ground HSR station. The station could be constructed using cut-and-cover techniques, and is potentially viable. However, the construction complexity means a station structure cost estimate of approximately \$150 million.

This site would be located within Hornsby town centre, immediately to the west of (and adjacent to) the existing Hornsby station, as shown in **Figure 4-22**. It would be located in an area currently used as a car park, between Jersey Street and Jersey Lane, adjacent to the Hornsby Council and NSW Police Local Area Command buildings. It would not require demolition of the Hornsby Council building or NSW Police Local Area Command buildings. The development of the station at this site could precipitate a major uplift and urban renewal opportunity in this area.

Figure 4-22 Location of Sydney North peripheral station



4.7.3 Sydney

Overview

Sydney has a population of approximately four million people, with a forecast of around seven million by 2056³⁹. Developed urban land in Sydney currently extends approximately 65 kilometres from the CBD to the southwest at Campbelltown, and around 30 kilometres to the north at Hornsby.

Parramatta, considered Sydney's second CBD, is 20 kilometres west of the Sydney CBD at the approximate geographic centre of the Sydney metropolitan area⁴⁰.

The *Metropolitan Plan for Sydney 2036* seeks to accommodate population growth to 2036 with an additional 770,000 dwellings and the creation of 760,000 new jobs⁴¹. Residential growth is planned through both infill development to higher densities within established urban areas, and expansion on Sydney's periphery, with growth areas designated on the urban fringe to the southwest and northwest of Sydney.

Employment growth is planned in existing city centres and new towns within the northwest and southwest growth areas. The Sydney CBD will remain Sydney's primary employment destination with approximately half a million jobs by 2036⁴². Parramatta is forecast to accommodate around 70,000 jobs by 2036⁴³.

The NSW Government has prepared a new transport master plan to support this growth. This master plan will seek to provide viable alternatives to car travel and build on current transport projects and studies, such as the South West and North West Rail Links, Southern Sydney Freight Line, expansion of the light rail system, and a Northern Beaches Bus Rapid Transit (BRT) system⁴⁴.

The draft master plan and the metropolitan strategy acknowledge the potential for an HSR connection through Sydney entering the city in the north and southwest. However, no HSR route is evident in Sydney metropolitan subregional strategies.

The deep valleys carved through the sandstone plateau to the north of Sydney Harbour present challenges for the alignment approaching the Sydney CBD, in addition to crossing the Parramatta River and/or Lane Cove River and Sydney Harbour.

In summary, the extent of existing development, topography and sensitive environmental attributes present major constraints in identifying suitable existing routes for HSR through the Sydney metropolitan area.

Strategic planning context and issues

The historical patterns of development in Sydney are reflected in the lower density development (predominantly single detached dwellings) within suburbs on Sydney's periphery (many of which emerged during the growth booms of the 1970s onwards) and middle ring (post World War II suburbs, also featuring detached dwellings), with denser suburbs of pre-war residential development and high street retail centres. The older inner areas have higher proportions of apartment buildings, terraces and semi-detached dwellings, and widespread heritage conservation areas. The heritage conservation areas within the inner suburbs (as well as the CBD areas of both Sydney and Parramatta), combined with the denser development, fragmented land ownerships and strata title buildings, present significant challenges for redevelopment in the inner areas of Sydney and Parramatta.

39 ABS, loc. cit.

40 NSW Department of Planning, *West Central Subregion: Draft Subregional Strategy*, 2007.

41 NSW State Government, loc. cit.

42 NSW Department of Planning, *Sydney City: Draft Subregional Strategy*, 2008.

43 NSW Department of Planning, 2007, loc. cit.

44 Transport for NSW, *NSW Long Term Transport Master Plan*, 2012.

The topography of Sydney features rolling hills to the southwest and plateau landforms in the northern parts of the metropolitan area with deep, steeply incised valleys. The existing road and rail networks reflect the topography with both road and rail corridors having many curves and changes in gradient that are unsuitable for HSR where the design speed for urban areas is 250 kilometres per hour. Sydney's undulating topography and drainage system has created a road pattern that is frequently circuitous, with few straight transport corridors in comparison with other Australian capital cities such as Perth or Melbourne. Furthermore, few new road or other transport corridors are being identified on statutory planning documents within the expanding areas of Sydney, with reliance instead on the expansion of existing corridors. Transport for NSW also has plans for upgrading and increasing the number of tracks within its existing rail corridors, which preclude their use for future HSR.

Sydney has historically been an expensive residential market, with desirable inner city and harbourside locations in particular commanding high land values, making the acquisition of property for transport corridors costly.

These characteristics present challenges for improving transport infrastructure within Sydney.

Environmental planning context and issues

The metropolitan area features five major rivers: the Nepean and Georges in the south and west, Lane Cove River and Parramatta River/Sydney Harbour in the central part of the metropolitan area, and the Hawkesbury in the north. The topography and waterways together with their associated ecological and Aboriginal heritage sites presented challenges to finding HSR alignments that would minimise environmental impacts on these natural features and landscapes.

The Sydney Basin is also framed by national parks to the south (Royal National Park, the oldest in Australia) and the north (Ku-ring-gai Chase National Park and Brisbane Water National Park). In addition, the Holsworthy military area to

the south extends over 30,000 hectares between Liverpool and Sutherland to the Royal National Park. Avoidance of ecological and heritage sites within the national parks was considered in the selection of a preferred HSR alignment.

Settlement and land use in Sydney has led to the majority of the native vegetation in the southwestern and western parts of the metropolitan area being cleared. Some of the remaining native vegetation, particularly the Cumberland Plain Woodland community, is endangered, and government environmental strategies and planning processes seek to retain as much of it as possible.

The topography and geology in the northern half of the metropolitan area has resulted in the retention of higher proportions of native vegetation in that area. Much of the northern extremity of metropolitan Sydney from the Hawkesbury River south to St Ives is dominated by native vegetation and the Ku-ring-gai Chase National Park. The extent of this park in the northern half of Sydney, and its dramatic plateau and incised valley topography, present environmental and construction challenges for locating road and rail infrastructure.

Assessment of potential station locations

Sydney would be the hub of HSR on the east coast. With HSR services planned to approach from both the north and south, a Sydney HSR station would need to accommodate nearly twice the volume of passenger flows compared to any other city HSR station. It would also be likely to have commuter services using the HSR infrastructure, which would add considerably to the peak hour passenger movements. As such, it would need efficient connections with the urban transport network, and in particular with the CBD as the primary destination for business users and tourists.

Phase 1 of the HSR study shortlisted four Sydney precincts:

- Central station precinct – a terminating station located within the current Central station footprint.

- Eveleigh precinct – a terminating station north of Eveleigh Yards, and two terminating station options oriented east–west in the vicinity of the Australian Technology Park.
- Homebush and surrounding precinct.
- Parramatta precinct.

Other areas considered in phase 1 but not pursued further included North Sydney, Strathfield and Sydney (Kingsford Smith) Airport⁴⁵. These areas were discounted for the following reasons:

- A suitable site at North Sydney could not be identified.
- An HSR station at Strathfield was not considered able to support existing or likely future metropolitan strategies. It would also be in a constrained location and likely to have major impacts on existing land uses.
- Analysis of patronage demand indicated that the primary demand for HSR services is to/from CBDs. The number of passengers transferring from HSR to air would not be sufficiently high to justify the city centre station being at Sydney Airport.

Although the Strathfield station site was not carried forward, it was included for completeness in assessing Homebush and its surrounds.

The assessment of station locations in Sydney was further complicated, when compared to other cities, by the cost of the urban access alignments, which forms a large proportion of the total infrastructure costs (approximately 23 per cent of the whole network). This cost varied significantly between the options.

The four shortlisted precincts are discussed below.

Central station precinct

Demand forecasts have confirmed that Sydney CBD is the primary destination for regional, domestic and overseas business travellers and tourists. This site (shown in **Figure 4-23**) would provide the most direct access for those passengers.

Central station would provide very high accessibility to transport networks because of the extensive pedestrian access and connectivity to the bus, rail and light rail networks. As Sydney's main suburban railway interchange, it would provide better connections to the metropolitan rail network than any other site. Potential extensions to the rail and light rail networks being investigated by the NSW Government would further improve the accessibility of Central station as a transport node. An HSR station at Central would therefore provide much greater user benefits than other potential station sites in Sydney.

Central station could be reconfigured to accommodate HSR services. This would require considerable planning and preliminary work to relocate current tracks and services from the Country Link platforms. As ten platforms would ultimately be required, it is proposed to provide these on two levels at the Lee Street side of the station, with a new street level concourse in between. The five platforms serving the southern line would be at the same level as the existing platforms, with those for the northern line beneath the new concourse. All HSR passengers travelling through Sydney would need to change trains at Central. Discussions with Transport for NSW confirmed that the proposed reconfiguration of Central station is compatible with long-term development plans for Central. Full details of the proposed station configuration can be found in **Chapter 5**.

Construction of facilities to serve HSR operations at Central station would involve both the conversion of existing platforms as well as construction of new platforms. The constructability of the station structure, while maintaining the ongoing operation of existing rail services, would be more complex than the alternatives at Eveleigh, Homebush and surrounds, or Parramatta.

The area surrounding Central station is currently undergoing urban renewal, with major developments occurring at Central Park (the former Carlton United Brewery) and the University of Technology City campus. While the areas around Central station and the southern CBD contain heritage buildings and recently constructed developments, there are likely to be further opportunities for urban regeneration, urban intensification, economic development and value capture created as the result of an HSR station and integrated land use/transport developments.

Eveleigh precinct

Three station sites were considered in the Eveleigh precinct: one at Eveleigh rail yards and two sites oriented east–west in the vicinity of the Australian Technology Park, as shown in Figure 423. Eveleigh is designated as a Specialised Centre within the *Metropolitan Plan for Sydney 2036*⁴⁶. Regeneration of Eveleigh is part of the renewal of Redfern, the suburb adjacent to the east, whose master plan includes improved transport facilities at Redfern station and the introduction of new retail and commercial buildings.

Eveleigh is located approximately two kilometres south of Central station, at the southern edge of the Sydney CBD. All sites at this location have lower accessibility than a site at Central station because there are fewer public transport connections and poorer access for pedestrians, cyclists and cars. User benefits are lower by an order of \$3 billion.

Eveleigh rail yards

Part of the Eveleigh site is used for rail maintenance purposes, with the remainder occupied by the Eveleigh Rail Yards building, a heritage asset used for regular markets that attract visitors from across Sydney. Construction of an HSR station in the Eveleigh rail yards would have significant impacts on heritage assets and the local community through the loss of community facilities and potential disturbance during construction. However, the reduction in user benefits (-\$3 billion) at Eveleigh when compared to Central was the deciding factor in this option not being taken forward.

Australian Technology Park

The Australian Technology Park was established by the NSW Government on the southern side of the Eveleigh rail yards. The potential station sites are located on an east-west alignment within the Australian Technology Park, one slightly to the north using part of the rail yards and one to the south solely within the Australian Technology Park.

Construction of an HSR station on either site would have significant impacts on businesses operating in the Australian Technology Park. The northern option would also require the relocation of rail maintenance facilities. The constructability of either option on this site has been ranked as moderate, because of the challenges of undertaking construction adjacent to operating rail lines and the impacts on residential and commercial property.

Figure 4-23 shows the potential city centre station locations for Sydney.

Figure 4-23 Potential city centre station sites, Sydney



KEY  Potential stations

Not to scale

Homebush and surrounds precinct

Four station options (shown in **Figure 4-24**) were considered in Homebush and surrounds: at Olympic Park station, Olympic Park/Bicentennial Park, Homebush West (adjacent to Flemington station) and north of Strathfield station. However, a terminal station in Homebush (or surrounds) would comparatively reduce the user benefits of an HSR network with a station terminating at Central by about \$38 billion. The reduction in user benefits is due to the distance of Homebush from the CBD. A significant addition to current public transport capacity would be required between Homebush and the Sydney CBD, if HSR terminated in the Homebush precinct.

Olympic Park (Olympic Park station and Olympic Park/Bicentennial Park)

Olympic Park is a major events centre (with the former Olympic Stadium, Arena, and Showgrounds) and is emerging as a commercial and residential precinct in its own right. The Olympic Park-Rhodes precinct has been designated as a Specialised Centre⁴⁷. New high density commercial development has commenced immediately adjacent to the existing Olympic Park station. Plans for the precinct involve more than one million square metres of floor space, including restructuring of existing low density business park uses south of the existing Olympic Park station.

Two station options were evaluated within the Olympic Park precinct: one at the existing Olympic Park station, the other at Olympic Park/Bicentennial Park to the south of Sarah Durack Avenue. The existing railway station is not large enough to accommodate a Sydney HSR station and would need to be demolished, causing significant disruption to the precinct during construction and compromising access for patrons of major events.

Implementing an HSR station at Olympic Park would assist with the commercial and residential plans for the precinct, and would raise its capacity for delivering patrons to major sporting and entertainment events. In this respect, the location of a station at Olympic Park would support NSW

Government policy, and would enable urban development and economic activity, albeit from a very low base compared to Central station.

Homebush West

This station site would provide connectivity to the Western Line at Flemington. It is south of the M4 Motorway, and could be accessed via the Centenary Drive interchange.

The station would probably need to be subsurfaced to avoid impacts on existing transport systems (the M4 Motorway and Western line) and surrounding communities. This would require a high cost station structure, comparable with other station options in this precinct.

Constructing an HSR station in this location would significantly impact adjacent land uses, including Flemington Markets which is a large agricultural market place. It would also impact nearby residential areas.

Strathfield station

An HSR station close to Strathfield would provide the opportunity for interface with the urban rail network at a key interchange location. The Northern, South, North Shore, Western and Inner West lines all pass through Strathfield, providing a high level of rail accessibility within the metropolitan area.

Access to the HSR station by road would be via the M4 Motorway and Leicester Avenue. The road network in this area is subject to congestion during peak periods, limiting access to the HSR station.

As the chief rationale for this location is to provide a good connection with the urban rail network, the HSR station would need to be located close to the existing station. However, an HSR station to the north of the existing Strathfield station, the only practicable site, would be located in a constrained urban environment and would have significant impacts on residential and retail properties.

Figure 4-24 shows the potential Sydney station sites at Homebush and surrounds.

47 NSW State Government, loc. cit.

Figure 4-24 Potential Sydney station sites at Homebush and surrounds



KEY Potential stations

Not to scale

Parramatta City Centre precinct

NSW Government policy is to develop Parramatta as Sydney's second CBD⁴⁸. There are plans to increase the number of jobs in Parramatta from 43,200 in 2006 to 70,000 by 2036⁴⁹. Parramatta's growth over the past two decades has been underpinned by government relocation strategies. An HSR station at Parramatta would support objectives to promote Parramatta as Sydney's second CBD.

Parramatta is a key centre for regional retail, entertainment and recreation facilities for Western Sydney. In recent years, the Parramatta City Centre has also been the focus of a significant number of high-rise residential developments, providing more affordable residential accommodation.

The station site at Parramatta (south of Westfield Shopping Centre) would have moderate accessibility for passengers, lower than all the other station sites considered, with its accessibility affected by the distance from the Sydney CBD. A station at Parramatta would significantly reduce HSR patronage demand to/from Sydney CBD because of the need to transfer modes and travel a further 20 kilometres, as well as the potential lack of parking to cater for demand by car. These issues are estimated to reduce user benefits by \$45 billion relative to a station at Central.

While Parramatta is centrally located within the Sydney urban area, the location for a station site is constrained by the current layout of the CBD and the existing rail services, heritage buildings and the highway system. As a result, the station at Parramatta would have to be underground and involve demolition of major existing structures, with the site vacant for the construction period of at least three years while station development occurs. An HSR station could not be provided beneath the existing Parramatta interchange because it would need to be located 30 metres below ground, which is considered undesirable from a user perspective. There is also no international precedent for a main HSR station at this depth. Limited land is available for parking close to the station in Parramatta, and the provision of large car parks within the city centre would reduce redevelopment opportunities around the station.

The constructability of an HSR station at Parramatta would be moderately difficult. There would be no direct interfaces with operational lines, and construction would require the demolition of buildings within the station footprint and approaches, as well as considerable disruption to residents and businesses during the construction period.

Figure 4-25 shows the potential Parramatta station site in Sydney.

48 NSW State Government, loc. cit.

49 *ibid.*

Figure 4-25 Potential Parramatta station site, Sydney



KEY Potential station

Not to scale

Preferred city centre station site

Although Central station has the highest capital cost of the Sydney CBD station options, the net benefits far exceed all other options. It has the highest level of accessibility for sites in Sydney, is located closest to the Sydney CBD, which was confirmed to be the main centre of demand, and provides opportunities for significant urban regeneration in the surrounding areas.

Station options at Eveleigh have lower accessibility for travellers and would have significant impacts on heritage assets. A terminal station in the Homebush precinct would reduce user benefits by \$38 billion compared to Central, and would have a significant impact on the total benefits of an HSR system. In addition, potential HSR stations at Homebush West and Strathfield would significantly affect residential areas and would have high construction costs.

Further analysis has been undertaken to examine the potential for Olympic Park as a through station, i.e. as a second Sydney station in addition to Central, providing access for users travelling to and from areas west of the Sydney CBD. While an HSR station at Central has been shown to provide the greatest overall benefits for trips to and from Sydney, a second station in Sydney would provide improved access for trips originating from areas west of the Sydney CBD, and may or may not replace through stations on Sydney's northern and southwest periphery.

A second station was found to involve additional costs that exceeded the anticipated benefits and has not been taken forward. The detailed evaluation is shown in **Appendix 3A**.

Although an HSR station in Parramatta could support its development as Sydney's second CBD, its lower capital costs (due to the shorter urban access alignments) are significantly outweighed by the reduction in user benefits, the likely significant cost of fast mass transit link(s) to the Sydney CBD, and the anticipated social and environmental impacts of the station construction.

Central is the preferred location for a city centre station in Sydney.

A summary of the station site assessment is presented in **Table 4-5**.

Table 4-5 Assessment of potential station sites, Sydney

Objective	Criteria	Central station	Eveleigh			
		Existing station footprint	Rail yards	Australian Technology Park (north)	Australian Technology Park (south)	
Economics and connectivity	Difference in relative user benefits from Central station(\$b)	0	-3			
	Pedestrian access to Sydney CBD	High	Low-moderate	Low	Low	
	Public transport access	High	Low-moderate	Low	Low	
	Proximity to residential centre	High	High	High	High	
	Connectivity to arterial roads	Low-moderate	Moderate	Moderate	Moderate	
	Overall accessibility	High	Moderate	Moderate	Moderate	
Infrastructure	Capital cost (\$b) (station structure)*	0.25	0.38	0.38	0.4	
	Capital cost (\$b) (access corridor)**	12.2	12.1	12.1	12.1	
	Capital cost (\$b) (total)	12.5	12.5	12.5	12.5	
	Constructability***	4	3	3	3	
Sustainability, land use planning and policy fit****	Maintain existing land use	4.0	4.0	4.0	4.0	
	Maintain community function	2.5	1.0	1.5	1.5	
	Promote economic development	6.0	4.0	2.7	3.3	
	Summary	Slightly detrimental	Slightly detrimental	Moderately detrimental	Slightly detrimental	
Conclusions		Preferred	-	-	-	
Principal reasons for non-selection			Lower accessibility and impact on community function	Lower accessibility and impact on community function	Lower accessibility and impact on community function	

*Comparative capital cost estimates for the station structure were based on six platforms for a station in Sydney.

Finalisation of the demand has resulted in a requirement for ten platforms. While the capital cost of the station structure is therefore higher than that shown above, the relative difference between station options does not change. The higher station structure cost has been included in the overall system capital cost estimates.

**Highest capital cost access corridor used for comparison.

***Constructability is assessed and scored between 1 and 5, with the higher score reflecting more construction complexity.

****Sustainability, land use and policy fit is assessed and scored between 1 (highly detrimental) and 7 (highly beneficial).

	Homebush and surrounds				Parramatta
	Olympic Park station	Olympic Park/Bicentennial Park	North of Strathfield station	Homebush West (adjacent to Flemington station)	South of Westfield shopping centre
	-38				-45
	Low	Low	Low	Low	Low
	Moderate	Low	High	Moderate	Moderate
	Moderate-high	Moderate-high	High	High	High
	High	High	High	High	Moderate
	Moderate-high	Moderate-high	Moderate-high	Moderate-high	Moderate
	0.54	0.42	0.32	0.42	0.65
	7.0	7.0	7.0	7.0	6.5
	7.5	7.4	7.3	7.4	7.1
	4	3	5	3	3
	3.6	4.0	4.0	4.0	4.0
	3.0	2.5	2.5	3.0	1.5
	6.0	6.0	6.0	2.7	6.0
	Slightly detrimental	Slightly detrimental	Slightly detrimental	Slightly detrimental	Slightly detrimental
	-	-	-	-	-
	Lower user benefits and difficult constructability	Lower user benefits	Lower user benefits and very difficult constructability	Lower user benefits and few opportunities for renewal	Significantly lower user benefits

4.8 Sydney-Goulburn

4.8.1 Overview

South of Sydney, a decision to select either a coastal corridor via Wollongong or an inland corridor via the Southern Highlands was required before urban alignment comparisons to the south of Sydney could be made.

Although the cost of construction for a corridor via Wollongong would be significantly higher than via the Southern Highlands, the option via Wollongong would serve a significant passenger catchment area. Analysis was therefore undertaken to assess the overall benefits of a Wollongong alignment; this is presented in **section 4.8.1**.

Potential alignments within each corridor were assessed between Central station and Hanging Rock (north of Goulburn), a common point to the south. The alignments via Wollongong and the Southern Highlands that performed best at the time of assessment were then selected for comparison⁵⁰. Details of these alignments and the context in which they were assessed are provided in **Appendix 3A**.

4.8.2 Wollongong alignment

Wollongong is a regional city of 192,418 people⁵¹ located around 85 km south of Sydney. It is part of the Illawarra region, which in 2011 had a population of around 276,000 people⁵². It comprises suburban settlements along the coast to the north, and more widespread suburban areas to the west and south. The urban areas are framed by the steep Illawarra escarpment, water catchment areas and national park, which feature important remnant vegetation, contrasting with the cleared, generally flatter land on which the urban development has occurred. These areas also feature significant areas of underground coal mining.

The population of the Illawarra is forecast to increase by around 50,000 over the next 25 years⁵³. This growth is anticipated through urban expansion in the southern Illawarra around West Dapto and the Calderwood Valley, as well as through infill development to higher densities in the established suburbs of Wollongong.

Finding undeveloped or unconstrained routes for an HSR alignment into Wollongong is a significant challenge due to topography, natural environment, and existing and committed urban development areas.

The alignment would traverse the Royal National Park to the south of Sydney. South of Helensburgh it would comprise a long (>15 kilometres) tunnel to accommodate the change in elevation of approximately 300 metres from the top of the Illawarra escarpment to Wollongong. The alignment would use a combination of surface sections, within the existing rail corridor, and tunnel sections between Woonona and Dapto.

The route south of Dapto would require a long (>22 kilometres) tunnel to accommodate a change in elevation of approximately 700 metres to the top of the Illawarra escarpment near Burrawang, continuing at grade to Hanging Rock. Both the northern and southern tunnels through the Illawarra escarpment would be deeper than the existing conventional rail tunnels and would pass through coal seams. These coal seams present the risk of explosive methane gas during construction and operation of the railway. There is no current engineering control measure available that would completely seal the tunnels from methane, presenting the risk of closure of the tunnels should methane be detected, with implications for the operational reliability of the entire Sydney-Melbourne line. These tunnels, combined with the need to treat past mine workings, present a significant risk for HSR and a \$7.3 billion dollar increase in the capital cost alone.

50 It is noted that after the comparison was complete, the alignment via Southern Highlands was refined further (see section 4.8.2). The refinement improved the performance of the Southern Highlands alignment and reinforced the decision to prefer the alignment via the Southern Highlands.

51 ABS, *Census Data by LGA*, 2011.

52 NSW Department of Planning, *Illawarra Regional Strategy*, 2008.

53 *ibid.*

A more detailed analysis of the issues and risks associated with these tunnels is contained in **Appendix 3A**.

Southern Highlands alignment

The Southern Highlands alignment has fewer high and moderate detrimental impacts than the Wollongong alignment. These potential impacts could be further reduced during the design phase by introducing small deviations to avoid sensitive

land uses. Details of the Southern Highlands alignment are discussed in **section 4.8.3**.

There is no tangible difference in net user benefits between the Wollongong and Southern Highland alignment options, with both producing user benefits of \$3.9 billion.

A summary of the comparison is provided in **Table 4-6**, while the detailed appraisal of the alignments is provided in **Appendix 3A**.

Table 4-6 Comparison of alignments in the Sydney-Goulburn corridor

Criteria	Sydney Central station-Hanging Rock	
	Via Wollongong	Via Southern Highlands
Length (km)	143	139
Estimated transit time (min)	37.2	31.6
Relative net user benefits (\$b)	0	0
Capital cost (\$b)	17.4	10.1
Constructability*	5	3
Sustainability and land use**	Not preferred	Preferred
Conclusion	-	Preferred

*Constructability is assessed and scored between 1 and 5, with the higher score reflecting more construction complexity.

**Sustainability and land use assessed on a pair-wise comparison against seven criteria.

The Southern Highlands alignment is the preferred option between Sydney and Goulburn.

4.8.3 Sydney

Assessment of urban access alignments to the south

Heading south from Central station, a number of existing transport corridors were examined for use. As discussed, the geometry of many of the corridors considered was unsuitable for high speed operation and, in many of those which were suitable in terms of geometry, any spare capacity at surface level was designated for future expansion of existing facilities.

Corridors assessed included:

- Central to Casula/Moorebank.
- Casula/Moorebank to Douglas Park.

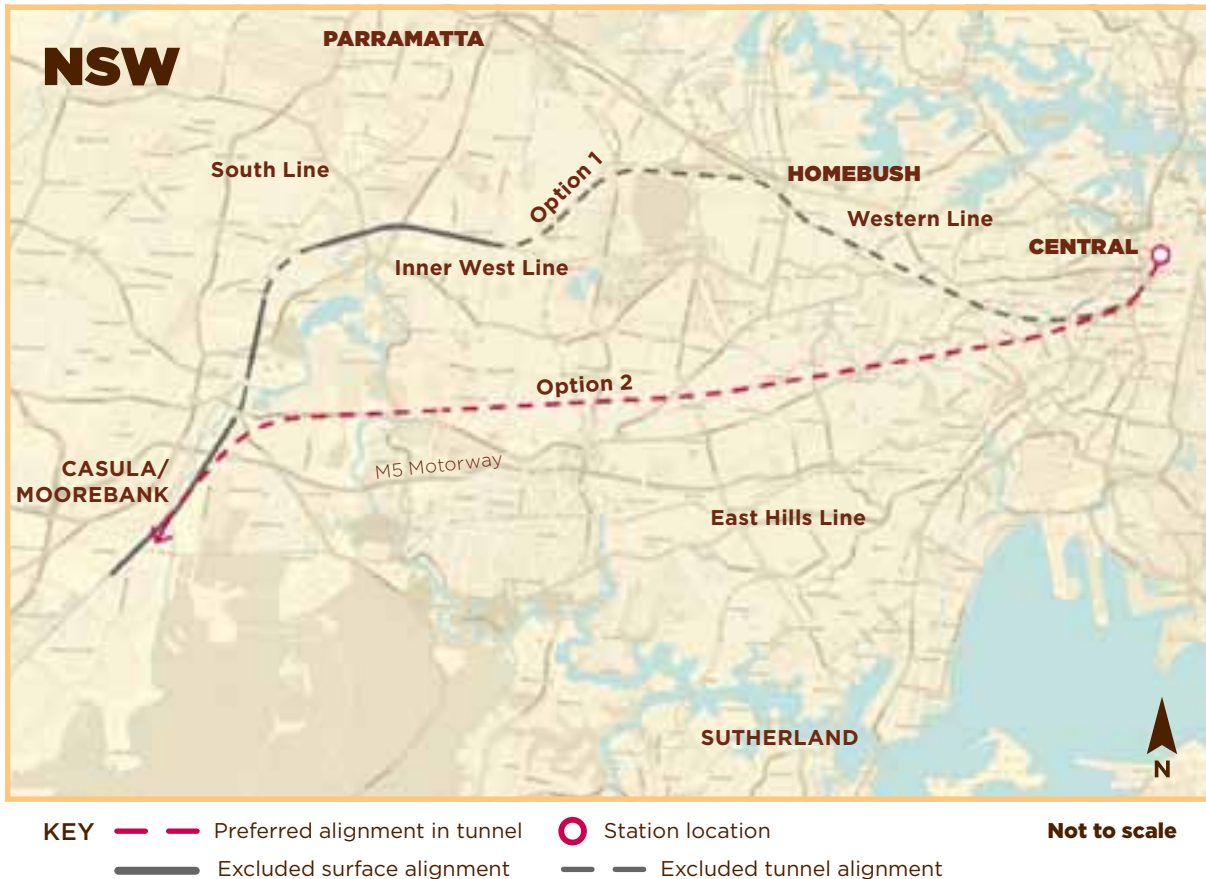
Central to Casula/Moorebank

Two potential alignments through metropolitan Sydney were identified heading south from Central station:

- Tunnel and surface lengths within the Inner West line (Option 1).
- A tunnel from Central to Casula/Moorebank (Option 2).

These options are illustrated in **Figure 4-26**. The preferred alignment is shown in red and labelled 'Option 2' on the map. The second option ('Option 1') is shown in grey.

Figure 4-26 Preferred urban access alignment to the south, Sydney



Details and comparative evaluation of these can be found in **Appendix 3A**.

The Option 1 route (in tunnel westward to Homebush and then following the Inner West line and the South line to Casula/Moorebank) would require longer transit times (because it would be longer and slower, to suit the alignment geometry) with consequent lower user benefits. It would be more difficult to construct due to interfaces with the existing rail corridor, and would have greater impact on existing urban areas.

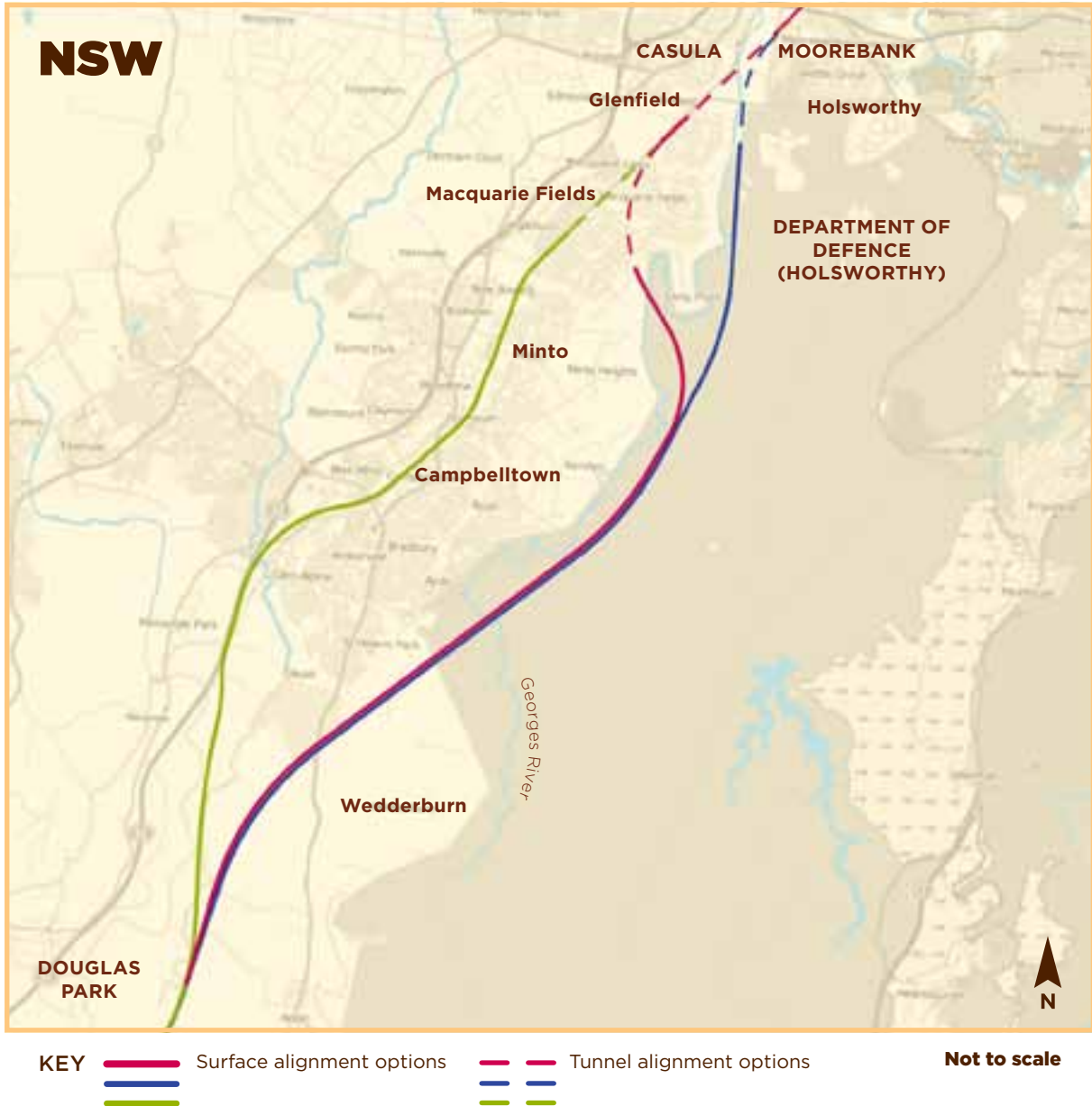
There is also a risk that the cost of Option 1 would increase, as it may require a longer length of tunnel due to the uncertainty of the future surface capacity within the Inner West/Bankstown line corridor. The Southern Sydney freight line, a single

track bi-direction freight line in the rail corridor which commenced operations in January 2013, may be duplicated in the future and the planned second Sydney Harbour rail crossing may connect commuter services from the North West Rail Link to the Bankstown line, both requiring additional infrastructure in the corridor⁵⁴.

As Option 2 is all in tunnel, it would have less environment and land use impact than Option 1, which would have some adverse impacts in its surface sections.

A tunnel directly from Central to Casula/Moorebank (designated Option 2) is the preferred alignment option to the southwest.

Figure 4-27 Casula/Moorebank-Douglas Park alignment options



Casula/Moorebank-Douglas Park

Further refinement south of Casula/Moorebank was undertaken to extend the alignment south beyond the urban edge to Douglas Park, to connect into the regional alignment. The potential to provide an interchange from HSR to the existing rail network at Glenfield, akin to the level of connectivity at Hornsby, was also assessed. Three options were identified as shown on **Figure 4-27**.

Preferred urban access alignment to the south

The blue alignment is nearly \$0.9 billion less expensive than the other options proposed. It is predominantly at surface level, generally following the Georges River to the east of Glenfield, Macquarie Fields, Minto and Campbelltown to Douglas Park. It would have minimal community impacts, but higher environmental impacts on native vegetation. It would not allow a peripheral

station to be co-located with Glenfield station. The peripheral station on this alignment would be located at the tunnel portal on the Department of Defence land at Holsworthy, and station access would be by road from the M5 Motorway and Moorebank Avenue. The blue alignment also traverses the Department of Defence land at Holsworthy.

While the green alignment uses the existing railway corridor, where practical, to minimise adverse impacts on built up areas, it is longer and has slower operating speeds due to geometric constraints. As a result, the green alignment has lower user benefits than the blue alignment, but it would permit connectivity between HSR and suburban rail via an HSR station at Glenfield. Although the green alignment would have minimal environmental impacts, it would have adverse impacts on community function, amenity and land use as it passed through more densely populated areas and would cause severance and noise impacts.

The green alignment would involve higher capital costs and would be more difficult to construct than the blue alignment, requiring significant staging and enabling works and multiple interfaces with external parties, including rail and road authorities. There is also a risk that the green alignment would require a longer length of tunnel to mitigate its adverse impacts on existing development, which would add to the capital cost estimate. The existing railway corridor is also likely to have limited capacity to accommodate additional infrastructure with the opening of the Southern Sydney Freight Line and the construction of the South West Rail Link.

The red alignment follows the green alignment in tunnel from Casula through to Glenfield, where an underground station could be constructed, before proceeding back into a tunnel under Macquarie Fields and joining the blue alignment at the surface. The red alignment would have minimal community impacts during construction (except at Glenfield), and similar environmental impact to the blue alignment. It would also traverse Department of Defence land at Holsworthy.

The three alignments were comparatively assessed using the pair-wise process. The green alignment performed worst and was therefore discarded on the basis of transit time (10.5 additional minutes) and user disbenefits (-\$1.9 billion) compared to the blue alignment, and the risk of an additional length of tunnel being required that would further increase the estimated capital cost of \$3.62 billion. The comparative assessment of the blue and red alignments is provided in **Appendix 3A**.

Both blue and red alignments impact Department of Defence land to varying extents, and the adoption of either alignment would be subject to resolving these impacts with the Department of Defence.

The preferred alignment for Casula/Moorebank-Douglas Park is the blue alignment.

Peripheral station assessment - Sydney South

Sites for peripheral stations south of Sydney are constrained by the Georges River (and its floodplain) and the location of the preferred HSR alignment in tunnel to the east of the Georges River, while Liverpool city centre and the urban rail network are to the west of the Georges River. Crossing the Georges River to access these areas would add significant cost. The Georges River creates a boundary between the developed areas to the west and the Defence land to the east, as shown in **Figure 4-28**. The alignment would pass through or beneath the developed areas, and only one site has been considered on the western side of the river.

Five potential sites were identified. Details and comparative evaluation of these can be found in **Appendix 3A**.

A peripheral station at Holsworthy would generate \$2.8 billion in relative user benefits at a reduced cost compared to other surrounding options at Moorebank and Glenfield. It would provide reasonable access to the regional road network via the M5 Motorway at the Moorebank Avenue interchange. A dedicated public transport link could be provided to nearby Glenfield station, which is on the urban rail network. This service would most likely be a shuttle bus service, subject to demand.

While the Glenfield site provides opportunities for urban renewal and creates excellent interchange opportunities with the urban rail system, it would require an additional \$0.91 billion in alignment

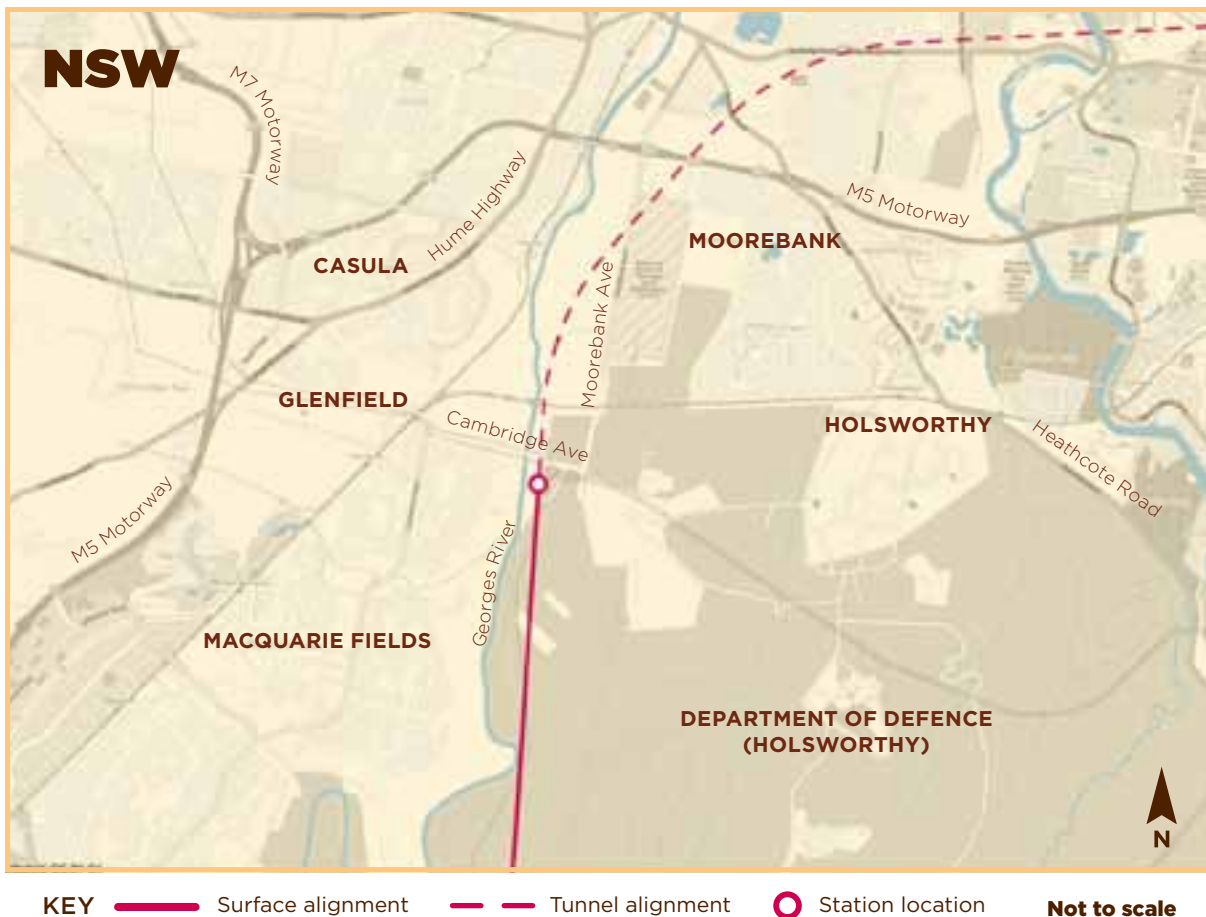
and station capital costs. Road access could be constrained, and additional road infrastructure may be required to provide capacity for vehicles accessing the HSR car park.

The Holsworthy site would accommodate a surface station just south of where the alignment emerges from the tunnel from Sydney Central. Locating a station any further north from this would mean that it would have to be sub-surface at considerable extra cost. However, no suitable location free of flooding was identified.

For HSR alone, the alignment via a peripheral station at the Holsworthy site provides the greatest user benefits at the least cost. Future opportunities to allow interchange with the urban rail network should be investigated if further phases of HSR development occur.

Holsworthy is the preferred Sydney South peripheral station site.

Figure 4-28 Location of Sydney South peripheral station site



Sydney – preferred station sites and urban access alignment

Sydney would be the hub of HSR on the east coast, with HSR services approaching both from the north and south. The Sydney station would therefore need to accommodate nearly twice the volume of passenger flows of any other city station. It would also have commuter services approaching from both directions, which would add considerably to the peak hour flows.

Urban development, topography and environmental issues present major challenges in identifying suitable routes for HSR through the Sydney metropolitan area. An appraisal of potential access alignments into Sydney has confirmed that direct tunnels from the periphery of Sydney to the CBD are the optimal arrangement.

The Central station option is preferred for HSR services in Sydney. Demand analysis shows that Central station provides large benefits for both business and leisure travellers, which far outweigh any difference in capital costs.

Peripheral stations would be located at Hornsby to the north of Sydney, and at Holsworthy to the south of Sydney, as these sites provide the highest net benefit.

4.8.4 Regional alignment and station assessments

Overview

Beyond the urban limits of Sydney's southern suburbs, the landscape changes into an area of relatively undisturbed forests and national parks, from the Blue Mountains to the Illawarra escarpment and the Southern Highlands.

The Southern Highlands is an important tourist destination with European heritage interest. The Hume Highway is the main road from Sydney to Canberra and beyond, through Yass and southwards to Melbourne. Regional and interstate rail services are operated on the Main South line, which broadly parallels the Hume Highway. The Southern Highlands towns of Berrima, Mittagong, Bowral and Moss Vale are close to both the Hume Highway and the conventional rail line.

West of the Illawarra escarpment and the deeply dissected river valleys of the Hawkesbury-Nepean, Wingecarribee and Paddys Rivers, the terrain becomes less difficult on the approach to Goulburn as the land transforms to the Southern Tablelands. The Sydney-Goulburn section of the preferred HSR alignment was divided into four sectors (as shown in **Figure 4-29**): Douglas Park to Bargo, Bargo to Yerrinbool, Yerrinbool to Hanging Rock (near Marulan), and Hanging Rock to Goulburn Airport.

One regional station is proposed in the Southern Highlands, east of Mittagong, near Mittagong Airport.

Figure 4-29 Sydney to Goulburn alignment options



- 1. Yanderra
- 2. Hill Top
- 3. Colo Vale
- 4. Mittagong
- 5. Bowral
- 6. Moss Vale



KEY — HSR alignment options — Station location

Not to scale

Douglas Park-Bargo

The blue alignment in **Figure 4-29** is generally to the east of the Hume Highway and the built-up areas of Menangle Park, Menangle, Douglas Park and Wilton, whereas the red alignment is generally to the west of the Highway. Other alignment options closer to the Hume Highway would have greater impacts on existing and proposed urban development. Options further east or west of the two shortlisted alignments are less direct, encounter steeper topography and would thus incur additional capital costs.

The red alignment would have slightly greater detrimental impacts on a planned urban release area at Menangle Park than the blue alignment, which would affect a smaller area on the eastern edge along with Broughton Anglican College. The red alignment would have an adverse impact on species listed as endangered under the EPBC Act and areas of cultural heritage significance. Both alignments would pass through the Sydney Catchment Authority water supply catchment south of Douglas Park. The blue alignment would be closer to any future potential airport at Wilton, and could therefore provide better opportunities for potential transport links.

The blue alignment is the preferred option between Douglas Park and Bargo.

Bargo-Yerrinbool

The alignment options for this short sector were reduced to a single alignment (shown in red in **Figure 4-29**) that follows the existing freeway, to minimise sustainability and land use impacts, primarily on the adjacent built-up areas and water supply catchments. Although the alignment passes through the western edge of the Avon Dam water supply catchment, it avoids impacts on the Bargo State Conservation Area and a succession of urban areas, including Mittagong, Colo Vale, Hill Top and Yerrinbool.

The alignment alongside the existing road corridor (shown in red in Figure 4-29) is preferred from Bargo to Yerrinbool.

Yerrinbool-Hanging Rock

The two shortlisted alignments selected for pair-wise comparison both run to the east of Mittagong, Bowral and Moss Vale.

Alignments to the west of these towns would have greater impacts on residential areas, including impacts on the towns of Berrima and Colo Vale, as well as Yanderra further to the north, and would require multiple crossings of the Hume Highway. Avoiding these towns would require alignments well west of the Hume Highway and would be less direct than other options.

While the blue alignment would have lesser environmental impacts along this route, the red alignment would impact upon existing and planned urban and semi-urban land east of Moss Vale. Although the blue alignment is located close to Wingecarribee Reservoir, the HSR footprint would be some 300 metres downstream of the dam structure. The capital cost of the red alignment would be approximately \$0.1 billion greater than the blue alignment.

The blue alignment is the preferred option between Yerrinbool and Hanging Rock.

Hanging Rock-Goulburn Airport

The red alignment would pass to the north of the township of Marulan, whereas the blue alignment would pass to the south. Other alignments options were less direct. The red alignment would affect the existing Marulan urban area and land to the south and west that is zoned for future residential and general industrial development.

The blue alignment would impact areas listed on the National Heritage Register at Old Marulan Town along the existing highway corridor, and a truck parking area within the Eastern Marulan Highway Service Centre. The potential impacts on Old Marulan Town could be mitigated by undertaking a detailed archaeological survey, excavation and thorough recording of the site, should a decision be made to proceed with HSR on this alignment.

The blue alignment to the south of Marulan is the preferred option between Hanging Rock and Goulburn Airport.

Figure 4-30 Preferred Southern Highlands station location



Southern Highlands station

The Southern Highlands encompasses the towns of Berrima, Bowral, Mittagong and Moss Vale in Wingecarribee LGA. The LGA had a population of 44,395 in 2011, with forecast growth to 61,085 in 2036 and 63,466 in 2056⁵⁵. Approximately 65 per cent of the population currently resides in the main towns, while the remaining 35 per cent is relatively evenly distributed between villages and regional districts.

As with the Central Coast, designation of an HSR station that is easily accessible to a dispersed population is challenging. The terrain is also a significant constraint in the area, influencing the choice of possible sites. Three potential station locations were identified along the preferred alignment:

- East of Mittagong near Mittagong Airport.
- Southeast of Bowral near the intersection of Kangaloon Road and Sheepwash Road.
- East of Moss Vale along the Illawarra Highway.

The track geometry at Bowral cannot provide the flat and straight alignment required for a station. Of the two remaining options, the site east of Mittagong would cater for the population of this large town. The option to the east of Moss Vale, located on the Illawarra Highway, would also provide good connectivity to the major town of Moss Vale and surrounding regional areas.

The Mittagong location is within a 30 minute drive for 75 per cent of the Southern Highlands (Wingecarribee LGA) population, compared to 72 per cent for the Moss Vale location.

Mittagong is the preferred location for a Southern Highlands station (Figure 4-30).

The site would provide good regional road access via both the new and old Hume Highways and Old South Road. Mittagong would be approximately five kilometres by road, Bowral approximately ten kilometres by road and Moss Vale approximately 20 kilometres by road from the proposed HSR station location. The site is well placed to serve

55 ABS, loc. cit.

future population growth, which is expected to mainly be centred in existing urban areas around Bowral, Mittagong and Moss Vale.

4.9 Goulburn-Yass (including Canberra)

4.9.1 Overview

This area comprises parts of the Southern Tablelands and part of the ACT. It is generally sparsely populated, apart from Canberra and the main towns such as Yass and Goulburn.

The area is characterised by generally flat country. Canberra is surrounded by mountainous terrain, with the Snowy Mountains to the south and the Brindabella Ranges to the west. Route options are further constrained by Lake George to the east.

The optimal alignment between Goulburn and Yass is dependent on how Canberra is accessed. The analysis of a 'spur' versus a 'through' alignment was followed by an assessment of the Canberra station location, and then the regional alignments between Goulburn and Yass and between Gunning and Sutton (linking into the spur line into Canberra).

4.9.2 Canberra

Canberra is Australia's capital city and is located in the ACT approximately 290 kilometres southwest of Sydney by road and approximately 660 kilometres northeast of Melbourne by road.

Strategic planning context and issues

The Australian Government established the National Capital Authority (NCA) to develop the National Capital Plan as the primary plan for the ACT. The NCA maintains Canberra's unique heritage (especially symbolic corridors) and national public places through the National Capital Plan.

The ACT Government's planning regime is managed by the Environment and Sustainable Development Directorate (ESDD), incorporating the ACT Planning and Land Authority (ACTPLA), the statutory agency responsible for planning, zoning, development control and future growth within the ACT. The ESDD is responsible for the Territory Plan, which must be consistent with the National Capital Plan.

Approximately 350,000 people currently live in Canberra, with this number projected to increase to 550,000 by 2056⁵⁶. Canberra's planning policy continues the development of a city based on a polycentric pattern, with the city centre (Civic) as the hub surrounded by urban precincts and residential areas, each with its own centre. While urban intensification is noted for other town centres and transit corridors, Civic is the focal point for urban intensification, and the 'city will remain the "first among equals" of the town centres' as the ACT's commercial and retail centre, with the Central National Area containing the prime administrative and cultural institutions⁵⁷.

The ACT's current transport plans include a range of transport projects to support population growth, including a rapid transit network based on the 'hub and spoke' network form, connecting Civic to other town centres (but not Canberra Airport, as illustrated in **Figure 4-31**)⁵⁸. Current government commitments are to the first stage of a light rail network between Civic and Gungahlin to the north, along the Northbourne Avenue transport corridor. Later stages are proposed to connect Civic with the other satellite suburban centres.

The role of Canberra Airport in the national aviation market was recently considered by the Australian and NSW Governments. This study concluded Canberra Airport is too far from the Sydney market to serve as Sydney's second major regular public transport airport, but that it will grow to serve the southern NSW region, and is the only airport in the region capable of serving as an aviation freight hub⁵⁹.

56 ABS, loc. cit.

57 ACT Government, *ACT Planning Strategy*, June 2012.

58 ACT Government, *Transport for Canberra: Transport for a sustainable city 2011–2031*, 2011.

59 Australian and NSW Governments, loc. cit.

Figure 4-31 ACT proposed rapid service public transport network (2031)



KEY — Rapid Corridors Alternative options **Not to scale**
 ● Stations / stops - - - Potential rapid lines
 (Contingent on future density and roadways)

Source: ACT Government, 2012

Environmental planning context and issues

The HSR approaches into the ACT from NSW are primarily in open country and relatively free of known environmentally sensitive features. However, extensive areas of environmentally sensitive ecological and biological features exist in and around Canberra itself.

In some cases, these reserves act as open space buffers between growing urban areas and are being expanded. Examples include the Crace Grassland Reserve, Gungahlerra Grasslands Reserve, Mulligan’s Flat Nature Reserve and Gorooyarroo Nature Reserve in the vicinity of Gungahlin. The golden sun moth, listed as a critically endangered species under the EPBC Act, is found in several locations in and around Canberra. GIS datasets for these and other sensitive areas and features were used extensively in planning the urban access alignment for Canberra.

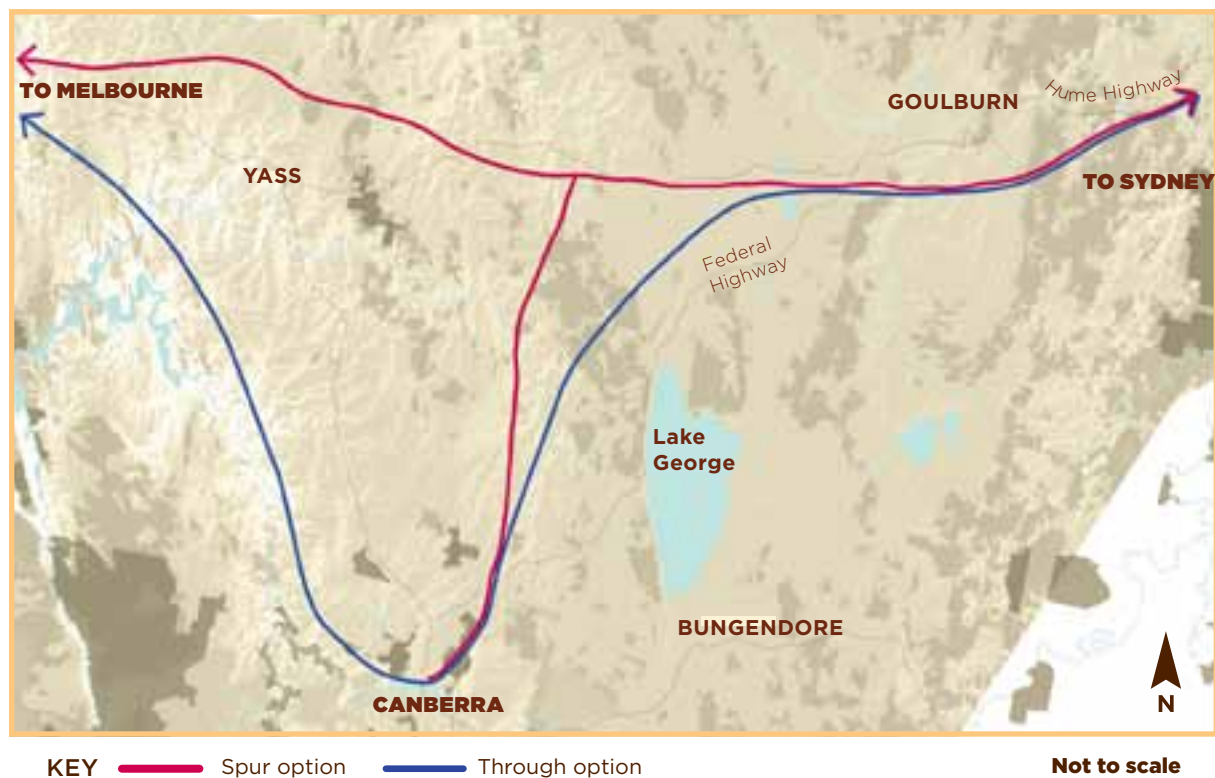
Access to Canberra

Canberra would be connected to the HSR network by a spur line (shown in red in **Figure 4-32**). The preferred alignment would be parallel to the Majura Parkway, east of Mount Ainslie and then deviate to the west in a 3.6 kilometre tunnel under Mount Ainslie towards Civic.

This alignment performs best in terms of overall capital cost, user benefits and fewest adverse impacts on urban land and residents in and around Canberra.

A ‘through’ alignment (shown in blue in **Figure 4-32**) was also considered for Canberra. However, compared to a more direct route between Yass and Goulburn paralleling the Hume Highway, the through alignment increases the travel time for passengers not travelling to or from Canberra by 13 minutes for a non-stopping train (and by 19 minutes for a service that stops at Canberra), as well as potentially exposing existing and planned Canberra suburbs to severance and noise impacts, regardless of whether trains stop in Canberra.

Figure 4-32 ‘Through’ and ‘spur’ alignments, Canberra



Spur vs. through alignment - sustainability and land use considerations

Stations on a ‘through’ alignment would require additional land for track junctions at each end of the station (the station throat). These stations would be a minimum of 800 metres long, inclusive of track junctions. The two through tracks would be located in the centre of the station, isolated by concrete walls from the stopping tracks and side platforms, to permit the passage of through fast trains.

Stations on the ‘spur’ alignment would terminate at Canberra, removing the need for one set of track junctions and reducing the overall station length to approximately 600 metres. Smaller station footprints on the ‘spur’ alignment would require less urban land in Canberra’s centre, and would have less impact on adjacent infrastructure such as roads, utilities and buildings. Any sub-surface station would have to be constructed by cut and cover requiring demolition of any buildings or loss of trees above its footprint. There would, however, be an opportunity for subsequent development above the station after completion, within the height limits imposed by the National Capital Plan to preserve views of Mount Ainslie.

Access into Canberra’s urban centre would require property acquisition, impact existing infrastructure (roads and utilities), and potentially create noise and vibration impacts. These impacts would be greater through urban areas for the ‘through’ alignments, because they are longer than the ‘spur’ alignments. Some of this impact could be mitigated through the use of tunnels.

Both alignments would affect rural areas beyond Canberra’s urban extents. Impacts in rural areas would be less intense than those in urban areas. The potential impact on rural land and infrastructure would be greater with the ‘through’ alignment due to its longer length. The spur alignment achieves shorter travel times for passengers travelling between Melbourne and Sydney (the largest market for HSR), and results in \$3.3 billion additional user benefits compared with the through alignment. It also has capital cost savings of \$1.3 billion (for the proposed station at Ainslie Avenue), fewer adverse impacts on urban land and residents, and little impact on the service frequency to or from Canberra. Canberra residents would also not be affected by noise emanating from 20 trains per hour (in 2065) travelling at speed through the suburbs and city, with only six stopping.

A spur link to Canberra is the preferred option.

A summary of the comparison is provided in **Table 4-7**, while the detailed appraisal of the alignment options is provided in **Appendix 3A**.

Table 4-7 Comparison of through and spur alignments into Canberra

Criteria	Corridor into Canberra	
	Through alignment	Spur alignment
Length (km) (regional and urban)	140	121
Relative transit time (min) (Sydney-Melbourne non-stop)	+13.0	0
Relative transit time (min) (to Canberra)	0	+3
Relative net user benefits (\$b)	0	+3.3
Capital cost (\$b)	3.1-4.6	2.4-3.5
Constructability*	4	3
Sustainability and land use**	Not preferred	Preferred
Conclusion	-	Preferred

*Constructability is assessed and scored between 1 and 5, with the higher score reflecting more construction complexity.

**Sustainability and land use assessed on a pair-wise comparison against seven criteria.

Assessment of potential station locations

Canberra has a smaller CBD than Brisbane, Sydney or Melbourne and the origin/destination of trips is more dispersed, with a higher proportion of car use. Four potential HSR station precincts were identified, as shown in **Figure 4-33**:

1. Lyneham, with a potential station site at Canberra Racecourse.
2. Dickson, with sites at Northbourne Avenue and Antill Street.
3. Civic, with sites at Northbourne Avenue and Ainslie Avenue.
4. Canberra Airport, with sites at the airport terminal and out of the airport grounds adjoining Pialligo Avenue.

Figure 4-33 Potential HSR station locations in Canberra



KEY  Potential stations

Not to scale

Lyneham precinct

This station site is located within the area currently used as Canberra Racecourse. If it were to be developed as an HSR station, the racecourse would need to be relocated.

The racecourse is located toward the north of a transport corridor between Gungahlin and Civic, which includes Flemington Road, the Federal Highway and Northbourne Avenue. Few HSR passengers would access this station on foot, with most travelling to the station by car/taxi or public transport. The site is approximately six kilometres to the north of Civic, which takes approximately 15 minutes by car. Northbourne Avenue experiences congestion during peak periods and trips may take longer at these times, and HSR passengers travelling by public transport would need to interchange at Civic for onward trips. A major parking facility could be provided adjacent to the station and it could be possible to integrate this station with the proposed light rail network. The area around the site could be redeveloped to provide residential, retail or employment opportunities. However, any development at Lyneham that attracts retail and employment opportunities is likely to have a detrimental impact on nearby Dickson, and is therefore contradictory to current planning for the centre of Canberra.

Dickson precinct

Very few passengers would access an HSR station at Dickson on foot. As with other station options located outside the Civic precinct, most passengers would arrive by car/taxi or public transport. Dickson is located toward the middle of the Gungahlin to City (Civic) public transport corridor, with the 4.5 kilometre drive to Civic taking around ten minutes. As with other station options in Northbourne Avenue, access to other areas of Canberra may be affected by peak period congestion. A major parking facility would need to be provided near the station, potentially requiring the removal of existing buildings. The station would also need to be underground, requiring the restriction of traffic access to Northbourne Avenue/Antill Street during the two to three years

of construction, which would also impact on the proposed light rail alignment and station.

Dickson-Antill Street

The Dickson-Antill Street HSR option would be located within Antill Street in the vicinity of the Dickson Centre, currently used for commercial and retail purposes. Construction would require the removal of existing buildings (commercial/retail and residential both north and south of Antill Street) and would impact on adjacent properties during construction and operation. The site would provide the opportunity for redevelopment to provide residential, commercial and/or retail facilities.

Dickson-Northbourne Avenue

The Dickson-Northbourne Avenue option would be located within the median of Northbourne Avenue. Potential redevelopment opportunities exist in the vicinity, through redevelopment of properties acquired for station construction. This option would have significant impacts on Northbourne Avenue during construction within the median, and would require removal of the trees that are an essential feature of this avenue as a gateway to Canberra. The construction of the station would require the complete closure of Northbourne Avenue, between Morphett Street and Antill Street, for approximately two to three years. This is considered an unacceptable impact on this significant formal entry to the national capital.

Civic precinct

The station sites identified in the Civic precinct are well located within Canberra's public transport network, and close to the city (Civic) interchange where the five rapid transit lines converge, providing good access to most of Canberra. Civic is the planned centre of the future transport network and urban growth in Canberra, and is the hub for the planned light rail service, commencing with the Civic to Gungahlin line⁶⁰. A major parking facility would need to be provided nearby, requiring the removal of existing buildings. A station in Civic yields the best user benefits.

60 ACT Government, loc. cit.

Civic-Northbourne Avenue

The Civic-Northbourne Avenue station site would be located within the median of Northbourne Avenue. It would not require property acquisition for the station itself, although it would significantly impact Northbourne Avenue and the proposed light rail during construction for a period of two to three years. The construction of the HSR station would require the complete closure of Northbourne Avenue, between London Circuit and Barry Drive/Cooyong Street, for two to three years, causing major disruption to Civic and through traffic. Potential redevelopment opportunities exist in Civic, which could be stimulated by an HSR station.

Civic-Ainslie Avenue

The Civic-Ainslie Avenue station option would be located within the median of Ainslie Avenue, requiring closure of most of Ainslie Avenue for two to three years during construction, and would not require property acquisition for the station itself. However, it is proposed that the site on the corner of Cooyong Street and Ainslie Avenue, currently developed as social housing, be used for additional multi-storey car parking combined with mixed use redevelopment. The current proposal for redevelopment of the site proposes buildings up to 15 storeys along Cooyong Street⁶¹. Existing buildings on the corner of Currong St and Ainslie Avenue are eight storeys high. Ainslie Avenue is a link in Canberra's transport network, although not as important as Northbourne Avenue, which acts as an entry avenue to Canberra. Potential redevelopment opportunities exist along Ainslie Avenue and in surrounding precincts, extending into Braddon.

Canberra Airport precinct

A submission from the ACT Government to the *Preliminary Draft Master Plan for Canberra International Airport* in 2009 indicated policy concerns around the expansion of employment activity at the airport. The submission stated that '*development outlined in the Draft Master Plan could challenge the role of Civic and the town centres in Canberra's commercial and retail hierarchy*'⁶².

Recognising that the airport plays an important employment role in Canberra, the submission went on to state:

*However, the Spatial Plan states that Civic and the town centres will be the primary focus for future employment growth. The town centres provide a focus for the surrounding residential population and are well served by public transport, appropriate community infrastructure and the arterial road network. On the contrary, uncontrolled growth at the airport has the potential to lead to increased travel time and associated greenhouse gas emissions as a result of longer more car dependant trips, compared to development at Civic and the town centres. Furthermore, the list of planned uses of Airport land goes beyond the essentially industrial, broadacre and transport-related uses envisaged for the eastern area of the ACT in the Spatial Plan*⁶³.

Canberra Airport is located on a 'frequent local service public transport corridor' (a category of public transport corridor defined by the ACT Government), which provides less public transport capacity than the core 'rapid service network'⁶⁴. Canberra's 'frequent local service public transport corridors' aim to provide a service every 15 minutes (or better), while the 'rapid service network' on Northbourne Avenue is intended to provide a service every two to ten minutes (or better)⁶⁵.

61 ACT Government Community Services Directorate, *Urban Renewal Project Sections 52 & 57 Braddon & Section 7 Reid*, Planning Report Volume One, September 2011.

62 Canberra International Airport Pty Ltd, *Preliminary Draft Canberra International Airport 2008 Master Plan*, 2008.

ACT Government, *Submission by the ACT Government on the Canberra International Airport 2009 Preliminary Draft Master Plan*, May 2009.

63 *ibid.*

64 ACT Government, 2012, *loc. cit.*

65 *ibid.*

Located eight kilometres from the city centre, all passengers would be required to access an HSR station at the airport by car/taxi or public transport. There may be some synergies to share transport facilities provided at Canberra Airport, although both the HSR system and airport would experience concurrent demands.

Canberra Airport-Terminal

The Canberra Airport-Terminal site would be located adjacent to the recently expanded airport terminal facilities. This site would affect existing airport infrastructure and operations, and would be moderately difficult to construct. Redevelopment opportunities may be created by the HSR station, although these are likely to be industrial or commercial land uses, given the potential impacts of airport operations. A proposal by Canberra Airport to fund an HSR station at Canberra Airport has been published and would introduce some private funding (suggested at \$140 million)⁶⁶.

Canberra Airport-Pialligo Avenue

The Canberra Airport-Pialligo Avenue site would be located adjacent to the airport, to avoid direct impacts on the airport precinct. It would be easier to construct than a site at the terminal, but the site is remote from the airport and would require connecting pedestrian bridges or underpasses to cross the road.

Preferred city centre station site

An HSR station in Civic would allow HSR passengers to walk to buildings within the CBD and provide better access to the primary tourist destinations in the Parliamentary Triangle than a station at Lyneham, Dickson or Canberra Airport.

Either Civic station site would benefit from the economic status of Civic as Canberra's CBD, planned employment and retail development, and good fit with territory government planning and growth policy, and would provide opportunities for urban renewal. The construction of a station

in Ainslie Avenue would not be as disruptive as a station built in Northbourne Avenue. However, a Civic station is dependent on vehicle access and parking arrangements in Civic being able to accommodate the volume of forecast HSR passengers, especially in peak periods.

Civic-Ainslie Avenue has been nominated as the preferred station site (see Figure 4-34).

Preferred urban access alignment

The alignment to Civic-Ainslie Avenue would cross over the planned Majura Parkway near its start at the intersection of Mount Majura Road and Majura Road⁶⁷, then run parallel to Majura Parkway east of Mount Majura and deviate to the west, with a tunnel under Mount Ainslie towards Civic. The railway would approach Ainslie Avenue in a cutting, passing beneath Limestone Avenue before surfacing for the station platforms.

This alignment would shield Canberra residents in the urban area to the west of Mount Ainslie from visual and noise impacts, and would minimise the visual and noise impacts of HSR in the immediate area. Ainslie Avenue would be reconfigured after construction to reinstate through traffic.

Further detail of the Ainslie Avenue station is provided in **Chapter 5**.

The Civic-Ainslie Avenue site provides significant net user benefits, and creates opportunities for urban renewal and consolidation in the centre of Canberra. The cost of the HSR station is estimated to be \$0.16 billion. An HSR station at Civic-Northbourne Avenue has the highest capital cost at \$0.28 billion, due to a longer and more complex access alignment and the deep cut-and-cover construction required in a constrained work site/ environment. It would require complex staging and enabling works to accommodate general traffic and construction access on Northbourne Avenue. The cut-and-cover construction in the median of Northbourne Avenue for the Northbourne Avenue station option would significantly impact works

66 Canberra Airport, *57 minutes Canberra to Sydney ... and less than a decade away*, media release, 12 June 2012.

67 The HSR alignment does not fully take account of the recently published Majura Parkway alignment. The HSR alignment would be elevated to pass over the Parkway, which would be constructed before HSR is built. A bridge is currently allowed for in the capital cost with further provisions within the capital cost risk allowances.

on the Gungahlin to City light rail project, which is planned to run in Northbourne Avenue⁶⁸. This disruption is anticipated to last two to three years.

The Dickson-Northbourne Avenue option is estimated to have a comparable cost to Ainslie Avenue, but would generate \$2 billion less in user benefits. The estimated total capital cost of the Dickson Antill Street option is \$100 million more, and user benefits would be \$2 billion less, than a station at Ainslie Avenue. The reduction in user benefits for the Dickson station sites are due to the longer station access times compared to the Civic station sites. Neither HSR station site at Dickson performed as well against the criteria as other sites. Stations at these sites have higher than average costs and would require demolition of buildings or impact Northbourne Avenue.

The Canberra Racecourse site has the lowest capital cost of the Canberra options of \$0.11 billion (the station structure), has a shorter access alignment than other options, would be relatively easy to construct and would be at surface level, removing the need for tunnelling. However, the user benefits are estimated to be \$2 billion lower than a station at Civic. The Canberra Racecourse site is not preferred because user benefits would be lower than other options, and the site is contrary to current centre planning in Canberra, even though it would provide opportunity for major mixed-use development adjacent to a station.

While the Canberra Airport sites had lower capital costs than other options, they also had the lowest user benefits of potential HSR sites in Canberra, limited redevelopment opportunities, and lowest public transport access. The proposed private funding contribution of \$140 million did not outweigh these issues. The sites are also contrary to current centre planning in Canberra, and lack the ability to generate mixed use development (residential and commercial) adjacent to a station, due to aircraft noise impacts.

The proximity of the Civic-Ainslie Avenue station site to the hub of a rapid transit system would facilitate public transport access to the HSR. In addition, car access to the HSR station could be accommodated by the provision of with multi storey public car park development with a mixed use commercial component on the site. Should capacity be exceeded, additional parking could be located towards the eastern end of Ainslie Avenue, with a shuttle bus service connecting the station precinct and car park. Nonetheless, if adequate parking were considered not to be feasible at Civic-Ainslie Avenue, a station at Canberra Airport is an alternative that could be further explored.

Table 4-8 presents a summary of the station options assessment. No peripheral stations are proposed in Canberra, due to the small size of the urban area. The preferred alignment may require slight amendment to accommodate the new Majura Parkway.

68 ACT Government, Gungahlin to City Transit Project, Project Update 3, September 2012.

Chapter 4 Alignment and station locations

Table 4-8 Assessment of potential city station options, Canberra

Objective	Criteria	Lyneham	Dickson		Civic		Airport	
		Racecourse	Antill Street	Northbourne Avenue	Northbourne Avenue	Ainslie Avenue	At Airport terminal	Adjacent to Pialligo Avenue
Economics and connectivity	Difference in user benefits from Civic options (\$b)	-2	-2	-2	-	-	-3	-3
	Pedestrian access to CBD	Low	Low - moderate	Low-moderate	High	High	Low	Low
	Public transport access (existing)	Moderate	Moderate	Moderate	High	High	Low	Low
	Parking availability (existing)	Low	Low-moderate	Low-moderate	Low	Low	High	Low - moderate
	Proximity to residential centre	Moderate	Moderate	Moderate	Moderate-high	Moderate-high	Low-	Low-
	Connectivity to arterial roads	High	High	High	Moderate - high	Moderate - high	High	High
	Overall accessibility	Moderate	Moderate	Moderate	Moderate - high	Moderate - high	Low-moderate	Low-moderate
Infrastructure	Capital cost – station structure only (\$b)*	0.11	0.21	0.15	0.28	0.16	0.13	0.11
	Station constructability**	1	5	5	5	3	3	1
	Capital cost – urban corridor (\$b)	0.31	1.0	0.92	1.5	0.95	0.52	0.52
	Urban corridor constructability**	2	4	4	4	3	2	2
	Capital cost – total (\$b)	0.42	1.21	1.07	1.78	1.11	0.65	0.63

Table 4-8 Assessment of potential city station options, Canberra (continued)

Objective	Criteria	Lyneham	Dickson			Civic		Airport	
		Racecourse	Antill Street	Northbourne Avenue	Northbourne Avenue	Ainslie Avenue	At Airport terminal	Adjacent to Pialligo Avenue	
Sustainability, land use planning and policy fit***	Maintain existing land use – station	4.0	3.6	3.8	3.8	4.0	3.8	4.0	
	Maintain community function – station	3.0	1.0	1.5	3.5	3.5	3.5	4.0	
	Promote economic development – station	4.7	4.7	4.7	4.7	4.7	2.3	2.3	
	Summary – station	Neutral	Slightly detrimental	Neutral	Neutral	Neutral	Neutral	Neutral	
	Summary – urban corridor	Neutral	Neutral	Neutral	Neutral	Neutral	Neutral	Neutral	
Conclusions		-	-	-	-	Preferred	-	-	
Principal reasons for non-selection		Lower net user benefits	Very difficult station constructability	Very difficult station constructability	High capital cost and very difficult station constructability	-	Lowest user benefits and accessibility. Lower economic development potential.	Lower user benefits and accessibility. Lower economic development potential.	

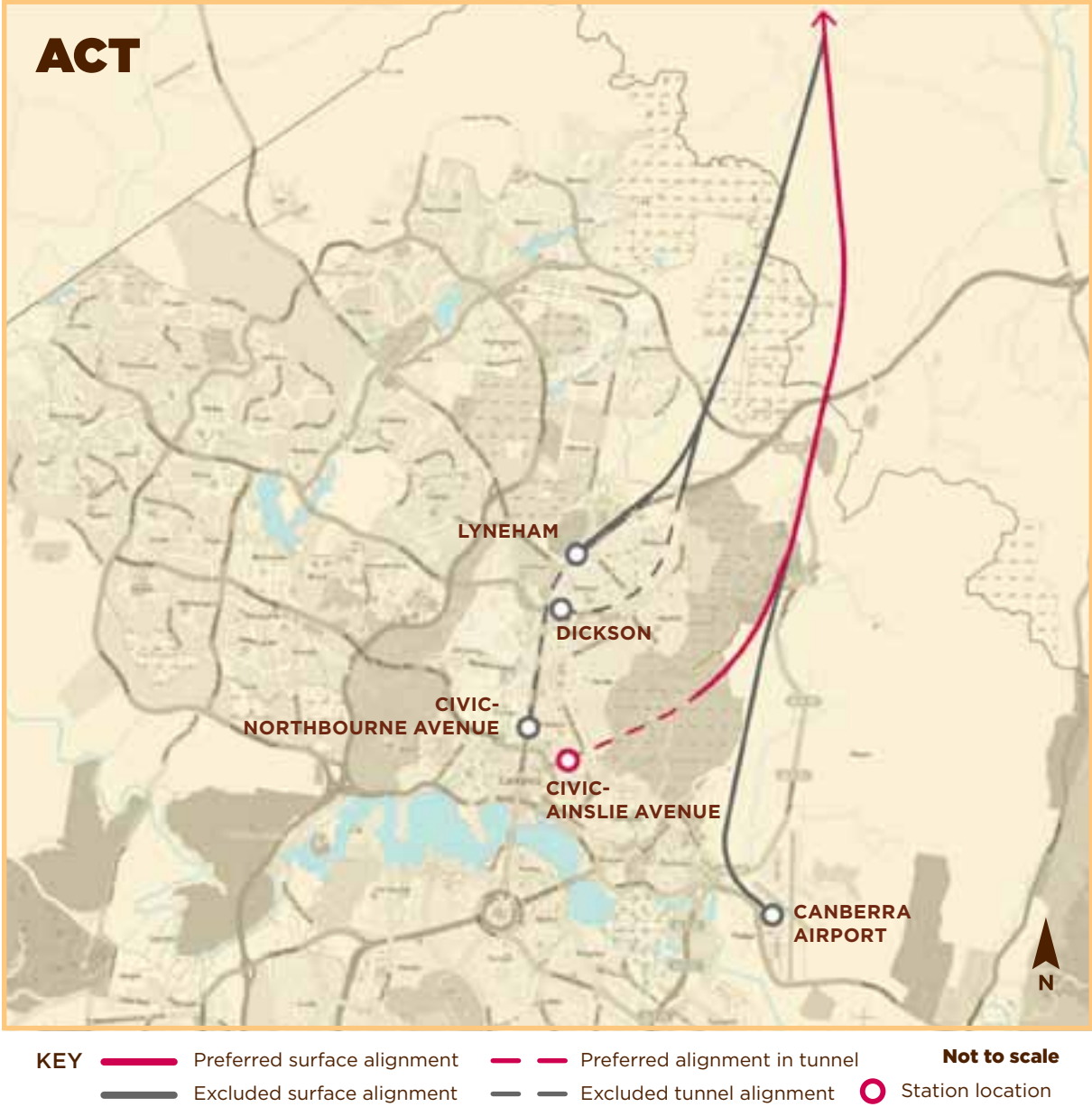
* Comparative capital cost estimates for the station structures were based on two platforms for a station in Canberra.

Finalisation of the demand has resulted in a requirement for three platforms. While the capital cost of the station structure is therefore higher than that shown above, the relative difference between station options does not change. The costs allowed in the capital cost estimate include all land, architectural finishes and car parking. The higher station structure cost has been included in the overall system capital cost estimates.

** Constructability is assessed and scored between 1 and 5, with the higher score reflecting more construction complexity.

*** Sustainability, land use and policy fit is assessed and scored between 1 (highly detrimental) and 7 (highly beneficial).

Figure 4-34 Preferred city centre station and alignment, Canberra



Canberra - preferred station site and urban access alignment

Civic-Ainslie Avenue is the preferred city centre station site in Canberra. This site provides more than \$2 billion additional user benefits over other options and an additional \$1 billion in net benefits when access and station construction costs are taken into account.

The preferred urban access alignment is broadly parallel to the Majura Parkway to the east of Mount Ainslie, with a tunnel section under Mount Ainslie to access Civic. This alignment would minimise the visual and noise impacts of HSR on the urban area to the west of Mount Ainslie. Ainslie Avenue would require reconfiguration to accommodate the station and its accesses, and to provide for through traffic.

4.9.3 Regional alignments (Goulburn-Yass connecting to Canberra spur)

Following the selection of the preferred station site and urban access alignment, the regional alignments between Goulburn and Yass, connecting to the Canberra spur at Gunning, were assessed (see **Figure 4-35**).

Goulburn Airport-Yass

The red alignment passes to the north of the township of Gunning, whereas the blue alignment passes to the south. An alternative alignment located between the shortlisted red and blue alignments, while being slightly more direct, would have greater impact on the built-up area of Gunning and was not progressed.

While both alignments are close to Goulburn Airport, both options have adequate clearance between the HSR alignment and the runway.

The red alignment would have more adverse sustainability and land use planning impacts and higher capital costs (approximately \$0.3 billion higher, because of the additional length of spur line required to connect the line to Canberra) and would adversely affect part of the village of Breadalbane. The red alignment would also require a greater number and total length of bridge structures compared to the blue alignment, in part due to its multiple crossings of the existing Sydney-Melbourne rail corridor and Old Hume Highway.

The blue alignment to the south of Gunning (shown in Figure 4-35) is the preferred alignment between Goulburn Airport and Yass.

Figure 4-35 Goulburn to Yass alignment options



Canberra spur alignment options

Two alignments were shortlisted, which connected to the preferred blue alignment between Goulburn Airport and Yass. The main difference was the junction point with the through line, as shown in **Figure 4-35**. The blue alignment connected to the east of Gunning, while the red alignment connected to the west. Other alignments east of the blue alignment would encounter steeper terrain north of Gundaroo, and would therefore be more costly.

The red alignment would require an additional distance of 13 kilometres to be covered on the through line for Sydney-Canberra, incurring an additional train transit time of 2.5 minutes. Although this would be a benefit for Melbourne-Canberra passengers, the majority of boardings and alightings at Canberra would be for travel to and from Sydney. The blue alignment would have less impact on vegetated areas than the red alignment.

The blue alignment is the preferred alignment option between Gunning and Sutton.

4.10 Yass-Albury-Wodonga

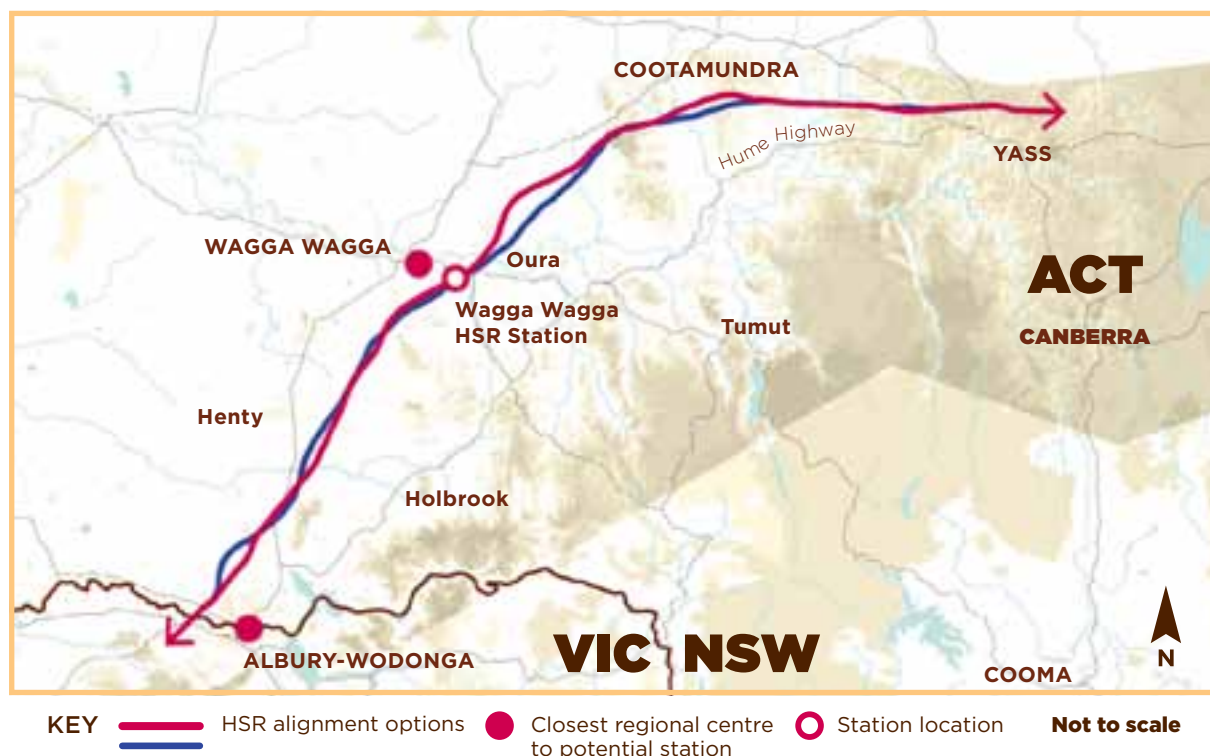
4.10.1 Overview

This area comprises parts of the South West Slopes and the Riverina. The terrain is hilly to the east but in the west towards Wagga Wagga the slopes ease to form the Riverina plain.

The region is generally sparsely populated, apart from the main towns such as Yass, Cootamundra, Gundagai, Tumut, Tarcutta, Wagga Wagga and Holbrook.

The higher altitude of much of this section means cooler temperatures, and some of the area is a recognised wine region. Away from the highlands, the area is characterised by flatter country which has generally been extensively cleared and is used for grazing purposes and modified wheat crops. Timber is a significant industry in the region, centred on Tumut. Major water courses include the Murray River and its main tributary, the Murrumbidgee River, with the associated wetlands of the Lowbidgee Floodplain. The Yass-Albury-Wodonga section is divided into two sectors: Yass-Wagga Wagga and Wagga Wagga-Albury-Wodonga, as shown in **Figure 4-36**.

Figure 4-36 Yass-Albury-Wodonga alignment options



4.10.2 Regional alignment and station assessments

Yass-Wagga Wagga

The two shortlisted alignments generally share a common route between Yass and Cootamundra, but between Cootamundra and Wagga Wagga are separated by up to six kilometres. Other options further south would involve significant additional capital costs due to the hillier terrain east of the Hume Highway.

The preferred option was selected taking into consideration the findings of the sustainability and land use planning appraisal, including minimising impacts at Oura and the Ulandra Nature Reserve. The blue alignment affects slightly more intensive agricultural land but the red alignment would have more significant impacts on urban areas, particularly Oura village.

The preferred alignment is an optimisation of the two shortlisted alignments.

Wagga Wagga station

Wagga Wagga is a major regional centre in the Riverina region. The Riverina is a major agricultural producer, with a large food and wine industry. Wagga Wagga City Airport is approximately ten kilometres east of the city centre on the Sturt Highway.

Wagga Wagga had a population of 59,458 in 2011, which is projected to grow to 72,800 in 2036 and 75,700 in 2056⁶⁹. A major growth area is proposed south of the city, around Lake Albert, which provides a constraint to potential station locations, as does the Murrumbidgee River, which runs east to west to the north of Wagga Wagga.

Options for station locations in the vicinity of Wagga Wagga City Airport were assessed.

The preferred location for a station at Wagga Wagga is to the south of the airport.

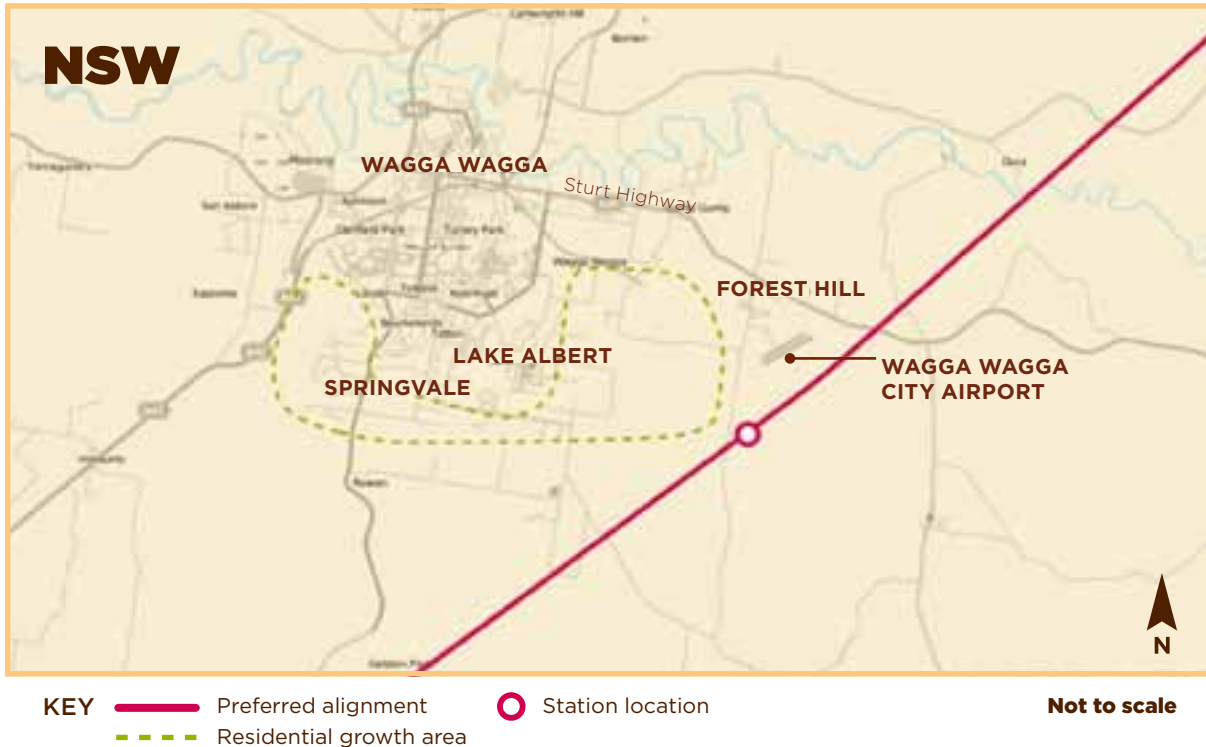
As shown in **Figure 4-37**, the location provides good access to the Sturt Highway via Elizabeth Avenue, with potential for synergy with the airport access off Elizabeth Avenue. Wagga Wagga, which has a conventional rail station, would be approximately 15 kilometres by road from the preferred station location.

Options to the north of the airport and Sturt Highway are constrained by the Kyeamba Creek floodplain and are likely to cost more, due to the added costs of construction in the floodplain. The urban development area planned to the south and east of Wagga Wagga would be supported by the station location, and there is a possible long-term option for a flood-free southern highway bypass on this land, which would improve accessibility to the station⁷⁰.

69 ABS, loc. cit.

70 ABS, loc. cit. Wagga Wagga City Council, Draft Spatial Plan, 2008.

Figure 4-37 Preferred Wagga Wagga station location



Wagga Wagga-Albury-Wodonga

The two alignments shown in **Figure 4-36** generally share a common route between Wagga Wagga and Henty. The alignments between Henty and Albury-Wodonga are separated by up to four kilometres. Alignment options to the east are less favourable because of the steeper terrain to the east and northwest of Albury-Wodonga. Alignments serving the Albury-Wodonga town centre along the route of the existing railway would have significant impacts on built-up areas, requiring acquisition of residential properties. Options further to the west are less direct and would have greater sustainability and land use planning impacts and/or higher capital costs.

There is no differentiation between the alignments on cost or travel time criteria.

The preferred alignment is therefore a further optimisation of the two shortlisted alignments to minimise potential impacts on agriculture and urban areas.

The blue alignment would have adverse impacts on a cluster of buildings at Maxwell and the edge of an intensive agriculture area, while the red alignment would have direct impacts on community infrastructure and the amenity of urban areas.

Albury-Wodonga station

Albury is located in the Murray region of NSW, while Wodonga is located in Victoria on the opposite bank of the Murray River. Together, Albury and Wodonga form a major regional centre, with a regional airport and the Charles Sturt University Campus. The population of Albury-Wodonga was 83,329 in 2011, which is projected to grow to 106,700 in 2036 and 113,500 in 2056⁷¹. A growth centre is proposed east of Albury around Thurgoona.

The area surrounding Albury-Wodonga has major natural features - including Lake Hume, the Murray River and hills northwest of Albury - as well as future residential growth areas. Potential HSR station zones were identified, taking these constraints into account while still seeking to provide good access.

Figure 4-38 Preferred Albury-Wodonga station location



Alignments and stations to the north and east of Albury would have significant adverse impacts on the existing built-up area.

As shown in **Figure 4-38**, options further north on the alignment would be constrained by the Murray River and its floodplain, while options further south would increase the station distance from Albury-Wodonga. The alignment would be constrained from moving closer to Albury-Wodonga by the topography north and west of Albury, Lake Hume to the north and east, and endangered species around Chiltern to the west.

The preferred station is located at Barnawartha North, southwest of Albury-Wodonga. The preferred location would provide good access to the Hume Freeway via the Murray Valley Highway. Albury would be approximately 25 kilometres by road and Wodonga approximately 20 kilometres by road from the proposed HSR station location,

between 15 and 20 minutes by vehicle via the Hume Freeway. A station in this area would also provide access to the Rutherglen and Murray Valley region to the west.

The preferred alignment could allow connections to be made between the HSR alignment and the existing rail line north and south of Albury-Wodonga in the future, if warranted, allowing regional services to access the existing stations. Options to the north of the Murray Valley Highway would be more costly, due to the additional costs of construction in the floodplain.

The preferred location for Albury-Wodonga station is northwest of the Hume Freeway/Murray Valley Highway interchange.

4.11 Albury-Wodonga-Melbourne

4.11.1 Overview

The landscape of the Albury-Wodonga-Melbourne area is dominated by the western edge of the Great Dividing Range, with the Hume Freeway tracing the path of least resistance as the range falls away from the High Country west to the Goulburn Valley region.

The main transport infrastructure is the Hume Freeway and the North East rail line. The main centres of population are the towns of Wangaratta, Benalla, Shepparton and Seymour. Agriculture in the region is diverse and includes fruit production and beef, dairy and sheep farms. The Goulburn

River flows west from the range and runs north through Seymour and Shepparton to join the Murray at Echuca. South of Seymour, the landscape gradually changes from regional to semi-regional to urban on the approach to Melbourne.

The Albury-Wodonga-Melbourne section is divided into three sectors: Albury-Wodonga-Wangaratta, Wangaratta-Seymour and Seymour-Craigieburn. Alternative sectors were subsequently established between Seymour and Wallan and Wallan to Craigieburn, to allow for the final assessment of the urban access corridors into Melbourne. This did not affect the preferred alignment between Seymour and Craigieburn.

The alignments assessed in this section are shown in **Figure 4-39**.

Figure 4-39 Albury-Wodonga-Melbourne alignment options



4.11.2 Regional alignment and station assessment

Albury-Wodonga-Wangaratta

Both the red and the blue alignments generally share a common route, with the greatest separation being less than two kilometres over relatively short lengths. Other alignment options were less direct and/or had increased sustainability and/or land use impacts.

The preferred alignment is an optimisation of the red and blue alignments.

This approach to options selection was based on the sustainability and land use planning impacts, particularly those on Boorhaman and the Chiltern Box-Ironbark National Park. The blue alignment would also have impacts on an industrial area adjacent to the Hume Highway.

Wangaratta-Seymour

The red alignment is a route via Shepparton while the blue alignment is a more direct route, generally following the Hume Highway as shown in **Figure 4-39**.

The red alignment is approximately 15 kilometres longer and would add 2.5 minutes to the train transit time, with a resulting disbenefit to through passengers of approximately \$0.8 billion. This would be broadly offset by the demand and user benefit (approximately \$0.7 billion) generated by an HSR alignment and a station close to Shepparton.

The red alignment via Shepparton would have a capital cost approximately \$0.1 billion higher than the more direct blue alignment. This relatively small difference, despite the considerable additional length, is because of the greater volume of earthworks that would be required on the more direct blue route due to its more undulating terrain.

Both alignments would have some impact on Plains Grassy Woodland, an endangered ecological vegetation class, that would need to be mitigated and/or offset during detailed design and construction should a decision be made to proceed

with HSR. The red alignment passes through the Rowan Swamp State Game Reserve. The blue alignment would impact on intensive agricultural land and would pass close to Longwood village, the Avenel Golf Course and the Avenel Aerodrome.

An alternative arrangement was also evaluated, which would serve Shepparton with a spur line from the blue alignment at Seymour, using either the existing rail line or a new dedicated HSR line between Shepparton and Seymour. However, neither option is justifiable on economic grounds (see **Appendix 3A** for details).

While the red alignment has a longer train transit time, the user disbenefit of the additional transit time would be broadly offset by the demand that would be generated by an HSR station close to Shepparton. The saving in capital cost for the blue alignment would be minimal and does not warrant bypassing Shepparton.

The red alignment is the preferred option between Wangaratta and Seymour.

Shepparton station

Shepparton is a regional city, located approximately 180 kilometres northeast of Melbourne. The City of Greater Shepparton had a population of approximately 60,449 people in 2011, which is projected to grow to 80,400 in 2036 and 88,200 in 2056⁷². The city has a regional airport and a conventional rail station with services to Melbourne.

Irrigation channels are a major constraint for any alignment close to Shepparton. Land east of Shepparton close to the Midland Highway would be the preferred area for a station. Options for station locations in this area were assessed and a preferred location was identified north of the Midland Highway, west of Pine Lodge Road, as shown in **Figure 4-40**.

This location would provide good road access on the Midland Highway from Shepparton, approximately ten kilometres by road from the proposed HSR station location. It would also avoid the fruit growing region and irrigation channels to the west.

Figure 4-40 Preferred Shepparton station location



Seymour-Craigieburn

The two alignments generally share a common route between Seymour and Craigieburn and pass the built-up areas of Broadford, Kilmore and Wallan to the east. However, the alignment options do diverge in some sections to avoid various potential impacts.

Alignment options to the west of the built-up areas of Broadford, Kilmore and Wallan would have adverse impacts on proposed future land release areas as well as being a less direct route. Alignment options to the east of the shortlisted alignments would traverse increasingly steep terrain, which would add to the capital cost.

The red alignment would have more adverse sustainability and land use planning impacts compared to the blue alignment. While both

alignments would impact on urban growth precincts located between Craigieburn and Wallan and the Hidden Valley Golf Course community near Wallan, the red alignment would impact on an existing community between Wandong and Heathcote Junction. Due to being co-located with the existing rail line, the blue alignment would impact on endangered ecological communities that have survived relatively undisturbed in the rail reservation. A mitigation strategy for impacts on these vegetation communities, which could include offsets, would be developed during the concept design phase, should a decision be made to proceed with HSR.

The blue alignment is the preferred alignment option between Seymour and Craigieburn.

4.11.3 Melbourne

Overview

Melbourne has a population of approximately four million, which is projected to increase to over 6.6 million by 2056⁷³. Planning for Melbourne is managed through the Victorian Department of Planning and Community Development. The Department oversees the preparation of the Metropolitan Plan for Melbourne and urban growth strategies for cities and regions, and is preparing a new strategy for Melbourne, following the publication of *Melbourne 2030: a planning update – Melbourne @ 5 million* in 2008⁷⁴. Local government prepares local zoning and development plans consistent with the state growth strategies.

The Growth Areas Authority is an independent statutory body responsible for preparing and implementing urban expansion plans within Melbourne's growth areas. The current growth strategies call for about half of Melbourne's expansion to be accommodated in new suburbs within growth areas on the edge of Melbourne, in four corridors:

- Casey-Cardinia in the southeast.
- Melton-Caroline Springs in the northwest.
- Hume-Mitchell-Whittlesea in the north.
- Wyndham in the southwest⁷⁵.

This expansion is being supported by the construction and planning of new infrastructure such as:

- The newly constructed South Morang Rail extension.
- The Sunbury Electrification project, under construction.
- The Regional Rail Link project, under construction.
- The proposed Outer Metropolitan Ring Road.
- The Tullamarine Freeway extension to the Outer Metropolitan Ring Road.

- The planned Melbourne Metro.
- A proposed Melbourne Airport Rail Link.

A key principle of an HSR system is the grade separation of HSR and other road and rail assets. A significant challenge in Melbourne is the large number of road/rail level crossings on the existing conventional rail network. This alone makes the strategy of following existing rail corridors at surface level very difficult in most cases.

Strategic planning context and issues

The northern and northwestern approaches to the Melbourne metropolitan area generally present few topographic constraints due to the gentle undulating landform that characterises this part of the state.

The Melton-Caroline Springs and Hume-Mitchell-Whittlesea growth areas are relevant to the HSR alignment, as access to the city from the north would be through one of these areas. Urban development already extends approximately 30 kilometres northwest from the CBD to Caroline Springs/Calder Park and around 35 kilometres north of the CBD to Craigieburn.

To the northwest of Melbourne, in the Melton-Caroline Springs growth corridor, growth areas are proposed around Rockbank, located in the vicinity of the planned Outer Metropolitan Ring Road. As part of the Hume-Mitchell-Whittlesea growth corridor in the north, key growth areas are proposed north of Craigieburn and include Donnybrook, Kalkallo and Beveridge. These straddle the transport corridor containing the existing railway line to Sydney and the Hume Freeway to northern Victoria. Planning for a number of these areas to the north and northwest of Melbourne is already underway and further new urban development is expected over the medium to long term.

73 ABS, loc. cit.

74 Department of Planning and Community Development, *Melbourne 2030: a planning update – Melbourne @ 5 million*, December 2008.

75 This excludes the announcement regarding further growth areas made by the Growth Areas Authority on 13 June 2012.

Environmental planning context and issues

The Kinglake National Park is located north and east of the main transport corridors north of Melbourne, and is sufficiently distant from these transport corridors to avoid adverse impacts from transport infrastructure and other development.

Elsewhere, environmental constraints include wide areas of native vegetation, wetlands and creeks, which tend to be concentrated east and west of the existing primary transport routes. Ecologically valuable grasslands are found throughout the northwestern and northern entry areas to Melbourne.

The entry points to Melbourne from the north are generally through farmland and sparsely vegetated areas, with widely scattered concentrations of native vegetation along creek and fence lines. Key sensitive ecological resources include areas of River Red Gums, threatened communities of natural temperate grasslands and Grassy Eucalypt Woodland of the Victorian Volcanic Plain. These are typically excluded from planned growth areas.

Other sensitive and protected ecological species and communities in these areas include Craigieburn Grasslands, Stony Knoll Scrubland, Plains Grassland, Curly Sedge and matted flax lily. Creek environments support the Growling Grass Frog, which is nationally listed as 'Vulnerable' under the EPBC Act and listed as 'Threatened' and classified as 'Endangered' under Victoria's *Flora and Fauna Guarantee Act 1988*⁷⁶. Existing highway and rail corridors tend to avoid these and other threatened species and communities, and provide opportunities for co-locating future transport infrastructure.

Assessment of potential station locations

Two station precincts were assessed: the Southern Cross station precinct, and a precinct adjacent to Dynon Road in North Melbourne, approximately two kilometres north of Southern Cross station. Within each precinct, two station sites were identified:

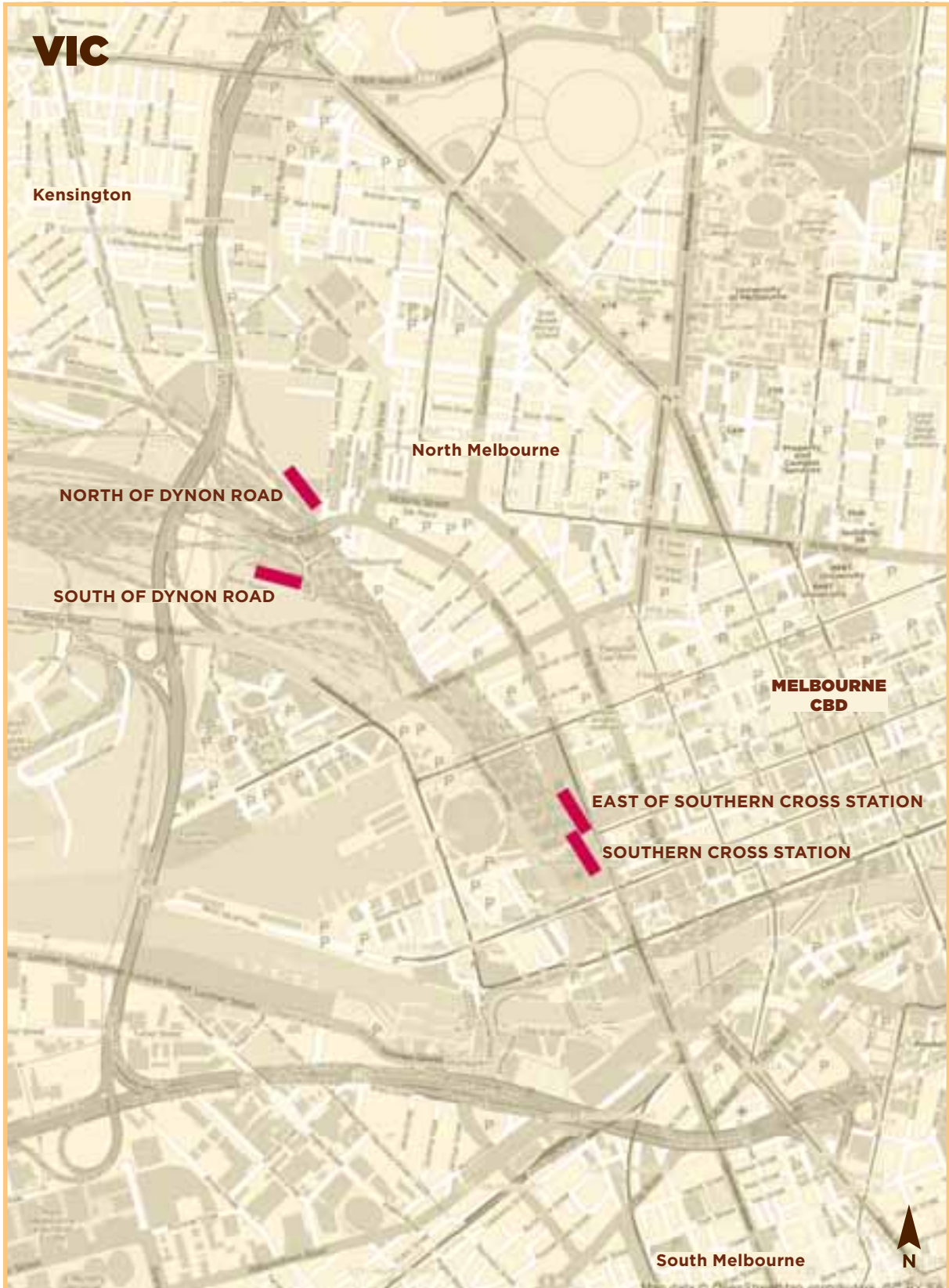
1. Southern Cross station
 - a. Existing platforms at Southern Cross station.
 - b. New platforms, to be constructed to the east of Southern Cross station, on the site of the current bus station.
2. North Melbourne
 - a. North of Dynon Road.
 - b. South of Dynon Road.

The station sites are shown in Figure 4-41, while Table 4-9 presents a summary of the station assessment.

Southern Cross station precinct

Two sites were considered within the Southern Cross station precinct, one using existing platforms within Southern Cross station, and the other immediately to the east, between the station proper and Spencer Street. Southern Cross station is close to the recently developed commercial and residential hubs of Docklands and Southbank, where significant investment has been made in tourism, sporting and entertainment facilities. Southern Cross station is also well connected to regional and interstate public transport, and existing road and pedestrian networks. It is the terminal for interstate rail services to Melbourne and the hub for the Victorian regional rail network (currently being expanded), and is served by tram and bus networks. Locating an HSR station at Southern Cross station is also consistent with Victorian Government policies that aim to reinforce the role of central Melbourne as a major employment centre.

Figure 4-41 Potential city centre station sites, Melbourne



KEY  Potential stations

Not to scale

Southern Cross station – existing platforms

The capital cost of an HSR station at Southern Cross station is estimated to be \$4.0 billion (\$3.9 billion for the urban access and \$0.1 billion for the station structure). There would be a marginal difference in user benefits for the two Southern Cross station options. Both would require relocation of the existing adjacent maintenance facility and stabling yards, as well as other rail infrastructure modifications, which have been priced in the final capital cost estimate.

East of Southern Cross station

Constructing an HSR station to the east of Southern Cross station is estimated to cost \$4.3 billion, \$0.3 billion more than putting the HSR platforms within the existing station, due to the need to demolish the existing bus terminal and construct an entirely new facility.

North Melbourne precinct

Two station options were considered in North Melbourne, to the north and south of Dynon Road. There is no difference between the two options in terms of capital cost or user benefits. When compared with the sites at Southern Cross station, however, they both result in a \$4.0 billion disbenefit to HSR passengers, mainly because of their distance from the CBD. An HSR station at North Melbourne is also not supported by current growth strategies for Melbourne, which do not identify North Melbourne as a significant centre.

North of Dynon Road

The site north of Dynon Road, between Arden Street, Laurens Street and Dynon Road, is currently a mix of industrial and low-medium density residential and commercial uses. There is likely to be demand for higher density development in the area in the future, although this would be from a relatively low base. Any opportunities for development would be restricted to the east of the existing metropolitan rail lines at surface level. This site has good connectivity to public transport and road networks, but poor pedestrian accessibility to the CBD. The proposed Melbourne Metro will pass to the north of the site, in an east-west direction along Queensberry Street.

South of Dynon Road

The site south of Dynon Road and west of the existing rail lines would require changes to the road and pedestrian infrastructure to improve its accessibility to the CBD and surrounding urban areas.

Preferred city centre station site

Southern Cross station has recently undergone redevelopment and, as such, operates well as an interchange. It would provide good accessibility between HSR and suburban and regional train services. Additionally, a number of bus and tram routes currently operate on Spencer Street outside the station.

The Southern Cross station precinct sites offer greater user benefits, such as better access and connectivity, than the North Melbourne precinct sites. An HSR station within the Southern Cross station precinct is likely to be a catalyst for more economic development and employment opportunities and is more closely aligned with Victorian Government planning policies.

Using the existing Southern Cross station platforms would be less costly, mainly due to the use of the existing and recently refurbished station structure. It also has less impact on surrounding land uses. The difference in user benefits between the Southern Cross station precinct sites would be marginal.

Both sites in the North Melbourne precinct perform less favourably against the criteria than the Southern Cross station sites. The North Melbourne sites have therefore not been carried forward for further assessment.

The preferred station site option is the Southern Cross station precinct, using the existing platforms.

Table 4-9 Assessment of potential city centre station sites, Melbourne

Objective	Criteria	Southern Cross station		North Melbourne	
		Existing platforms	East of Southern Cross station	North of Dynon Road	South of Dynon Road
Economics and connectivity	Difference in user benefits from Southern Cross (\$b)	-	-	-4	-4
	Pedestrian access to CBD	High	High	Moderate	Moderate
	Public transport access (existing)	High	High	Moderate-high	Low
	Parking availability (existing)	Low	Low	Moderate	Low
	Proximity to residential centre	Moderate-high	Moderate-high	Low	Low
	Connectivity to arterial roads	Moderate	Moderate	Low	Low
	Overall accessibility	High	High	Low	Low
Infrastructure	Capital cost (\$b) (station basic structure)	0.1	0.4	0.2	0.2
	Capital cost (\$b) (access corridor)	3.9	3.9	3.8	3.8
	Capital cost (\$b) (total)*	4.0	4.3	4.0	4.0
	Constructability**	2	3	3	2
Sustainability, land use planning & policy fit***	Maintain existing land use	3.8	3.2	3.8	3.4
	Maintain community function	3.5	3.0	2.5	4.0
	Promote economic development	7.0	7.0	5.7	5.7
	Summary	Slightly beneficial	Neutral – slightly beneficial	Neutral	Neutral – slightly beneficial
Conclusions		Preferred	-	-	-
Principal reasons for non-selection			Capital cost	Lower user benefits and accessibility	Lower user benefits and accessibility

* Highest cost preferred access corridor used for consistent comparison purposes.

** Constructability is assessed and scored between 1 and 5, with the higher score reflecting more construction complexity.

*** Sustainability, land use and policy fit is assessed and scored between 1 (highly detrimental) and 7 (highly beneficial).

Assessment of urban access alignments

In arriving at the preferred HSR urban access alignments, existing and proposed Victorian Government infrastructure schemes were examined for synergies, in terms of both shared infrastructure and shared sites for peripheral stations, while ensuring the HSR would not adversely impact these schemes.

The relatively straight highway and rail corridors linking metropolitan Melbourne with towns in northern Victoria present opportunities to co-locate HSR in outer urban areas, helping to minimise environmental and land use impacts. Similarly, consideration was given to minimising impacts on existing inner urban development by co-locating alignments within, adjacent to or below existing rail and road corridors. Viaducts were also considered, but were found to cost as much as tunnelling in urban areas, because of their additional land requirements and the need for complex grade separated crossings at major intersections.

A particular constraint on Melbourne's inner urban rail system is the large number of existing level crossings. Therefore, bored tunnel inner urban alignments were preferred from a sustainability, land use, environmental and policy perspective, to eliminate or reduce impacts to level crossings. However, where the alignment emerges from a tunnel, or where the radius of an existing corridor is too tight for high speed trains, there would be increased environmental impacts including property acquisition and demolition as the result of the necessarily widened corridor.

Ten potential alignments were identified to access the Melbourne station at the Southern Cross station precinct. Details and comparative evaluations of these can be found in **Appendix 3A**.

Preferred urban access alignment

The environmental and land use impacts of the various options are very similar. The main factors determining the shortlist were capital cost, user benefit and constructability. Three urban access alignments were selected for more detailed investigation:

- Via Craigieburn and Jacana (shown in green on **Figure 4-42**).
- Via Craigieburn and Upfield (shown in red on **Figure 4-42**).
- Via Yuroke (shown in blue on **Figure 4-42**).

These were extended to a common point at Wallan (to the north), to enable identification of the best overall access to Melbourne. Further detail of this process can be seen in **Appendix 3A**.

The alignments via Craigieburn (shown in green and red on the map) were preferred over the blue alignment, as they would have lower capital cost and would offer time savings.

Of these two alignments, the green alignment has the advantage of providing a shared corridor and, potentially, shared infrastructure with a future express rail link between Melbourne Airport and Southern Cross station. The Victorian Government has already allocated funding to plan for a rail link to Melbourne Airport.

However, for HSR alone, the least costly and most efficient urban alignment is via Upfield, shown in red. This alignment would deliver a time and cost benefit, with less complex construction, when compared to the alternative green alignment. This alignment forms part of the overall HSR capital cost estimate in **Chapter 6**. The cost estimate does not include peripheral costs of additional links.

The preferred urban access alignment is via Craigieburn and Upfield, shown in red on Figure 4-42.

Future opportunities for synergies between HSR and a Melbourne Airport rail link should be investigated further as the Victorian Government finalises its proposals.

Figure 4-42 Preferred alignments to Southern Cross station, Melbourne



Peripheral station assessment

Two potential peripheral locations were identified on the preferred route: one at Craigieburn and the other at Campbellfield. The selection process is outlined in **Appendix 3A**.

The preferred peripheral station is Campbellfield, near the M80 Western Ring Road.

The site is located north of Gowrie, to the west of the intersection of Camp Road and the Hume Highway, as shown in **Figure 4-43**. The station would be constructed at ground level, oriented north–south.

The site has potential access to the Hume Highway to the east and Camp Road to the south. These roads provide access to the M80 Western Ring Road/Hume Highway interchange for regional road network access throughout Melbourne. Local car parking access roads would be required. There is potential for a future interchange between the HSR station and the urban rail network which passes to the east of the site.

The site is adjacent to land currently occupied by light industrial units. Location of an HSR station in Campbellfield could stimulate future development and increase land use densities. Provision of an HSR station in Campbellfield would yield user benefits of \$3 billion.

Figure 4-43 Location of Campbellfield peripheral station, Melbourne



KEY — Surface alignment — Tunnel alignment ○ Station location **Not to scale**

The station site at Craigieburn is adjacent to both the Hume Highway and Hume Freeway, providing good access to the regional road network to northern Melbourne. The proposed Outer Metropolitan Ring Road (E6), adjacent to the existing suburban Craigieburn station, would further increase regional road accessibility and provide a direct interchange with the existing rail network.

The site is largely brownfield and includes a light industrial property. This area is planned as a major growth centre for Melbourne, with a future town centre to the west of the HSR station site. The appraisal found that an HSR station in Craigieburn could yield user benefits of \$1.8 billion – considerably lower than the Campbellfield site.

Melbourne – preferred station site and urban access alignment

A city centre station at Southern Cross station is preferred over North Melbourne. It would generate greater economic benefits and be better aligned with Victorian Government planning policies than the options at North Melbourne. It would also provide better connectivity with Melbourne CBD and nearby complementary infrastructure, and yield greater user benefits than the North Melbourne options.

If the Melbourne Airport Rail Link project were to proceed, combining the rail link and HSR projects into the same corridor could be cost efficient, minimise social impacts through the use of one corridor, and offer a better planning solution for access to Melbourne CBD. The overall net benefit of developing the two projects together may be higher than developing the projects separately.

The access corridor via Craigieburn is preferred over the corridor via Yuroke, as it has a lower capital cost and would offer time savings.

For HSR alone, the least costly and most efficient urban alignment would be via Upfield.

The Jacana alignment has the advantage of providing a shared corridor and, potentially, shared infrastructure with a future express rail link between Melbourne Airport and Southern Cross station. Future opportunities for synergies between HSR and a Melbourne Airport rail link should be investigated further as the Victorian Government finalises its proposals.

Campbellfield on the Upfield alignment is the current preferred peripheral station for Melbourne, adjacent to the M80 Motorway. This option has good accessibility to the regional road network via the M80 Motorway (Western Ring Road) and provides opportunity for access to the urban rail network via the Upfield line.

4.12 Conclusion

The process of identifying, evaluating and selecting the alignment and station options for the HSR system has been extensive and detailed, even at this early strategic stage.

As noted at the beginning of this chapter, a range of alternative alignments and station locations were analysed and compared to select the preferred HSR alignment, with the aim of:

- Maximising the value of each option in serving travel demand.
- Avoiding significant adverse environmental impacts.
- Minimising the acquisition of private property.
- Supporting land use planning strategies where feasible.
- Limiting construction risks, including impacts on existing railway operations and major roads.

The methodology employed to analyse the various options focused on achieving maximum value from each option, minimising environmental impacts and the need to acquire land, supporting existing land use planning strategies and limiting construction risks, including impacts on existing railway operations and major roads.

International experience shows that HSR journeys of less than three hours can attract over 50 per cent of the travel market mode share. The focus throughout much of this stage of the study has therefore been on selecting an alignment that is capable of achieving high average speeds, so that the HSR can compete with other travel modes, particularly air.

The track geometry required to achieve these speeds would make a surface alignment highly disruptive in densely populated areas, would require extensive land acquisition (and associated costs), and would result in noise impacts, community severance and poor visual amenity to a large number of people, particularly where the route would pass through the middle and inner suburbs of the capitals. In densely populated areas such as Sydney and Melbourne, tunnelling would alleviate these impacts, and would also allow for sufficient operating speeds to connect the capital cities within three hours and remain competitive with air travel.

The analysis considered the costs, user benefits, accessibility, and environmental and social impacts of each alternative, as well as the associated risks during construction. These criteria are explained in the introduction to this chapter, and detailed more fully in **Appendix 3A**.

The selected alignment serves the major cities, but also importantly the key regional areas, across three states and the ACT. The preferred alignment and station locations have been identified through a rigorous selection process that was based on well-proven engineering, and which balances environmental, social and cost considerations.

The preferred alignment described throughout this chapter has been used to generate the capital cost estimate in **Chapter 6**.



5

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5

Station concepts and layouts

5.1 Introduction

The preferred HSR system has 20 stations:

- Four city centre stations – one each in Brisbane, Sydney, Canberra and Melbourne.
- Four city peripheral stations – one in Brisbane, two in Sydney and one in Melbourne.
- A regional terminal station at Gold Coast opposite the existing Robina station.
- Eleven regional through stations located throughout Queensland, New South Wales and Victoria.

This chapter describes the requirements that have informed the development of station concepts and the specifications designed to meet these requirements. It also illustrates how the requirements, specifications and concepts have been interpreted at each of the capital city locations. Station capital costs in **Chapter 7** are based on the concepts and layouts described in this chapter.

At several stages throughout the study, emerging concepts for both city centre and city peripheral stations within the metropolitan areas were presented to the ACT and state jurisdictions. Feedback obtained from these presentations assisted in finalising the concepts and layouts presented in this chapter.

5.2 Station requirements and specifications

5.2.1 Station context

To assist with the station analysis, the requirements and specifications have been grouped into four categories, from the wider urban context to specific facilities requirements, as shown in **Figure 5-1**.

Figure 5-1 Station context diagram



5.2.2 HSR system parameters

The system parameters cover all aspects arising from the passenger demand and transport product being offered as part of the HSR system, including the number of passengers per service (specifically the departure peak hour, as passengers tend to dwell at stations more in advance of departure than after arrival). The number and length of platforms is determined by the service patterns and types described in **Chapter 3** and the rolling stock specified to deliver the service. Other factors featuring in the requirements include facilities for ticket purchase, luggage trolley provision and information provision.

The HSR demand forecast in **Chapter 2**, together with the volume of train services defined in **Chapter 3**, provides the basis for determining:

- Platform length (train length defined by train capacity requirement).
- Number of platforms (dependent on the number of services).
- Concourse size (defined by maximum number of passengers for the train services).

Demand in the year 2065 was used to determine the requirement. The resulting specification is shown in **Table 5-1**, which defines the passenger demand, required minimum concourse size and number of station platforms for all stations. Platform length is simply a function of the size

of train serving the station. However, in the city centre stations, greater flexibility during operations is provided by longer platforms, which would allow two trains to be berthed in one platform at the same time (known as ‘double stacking’), enabling shorter (200 metre) trains to be stabled overnight or services to be ‘double stacked’ if a platform is

unavailable for any operational reason. Longer platforms have therefore been proposed at the busiest termini at Melbourne and Sydney (with some limitations), but cannot be accommodated at Brisbane due to space constraints and would not be required at Canberra.

Table 5-1 Station parameters

Name	Designation	Number of platforms	Length of platforms (metres)	Peak hour passenger demand (2065)
Brisbane	City centre	4 (2 sides, 1 island)	All 315 m	4,600
Brisbane South	City peripheral	2 (2 sides, 2 through lines)	All 315 m	1,400
Gold Coast	Regional	3 (1 side, 1 island)	All 215 m	2,600
Casino	Regional	2 (2 sides, 2 through lines)	All 215 m	500
Grafton	Regional	2 (2 sides, 2 through lines)	All 215 m	300
Coffs Harbour	Regional	2 (2 sides, 2 through lines)	All 215 m	800
Port Macquarie	Regional	2 (2 sides, 2 through lines)	All 215 m	500
Taree	Regional	2 (2 sides, 2 through lines)	All 215 m	500
Newcastle	Regional	2 (2 sides, 2 through lines)	All 215 m	1,700
Central Coast	Regional	2 (2 sides, 2 through lines)	All 215 m	1,300
Sydney North	City peripheral	2 (2 sides, 2 through lines)	All 315 m	1,700
Sydney Central	City centre	10 on two levels	From 380 m to 400 m	12,800
Sydney South	City peripheral	2 (2 sides, 2 through lines)	All 315 m	1,300
Southern Highlands	Regional	2 (2 sides, 2 through lines)	All 215 m	1,400
Canberra	City centre	3 (1 side, 1 island)	All 315 m	3,200
Wagga Wagga	Regional	2 (2 sides, 2 through lines)	All 215 m	500
Albury-Wodonga	Regional	2 (2 sides, 2 through lines)	All 215 m	1,100
Shepparton	Regional	2 (2 sides, 2 through lines)	All 215 m	600
Melbourne North	City peripheral	2 (2 sides, 2 through lines)	All 315 m	1,500
Melbourne	City centre	5 (1 side, 2 islands)	4 at 415 m	8,100

5.2.3 Station master plan and urban context

The nature of the station and its configuration is significantly affected by its locality, including geographic features, content of the existing station's master plan, local town planning requirements and constraining structures (where available or relevant). Specifically, planning compatibility with the town centre master plan and the effect on the social and natural environment surrounding the station location needs to be considered. Within the station itself, compatibility with the existing station master plan and the location of any constraining structures, such as roads and sewers, are important considerations. The value of the land required, disruption to existing station users and the wider community must also be considered.

These requirements are location specific and were derived on a site-by-site basis. They were more important for the city centre and city peripheral stations than for the regional stations.

5.2.4 Complementary access

Many passengers would join and leave the HSR service via other transport modes; therefore, how HSR would integrate with all arrival and departure modes (which is logically a function of the modes available, described as 'complementary access') is an important feature of the overall journey. Specific onward travel facilities to be considered include:

- Regional and suburban rail services provided by conventional trains on separate infrastructure.
- Light rail and trams.
- Bus services.
- Park and ride by private car.
- Pick up and set down via taxi or private car.
- Pedestrian connectivity to town centres, local buildings and other nearby facilities such as retail, offices, leisure, and public space.
- Cycling facilities including secure storage and changing facilities.

The predominant modes used would vary according to location. For example, at city centre stations located close to metropolitan CBDs (which excludes Canberra), no private car parking has been assumed. However, at regional stations and in Canberra, private car is expected to be the predominant mode and parking has been provided.

The transport product and the complementary access provision define the requirements for onward transit. Specification of onward transit capacity determines whether complementary access projects need to be specified to deliver the required level of accessibility for the HSR system. Two types of complementary projects were considered:

- Local projects within the vicinity of HSR stations.
- City-wide projects that form part of the broader transport network.

The transport services assessment included a review of currently planned transport projects for the cities and regions that were assumed in the forecasts of HSR demand. The demand model used data provided by the state authorities for access times by mode to the Brisbane, Newcastle, Central Coast, Sydney and Melbourne HSR stations.

The transport demand model developed in **Chapter 2** used estimated private vehicle access times, calculated from the access distances, and assumed no public transport access for the HSR stations outside the areas covered by the state data. While it therefore provides some guidance on access requirements, its output was supplemented by an understanding of local conditions for each station, which would also be required to determine complementary access provisions for the HSR stations.

Access/egress modes were estimated separately in the demand model for the 'home' and 'destination' ends of an HSR journey, as passengers would be more likely to have a car available at 'home'. Car is expected to be the dominant mode for access to HSR stations (other than city centre stations) by passengers at the 'home' end of their journeys. This reflects the wide geographical distribution of the residential catchment for regional HSR stations,

making public transport a less attractive access option. The geographical distribution of the access/egress trip ends differs significantly between the 'home' and 'destination' ends of the HSR trips.

Car parking provision was estimated from the forecasts of passengers accessing the HSR stations using park and ride. Based on the number of passengers in each car and the duration of their trip, the number of car parking spaces was derived. The factors used were derived from an analysis of the demand forecasting data¹.

5.2.5 Station facilities

Facilities for both passengers and staff that support HSR operation determine how much space is required within the station envelope and its immediate environs. Passenger facilities include waiting areas such as concourses and lounges, where public information including train departure boards, locality information, information points and ticket offices would be located. Public spaces would be connected by walking routes, lifts and escalators with appropriate circulation space and access to facilities such as toilets. Accommodation is also required for the staff at these facilities and for security provision.

The requirement for station facilities is based on the estimated number of passengers in a peak hour and the number of staff required to support the operation. Concourse support accommodation includes ticket offices, waiting lounges, retail units, toilets and other concourse-facing public facilities.

Back of house accommodation includes the train crew, station management, station control and other related facilities. The area occupied by these functions was assumed to be comparable to the concourse support accommodation.

5.3 Station configurations

The number of platforms noted in **Table 5-1** is defined by the number of services using the station. The type of service using the station, and whether that requires a 200 metre or 300 metre train set, defines the required length of the platforms. The 200 metre and 300 metre trains would require platform lengths of 215 metres and 315 metres respectively. Trains longer than 200 metres are only envisaged for inter-capital express services; therefore, all regional stations were specified at 215 metres.

The proposed configurations would accommodate the anticipated increased size of trains over time through to 2065.

5.3.1 Platform width and spacing

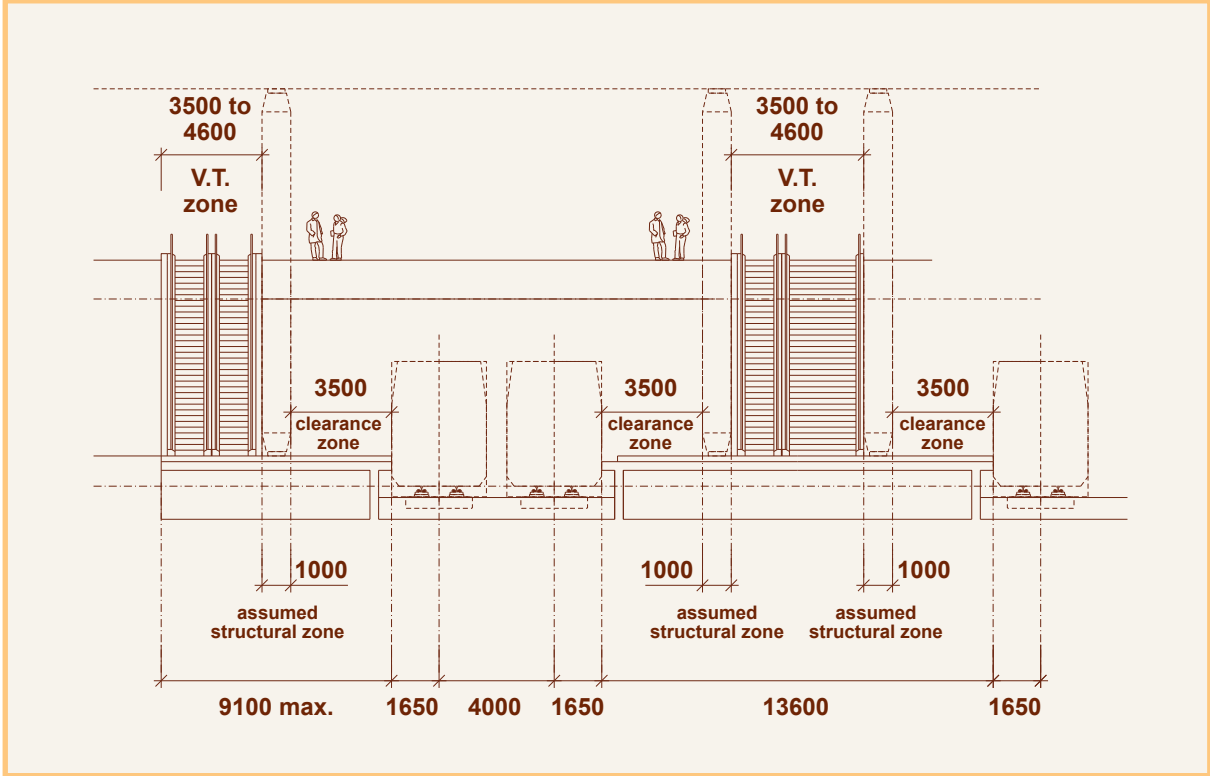
Over and under bridges located mid-platform were generally assumed for passenger circulation and platform access, and were designed to manage the maximum number of people carried by the longest train (300 metres). The platform width was derived as follows:

- 3.5 metre clearance zone from the edge of platform to any structure.
- One metre zone either side of vertical transportation (elevators and escalators) for seating and structure.
- 4.6 metre zone for vertical transportation.
- 0.9 metres to the safe 'stand back' line from edge of platform.

A generic station cross-section is shown in **Figure 5-2** giving typical dimensions.

¹ The average vehicle occupancy for park and ride access was 2.1 passengers and the average parking duration was 3.1 days. A factor of 1.31 was applied to ensure sufficient parking for seasonal peak demand.

Figure 5-2 Typical station cross-section

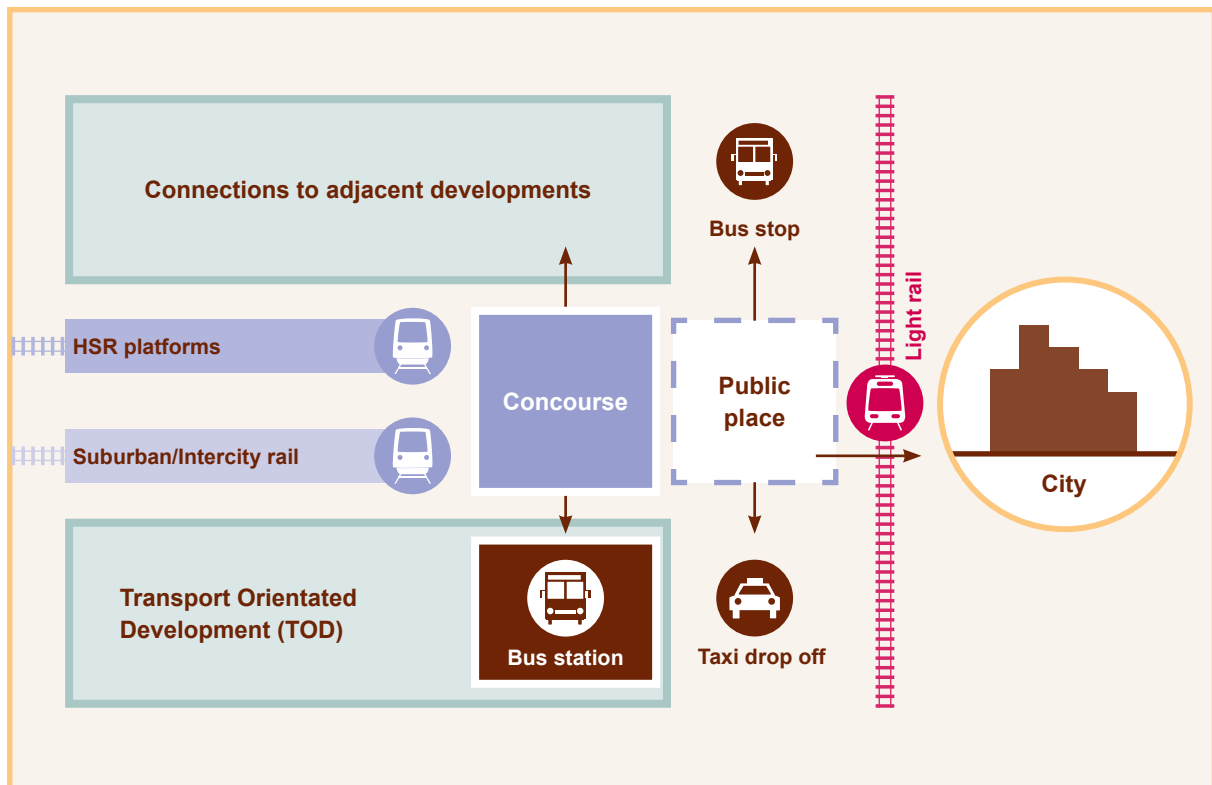


Note: V.T = vertical transportation, e.g. escalators, stairs, lifts. Dimensions in millimetres.

5.3.2 Station concourse

The concourse size is based on the maximum peak hour passengers and an estimated maximum number of passengers in the station at a given time (15 minutes of the peak hour). Typically, a new station concourse would provide one square metre per person. However, given the nature of the HSR product, an allowance of 1.5 square metres per person has been used to allow for a greater number of passengers travelling with luggage, comparable to domestic airline travel. This includes an additional ten per cent for people meeting and greeting passengers but not travelling.

Figure 5-3 Typical layout of city centre station



5.4 Station concepts

5.4.1 City centre stations

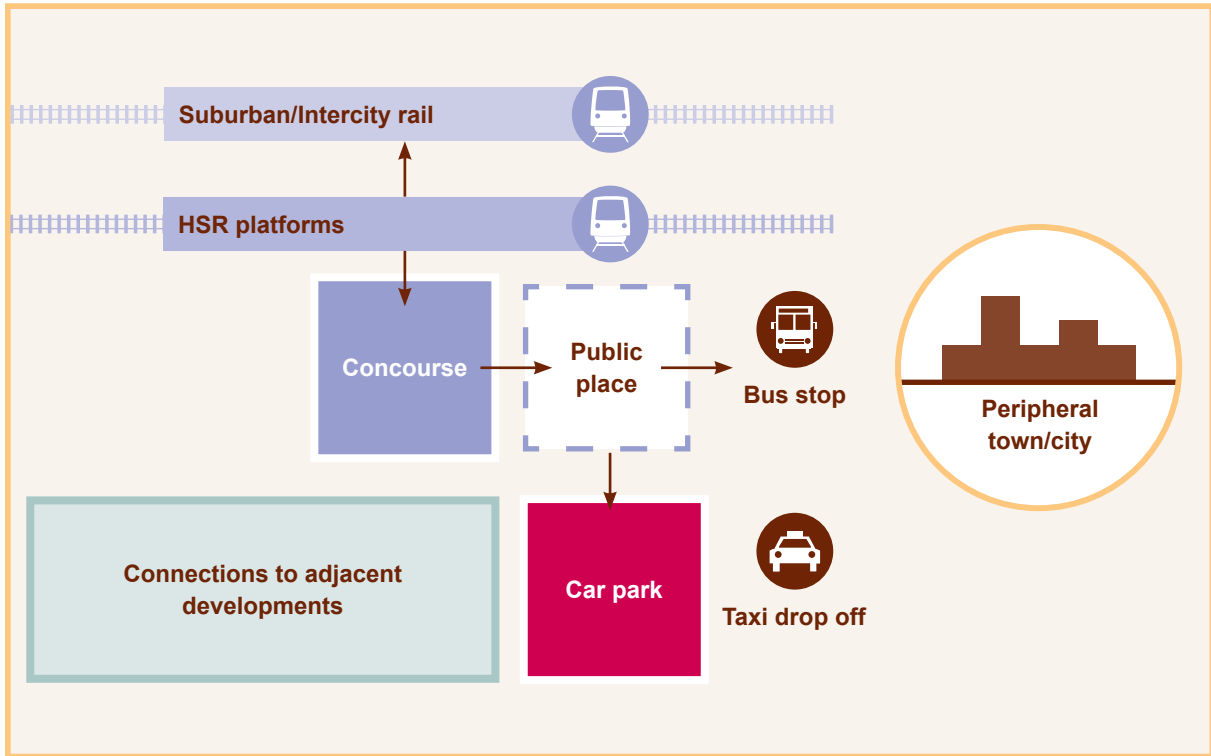
All trains would terminate at the city centre stations. These stations would be located within the CBD of the capital cities (the main destination of the travel market visiting those cities) and would provide access to other metropolitan transport services. The city centre stations would be integrated with existing station facilities, with the exception of Canberra, which is a completely new station.

A typical layout is illustrated in **Figure 5-3** and comprises HSR platforms and a central concourse that provides the link to onward travel modes including other rail services. Other modes, such as light rail or tram where appropriate, would generally be accessed via a public area outside the station. The station layout would also provide for access via bus, coach, cycling and the local pedestrian network.

5.4.2 City peripheral stations

City peripheral stations would be new stations on alignments into and out of capital cities (except Canberra), generally located on the outskirts of the metropolitan areas. Many services would pass through the station without stopping, so generally four tracks would be provided at these stations – two without platforms for the non-stopping services and an additional two tracks with platforms where passengers would board and alight stopping trains.

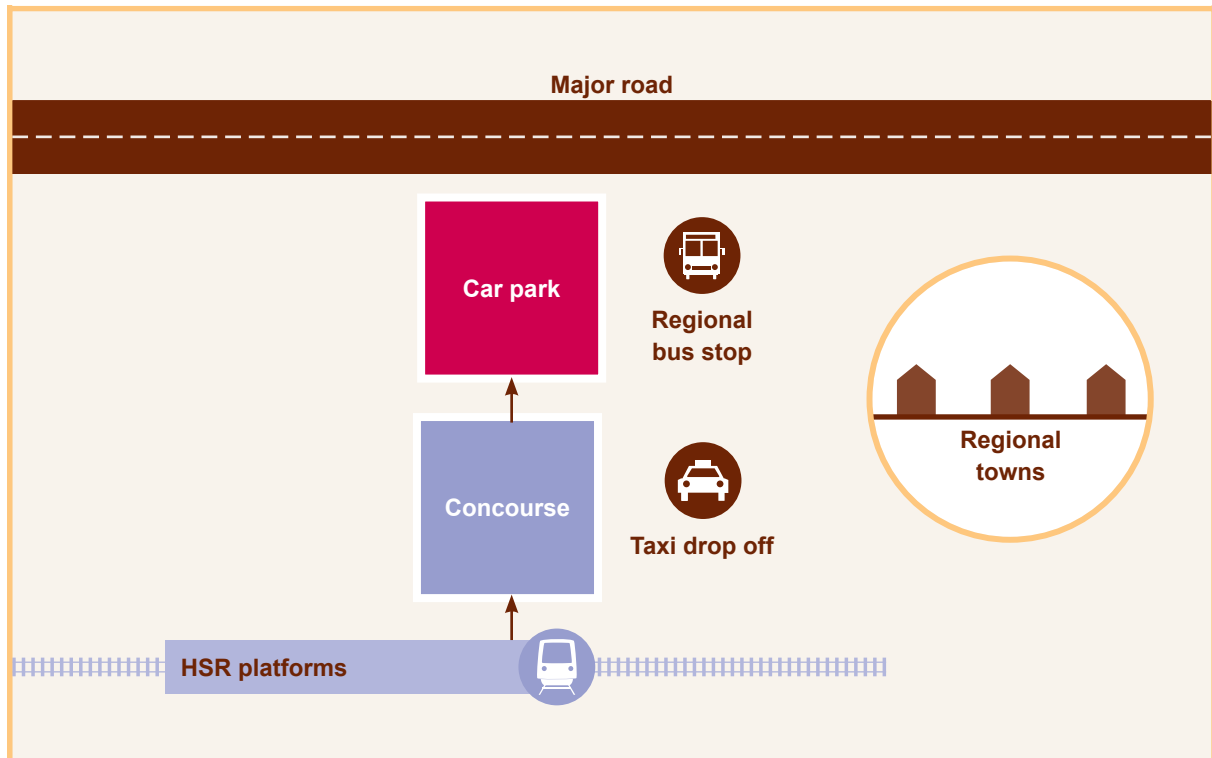
Figure 5-4 Typical layout of city peripheral station



The city peripheral stations would provide access to the HSR system for a wider catchment of city residents through connections to suburban and regional transport links. They would, however, also attract passengers via car and taxi from the wider metropolitan area. Good access from expressways and the arterial road network was therefore an important consideration in their location. As well as park and ride facilities, they would also provide for access via bus, coach, cycling and the local pedestrian network.

A typical layout is illustrated in **Figure 5-4**.

Figure 5-5 Typical layout of regional station



5.4.3 Regional stations

One regional station is proposed at Gold Coast. This would be of a comparable scale and size to Canberra and is described further in **section 5.6.2**.

The other 11 regional stations would provide access to the HSR system for major regional population centres. As described in **Chapter 4**, regional through stations were located to provide access to existing and future centres without conflicting with town planning, and avoiding demolition of properties where possible.

Regional stations would generally provide park and ride facilities outside the developed urban area. They have been located to provide direct and easy access to major road networks connecting regional centres and regional public transport networks, including coach and bus transit.

These stations are relatively simple in design and consist of two platforms, each 215 metres in length, and through lines for non-stopping trains. The onward transit modes specifically provided for include car, taxi and bus.

A typical layout is illustrated in **Figure 5-5**.

5.5 City stations

This section describes how the above specifications were interpreted at each of the capital city locations.

5.5.1 Brisbane city centre station

The Brisbane HSR station would be the northern terminal of the preferred HSR system. It would offer inter-capital express services to Sydney and inter-capital regional services to locations between Brisbane and Sydney. It is forecast that 16.7 million HSR passengers would pass through Brisbane in 2065. Peak hour passenger demand is forecast to be 4,600 passengers per hour. In the busiest hour, there would be ten arrivals or departures of HSR services, requiring four platforms of 315 metres in length to accommodate the longer 300 metre inter-capital express services forecast to be required in 2065.

Trains 200 metres in length would be sufficient for inter-capital regional services.

An HSR station at Brisbane is proposed for the site currently occupied by the Brisbane Transit Centre. The station site is to the south of the existing Roma Street station, as shown in **Figure 5-6**, between the heritage station building and Roma Street, and is located approximately half a kilometre from the Brisbane CBD. The site is currently occupied, and acquisition and demolition of the existing buildings would be required. The station would be below ground, to fit with the track alignment approaching from the west, with a rail level approximately ten metres below Roma Street. Because the footprint is alongside the existing operational station, none of the existing platforms would be required for HSR and therefore construction interfaces with existing and future operations would be minimised. Redevelopment of the site above the station is anticipated.

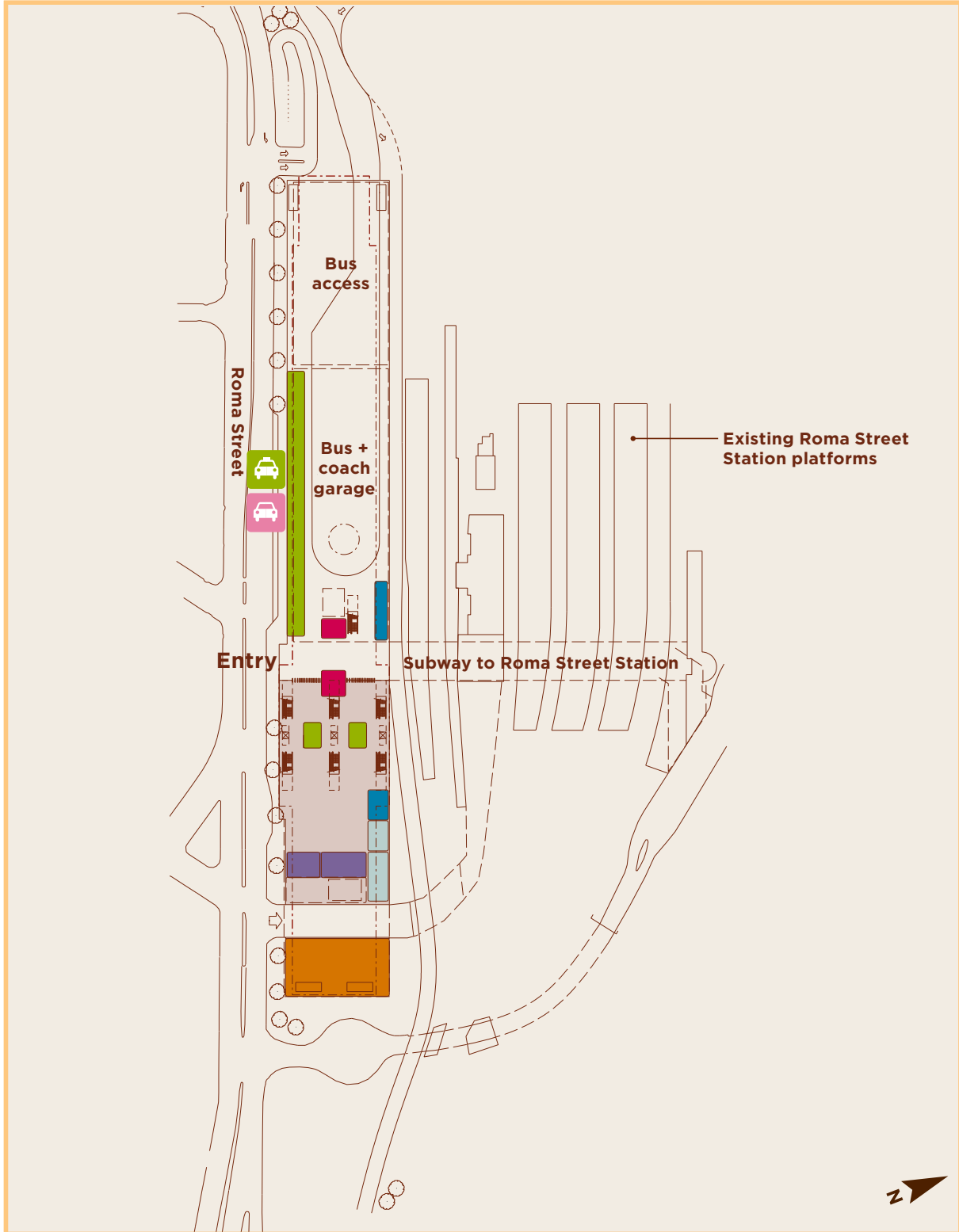
Figure 5-6 Brisbane HSR station location plan



The concourse at street level, shown in **Figure 5-7**, would house the ticketing and public-facing facilities that include waiting rooms, retail premises and public toilets. Catering and plant would also be located within the station building on the Roma Street level. The platforms, shown in **Figure 5-8**, would accommodate a series of blocks, each providing plant and staff accommodation. Passenger egress is provided via escalators and elevators connecting the platform level to the concourse. Emergency exit cores are also provided at the eastern and western ends of the platforms, which exit to the surface.

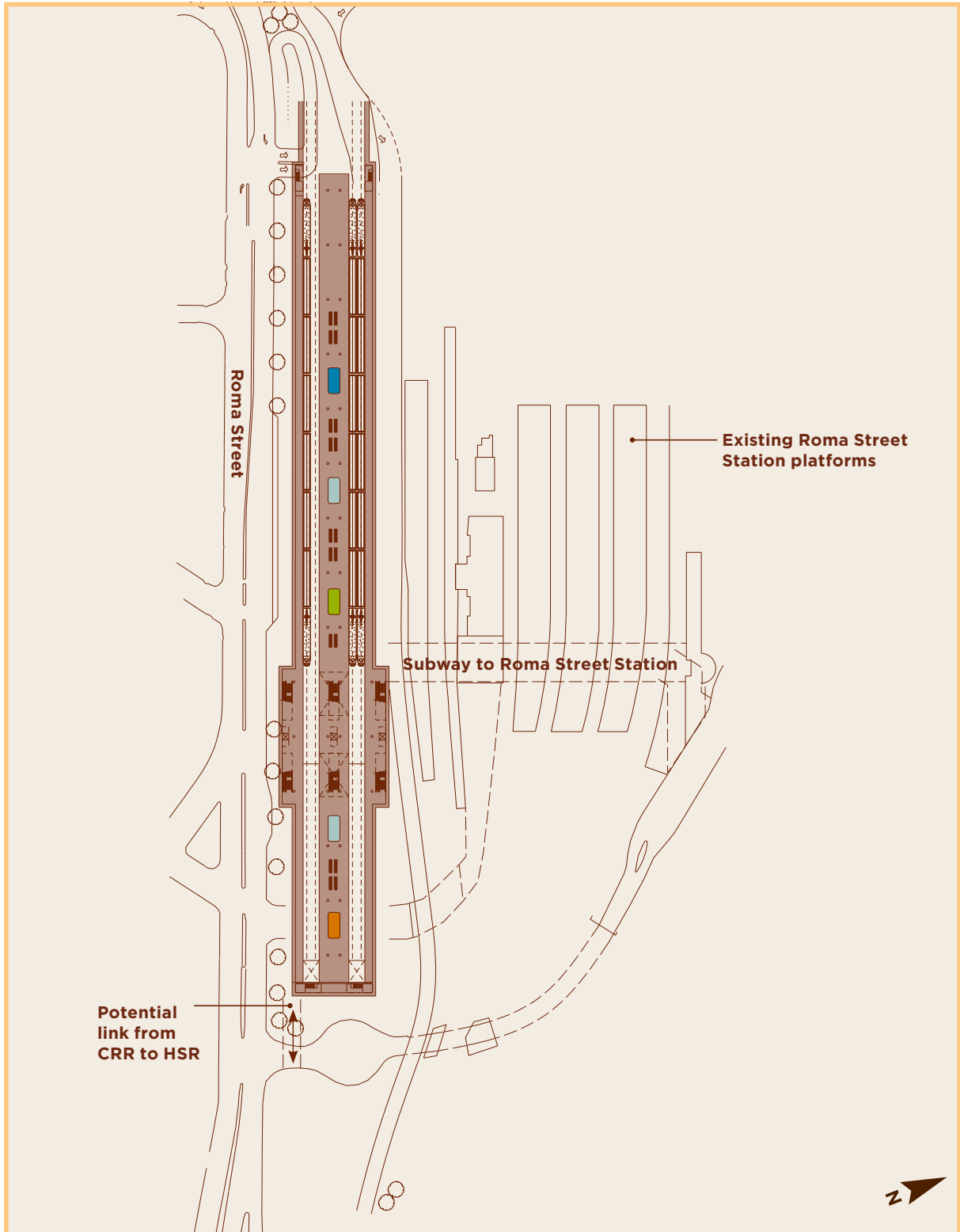
As well as access from the central concourse that currently serves the suburban and regional platforms, there is potential for direct access to the Queensland Government's proposed Cross River Rail (CRR) service, as shown in **Figure 5-8**. This access would be located to the southernmost end of the station, addressing the CBD and the proposed CRR station entrance. Bus access would be provided on a purpose-built structure over the western end of the station with taxi and pick up/set down facilities on Roma Street itself. Roma Street currently has short-term parking available, which would attract pick up and set down passenger access, but no longer term parking was assumed for HSR users.

Figure 5-7 Brisbane HSR station street level plan



KEY	 Concourse	 Ticketing	 Retail	Not to scale
	 Waiting lounge	 Toilets	 Plant and services	
	 Staff and administration	 Taxi rank	 Pick up / set down	

Figure 5-8 Brisbane HSR station platform level plan








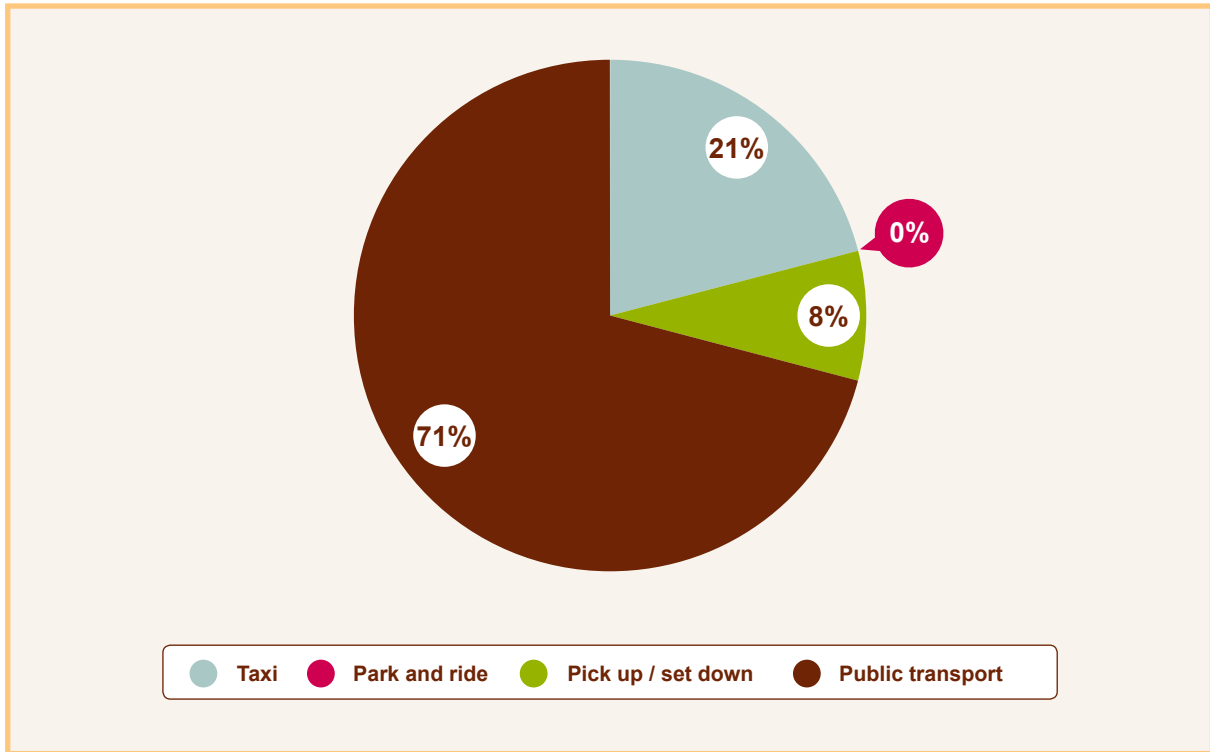
KEY	 HSR new platforms	 Retail	 Staff and administration	Not to scale
	 Toilets	 Plant and services		

Figure 5-9 Brisbane HSR station access and egress mode share in 2065



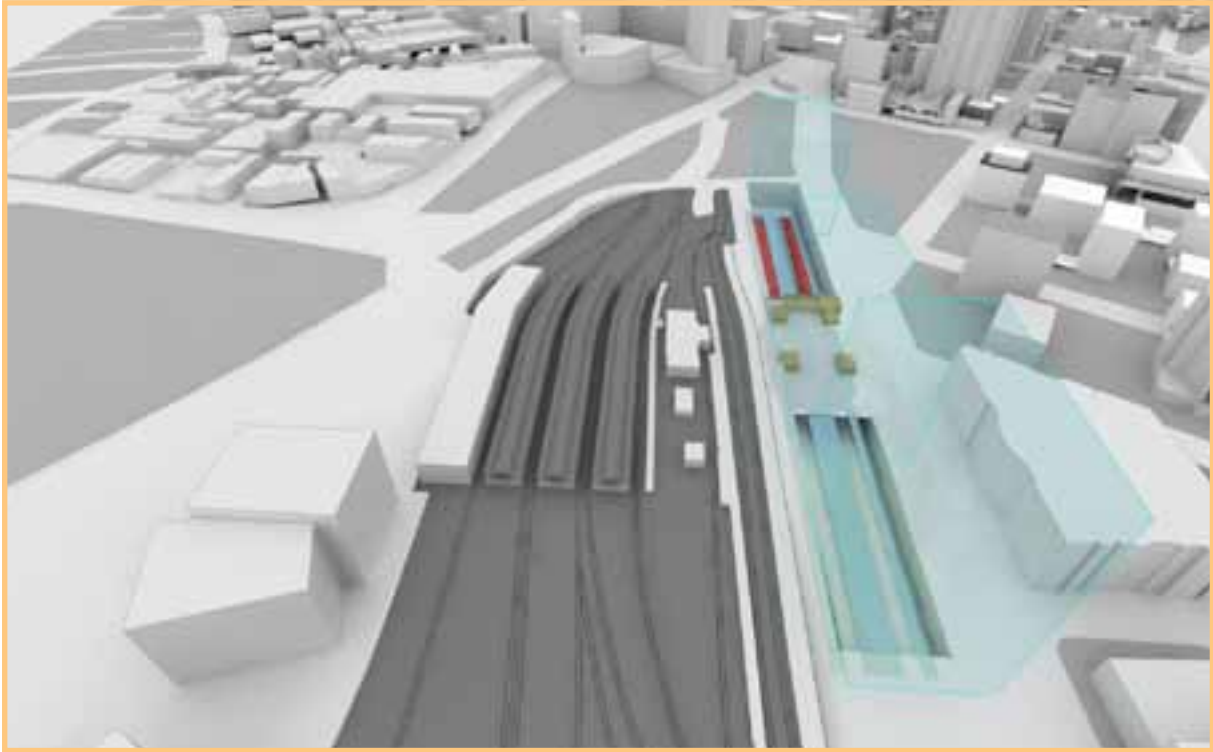
As described in **section 5.2.4**, travel to and from the HSR station is expected to be shared among modes, as shown in **Figure 5-9**. Public transport access/egress mode share for Brisbane was forecast to be the highest of the three metropolitan HSR CBD stations, at 71 per cent, although the passenger volumes at Brisbane were lower than at Sydney or Melbourne. HSR demand at the Brisbane HSR station would represent less than two per cent of the total South East Queensland transport demand. As the peak travel time for HSR access is unlikely to coincide with the peak commuter travel times², it is estimated that this volume would be accommodated by recasting services on the public transport network, without the need for major new infrastructure.

No park and ride facility for HSR is proposed at the Brisbane HSR station.

The Brisbane Transit Centre, a major interchange hub serving the city, currently occupies the proposed HSR station site. The proposed station aims to enhance the existing interchange capacity, and connect to Roma Street train station, bus and coach terminal, various local bus ways, and to the proposed Cross River Rail station. Pedestrian connectivity between the various modes would also be enhanced. A visualisation of the Brisbane HSR station to the right of the existing Roma Street station is illustrated in **Figure 5-10**, which shows the HSR station highlighted in blue, next to the existing Roma Street platforms.

² Peak HSR departures are likely to be between 5.30am and 7.30am and peak HSR arrivals between 8.30am and 10.30am (allowing for travel time between Brisbane and Sydney). The commuter peak is 7am to 9am.

Figure 5-10 Brisbane HSR station visualisation



5.5.2 Brisbane South peripheral station

The preferred option at Brisbane South is a station located to the west of the Motorway Business Park, south of the M2 between Browns Plains and Forest Lake, as shown in **Figure 5-11**. Motorway access would be provided to most of outer Brisbane by links to the South East Gateway and Centenary Motorway. The station would be accessed from existing intersections at Stapylton Road, as shown in **Figure 5-11**, with new local access roads required to service the site. The station would be located on the western side of the proposed rail corridor with access from Stapylton Road. The nearest Citytrain stations are at Richlands (ten kilometres north) and Loganlea (12 kilometres east). The station would provide two platforms 315 metres in length to allow the inter-capital express services to stop at the station. A platform level plan is provided in **Figure 5-12**.

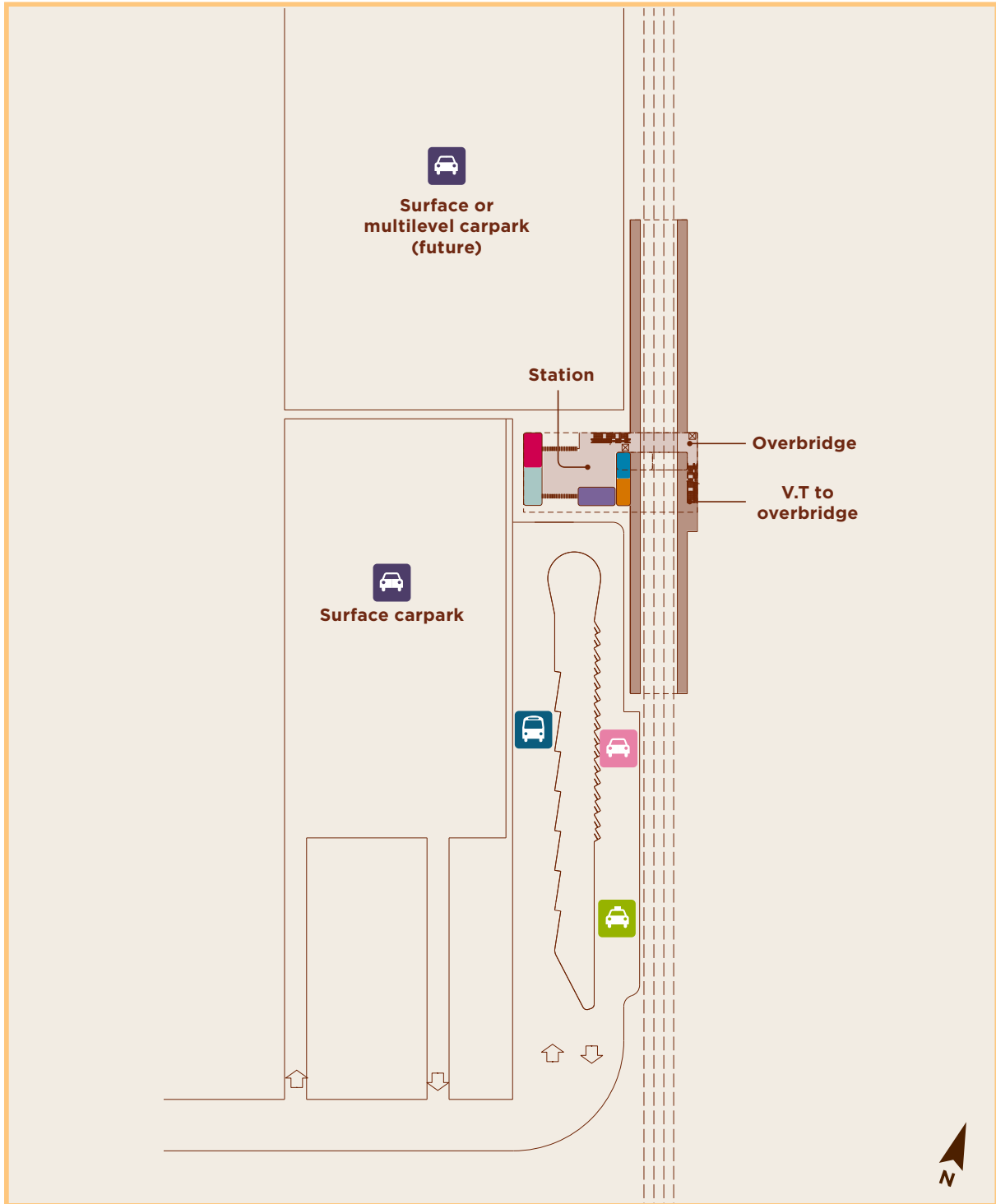
Figure 5-11 Brisbane South station location plan



KEY — Surface alignment ○ Station location

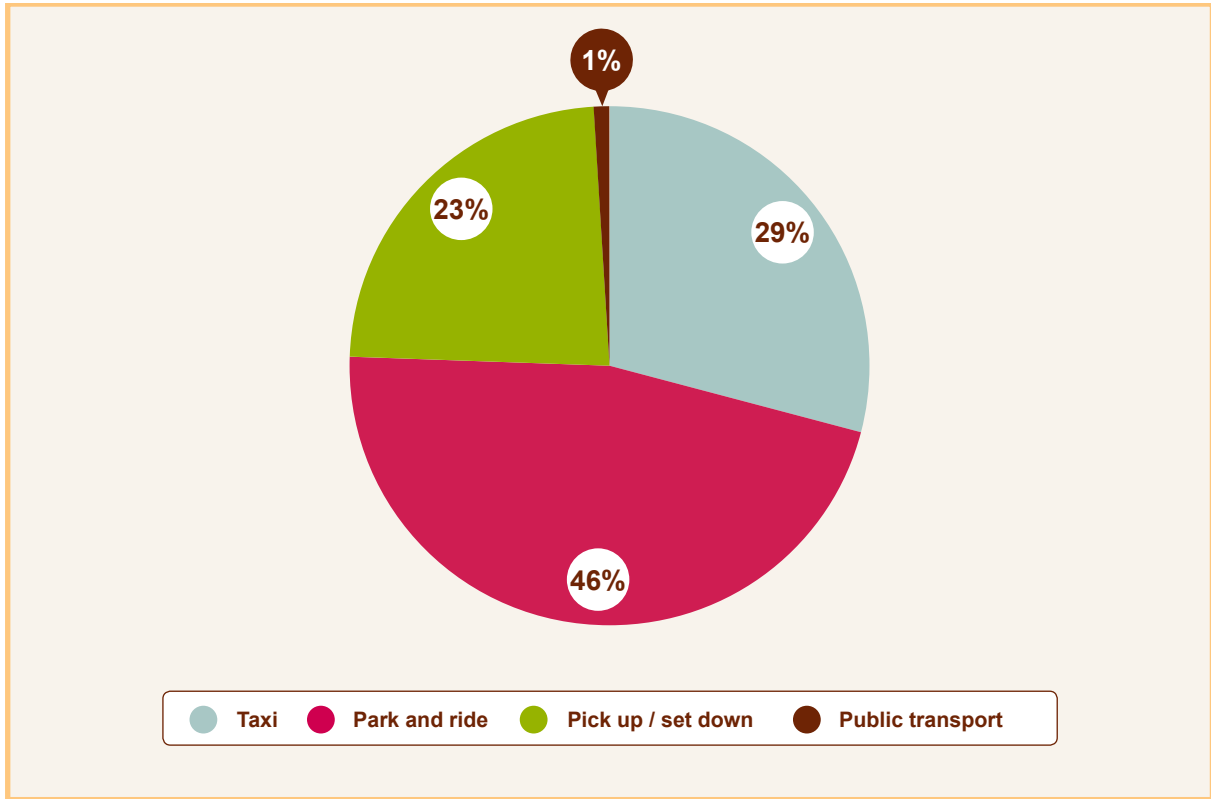
Not to scale

Figure 5-12 Brisbane South station platform level plan



KEY	Concourse	Ticketing	Taxi rank	Not to scale
	Waiting lounge	Toilets	Pick up / set down	
	Staff and administration	Plant and services	Bus and coach stops	
V.T. =	Vertical transportation (e.g. escalators, stairs, lifts)	HSR new platforms	Carparking	

Figure 5-13 Brisbane South HSR station access and egress mode share in 2065



Note: Total does not add up to 100% due to rounding.

Forecast demand at the Brisbane South station is five million passengers in 2065; 1,400 passengers in the peak hour. This amounts to 23 per cent of the HSR passenger demand in Brisbane overall. There would be no requirement for additional complementary access infrastructure at these demand volumes. Travel to and from the HSR station is expected to be shared among modes as shown in **Figure 5-13**.

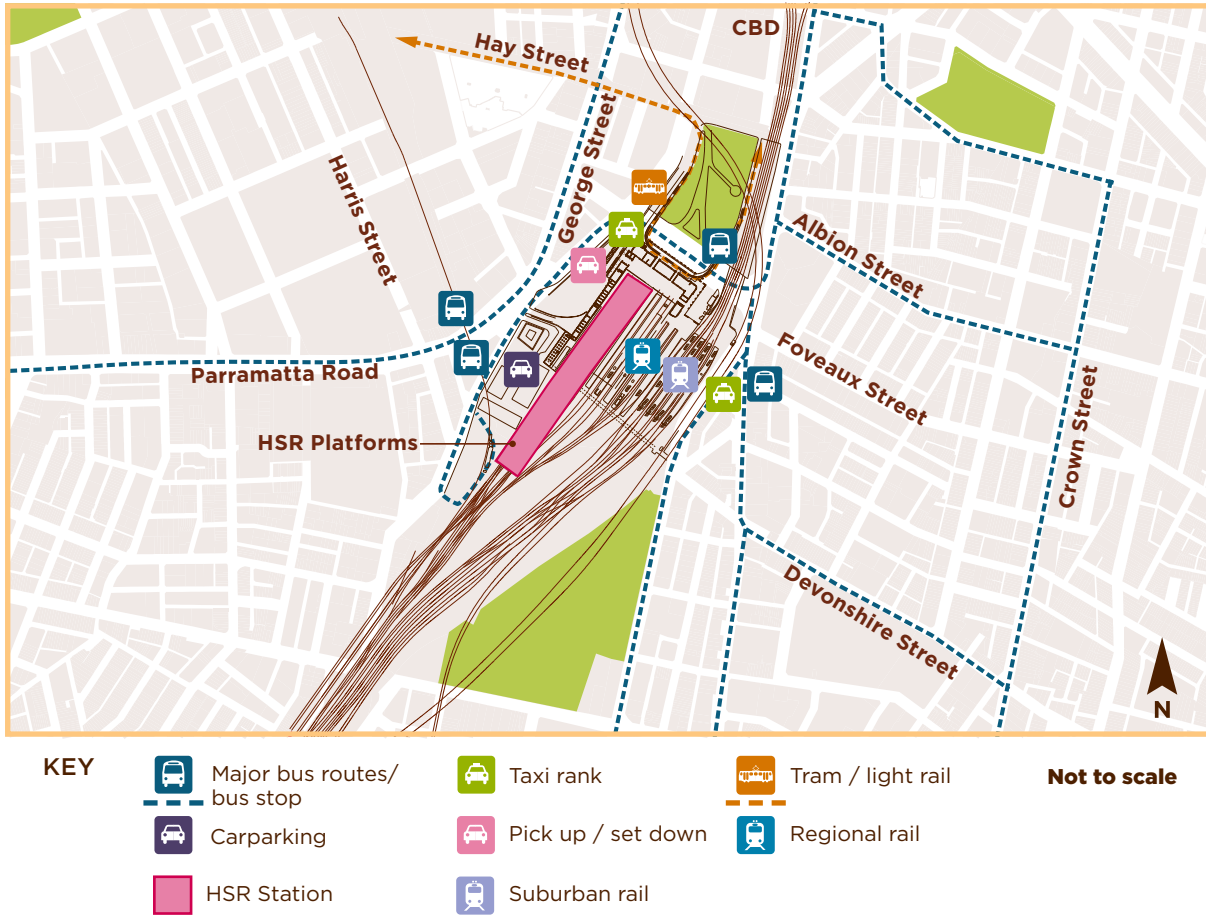
Park and ride is the most prominent access mode (accounting for about 46 per cent of all HSR passengers using this station), and 6,200 parking spaces would be required. Pick up and set down has a share of 20 to 25 per cent.

The peak hour passenger volumes are insufficient to justify a rail link connecting with the Citytrain network. However, the public transport access mode share would be improved by a dedicated HSR bus link service from the HSR station to

the Citytrain stations at Richlands and Loganlea, while the potential Beaudesert rail line would offer a more direct interchange with the metropolitan rail network.

The connecting coach service would provide two to three trips per hour, to connect with up to seven HSR arrivals and departures per hour. These services would carry, on average, 12 to 18 passengers per trip into and away from the HSR station, capturing up to ten per cent of HSR passengers accessing and egressing the station.

Figure 5-14 Sydney HSR station location plan



5.5.3 Sydney city centre station

Sydney would be the hub of HSR operation on the east coast, serving locations to the north and south. The forecast HSR demand for Sydney Central station is 46 million passengers per year in 2065; 21 million using the line to the north and 25 million the line to the south. In addition, a further 12 million passengers would be transferring between the two³. About 12,800 HSR passengers are forecast to enter or leave the HSR station at Sydney during peak hour in 2065. The total number of HSR services arriving and departing Sydney in the peak hour would be 32, with 17 using the line to the north and 15 using the line to the south. The smaller number

of services travelling south, despite the greater number of passengers, is accounted for by the fact that, by 2065, longer trains are planned to be in use between Sydney and Melbourne. This number of services arriving and departing Sydney, coupled with provision for commuter services, requires a minimum of ten platforms - five for each of the northern and southern railways.

The proposed HSR station for Sydney is located within the building envelope of Central station. Central station is located to the south of the CBD, as shown in **Figure 5-14**, and is the largest station in NSW. The area surrounding Central station is currently undergoing urban renewal,

³ As transfer passengers will alight and board, this implies 70 million boardings and alightings forecast for Sydney Central station in 2065 (46 million origin/destination passengers + 2 x 12 million transfer passengers).

with major developments occurring at Central Park (the former Carlton United Brewery) and the University of Technology City campus. While the areas around Central station and the southern CBD contain heritage buildings and recently constructed developments, there are likely to be further opportunities for urban regeneration, urban intensification, economic development and value capture created as the result of an HSR station and integrated land use/transport developments.

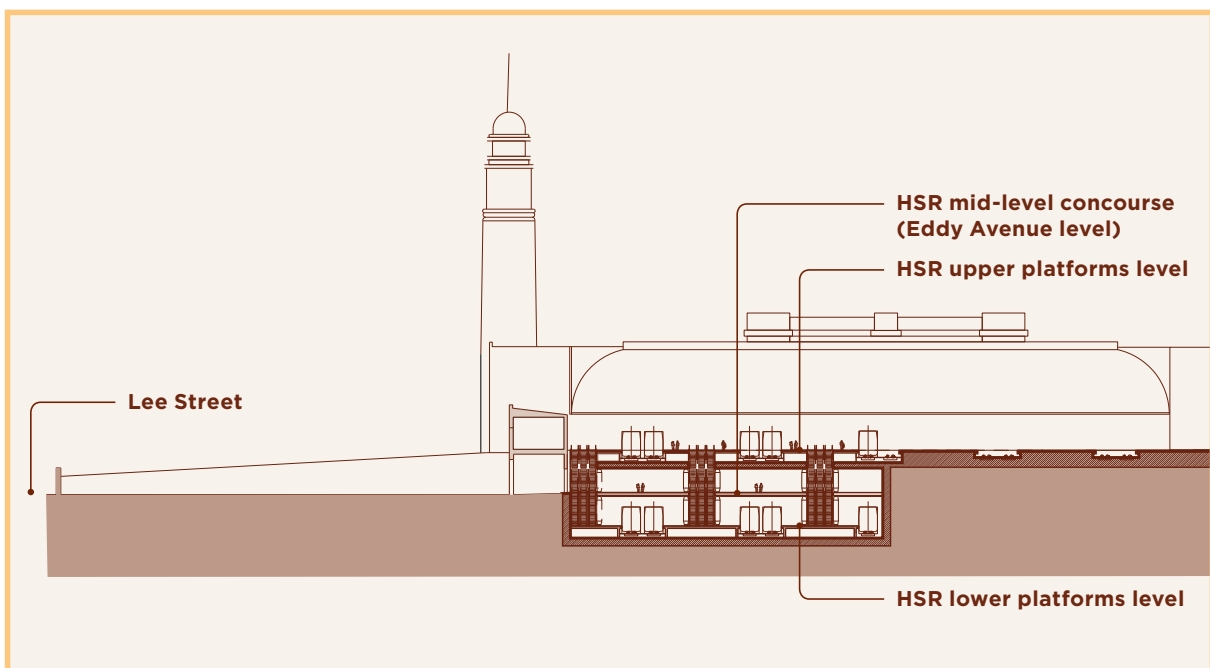
All Central station platforms are currently in operational use, and a number of these would need to be re-assigned to HSR, requiring the station to be reconfigured. Construction of facilities to serve HSR operations at Central would be complicated by the ongoing operation of existing rail services, and would require a considerable amount of planning and preliminary work to relocate existing tracks and services.

It was not feasible to locate all platforms on one level within the existing structure, so a split-level facility was developed, as illustrated in **Figure 5-15**.

The HSR station would consist of newly built infrastructure, five platforms at surface aligned with the existing main hall concourse, and five platforms approximately 16 metres below main hall level, with a new HSR concourse level in between. The proposed location of the HSR platforms is the Lee Street side of the station. The five platforms serving the southern line would be at the same level as the existing platforms, with those for the northern line beneath the new concourse, as shown in **Figure 5-16** and **Figure 5-17**.

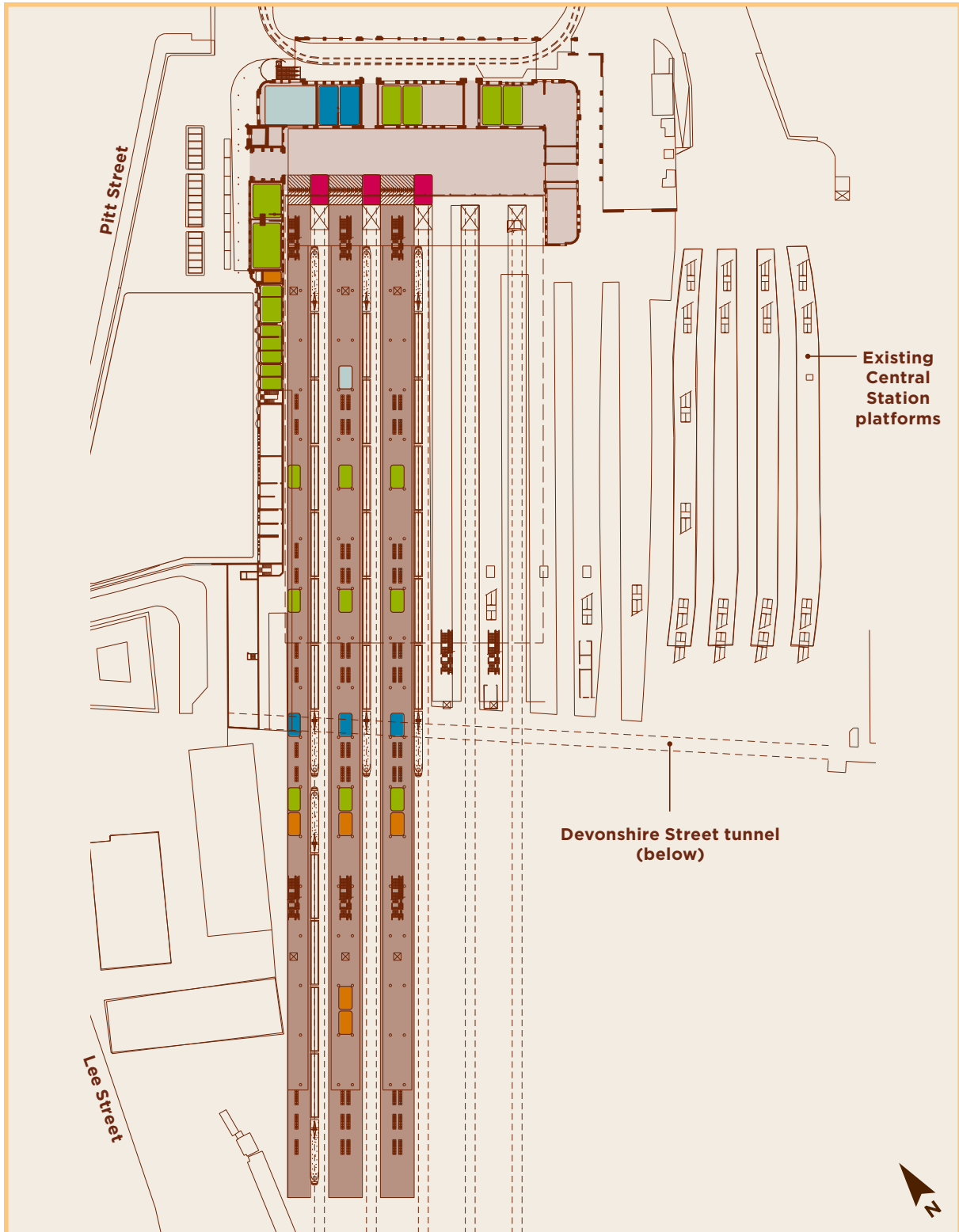
These platforms would generally be 400 metres long to provide operational flexibility through double stacking trains of 200 metres in length, but in the lower level the presence of an existing outfall sewer limits two platforms to a maximum of 380 metres. All HSR passengers travelling through Sydney would need to change trains and move from one platform level to the other. Lifts and escalators along the length of the platforms would ensure ease of movement between the two platform levels and to/from the HSR mid-level concourse at Lee Street level.

Figure 5-15 Sydney HSR station cross-section



Not to scale

Figure 5-16 Sydney HSR station upper platform level










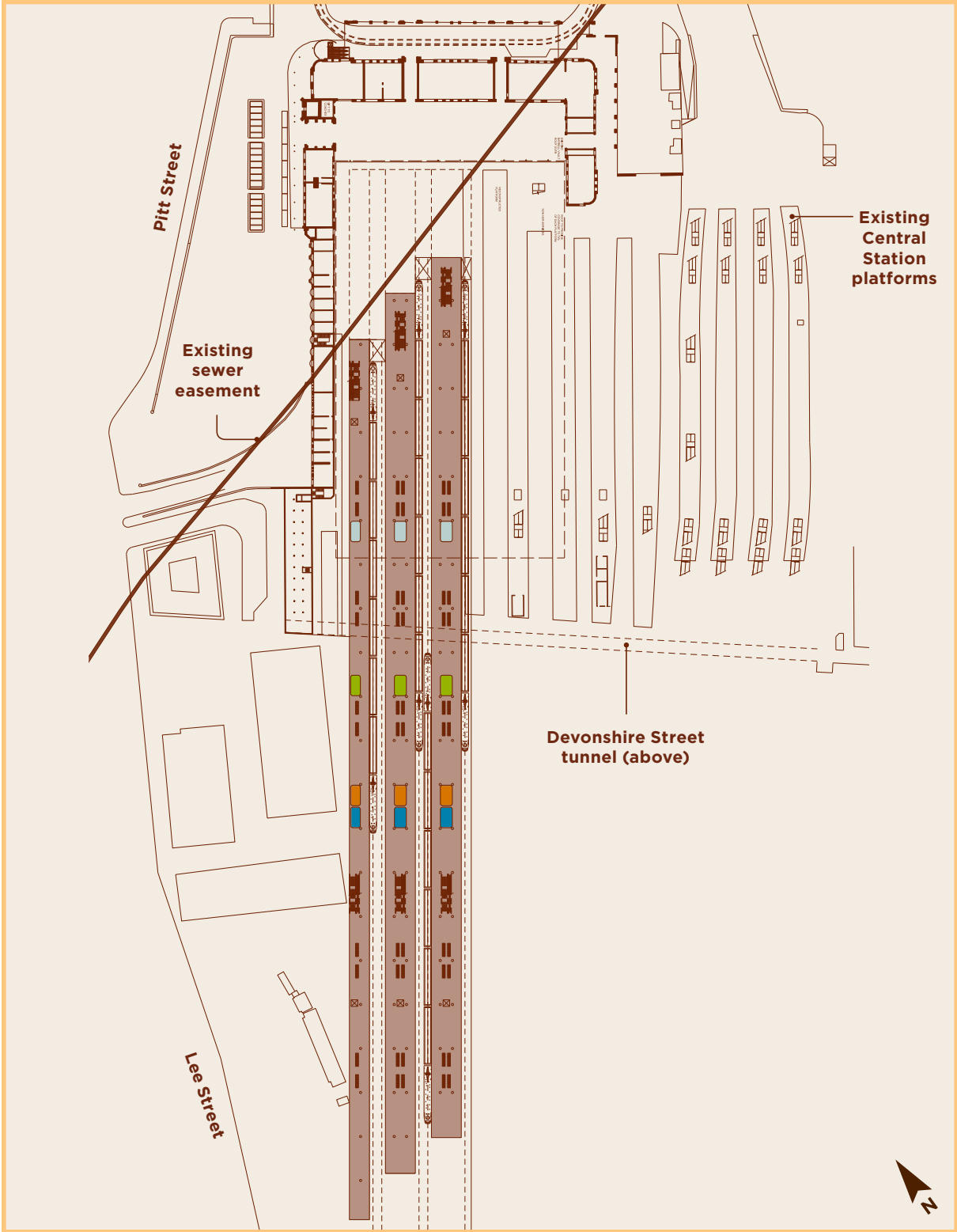
KEY	 Concourse	 Ticketing	 Retail	Not to scale
	 Toilets	 Plant and services		
	 HSR new platforms	 Staff and administration		

Figure 5-17 Sydney HSR station lower platform level



- | | | | | |
|------------|---|--|--|---------------------|
| KEY | HSR new lower level platforms | Toilets | Retail | Not to scale |
| | Staff and administration | Plant and services | | |

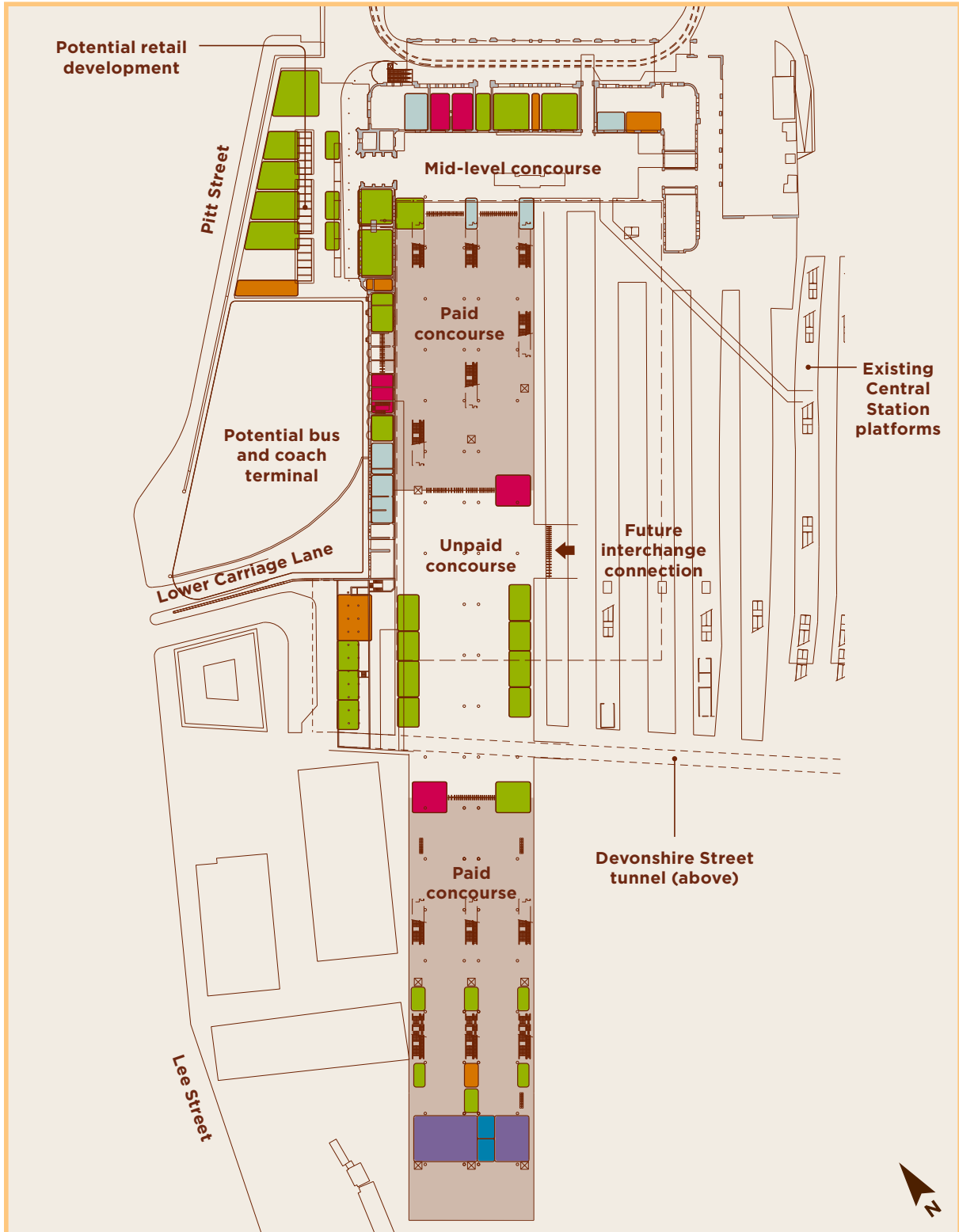
A mid-level concourse level is proposed to facilitate connection and interchange with the external precinct and existing regional rail network, and the existing basement of the station would be redeveloped to an internal retail concourse and precinct. There is potential for the current western forecourt to be opened up to the Lee Street level to incorporate a bus, coach and taxi interchange.

On the mid-level concourse level shown in **Figure 5-18**, the undercroft of the existing heritage building would be redeveloped to provide extensive retail and commercial premises. The current pedestrian connection from Elizabeth Street to Railway Square, known as the Devonshire Street tunnel (which is heritage listed in part), would be maintained and would pass above the concourse, while proposed future interchange connections to the suburban and regional train platforms would provide access from Lee Street and Lower Carriage Lane (formerly Ambulance Avenue) to the regional train services beyond the HSR platforms.

Vehicular access and loading would be along Lower Carriage Lane, and catering storage facilities would be provided to the west wing of the station. The lower level platforms would be staggered to avoid the major existing drainage sewer that crosses the site. The sewer is listed under the heritage register for Central station, and is currently in use. There would be minimal provision for station and customer facilities on this platform level. Accommodation blocks would be allocated to provide plant, retail and staff facilities.

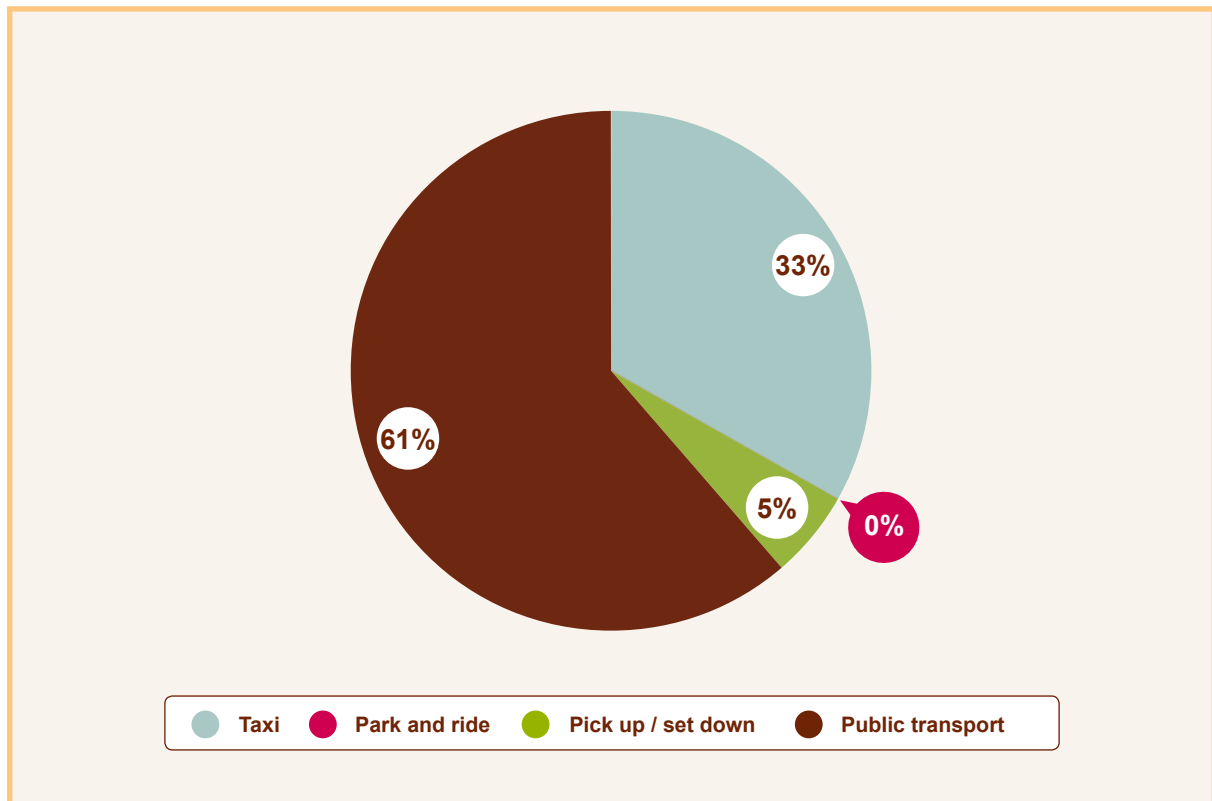
All of the structural changes to Central station would have to be implemented for the first stage of HSR development. It is proposed that, initially, only the upper level be equipped for HSR services for the southern railway. The lower level could subsequently be equipped with minimal interference to the operational upper level.

Figure 5-18 Sydney HSR station mid-level concourse



KEY	 Concourse	 Ticketing	 Retail	Not to scale
	 Waiting lounge	 Toilets		
	 Staff and administration	 Plant and services		

Figure 5-19 Sydney HSR station access and egress mode share in 2065



Note: Total does not add up to 100% due to rounding.

Central station would provide very high accessibility to transport networks because of the extensive pedestrian access and connectivity to the bus, rail, and light rail networks. Potential extensions to the rail and light rail networks that would further improve the accessibility of Central station as a transport node are being investigated by the NSW Government.

Sydney Central HSR station is therefore expected to attract a high public transport access/egress mode share of around 61 per cent in 2065. The Sydney metropolitan public transport (bus, ferries, CityRail and light rail) network carries 1.8 million passengers per day⁴. The NSW Government expects this to grow at a rate of 1.7 per cent per year up to 2036. HSR access would account for

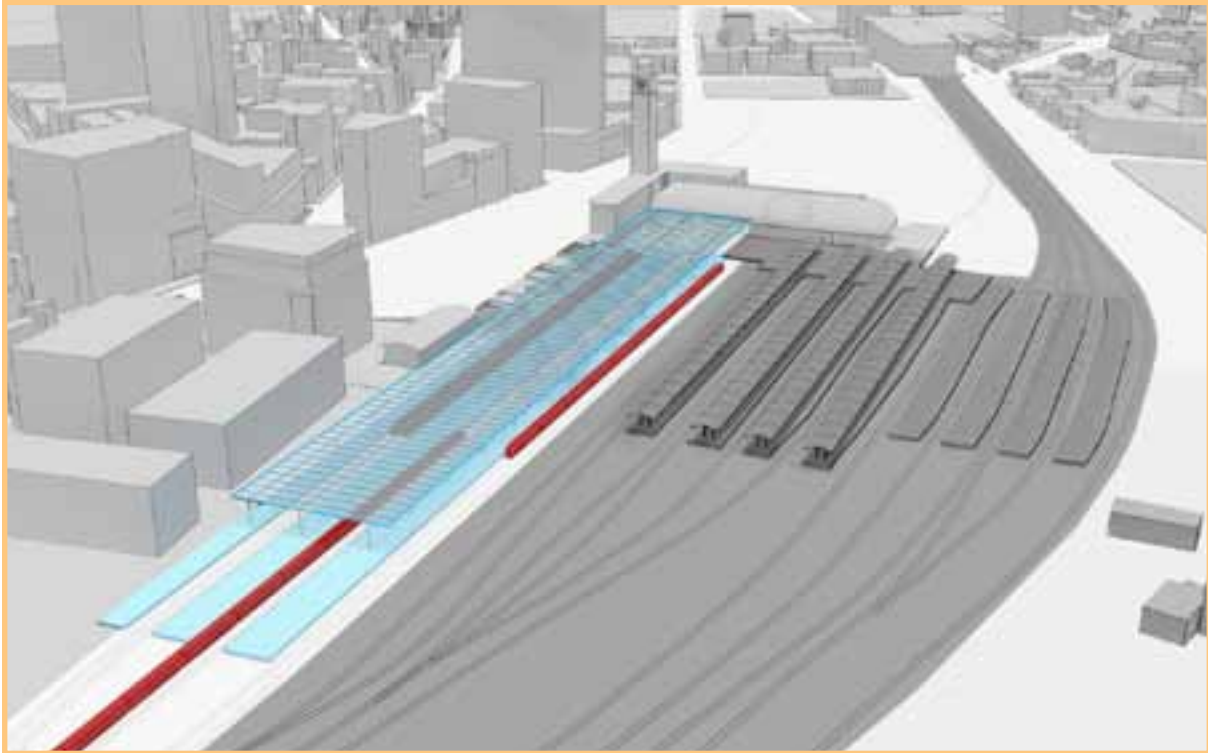
approximately 2.1 per cent of the total network transport task in the HSR forecast years. As the peak travel time for HSR access is unlikely to coincide exactly with the peak commuter travel times, this volume could be accommodated on the city's metropolitan transport network without additional new infrastructure⁵. The high taxi access volumes would require significant taxi pick up and drop off and holding areas at the station. Travel to and from the HSR station is expected to be shared among modes as shown in **Figure 5-19**. No park and ride facility for HSR is proposed at the Sydney HSR station.

A visualisation of the Sydney HSR station within the existing Central station is illustrated in **Figure 5-20**.

⁴ Transport for NSW, *Rail options for the Sydney Greater Metropolitan area, Draft options paper*, November 2011, p. 4

⁵ Peak HSR departures are likely to be between 5.30am and 7.30am and peak HSR arrivals between 8.30am and 10.30am (allowing for travel time between Brisbane or Melbourne and Sydney). The commuter peak is 7am to 9am.

Figure 5-20 Sydney HSR station visualisation



5.5.4 Sydney North peripheral station

The preferred Sydney North HSR station is located adjacent to the CityRail station at Hornsby, as shown in **Figure 5-21**. This station is a major junction on the CityRail network with frequent services to/from:

- North Sydney via Gordon and Chatswood.
- North Sydney via Macquarie Park and Chatswood.
- Sydney CBD via Epping and Strathfield.
- Central Coast/Newcastle.

The HSR station would also be close to the F3 Freeway. There have been proposals to extend the F3 south to provide a motorway link to the Sydney Orbital M2 and M7⁶. The station, as shown in **Figure 5-21**, is to the immediate west of the existing railway station, parallel to the

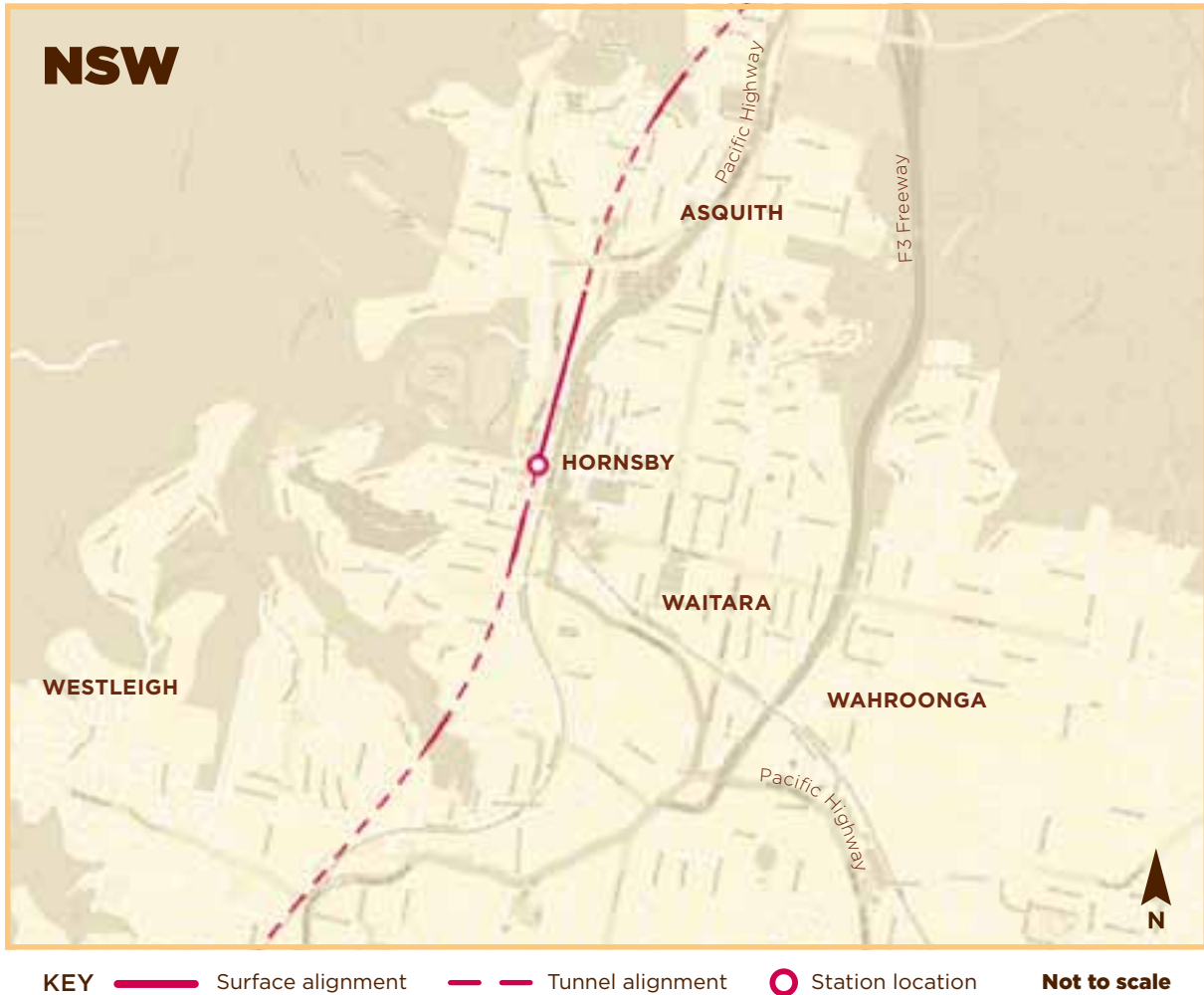
Pacific Highway, and would facilitate an effective interchange.

The CityRail network offers a high level of connectivity; therefore, parking demand is proportionately lower than at other city peripheral stations (around 26 per cent of Sydney residents would use park and ride to access HSR services at Sydney North station, compared with almost 50 per cent at Sydney South station, for example).

Forecast demand at the Sydney North HSR station is 6.2 million passengers per year in 2065. Public transport has an 18 per cent share of the access modes for passengers using this station, which is equivalent to 160 passenger trips in the peak hour for departing trips in 2065. There would be no requirement for additional public transport access infrastructure at these demand volumes.

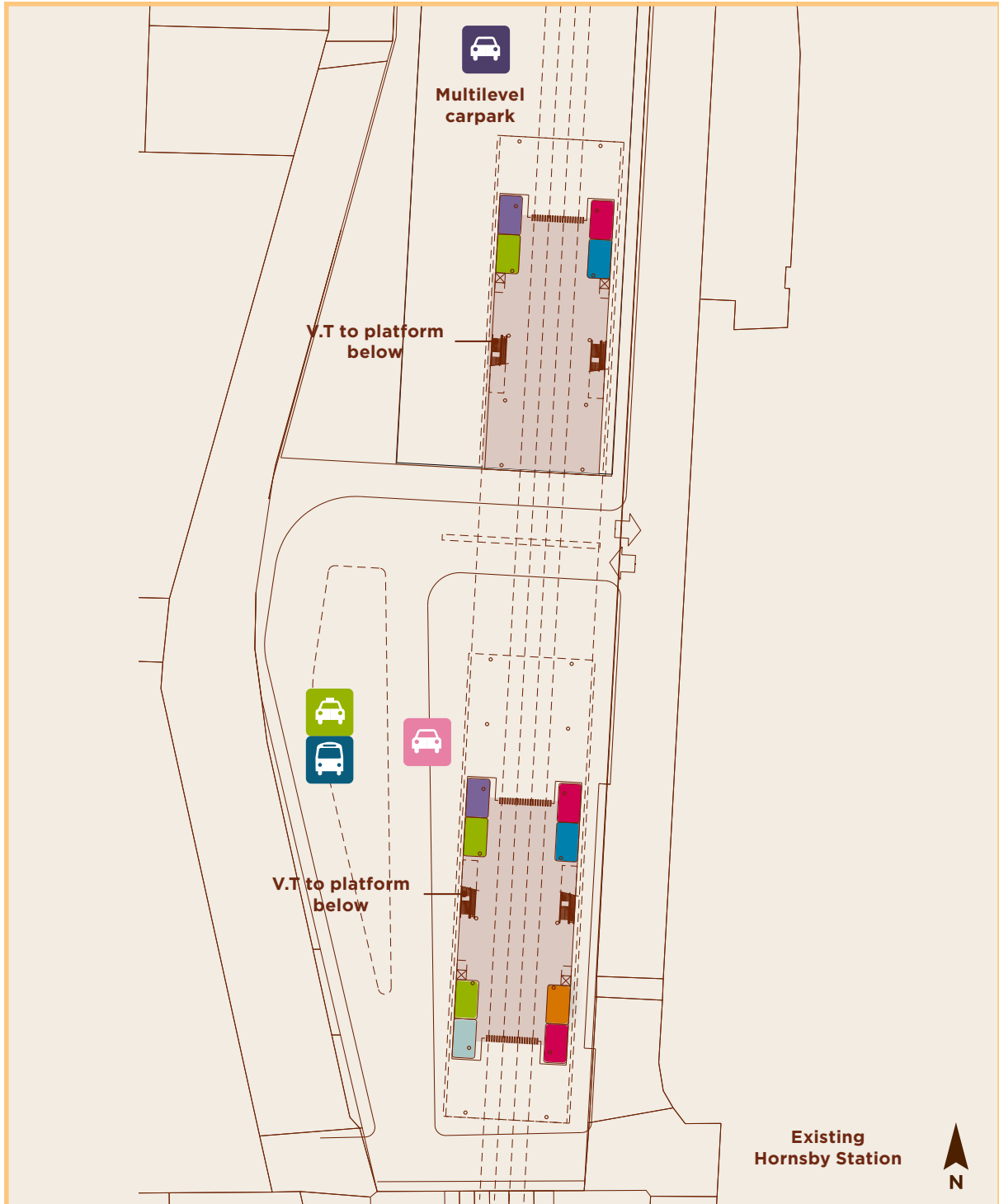
6 This link is a recommendation of Infrastructure NSW's State *Infrastructure Strategy, 2012–2032*, released 3 October 2012.

Figure 5-21 Sydney North station location plan



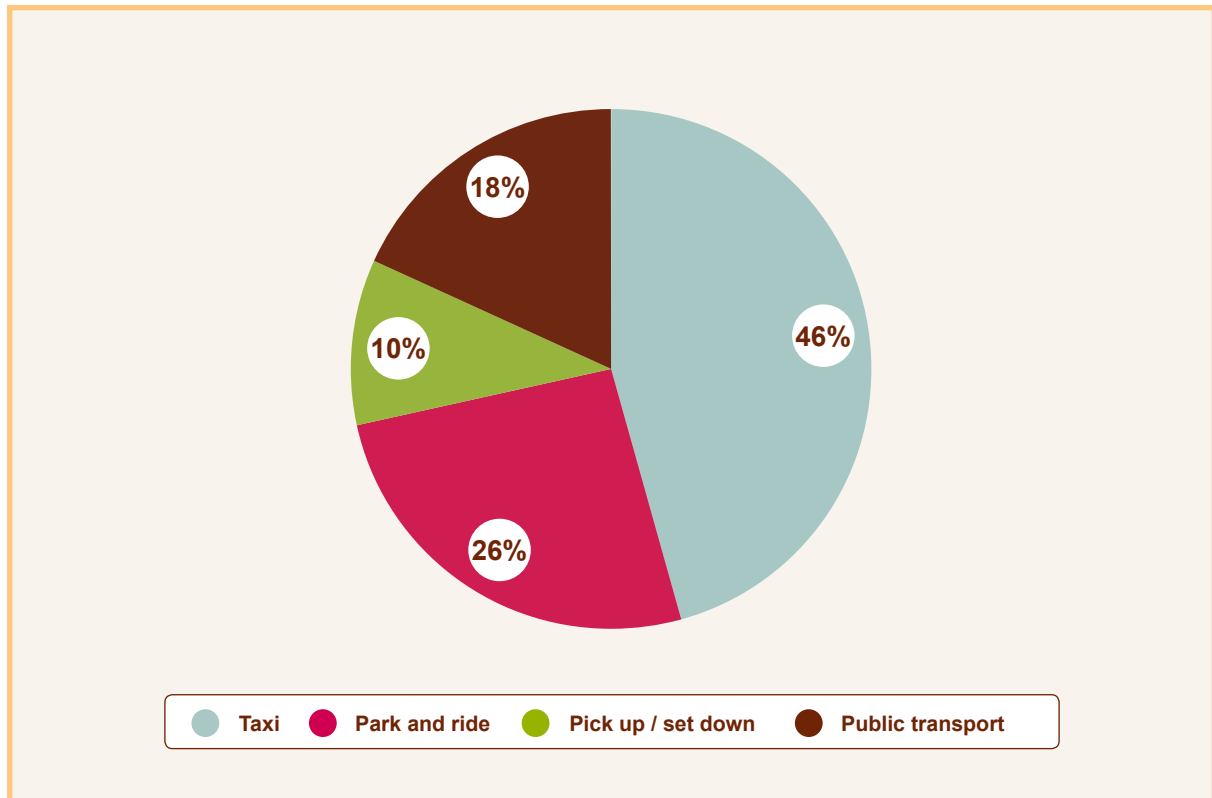
The station entrance would be at street level, as shown in **Figure 5-22**, but the station platforms would be constructed within a cut-and-cover box with track level approximately ten metres below. Vehicular access would need upgrading to connect the car park to the Pacific Highway. Parking would be accommodated in a multi-deck structure.

Figure 5-22 Sydney North station ground level plan



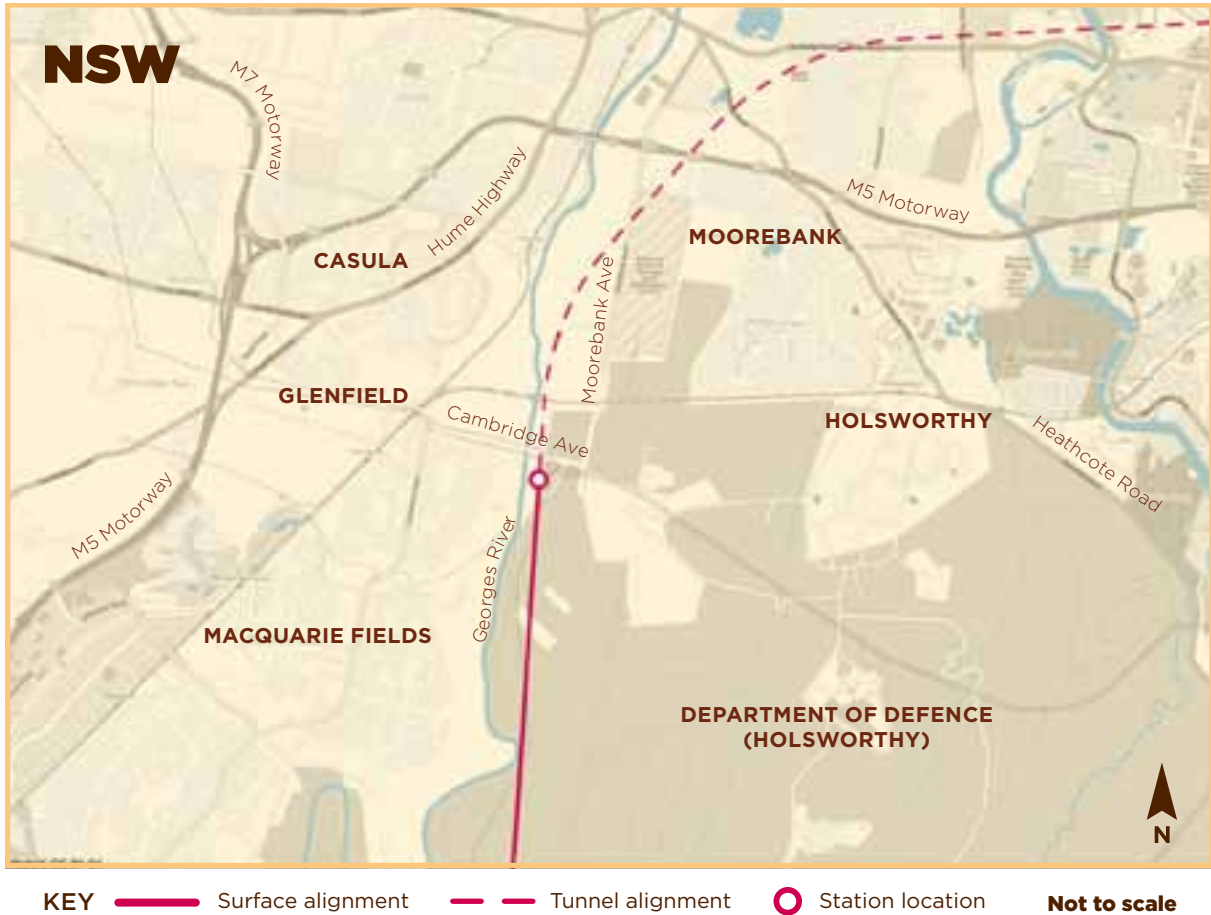
KEY	 Concourse	 Ticketing	 Taxi rank	Not to scale
	 Waiting lounge	 Toilets	 Pick up / set down	
	 Staff and administration	 Plant and services	 Bus and coach stops	
	 Retail		 Carparking	
	V.T. = Vertical transportation (e.g. escalators, stairs, lifts)			

Figure 5-23 Sydney North HSR station access and egress mode share



This station is forecast to attract 6.2 million passengers per year and a peak hour demand of 1,700 passengers in 2065, which amounts to 11 per cent of the peak HSR demand in Sydney overall. The station would provide two platforms of 315 metres in length to allow the inter-capital express services to call at the station. Travel to and from the HSR station is expected to be shared among modes as shown in **Figure 5-23**. Park and ride would require 4,200 parking spaces at 2065 demand levels.

Figure 5-24 Sydney South station location plan



5.5.5 Sydney South peripheral station

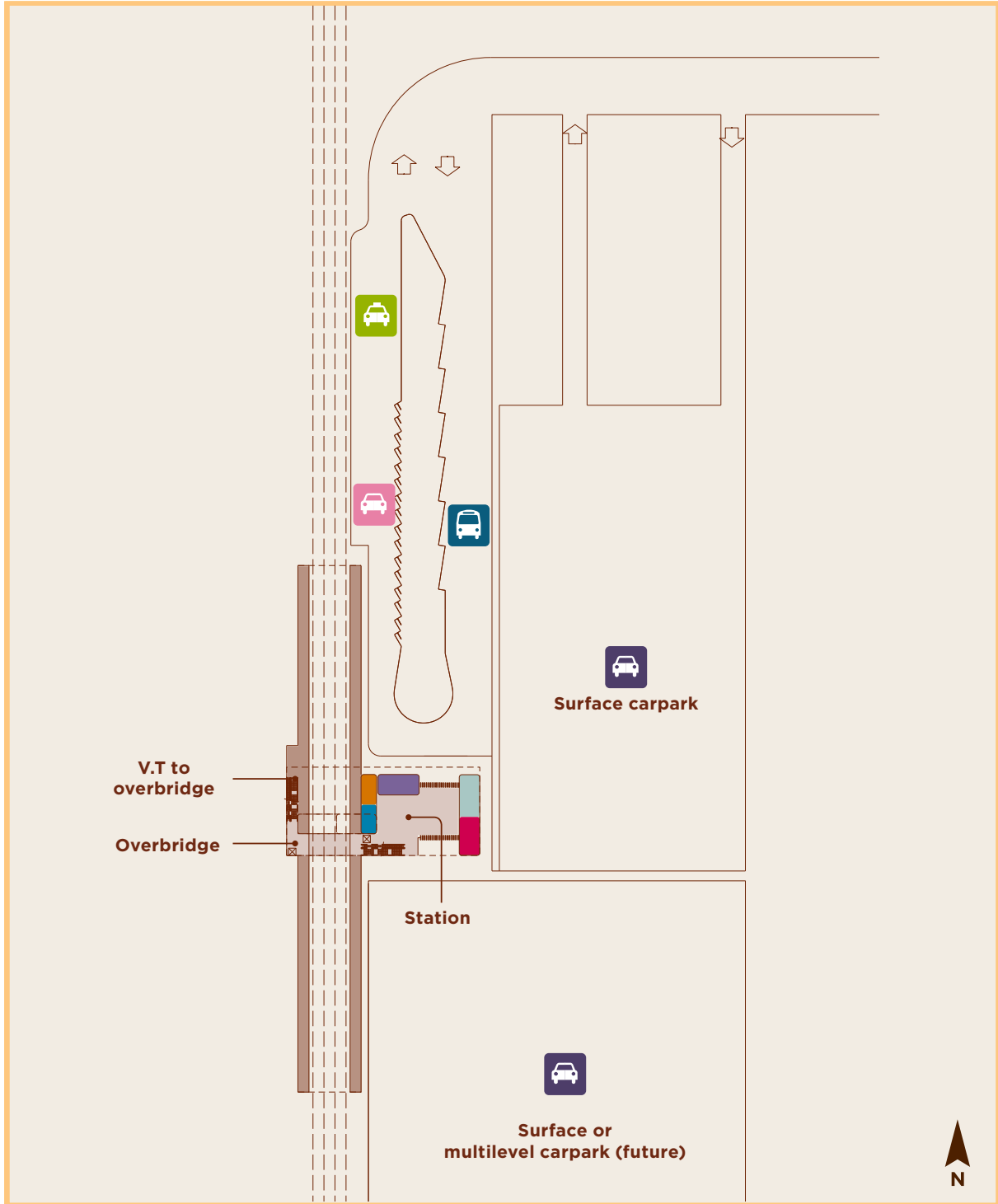
The Sydney South peripheral station would be located at Holsworthy, west of Moorebank Avenue, to the south of Cambridge Avenue, as shown on **Figure 5-24** and **Figure 5-25**, and between the CityRail stations at Glenfield and Holsworthy. It would be located approximately three kilometres south of the M5 Motorway and ten kilometres east of the M5/M7 junction, providing motorway access from most parts of the metropolitan region.

Sydney South is forecast to attract 4.6 million passengers per year and a peak hour demand of 1,300 passengers in 2065, which amounts to eight per cent of the peak demand in Sydney overall. The

station would provide two platforms of 315 metres in length to allow the inter-capital express services to call at the station.

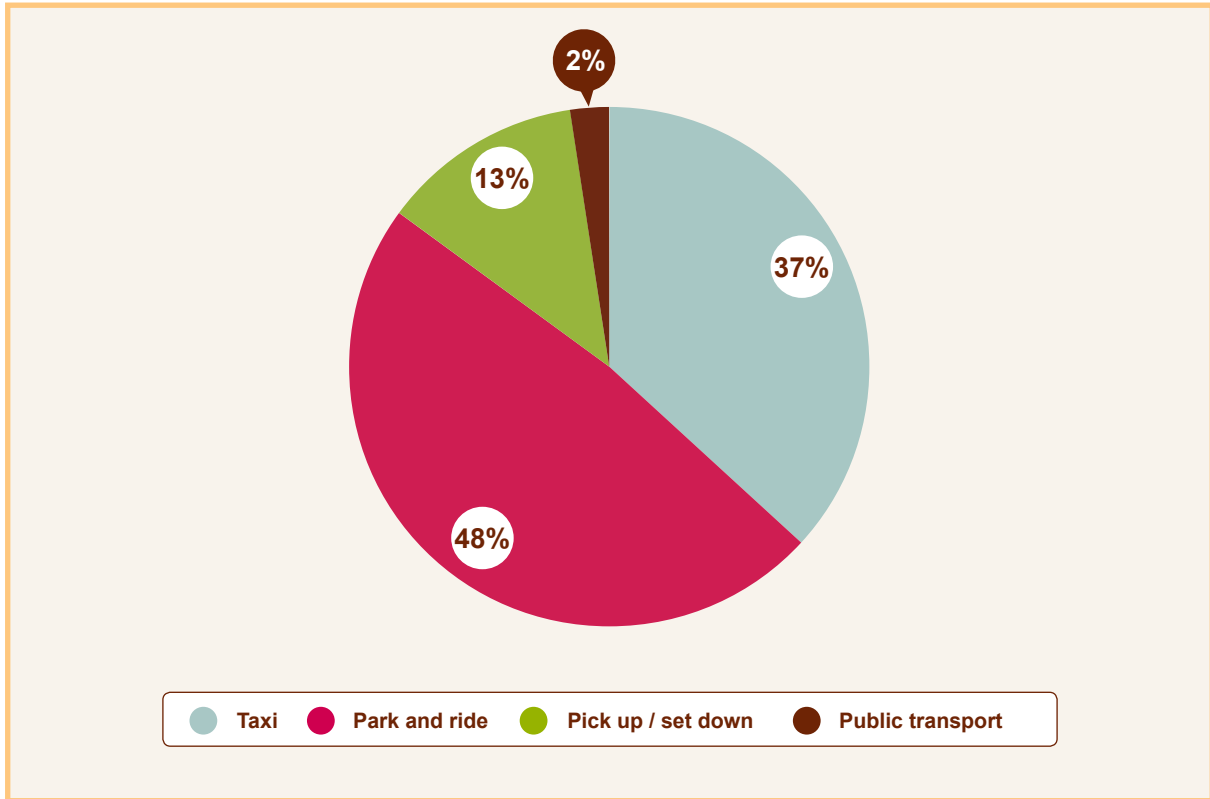
The station would be located on ground level or in a shallow cut to suit the track alignment, which would then dive into a tunnel below Moorebank on approach to Sydney. The station would be accessed by Moorebank Avenue. Car parking would be provided with a multi-deck structure. The freeway would facilitate access from locations across the western suburbs including Parramatta, which is also connected to nearby Glenfield station via the Cumberland line. Road access could be constrained, and additional road infrastructure may be required to provide capacity for vehicles accessing the HSR car park.

Figure 5-25 Sydney South station platform level plan



KEY	Concourse	Ticketing	Taxi rank	Not to scale
	Waiting lounge	Toilets	Pick up / set down	
	Staff and administration	Plant and services	Bus and coach stops	
V.T. =	Vertical transportation (e.g. escalators, stairs, lifts)	HSR new platforms	Carparking	

Figure 5-26 South HSR station access and egress mode share



It is likely that the public transport network in the area would be refocused to provide improved links to the HSR station, particularly from Glenfield. However, even if the access mode share for public transport is significantly increased from two per cent to ten per cent, just over 50 passengers would be accessing HSR by public transport per peak hour.

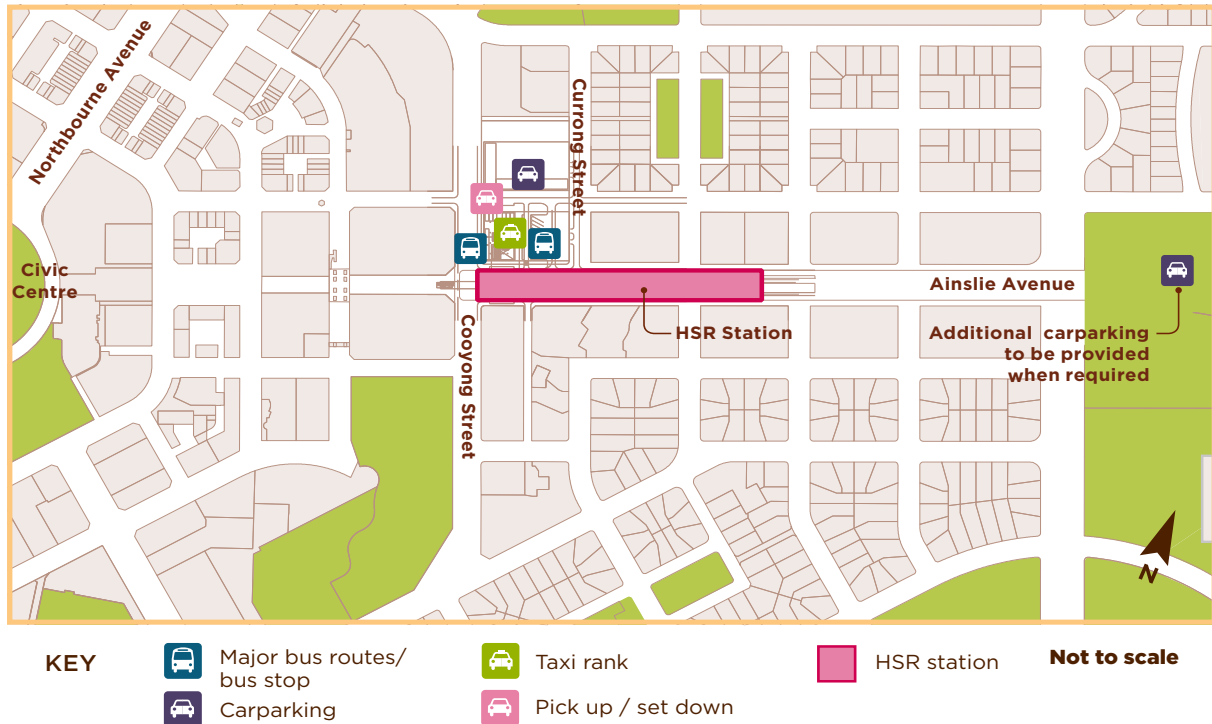
Forecast demand at the Sydney South HSR station is 4.6 million passengers in 2065, of which just under 400 passengers per day are expected to arrive or leave by public transport. There would therefore be no requirement for additional access infrastructure at these demand volumes. The level of HSR demand at the Sydney South station is more than five times higher for Sydney residents than for visitors to Sydney. Parking demand is driven by the high rate of private car access for Sydney residents (over 45 per cent).

Travel to and from the HSR station is expected to be shared among modes as shown in **Figure 5-26**. Park and ride is the most prominent access mode (about 48 per cent of all HSR passengers using this station) and would require 5,800 parking spaces.

5.5.6 Canberra city centre station

Canberra HSR station would be served by trains from Sydney and Melbourne, some also calling at intermediate stations. Canberra HSR station is forecast to attract 11 million passengers per year and 3,200 in the 2065 peak hour. In 2065, there would be up to eight HSR service arrivals or departures in any one hour and this would require three platforms.

Figure 5-27 Canberra HSR station location plan



A station of this size could be accommodated within the median of Ainslie Avenue, as shown in **Figure 5-27**. The station is close to the Canberra Centre, and has good vehicular connection to local and arterial roads. The site inclines to a high point in the east and falls to the west, so the station would be part cut-and-cover, part surface construction. Some of the roads crossing the Ainslie Avenue median that would need to be closed for the construction period would

be re-opened on completion to maintain local accessibility and Canberra's road layout. The station entry for passengers would be to the westernmost part of the site, providing public access from Cooyong Street and the Canberra Centre. Three 315 metre platforms are proposed to accommodate the 300 metre trains, as shown in **Figure 5-28**.

Travel to and from the HSR station is expected to be shared among modes, as shown in **Figure 5-29**.

Figure 5-28 Canberra HSR station platform level plan

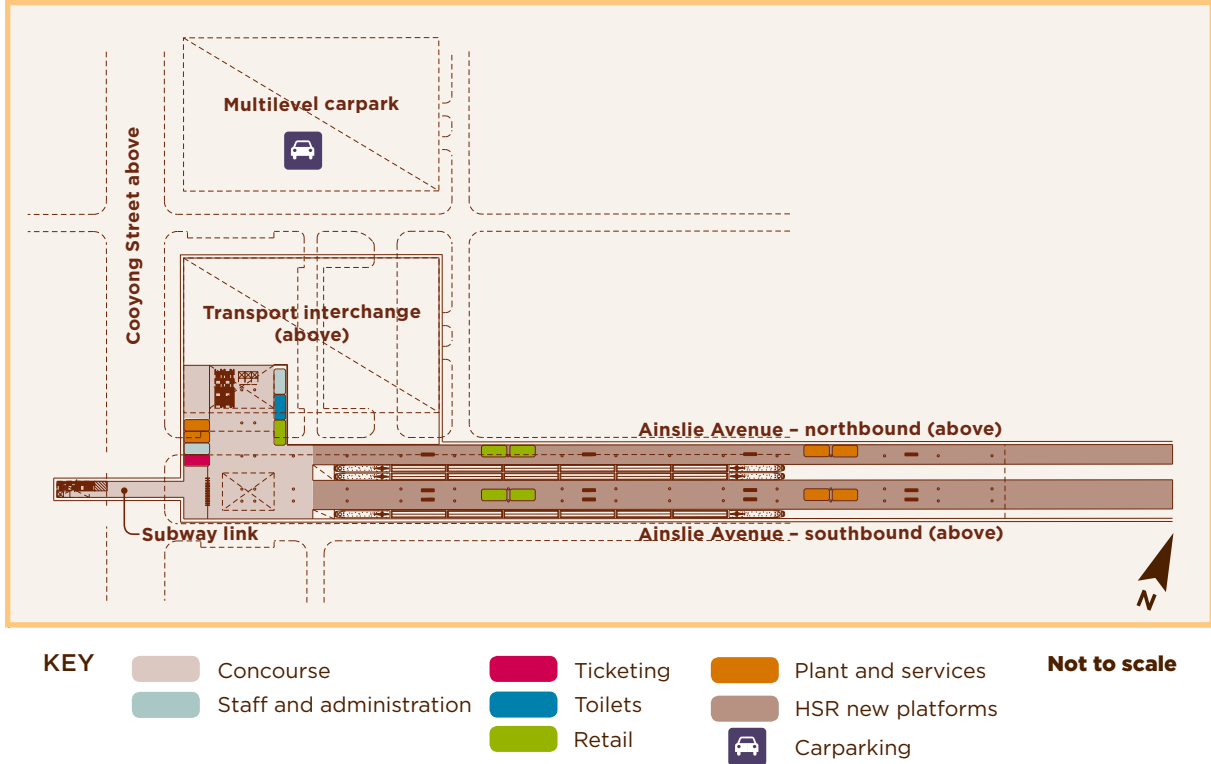
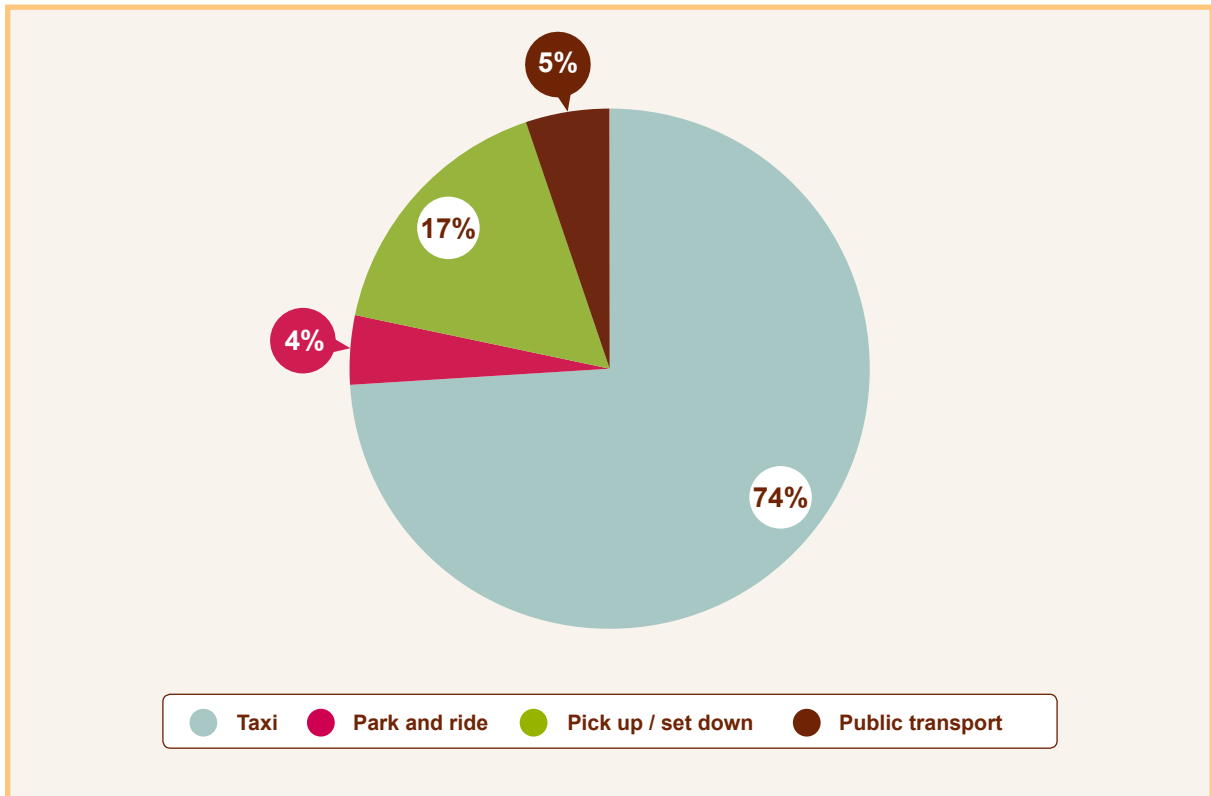


Figure 5-29 Canberra HSR station access and egress mode share in 2065



Taxi would be the most significant access and egress mode with 74 per cent share. Given the geographically dispersed catchment area, no specific additional transport corridor infrastructure is proposed to improve public transport access mode shares. The recently announced light rail scheme, which has a hub at Civic, would add to the proposed station's connectivity and the creation of a major transport hub. The station location is less than 600 metres walking distance from Northbourne Avenue, the route of the proposed Canberra light rail line (Stage 1). The introduction of HSR services from Civic should help support the goal of improving public transport mode share within the ACT.

A car parking charging regime and the provision of some dedicated HSR access bus services, to and from other town centres and the Queanbeyan CBD (similar to the current SkyBus service that links the airport and CBD in Melbourne), could constrain the upper limit of the car parking requirement to a maximum of 6,000 in 2065.

A mixed-used development with a multi-level car park would be located to the north of the station, between Cooyong Street and Currong Street North, creating a new public station precinct and interchange. This site is currently occupied by multi-storey social housing, although it has been designated for renewal. Should capacity be exceeded, additional parking could be located towards the eastern end of Ainslie Avenue, with a shuttle bus service connecting the station precinct and car park. Coaches and buses serve a significant proportion of the Canberra tourism market and access to the station building would be provided as shown in **Figure 5-27**. Traffic management during and after construction of the HSR station in the median of Ainslie Avenue are discussed in **Chapter 4**.

A visualisation of the Canberra HSR station is illustrated in **Figure 5-30**.

Figure 5-30 Canberra HSR station visualisation

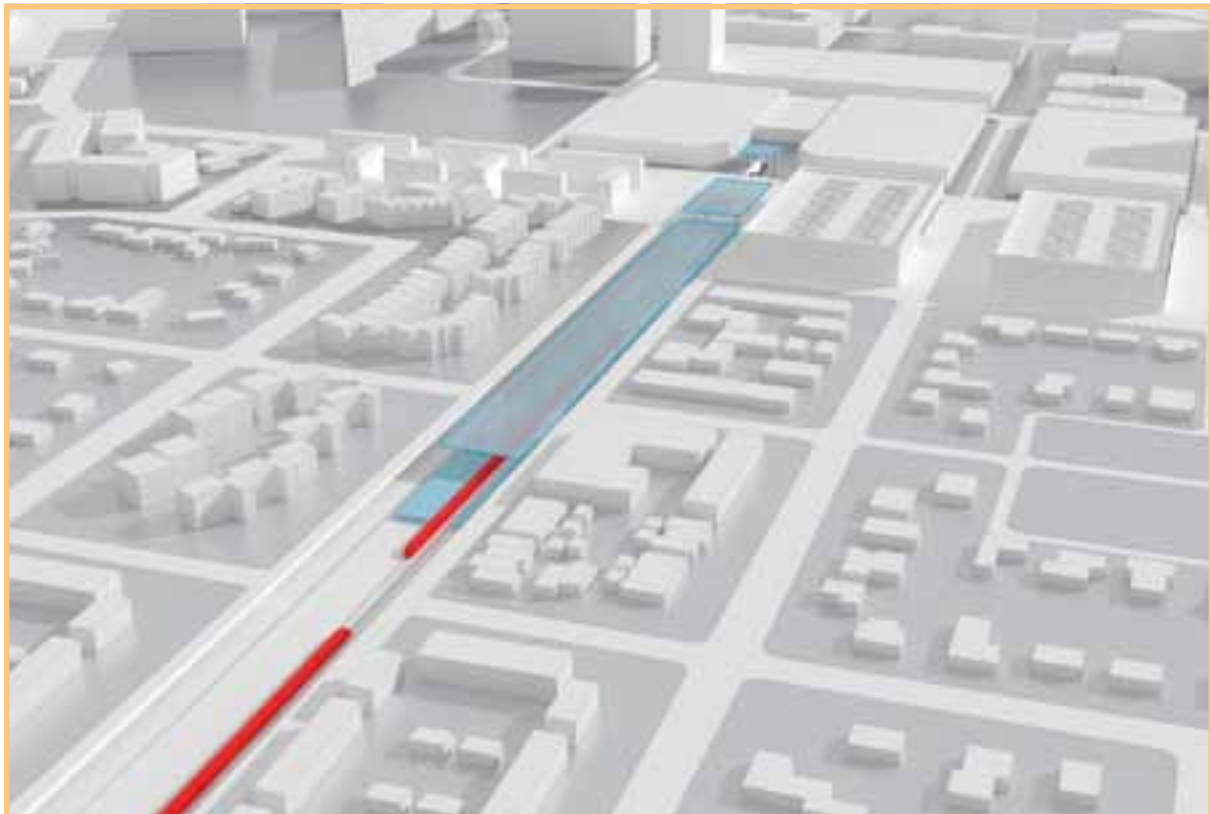


Figure 5-31 Melbourne HSR station location plan



5.5.7 Melbourne city centre station

Melbourne would be the southern terminal of the preferred HSR system. The proposed HSR station site is within the envelope of Southern Cross station, which is positioned on the edge of the CBD, as shown in **Figure 5-31**.

Forecast HSR demand for Melbourne’s Southern Cross station is 29 million passengers per year in 2065, with a peak demand of 8,100 passengers per hour. This would require five platforms: four new platforms on the site of the existing platforms two to five, plus a reconfiguration of the existing platform one.

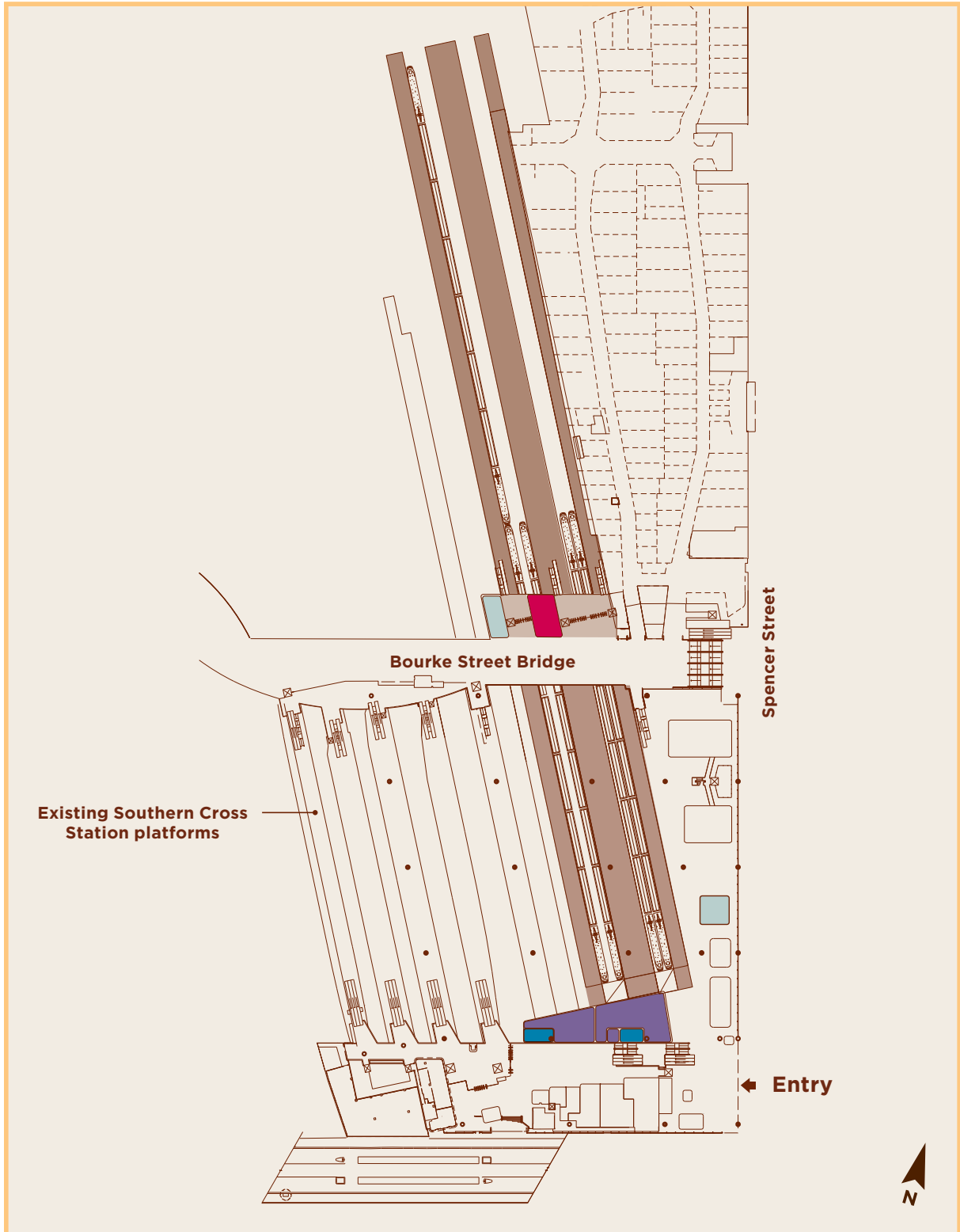
Southern Cross station has recently undergone redevelopment and operates well as an interchange. It would provide good accessibility between HSR and suburban and regional train services. Additionally, a number of bus and tram routes currently operate on Spencer Street outside the station.

The HSR platforms would be located on the east side of the station. The construction of HSR

platforms would require possession of existing platforms one to five. Analysis of the utilisation of these platforms indicates this could be achieved by relocating the services currently using these platforms to other platforms within the station. This would need to be confirmed through more detailed operational modelling, should the HSR proposition be progressed through further stages of design development.

The proposed works at Southern Cross station have been split into two stages. The initial stage would include construction of full-length platforms, and is arranged to suit passengers accessing the trains from the ticket barrier end of the platform. When the longer 300 metre trains are introduced, additional platform lengths would be used and the existing passenger overbridge would be modified to accommodate the increased patronage expected from the HSR service. This also provides vertical circulation as shown in **Figure 5-32**. The overbridge would also house additional ticketing and concourse facilities, as well as staff and plant rooms.

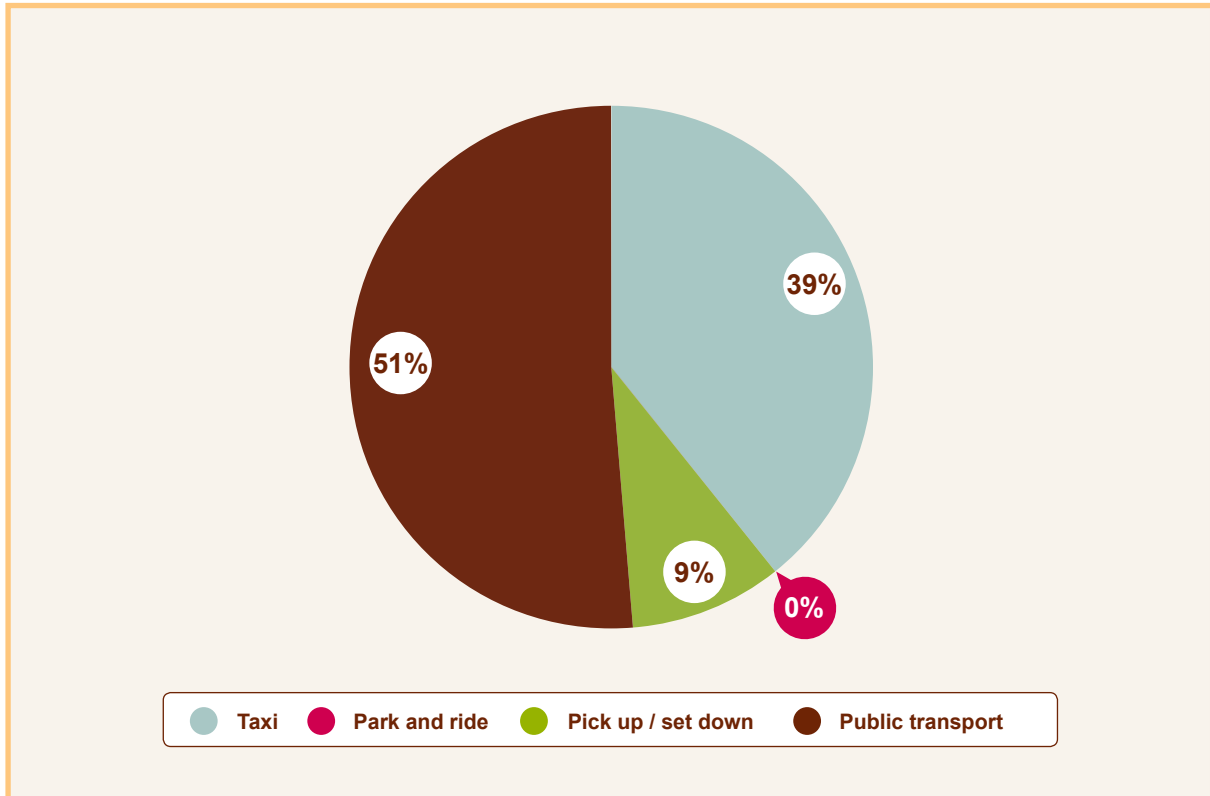
Figure 5-32 Melbourne HSR station platform level plan



KEY	 Concourse	 Ticketing
	 Waiting lounge	 Toilets
	 Staff and administration	 HSR new platforms

Not to scale

Figure 5-33 Melbourne HSR station access and egress mode share



Note: Total does not add up to 100% due to rounding.

Travel to and from the HSR station is expected to be shared among modes as shown in **Figure 5-33**. No park and ride facility is proposed at the Melbourne HSR station.

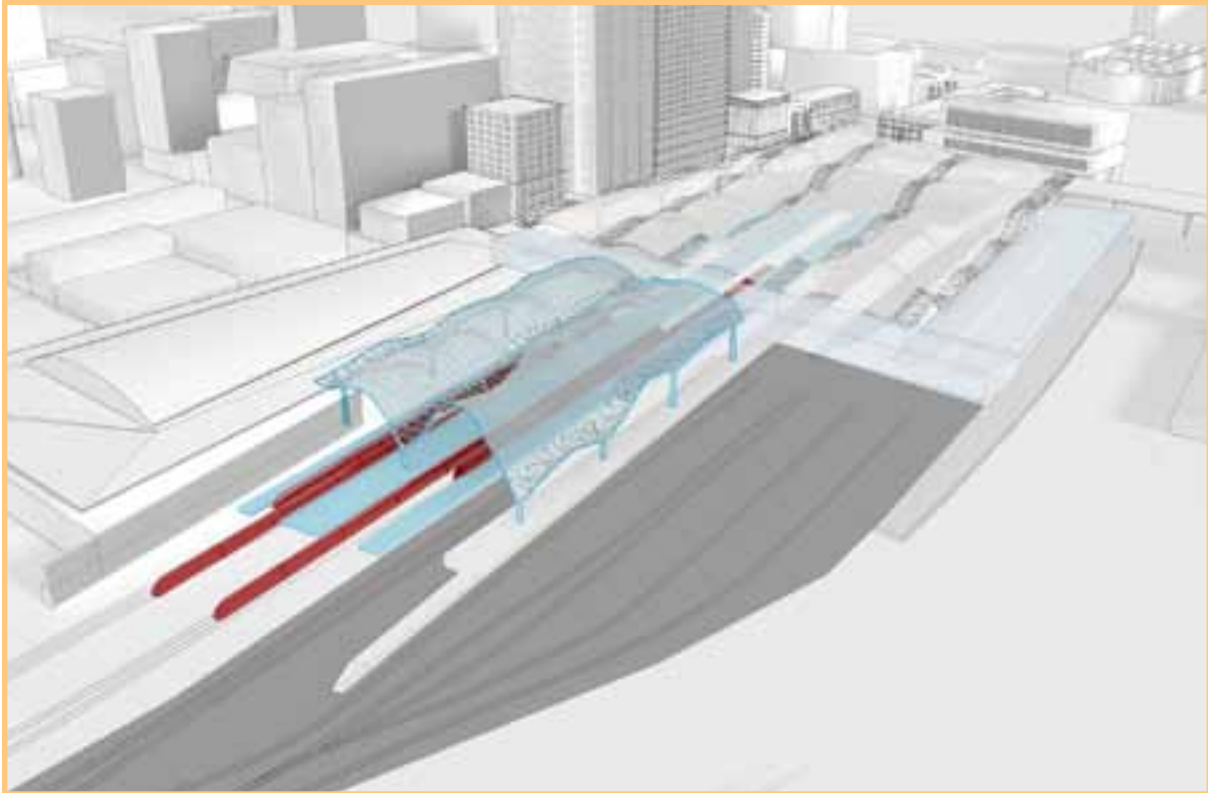
Public transport would be the main access mode at Southern Cross, with 51 per cent accessing HSR services this way. In 2010-11, the Melbourne metropolitan public transport network (including trams, buses and suburban trains but excluding regional train services) carried 517 million passengers, equivalent to an average weekday total of 1.7 million trips⁷. Since the peak hours for HSR access and egress are not expected to coincide exactly with the Melbourne commuter peaks, it is assumed that this volume can be accommodated on the public transport network without major additional infrastructure⁸.

A visualisation of the Melbourne HSR station within the existing Southern Cross station is illustrated in **Figure 5-34**.

⁷ Public Transport Victoria, *Melbourne Public Transport Patronage Long Run Series 1945-46 to 2010-11*, 2012.

⁸ Peak HSR departures are likely to be between 5.30am and 7.30am and peak HSR arrivals between 8.30am and 10.30am (allowing for travel time between Melbourne and Sydney). The commuter peak is 7am to 9am.

Figure 5-34 Melbourne HSR station visualisation



5.5.8 Melbourne North peripheral station

The preferred option for a city peripheral station to the north of Melbourne is located north of Gowrie, to the west of the Camp Road and Hume Highway intersection, as shown in **Figure 5-35**.

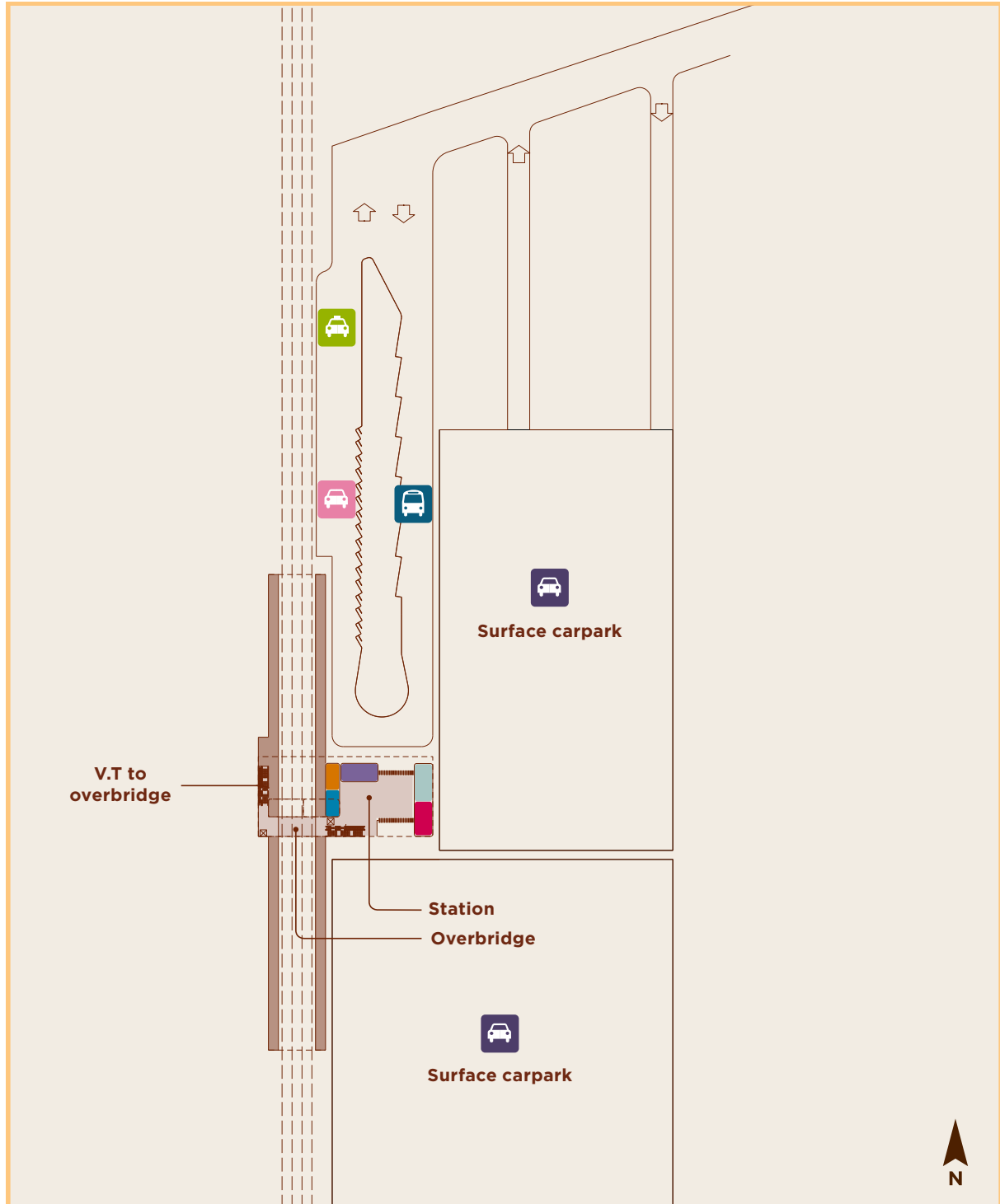
The station would be located adjacent to the Upfield metropolitan rail line between Upfield and Gowrie stations. Broadmeadows station on the Craigieburn line is three kilometres west of the HSR station. Four bus routes serve the area, including the orbital Smartbus route 902 which links with Broadmeadows station in the west and Doncaster, Glen Waverley and Chelsea in Melbourne's east and south. If the access route via Jacana were to be adopted, then the peripheral station would be at Craigieburn.

Figure 5-35 Melbourne North station location plan



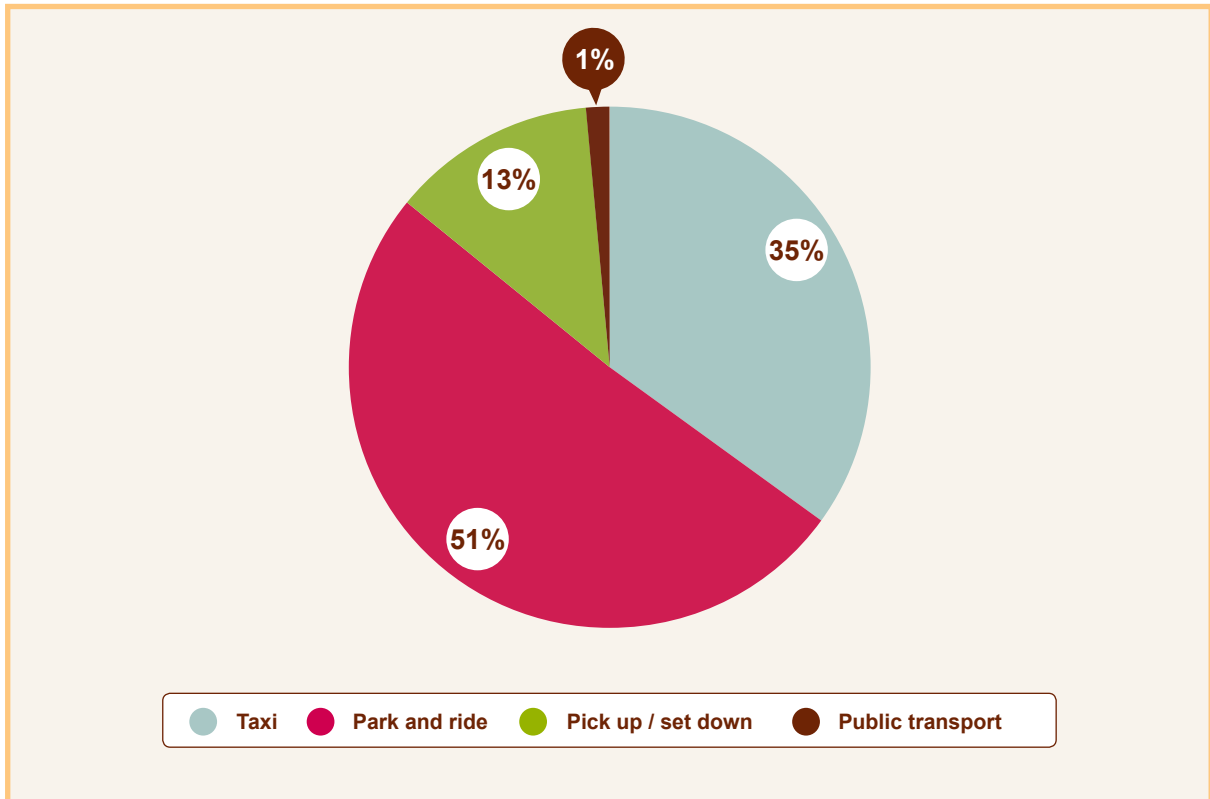
The HSR station would be constructed at surface level and oriented north–south with access from Northcorp Boulevard. Two platforms, 315 metres in length, would be provided to allow the inter-capital express to Sydney to serve the station, as shown in **Figure 5-36**.

Figure 5-36 Melbourne North station platform level plan



KEY	Concourse	Ticketing	Taxi rank	Not to scale
	Waiting lounge	Toilets	Pick up / set down	
	Staff and administration	Plant and services	Bus and coach stops	
V.T. =	Vertical transportation (e.g. escalators, stairs, lifts)		Carparking	
	HSR new platforms			

Figure 5-37 Melbourne North HSR station access and egress mode share in 2065



Forecast demand at the Melbourne North HSR station is 5.4 million passengers per year and up to 1,500 HSR passengers in the peak hour by 2065. This amounts to 16 per cent of the overall demand for HSR in Melbourne. There would be no requirement for additional access infrastructure at these demand volumes.

Parking demand would be driven by the high private car access for Melbourne residents (over 50 per cent) requiring 7,300 parking spaces. Public transport would be used by few HSR passengers to access Melbourne North HSR station. Travel to and from the HSR station is expected to be shared among modes as shown in **Figure 5-37**.

5.6 Regional stations

5.6.1 Regional station characteristics

These stations are relatively simple in nature, located on the outskirts of the towns that they serve and, with the exception of Gold Coast, consist of two 215 metre platforms and through lines for non-stopping trains.

There are 12 regional HSR stations proposed, as shown in **Table 5-2**. The demand forecasts assume no fixed link public transport access to HSR stations, as most stations (apart from the Gold Coast station) are remote from frequent local public transport routes. To provide an attractive alternative to private car use for HSR passengers, a high quality coach link is proposed (similar, for example, to the existing Melbourne SkyBus service) between the regional centres and the

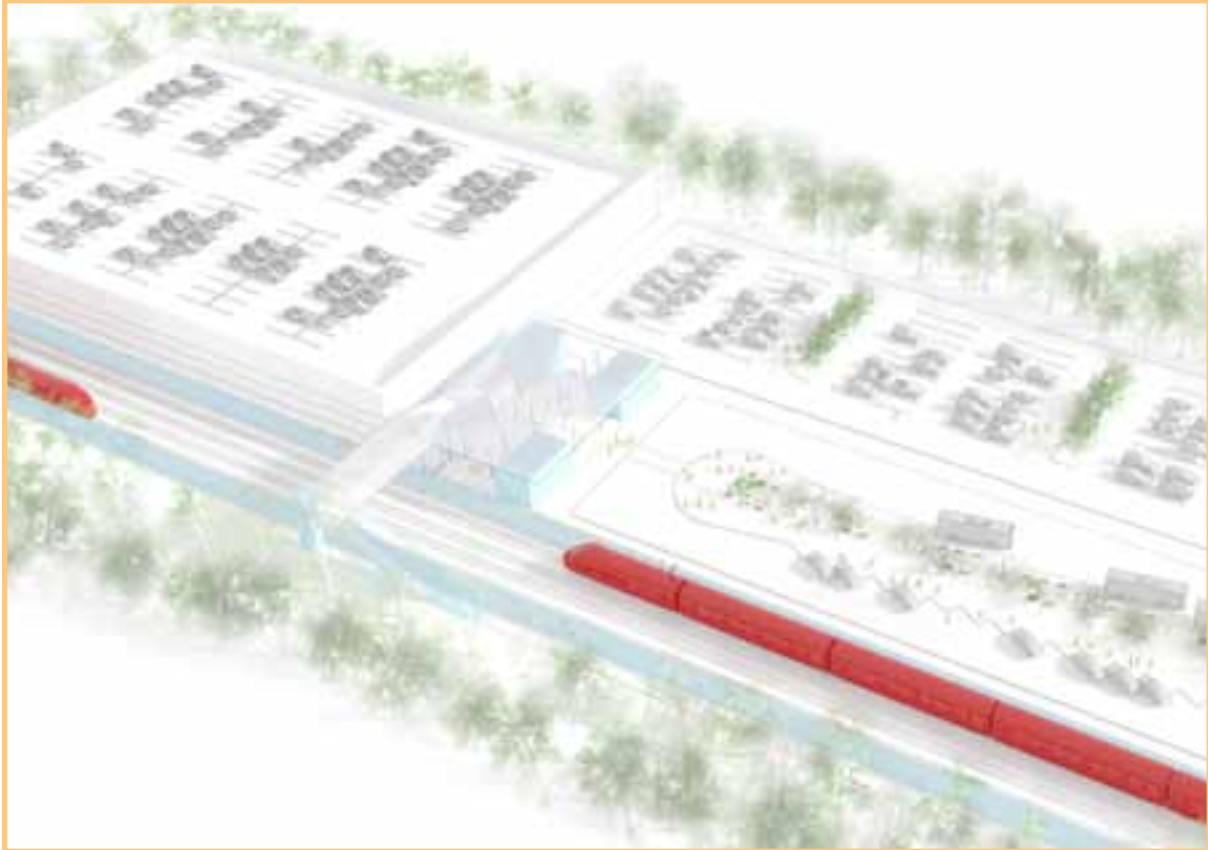
HSR station to meet the key trains each day. This approach would help to encourage the use of public transport to access the HSR system.

A visualisation of an indicative regional station is illustrated in **Figure 5-38**.

Table 5-2 Regional station summary

Regional station	Proposed location	Distance to the nearest town centre by road	Car park spaces (2065)
Gold Coast	Adjoining existing Robina railway station	12 km to Burleigh Heads 13 km to Surfers Paradise 18 km to Southport 25 km to Coolangatta/ Tweed Heads	3,700
Casino	West of Casino, north of Bruxner Highway	9 km to Casino 40 km to Lismore	2,200
Grafton	Southeast of Grafton, south of Grafton Airport	13 km to Grafton	800
Coffs Harbour	West of Bonville, south of Valery and Gleniffer Rds	15 km to Coffs Harbour	1,900
Port Macquarie	West of Pacific Highway, north of Oxley Highway	10 km to Port Macquarie	1,200
Taree	East of Taree, north of Old Bar Rd	9 km to Taree	1,100
Newcastle	Cameron Park, east of Sydney-Newcastle Freeway	20 km to Newcastle City Centre 25 km to Maitland	8,400
Central Coast	West of Sydney-Newcastle Freeway, north of Ourimbah interchange	10 km to Wyong 12 km to Gosford	6,600
Southern Highlands	North east of Mittagong Airport	5 km to Mittagong 10 km to Bowral 20 km to Moss Vale	8,300
Wagga Wagga	South of Wagga Wagga City Airport, east of Elizabeth Avenue	13 km to Wagga Wagga	2,300
Albury-Wodonga	Barnawartha North, northwest of Murray Valley Highway/Hume Highway interchange	20 km to Wodonga 25 km to Albury	4,200
Shepparton	East of Shepparton, north of Midland Highway, west of Pine Lodge South Rd	10 km to Shepparton	2,600

Figure 5-38 Regional station visualisation

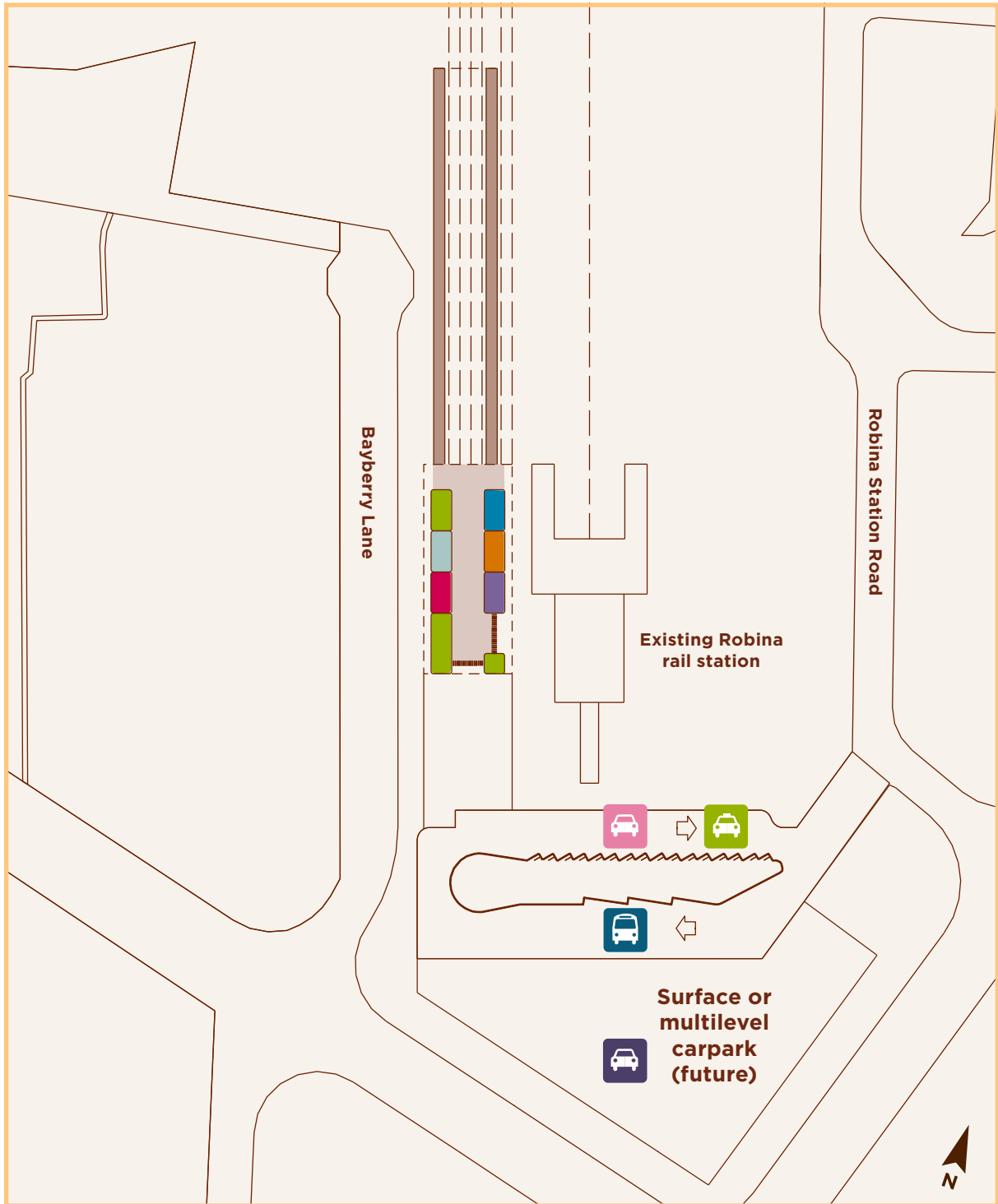


5.6.2 Gold Coast station

The Gold Coast HSR station would be located on a spur off the main line, and would be served by trains travelling from Sydney. This station is forecast to attract 9.5 million passengers per year and 2,600 in the peak hour in 2065. There would be up to seven HSR service arrivals or departures in any hour and this would require three platforms.

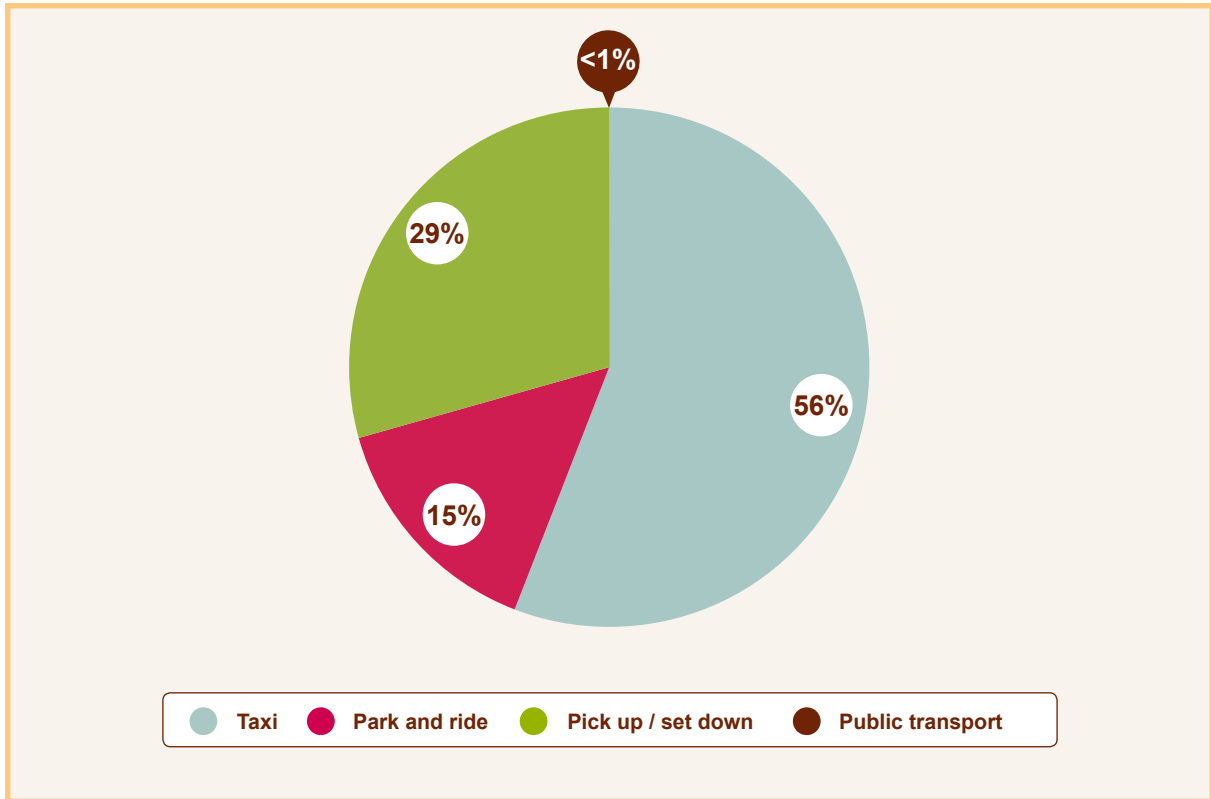
The Gold Coast station is proposed to be located near to the existing Robina station, as shown in **Figure 5-39**. The station is close to Robina Hospital, and has good vehicular connection to local and arterial roads.

Figure 5-39 Gold Coast station platform level plan



- | | | | |
|--------------------------|--------------------|--------------------|---------------------|
| Concourse | Ticketing | Bus stop | Not to scale |
| Waiting lounge | Toilets | Carparking | |
| Staff and administration | HSR new platforms | Taxi rank | |
| Retail | Plant and services | Pick up / set down | |

Figure 5-40 Gold Coast HSR station access and egress mode share



Note: Total does not add up to 100% due to rounding.

The HSR station location is well served by local public transport and is adjacent to the Citytrain station at Robina. Travel to and from the HSR station is expected to be shared among modes as shown in **Figure 5-40**.

The taxi mode share is the highest for any of the HSR stations, apart from Canberra. For over two-thirds of HSR passengers using this station, the Gold Coast is the ‘destination’, as opposed to the ‘home’, end of the trip. Since car availability is likely to be highest at the ‘home’ end, the park and ride mode share for HSR passengers is relatively low. To meet the projected demand, 3,700 car

parking spaces would likely be required. The Gold Coast HSR station is expected to become a significant public transport interchange for bus and local rail services, with public transport potentially capturing up to ten per cent of the Gold Coast station access/egress for HSR passengers.

5.7 Conclusion

HSR demand would be strongly focused on the capital cities. Location of HSR stations at existing main termini would provide good accessibility and promote public transport for onward travel to and from HSR stations.

Further analysis of station capacity would be required should the HSR program progress through subsequent development stages. However, analysis in this study indicates that, with careful planning, the capital city termini could accommodate HSR demand and facilities as the network develops.

At Brisbane this would require the provision of new platforms on the site of the existing transit centre, and at the Gold Coast a new station would be provided adjacent to the existing Robina station. Sydney would require construction of new platforms and facilities beneath the existing concourse at Central station. At Canberra, a completely new station could be provided in the median of Ainslie Avenue, providing good access to Civic. The area occupied by the existing platforms one to five at Melbourne's Southern Cross station would need to be reconfigured and extended.

There is no requirement for significant additional major public transport infrastructure to provide access to the preferred city centre stations. Modifications would, however, be required at all city locations to cater for the increased demand from HSR.

Regional stations have generally been located outside existing developed areas, where they would be well served by the regional highway network and where parking could be provided with minimal impact on existing communities. Access to regional stations would be predominantly by car and taxi.



6

The background features several diagonal stripes in various shades of teal, ranging from light to dark, running from the top-left towards the bottom-right. The stripes are of varying widths and create a dynamic, layered effect. The bottom-right corner of the image is a solid white triangle.

6

Staged delivery

6.1 Rationale and methodology for system staging

The size and complexity of an HSR program, together with the overall estimated capital cost, are sufficient to conclude that it would need to be delivered not as a single project, but in a series of stages.

A staged approach would reduce the upfront funding demands and allow for future funding to be staggered. It would also allow revenue to be generated on sections of the system as they are completed.

The optimal timing and order of stages is primarily driven by passenger demand, economic conditions and financial (funding) considerations. This chapter describes the assessment of the staged delivery of a future HSR system, drawing upon the travel markets analysis presented in **Chapter 2**, the commercial appraisal presented in **Chapter 7** and the economic appraisal presented in **Chapter 8**.

The demand assessment and the analysis of HSR system alternatives and alignments have identified five primary route segments along the east coast travel corridor, connecting the major centres of expected future demand:

- Brisbane-Gold Coast.
- Gold Coast-Newcastle.
- Newcastle-Sydney.
- Sydney-Canberra.
- Canberra-Melbourne.

The optimal staged delivery of a future HSR program has to consider the sequencing and timing of construction of each of these five primary segments, based on a consideration of net economic benefit and the financial implications of the various options.

The net economic benefit is assessed using cost-benefit analysis (CBA), which seeks to provide a comprehensive assessment of the costs and benefits to users and operators of HSR that can be valued in monetary terms over the evaluation period. It also includes an assessment of externalities, such as environmental impacts, accident cost savings and decongestion benefits. This analysis is conducted for each potential stage. Performance is assessed using the economic internal rate of return (EIRR) and the ratio of economic benefits to cost (the economic benefit-cost ratio, or EBCR).

Chapter 8 provides more detail on the background to the CBA.

Financial implications are assessed by bringing together all costs and revenues for the evaluation period on a risk-adjusted basis. This means that estimates have been adjusted to allow for the variability in components of forecast revenues and

costs. The financial performance of staging options is assessed in terms of the financial internal rate of return (FIRR) and the financial net present value (FNPV). **Chapter 7** provides more detail on the assessment of financial implications.

6.2 Individual segment economic performance

A CBA was undertaken for each segment along the preferred HSR alignment, to assess the comparative economic performance of each segment if it were to commence operation in 2035 on a stand-alone basis (i.e. if each segment was operated independently¹). The results for each segment are presented in **Table 6-1**. Costs and benefits are measured in present values, discounted at four per cent. An explanation of the various economic measures and further detail on the economic analysis is provided in **Chapter 8**.

Table 6-1 Analysis of segment performance (present value (PV), \$2012, \$billion, patronage in 2035, 4% discount rate)

	Sydney- Canberra	Newcastle- Sydney	Brisbane- Gold Coast	Gold Coast- Newcastle	Canberra- Melbourne
Passengers (millions)	5.6	4.2	1.3	1.6	5.1
Passenger kilometres (millions)	1,204	460	124	607	2,007
Distance (kilometres)	283	134	115	606	651
Total costs	22.2	17.2	10.2	35.2	29.9
Total benefits	20.4	7.4	1.9	3.7	19.8
EIRR	3.8%	1.3%	-0.8%	-2.9%	2.6%
EBCR	0.9	0.4	0.2	0.1	0.7

Of all the segments, Sydney-Canberra performs best on a stand-alone basis, but none of the segments would generate satisfactory economic returns as stand-alone lines.

1 Note this means that the costs and benefits of the individual segments cannot simply be aggregated in **Tables 6-2** and **6-3**. In **Table 6-1** each segment is assumed to be independently operational in 2035 for the purposes of determining the first stage. The spur to Canberra is therefore included in both the Sydney-Canberra and the Canberra-Melbourne data but would only be included once when Line 1 as a whole is considered. In addition, the construction of the Sydney-Melbourne line would be in two stages (Sydney-Canberra and Canberra-Melbourne), with the former opening in 2035 and the latter in 2040. The discounted cost would also reduce because of the timing differences.

Table 6-2 compares the performance of the stand-alone segments (Sydney-Canberra and Canberra-Melbourne) with the performance of a completed Sydney-Melbourne corridor. Not

surprisingly, the results improve, as completion of the full corridor allows access to the Sydney-Melbourne market.

Table 6-2 Analysis Sydney-Melbourne segment performance (PV, \$2012, \$billion, 4% discount rate)

	Stand-alone segment performance		Sydney-Melbourne (including Canberra)
	Sydney-Canberra	Canberra-Melbourne	
Passengers (in 2035) (millions)	5.6	5.1	23.7
Passenger kilometres (in 2035) (millions)	1,204	2,007	13,557
Distance (kilometres)	283	651	894
Total costs	22.2	29.9	46.5
Total benefits	20.4	19.8	115.7
EIRR	3.8%	2.6%	7.8%
EBCR	0.9	0.7	2.5

Similar results are evident in the Sydney-Brisbane corridor, as shown in **Table 6-3**. Connecting the three segments significantly increases benefits in comparison to the stand-alone segments, leading

to significantly improved economic results for the full corridor compared to any of the individual segments calculated on a stand-alone basis.

Table 6-3 Analysis of Brisbane-Sydney segment performance (PV, \$2012, \$billion, 4% discount rate)

	Stand-alone segment performance			Brisbane-Sydney (including Gold Coast)
	Newcastle-Sydney	Brisbane-Gold Coast	Gold Coast-Newcastle	
Passengers (in 2035) (millions)	4.2	1.3	1.6	20.7
Passenger kilometres (in 2035) (millions)	460	124	607	10,028
Distance (kilometres)	134	115	651	854
Total costs	17.2	10.2	35.2	48.5
Total benefits	7.4	1.9	3.7	71.5
EIRR	1.3%	-0.8%	-2.9%	5.5%
EBCR	0.4	0.2	0.1	1.5

From an economic perspective, the preferred order would be to construct the Sydney-Melbourne line (Line 1) first. Within Line 1, the Sydney-Canberra segment generates higher benefits than the Canberra-Melbourne segment, and also has a higher economic rate of return (3.8 per cent compared to 2.6 per cent). Sydney-Canberra is therefore preferred as the first stage of Line 1, with construction through to Melbourne commencing as soon as practicable thereafter.

On the northern route from Brisbane to Sydney (Line 2), Newcastle-Sydney generates the highest economic return of the three segments between

Sydney and Brisbane, and is the preferred first stage of the northern route (Line 2). Construction of the Newcastle-Sydney segment would also create network benefits by linking Newcastle into the Sydney-Melbourne line. The final sections of the route to be delivered would therefore be Brisbane-Gold Coast and Gold Coast-Newcastle. Given the size and nature of the construction task for the Gold Coast-Newcastle segment, it is preferable for Brisbane-Gold Coast to be constructed before Gold Coast-Newcastle. The preferred sequence of construction by segment from an economic perspective is shown in **Table 6-4**.

Table 6-4 Cumulative economic impacts for each additional stage of the preferred HSR program staging (PV, \$2012, \$billion, 4% discount rate)

	Sydney- Canberra (1)	Sydney- Melbourne (2)	Newcastle- Melbourne (3)	Brisbane- Gold Coast & Newcastle- Melbourne (4)	Full HSR program (5)
Total costs	22.2	46.5	58.6	64.3	79.3
Total benefits	20.4	115.7	126.7	128.2	180.6
EIRR	3.8%	7.8%	7.3%	7.1%	7.6%
EBCR	0.9	2.5	2.2	2.0	2.3

As illustrated in **Table 6-4**, the Sydney-Melbourne component of the future HSR program generates the highest economic internal rate of return (EIRR) of 7.8 per cent. The first stage from Sydney-Canberra would deliver an economic return of only 3.8 per cent, but completion of the Sydney-Melbourne line would add substantially to the return.

The addition of Newcastle-Melbourne reduces the EIRR to 7.3 per cent. The addition of Brisbane-Gold Coast has a similar impact, with the EIRR reducing to 7.1 per cent. However, completing the Sydney-Brisbane line and finishing construction of the entire network increases the EIRR to 7.6 per cent, due to the wider travel opportunities available across the complete HSR system.

6.3 Financial implications

From a financial perspective, all incremental segments show a negative present value after incorporating all costs and revenues, although a future HSR program would deliver positive operating cash flows once the line was completed through to Melbourne. **Table 6-5** shows construction and operating costs for each segment (in the top two rows) (undiscounted), as well as the incremental financial impacts for each stage of the program (in the bottom two rows).

Table 6-5 Incremental financial impacts for each additional stage of the future HSR program (\$2012, \$billion)

	Sydney- Canberra (1)	Sydney- Melbourne (2)	Newcastle- Melbourne (3)	Brisbane- Gold Coast & Newcastle- Melbourne (4)	Full HSR program (5)
Total capital costs	23.0	49.9	68.8	79.8	114.0
Total operating cashflows	-1.7	38.8	43.2	41.5	64.8
FNPV¹	-21.5	-26.5	-35.2	-41.3	-47.0
FIRR²	N/A³	1.0%	0.9%	0.4%	0.8%

Notes: 1. FNPV has been discounted at four per cent.

2. Real post-tax.

3. N/A denotes an FIRR significantly less than zero that cannot be mathematically calculated.

6.4 Preferred staging of a future HSR program

It is clear that the market, economic and financial performance of HSR is significantly greater for lines completed between state capitals than for the shorter route sections. Additionally, Sydney-Melbourne demonstrates superior economic performance when compared to Brisbane-Sydney. The first priority for the HSR system should therefore be to connect Sydney and Melbourne. This line would have higher demand and greater economic return and financial viability than the line between Sydney and Brisbane, and could also be provided at lower cost.

These two lines could be procured, constructed and operated independently and, for the purposes of staging, are denoted as follows:

- Line 1 - Sydney-Melbourne.
- Line 2 - Brisbane-Sydney.

These two lines would in themselves need to be delivered in stages:

Line 1 Sydney-Melbourne

- Stage 1 – Sydney-Canberra, including Canberra spur.
- Stage 2 – Canberra-Melbourne.

Line 2 Brisbane-Sydney

- Stage 1 – Newcastle-Sydney.
- Stage 2 – Brisbane-Gold Coast, including Gold Coast spur.
- Stage 3 – Gold Coast-Newcastle.

The breakdown of the lines and stages can be seen diagrammatically in **Figure 6-1**.

Figure 6-1 Preferred staging



- KEY** — State border ○ Station location **Not to scale**
- | | |
|---|---|
| Line 1 - Sydney to Melbourne | Line 2 - Sydney to Brisbane |
| — Line 1 - Stage 1 Sydney to Canberra | — Line 2 - Stage 1 Sydney to Newcastle |
| — Line 1 - Stage 2 Canberra spur to Melbourne | — Line 2 - Stage 2 Brisbane to Gold Coast |
| | — Line 2 - Stage 3 Gold Coast spur to Newcastle |

The sequencing of delivery of HSR on the east coast is based on the preferred staging shown in **Figure 6-1**. The program for the first and subsequent stages is described in more detail in the Implementation Plan, provided in **Chapter 12**.

The performance of each of the two segments between Sydney-Canberra and Canberra-Melbourne is substantially inferior to the whole of Line 1. Sydney-Canberra is preferred as the first stage of Line 1, but the economic and financial

analysis makes it clear that the first stage should only be the initial step to establishing the line between Sydney and Melbourne.

HSR demand would be heavily influenced by the completion of the lines between the capital cities. This is reflected in the build-up of demand shown in **Table 6-6**. The *incremental* costs and demand represent the impacts of each individual stage; the *cumulative* totals represent the running total of the costs and demand at each point.

Table 6-6 Cost and demand build up between Brisbane and Melbourne with preferred staging to 2065

Route sector	Cost PV (\$2012 billions) ⁽¹⁾		Demand (millions of passengers per year)	
	Incremental ⁽²⁾	Cumulative	Incremental ⁽²⁾	Cumulative
Sydney-Canberra	22.2	22.2	8.4	8.4
Canberra-Melbourne	24.3	46.5	31.5	39.9
Newcastle-Sydney	12.0	58.6	6.9	46.8
Brisbane-Gold Coast via Gold Coast spur	5.7	64.3	2.3	49.1
Gold Coast-Newcastle	15.0	79.3	34.5	83.6

Note: 1. Costs are different from those in **Table 6-2** and **Table 6-3** as they reflect the timing for the staged program.

2. Incremental demand for these sections is heavily influenced by the travel between the state capitals facilitated through the completion of Line 1 and Line 2.

6.4.1 Timing

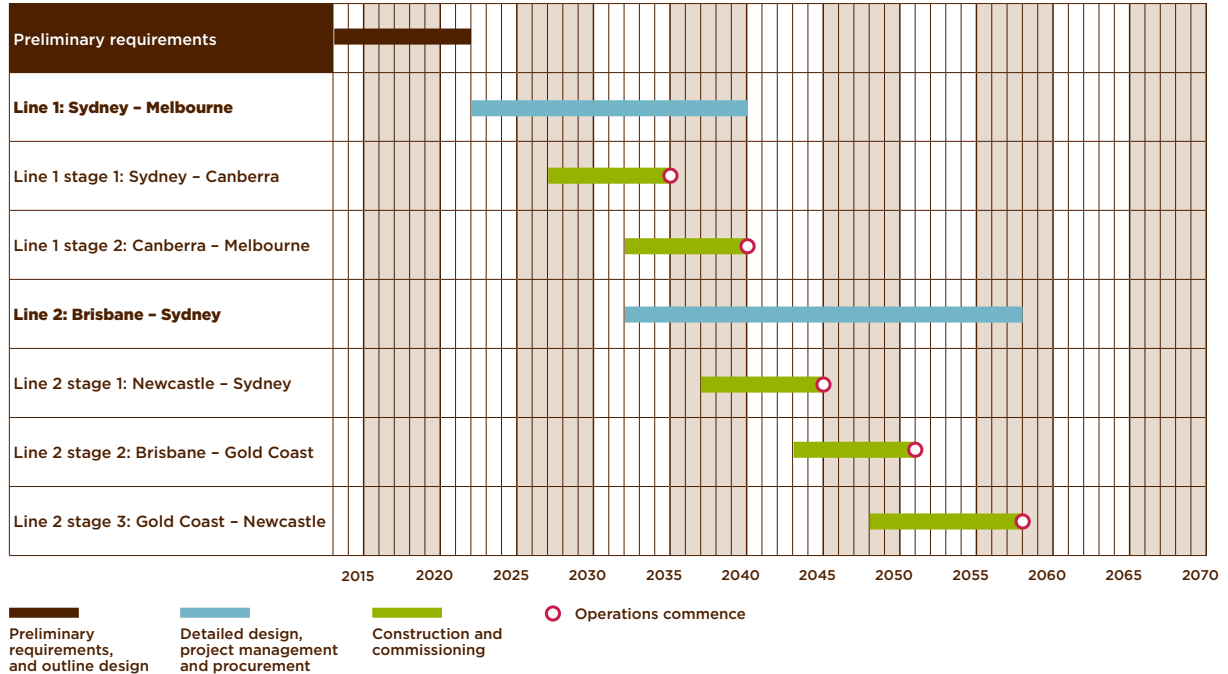
The timing estimates described in this chapter have been developed using established Australian methodologies and capabilities, blended with international precedents of HSR.

The preferred staging of a future HSR program, as shown in **Figure 6-2**, sets out the order of construction with regard to the economic and financial performance of individual segments.

The Sydney-Canberra stage of Line 1 (Line 1 stage 1) would be the first stage to be constructed. The second stage of Canberra-Melbourne (Line 1 stage 2) would follow as soon as practicable

thereafter. Construction timing would be subject to economic and budgetary considerations, but if each stage were to follow soon after the previous stage, the total program would still take around 30 years to fully construct. Although the construction could be accelerated, there are practical issues to consider, including the capacity of industry to efficiently construct a project of this size.

Figure 6-2 Indicative timing of the preferred staging of a future HSR program



For evaluation purposes, the commercial and economic appraisals that follow in **Chapter 7** and **Chapter 8** are based on the indicative program illustrated in **Figure 6-2**, with the opening of the first stage of the HSR program in 2035 and completion of the entire network in 2058. This does not necessarily represent the economically optimal commencement date. Two other options were tested:

- Accelerated roll-out – consists of bringing forward by five years the construction timeline. A 50 year appraisal timeframe has been applied from the date of commencement of construction, with an end date of 2080.

- Deferred roll-out – consists of pushing the construction timeline back by five years. A 50 year appraisal timeframe has been applied with an end date of 2090.

The impacts on the economic and financial results for the accelerated roll out are summarised in **Table 6-7** and **Table 6-8** respectively, with the results for the deferred roll out summarised in **Table 6-9** and **Table 6-10**. The incremental impacts column in each of the tables shows the incremental (i.e. additional) costs and benefits of the accelerated and deferred roll out in comparison to the reference case.

Table 6-7 Impact of an accelerated construction timeframe on the economic results (PV, \$2012, \$billion, 4% discount rate)

Measure	Reference case	Accelerated roll-out	Accelerated roll-out incremental impacts
Total costs	79.3	94.5	15.2
Total benefits	180.6	193.1	12.5
EIRR	7.6%	6.8%	<4%
ENPV	101.3	98.6	-2.7
EBCR	2.3	2.0	0.8

Note: Consistent with the ATC National Guidelines, the accelerated and deferred timeframe applies the same base year (2028) and appraisal timeframe (i.e. 50 years) as the reference case analysis.

The incremental EIRR cannot be accurately calculated due to different end dates for the appraisal period and negative yearly cash flows. As the EBCR is less than 1.0 (applying a four per cent discount rate) it can be inferred that the EIRR is less than four per cent.

Table 6-8 Impact of an accelerated construction timeframe on the financial results (PV, \$2012, \$billion, 4% discount rate)

	Reference case	Accelerated roll-out
Total capital costs	72.0	86.4
Total operating cashflows	15.5	17.1
FNPV	-47.0	-58.7
FIRR (real, post tax)	0.8%	0.5%

Bringing the construction of the future HSR program forward by a period of five years increases both the projects costs and benefits. The incremental economic benefits of the accelerated timeframe (in comparison to the reference case) are, however, less than the incremental economic costs. This generates a reduction in the ENPV of around \$2.7 billion in present value terms (\$2012) although the EBCR remains positive at 2.0. The financial performance under the accelerated roll-out is also inferior to the reference case with a decrease in FIRR of 0.3 per cent.

Table 6-9 Impact of an deferred construction timeframe on the economic results (PV, \$2012, \$billion, 4% discount rate)

Measure	Reference case	Deferred roll-out	Deferred roll-out incremental impacts
Total costs	79.3	66.3	-13.0
Total benefits	180.6	168.7	-11.9
EIRR	7.6%	7.7%	<4%
ENPV	101.3	102.3	1.0
EBCR	2.3	2.5%	0.9

Note: Consistent with the ATC National Guidelines, the accelerated and deferred timeframe applies the same base year (2028) and appraisal timeframe (i.e. 50 years) as the reference case analysis.

The incremental EIRR cannot be accurately calculated due to different end dates for the appraisal period and negative yearly cash flows. As the EBCR is less than 1.0 (applying a four per cent discount rate) it can be inferred that the EIRR is less than four per cent.

Table 6-10 Impact of an deferred construction timeframe on the financial results (PV, \$2012, \$billion, 4% discount rate)

	Reference case	Deferred roll-out
Total capital costs	72.0	60.0
Total operating cashflows	15.5	13.9
FNPV	-47.0	-37.3
FIRR (real, post tax)	0.8%	1.1%

Deferring the construction by five years increases the ENPV by around \$1.0 billion in present value terms (\$2012). While this appears to suggest there may be some economic gain from deferring the project, an additional benefit of around \$1.0 billion it is relatively small when compared to the total reference case ENPV of \$101.3 billion.

It does, however, improve the financial performance compared to the reference case with an increase in FIRR of 0.3 per cent.



7



7

Appraisal of the commercial performance of HSR

7.1 Introduction

The purpose of this chapter is to:

- Identify future HSR program financial costs and revenues.
- Explain the methodology employed to develop the cost and revenue estimates.
- Assess the commercial viability of the future HSR program.
- Outline the level of government support the future HSR program would require if it were to proceed.

In particular, this chapter seeks to answer the following questions:

- What would be the future HSR program's costs and revenues and is the HSR program commercially viable?

- What contribution could the private sector make to financing the future HSR program?
- What is the future HSR program's projected commercial financing gap and how might this gap be closed?

7.2 Financial analysis methodology

A detailed financial model has been developed to support the appraisal of the commercial performance of the future HSR program. The financial model presents the total financial picture of the future HSR program by bringing together all costs and revenues for the evaluation period. An evaluation period of 2015 to 2085 has been selected for the financial analysis so that all project cashflows from the project development stage until 2085 are captured in the analysis, in line with accepted financial analysis principles.

The financial model has been developed in accordance with best practice modelling principles and has been independently audited.

The financial model has been structured to support the analysis of:

- Alternative options for staging the future HSR program, including building from multiple points simultaneously, and the analysis of the future HSR program at initial and various stages of development, including construction, operations or where these are happening simultaneously on different track segments.
- The future HSR program and each business unit individually (infrastructure assets, rolling stock, stations and operations) for the preferred sectors of the alignment (station-to-station or a group of stations).
- Alternative operating regimes including, for example, a single vertically integrated operator, a single vertically separated operator, multiple vertically separated operators, an HSR operator together with separate commuter service operators, and so on.
- Scenario and sensitivity testing around key assumptions and inputs, including demand, fare prices, capital and operational costs, financing and indexation.

A complete listing of financial model assumptions is contained within the financial model data book at **Appendix 6D**. The financial results presented in this chapter are presented in real terms (i.e. in \$2012) unless otherwise stated. Present values have been obtained by discounting cashflows by the evaluation discount rate of four per cent (real) to the base year of 2028 (construction commencement).

The financial analysis in this chapter is presented on a risk-adjusted basis, meaning that estimates have been adjusted to allow for the variability in components of forecast revenues and costs. The risk assessment and quantification process is discussed in **section 7.9** and in detail in **Appendix 6C**. Where costs are presented excluding risk adjustments, they are said to be ‘indicative’.

The analysis presented in this chapter differs from the cost-benefit analysis presented in **Chapter 8** in that it does not include estimates of user benefits or external costs and benefits, but is concerned purely with the financial performance of the project as a commercial undertaking.

7.3 Financial performance and cost

This section outlines the financial performance and cost of the future HSR program and its incremental stages with a focus on the following:

- Line 1 stage 1: Sydney-Canberra (Sydney-Canberra operational).
- Line 1 stage 2: Canberra-Melbourne (Sydney-Melbourne operational).
- Line 2 stage 1: Newcastle-Sydney (Newcastle-Melbourne operational).
- Line 2 stage 2: Brisbane-Gold Coast (Brisbane-Gold Coast and Newcastle-Melbourne operational).
- Line 2 stage 3: Gold Coast-Newcastle (entirety of the HSR program operational).

For example, results for Sydney-Melbourne are based on a system that consists of stages 1 and 2 of Line 1 being operational up to the end of the evaluation period and no further stages being developed.

The timing assumed in the financial analysis for the above stages is consistent with the staging outlined in **Chapter 6**.

The analysis of the financial performance of the future HSR program includes the overall financial results and then explores each of the following components of the program (including how these have been estimated) in more detail:

- Development costs (**section 7.3.2**).
- Construction costs (**section 7.3.3**).
- Rolling stock (**section 7.3.4**).
- Revenue (**section 7.3.5**).
- Operational costs (**section 7.3.6**).
- Asset renewals (**section 7.3.7**).

In addition to this financial performance analysis, **section 7.3.8** and **Chapter 8** present the results of scenario and sensitivity testing of key components and assumptions.

Further details and analysis of the financing assessment and scenarios and sensitivities are provided in **Appendix 6A** and **Appendix 6B**.

7.3.1 HSR program financial results

This section summarises the estimated financial performance of the future HSR program and its stages¹.

Table 7-1 outlines the total project cashflows for risk-adjusted capital costs, revenue, operating costs (including finance leases) and asset renewals over the evaluation period in real terms.

Table 7-1 Summary risk-adjusted capital costs, revenues, operating costs and asset renewals over the evaluation period (\$2012, \$billion)

Item	Sydney-Canberra	Sydney-Melbourne	Newcastle-Melbourne	Brisbane-Gold Coast & Newcastle-Melbourne	HSR program (i.e. Brisbane-Melbourne)
Total development costs	2.2	4.6	6.4	7.4	10.4
Total construction costs	20.8	45.2	62.4	72.4	103.6
Total capital costs	23.0	49.9	68.8	79.8	114.0
Total revenue	17.2	151.8	167.2	169.5	277.8
Total operating costs	-14.2	-96.1	-105.4	-108.2	-189.4
Payments for rolling stock finance leases*	-0.4	-4.7	-5.1	-5.1	-7.5
Total asset renewals	-4.3	-12.2	-13.5	-14.7	-16.1
Total operating cashflows	-1.7	38.8	43.2	41.5	64.8
Terminal value	-1.5	36.9	51.9	49.3	83.4

Notes: Total may not sum due to rounding differences.

As noted above, Brisbane-Gold Coast and Newcastle-Melbourne comprise the fourth stage of the future HSR program. While this stage is operating, two separate sections of track are operating independently and, until the full HSR program is built, there are no services between the Gold Coast and Newcastle.

*Payments for rolling stock finance leases exclude any interest. Assumes that rolling stock is acquired by the future HSR program entering into a finance lease with a third party provider.

¹ The financial analysis presented in this chapter assumes that fast commuter services are operated by a third party under arrangements with relevant state governments. Accordingly, the costs and revenues associated with the running of these services are excluded and a small access charge revenue stream is included in the analysis.

Table 7-1 illustrates that the future HSR program, once the system is constructed with financing by government, is expected to produce sufficient revenue to cover its operating and asset renewals costs. This is the case for all stages of the program, apart from Sydney–Canberra as a stand-alone stage (which generates sufficient revenue to cover its operating costs, but insufficient revenue to maintain and renew its infrastructure asset base into the future).

It should be noted that, due to the long development timeline, the HSR system as a whole is only fully operational for 27 years of the evaluation period (from 2058, when the entirety of the HSR system is assumed to be completed, through to the end of the evaluation period in 2085) and, due to demand ramp-up assumptions², is only operating at full demand for

23 of those years. Accordingly, over the evaluation period, the difference between the total operating cashflows of the HSR program as a whole versus a HSR program consisting of only Sydney–Melbourne is not directly comparable (as Sydney–Melbourne is fully operational for an additional 16 years).

The terminal value shown in **Table 7-2** represents the value of the HSR program's future cashflow generating ability at the end of the evaluation period (i.e. 2085). This value has been calculated by applying the Gordon Growth Model³ to normalised final year cashflows.

Table 7-2 expresses the cashflows in present value terms (i.e. discounted at the evaluation discount rate of four per cent to 2028 (construction commencement)).

Table 7-2 Summary risk-adjusted capital costs, revenues, operating costs and asset renewals over the evaluation period (PV, \$billion, 4% discount rate)⁴

Item	Sydney- Canberra	Sydney- Melbourne	Newcastle- Melbourne	Brisbane- Gold Coast & Newcastle- Melbourne	HSR program
Total development costs	2.3	4.7	6.1	6.8	8.8
Total construction costs	18.6	36.4	46.7	51.5	63.2
Total capital costs	20.9	41.1	52.8	58.3	72.0
Total revenue	5.0	39.4	43.0	43.5	62.7
Total operating costs	-4.4	-25.1	-27.3	-27.9	-42.2
Payments for rolling stock finance leases	-0.1	-1.3	-1.3	-1.3	-1.8
Total asset renewals	-1.0	-2.5	-2.8	-3.0	-3.2
Total operating result	-0.4	10.5	11.6	11.3	15.5
Terminal value	-0.2	4.0	5.6	5.4	9.1
Financial net present value (FNPV)	-21.5	-26.5	-35.2	-41.3	-47.0

Note: Totals may not sum due to cashflow timing and taxation.

Table 7-2 illustrates that neither the HSR program as a whole nor any of its stages produces a positive FNPV at the evaluation discount rate of four per cent. A negative FNPV indicates that neither the

entire HSR program nor any of its stages generates a return in excess of the evaluation discount rate of four per cent.

² Ramp-up assumptions are described in **Chapter 2**.

³ An accepted model for determining the present value of a series of future cashflows.

⁴ Present value costs and revenue obtained by discounting cashflows by the evaluation discount rate of four per cent (real) to the base year of 2028 (construction commencement).

Table 7-3 outlines the profit and loss performance for the future HSR program at key dates during the development and operation of the system. The future HSR program is forecast to produce a positive operating result (operations excluding depreciation) subsequent to Sydney-Melbourne commencing operations in 2040.

By 2065, when the system would be fully operational and passenger demand is fully ramped up, it is expected that the future HSR program would produce a small net profit after tax.

Table 7-3 Summary of profit and loss performance: HSR program (\$2012, \$billion)

Item	Whole of evaluation period	2035	2050	2065
Total revenue	277.8	0.1	3.1	7.7
Total operating costs	-189.4	-0.2	-1.9	-5.3
Gross margin	88.4	-0.1	1.2	2.4
Depreciation on infrastructure assets	-42.3	-0.4	-0.7	-1.0
Depreciation on rolling stock	-6.8	0.0	-0.1	-0.2
Depreciation	-49.1	-0.4	-0.9	-1.2
Interest on external loans and finance leases*	-41.8	0.0	-0.7	-1.2
Profit before tax	-2.5	-0.4	-0.4	0.1
Tax benefit/(expenses)	0.8	0.1	0.1	0.0
Profit after tax	-1.8	-0.3	-0.3	0.1

Notes: Totals may not sum due to rounding differences.

The above table assumes that the following segments will be operational on or before the following dates:

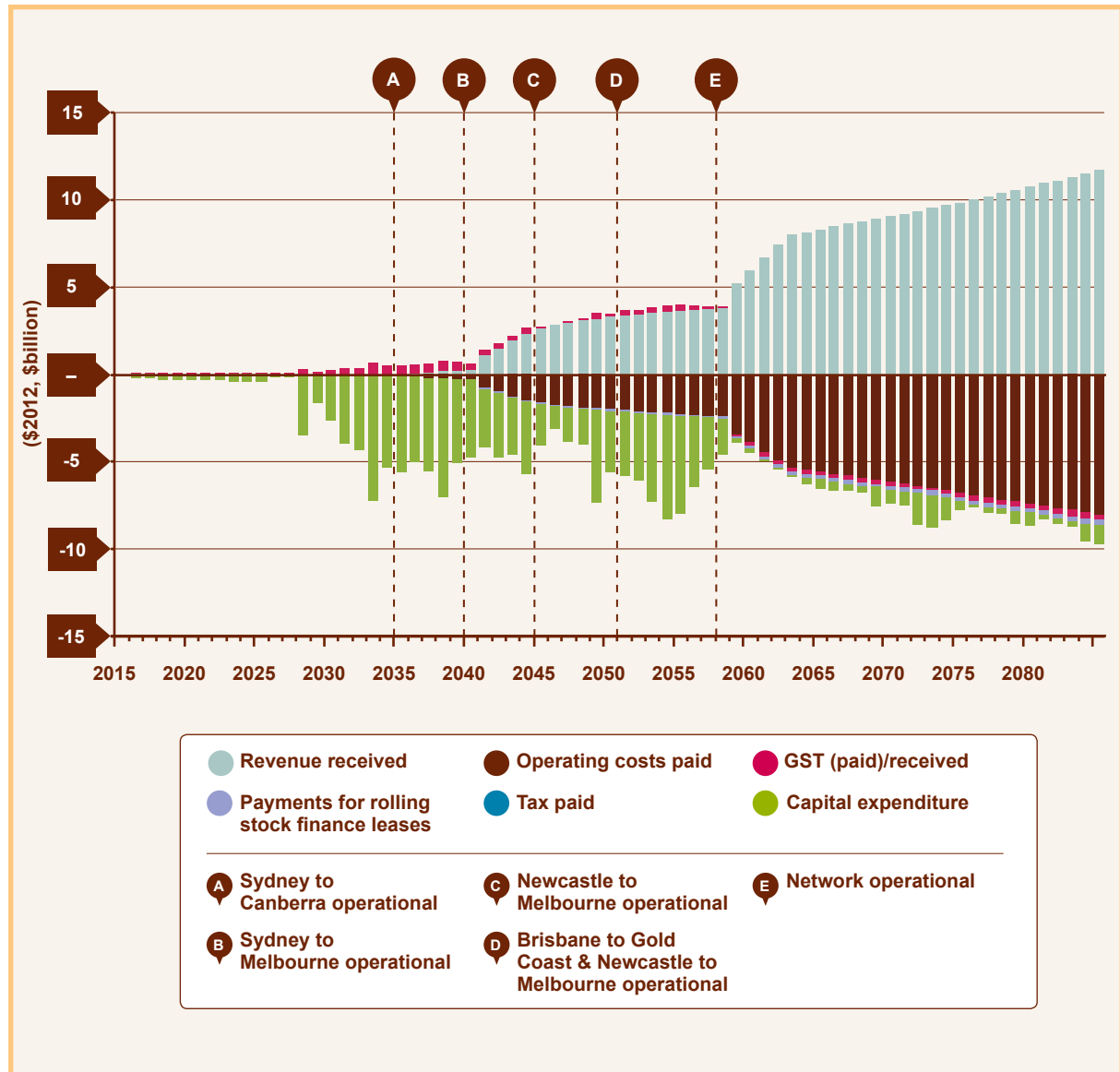
2035: Sydney-Canberra; 2050: Newcastle-Melbourne; 2065: entirety of the HSR program.

In 2035, the first year of system operations, it has been assumed that demand is 40 per cent of the fully ramped-up demand forecast (see **Chapter 2**).

The financial analysis assumes that rolling stock is purchased on finance lease from a third party and that external debt finance is drawn down at the completion of each stage of the system.

*Specifically for the purpose of the above analysis, interest on external loans has been calculated assuming that external loans equal to the HSR program's maximum debt-carrying capacity are drawn down as available during the construction of the future HSR program. Refer to **section 7.4.2** for discussion around the future HSR program's debt-carrying capacity.

Figure 7-1 HSR program risk-adjusted cashflows per year (\$2012, \$billion)



Note: 'Operational' means construction is completed and services are running on that part of the system.

Figure 7-1 illustrates the timing of, and growth in, project cashflows over the evaluation period.

This figure shows the extent to which future HSR program cashflows are expected to be driven by the implementation plan, with significant capital outlays being followed by growth in revenue and operating costs as new sectors become operational. The revenue profile illustrates the step changes in patronage when Sydney-Melbourne and the full HSR program are completed, and the assumed demand ramp-up to full revenue over five years. The figure also highlights that operating costs

move largely in line with revenue due to their highly variable nature.

This also illustrates the significant contrast in cashflow profile with typical infrastructure projects that have an initial construction period of three to five years followed by an operational period. By comparison, the future HSR program has capital works being undertaken over approximately 30 years; and during this period has both significant capital expenditure and operational cashflows occurring at the same time.

Figure 7-2 Net risk-adjusted project cashflows per year (\$2012, \$billion)

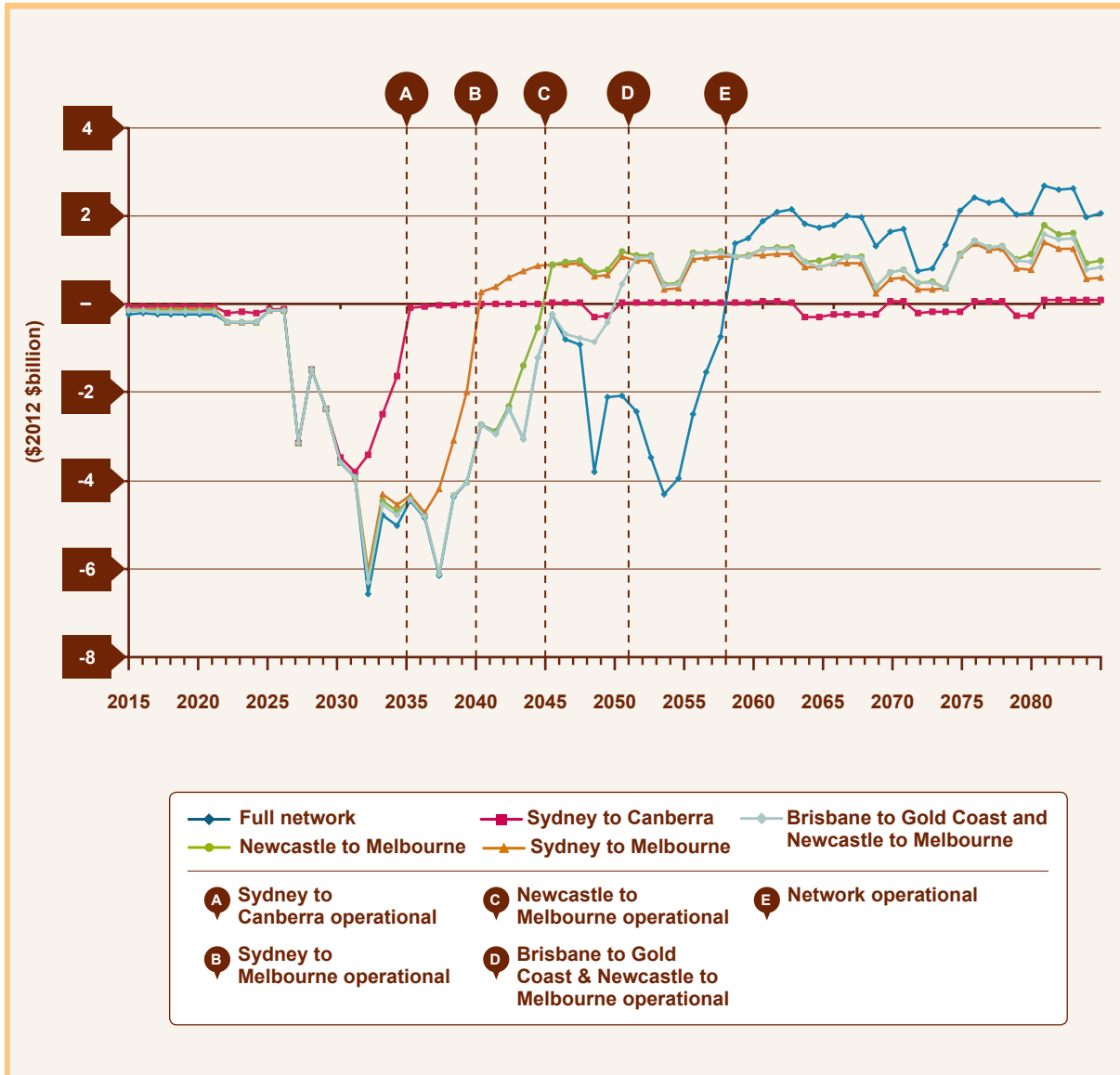


Figure 7-2 illustrates the net risk-adjusted cashflows per year for the future HSR program and its potential stages over the evaluation period.

Subsequent to the construction phase, each of the future HSR program stages is expected to generate sufficient operating income to cover ongoing operational and asset renewal costs (with the exception of Sydney-Canberra as a stand-alone stage⁵). Given this and based on forecast patronage and capital and operating costs being

achieved, there would be no ongoing requirement for governments to subsidise the HSR program operations. Furthermore, by 2065, in all but the +30 per cent cost sensitivity test, the future HSR program generates significant project cashflows (i.e. revenue less operating expenses less renewal of infrastructure assets) of between \$1.1 billion and \$3.9 billion (\$2012) per year (refer to section 7.3.8 for further detail).

5 As Sydney-Canberra is the first stage to be constructed, its financial performance only benefits from the demand in the Sydney-Canberra corridor and not the benefits of travel on the wider network which contributes to the performance of subsequent stages of the future HSR program. It also experiences proportionately high asset renewal costs associated with the high capital value of the first stage.

Table 7-4 summarises the results of the FNPV and Financial Internal Rate of Return (FIRR) analysis on a pre- and post-tax basis for the future HSR program and its stages. To calculate these figures, the future HSR program cashflows have been modelled for the full evaluation period and adjusted to include a terminal value to quantify the HSR program's residual value at the end of the evaluation period (refer to **Appendix 6A** for further discussion).

Table 7-4 Summary of FNPV (4% discount rate) and FIRR results

	Sydney- Canberra	Sydney- Melbourne	Newcastle- Melbourne	Brisbane- Gold Coast & Newcastle- Melbourne	HSR program
FNPV (\$billion)	-21.5	-26.5	-35.2	-41.3	-47.0
FNPV (\$billion, pre-tax)	-21.5	-25.0	-35.2	-41.3	-47.0
FIRR (real)	N/A	1.0%	0.9%	0.4%	0.8%
FIRR (real, pre-tax)	N/A	1.4%	0.9%	0.4%	0.8%
FIRR (nominal)	N/A	3.6%	3.4%	2.9%	3.3%
FIRR (nominal, pre-tax)	N/A	3.9%	3.4%	2.9%	3.3%

Notes: N/A denotes an FIRR significantly less than 0 per cent that cannot be mathematically calculated.

Due to accumulated tax losses (primarily from depreciation on the infrastructure asset base), only the Sydney-Melbourne stage pays corporations tax during the evaluation period. Where tax is not payable, the FIRR and FNPV do not differ on a pre- and post-tax basis.

FNPVs are presented in \$billion with an evaluation base date of financial year 2028 (commencement of construction).

Table 7-4 illustrates that the future HSR program and its potential stages (with the exception of Sydney-Canberra as a stand-alone stage) produce only a small positive return on investment. Consistent with these returns being lower than the evaluation discount rate of four per cent real, neither the future HSR program nor any of its stages would generate positive FNPVs.

The FIRR for Sydney-Canberra as a stand-alone stage cannot be mathematically determined but is significantly negative. However, as noted earlier, the financial performance of this stage on a stand-alone basis is adversely impacted compared to other stages by not having the benefit of additional network demand created when two or more stages are connected.

The following sections (**section 7.3.2** to **section 7.3.7** inclusive) discuss elements of the future HSR program costs and revenues in further detail.

7.3.2 Development costs

Project development costs represent the costs that would be incurred by governments to manage the development of the future HSR program.

These costs include:

- Pre-phase and preliminaries – comprising the costs incurred before the detailed planning and design of the HSR system. This category includes the establishment of HSR program governance arrangements.
- Planning, design and procurement – costs associated with the planning and design of the HSR program including the procurement and preparation of construction contracts and the establishment of a project management framework to oversee the development of the system.
- Construction oversight – comprising the costs borne by the HSR program during the construction phase (project management, supervision, documentation and compliance).

- Commissioning – comprising the costs incurred during the testing and trial running prior to commencement of public operation.

Pre-phase and preliminaries costs would be incurred at the commencement of the future HSR program. Planning, design and procurement costs would be incurred in two phases before construction of each of the lines (Sydney–Melbourne and Brisbane–Sydney). Construction oversight and costs relating to the commissioning of the system would be incurred over the duration of the construction period.

These costs exclude any costs that would be incurred by contractors to design and construct the future HSR program; these costs are outlined in **section 7.3.3**.

Estimates for the development costs for the proposed Australian HSR system have been determined by considering benchmarks from the following HSR lines:

- France (TGV Mediterranee).
- France (Vaires-sur-Marne–Baudrebourg).
- Germany (Rhine/Main).

- Germany (Erfurt–Leipzig/Halle).
- Spain (Madrid–Barcelona).
- Italy (Rome–Naples).
- United Kingdom (HS1).

Development costs on these high speed lines ranged from 7.5 per cent to 16.5 per cent of the aggregate capital costs, with the majority incurred during the construction phase. This wide range between countries reflects a number of factors, including the differences in the length and complexity of HSR systems, as well as the countries' employment and wage structures, and their legal, legislative and political frameworks.

For the future HSR program, 11.5 per cent of the aggregate indicative capital costs has been assumed for development costs, with a distribution between components as shown below in **Table 7-5**. This takes into consideration that the costs from the benchmarked systems included land acquisition costs (which in this study are separately estimated at 3.4 per cent of total indicative costs) and the length of the proposed HSR route when compared to the above international examples (2.5 to 16 times longer).

Table 7-5 Summary of development cost components

Development cost component	Assumed cost (% of aggregate indicative capital expenditure)
Pre-phase and preliminaries	1.7
Planning, design and procurement	3.0
Construction oversight	6.2
Commissioning	0.6
Total	11.5

Table 7-6 summarises the risk-adjusted project development costs for the future HSR program and its stages.

Figure 7-3 illustrates cumulative risk-adjusted project development cashflows over the evaluation period on the basis that the full future HSR program would be delivered.

Table 7-6 Risk-adjusted project development costs (\$2012, \$billion)

Cost	Sydney- Canberra	Sydney- Melbourne	Newcastle- Melbourne	Brisbane- Gold Coast & Newcastle- Melbourne	HSR program
Pre-phase and preliminaries	0.3	0.7	0.9	1.1	1.5
Planning, design and procurement	0.6	1.2	1.7	1.9	2.7
Construction oversight	1.2	2.5	3.4	4.0	5.6
Commissioning	0.1	0.2	0.3	0.4	0.5
Total	2.2	4.6	6.4	7.4	10.4

Note: Totals may not sum due to rounding differences.

Figure 7-3 HSR program risk-adjusted cumulative project development costs (\$2012, \$billion)

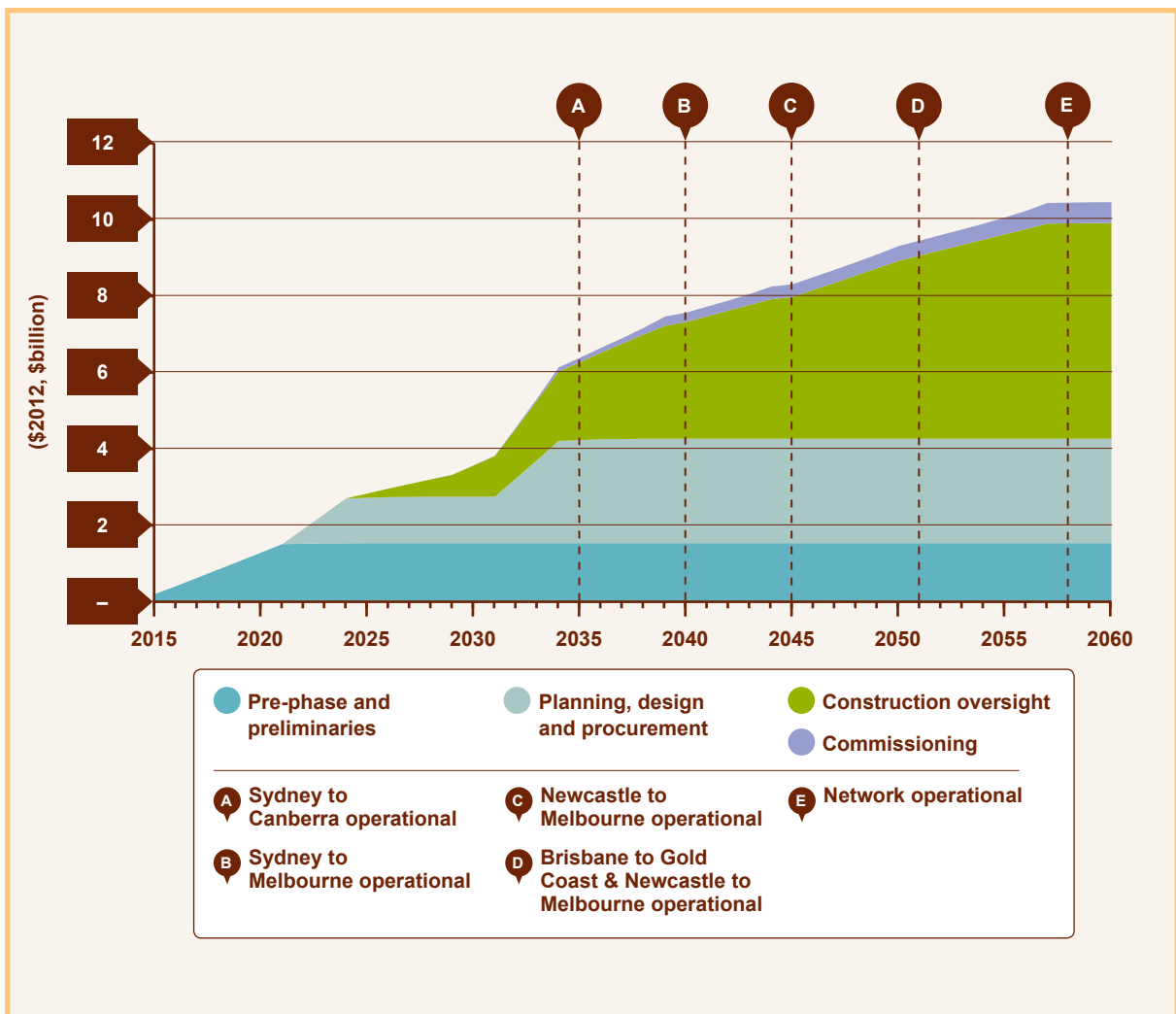


Figure 7-3 illustrates that the project development cashflows are driven by the implementation plan for the future HSR program and reflect the proposed timeline for development and commencement of construction for individual HSR program stages.

7.3.3 Construction costs

The construction cost estimates take into consideration the development of all aspects of the HSR infrastructure, stations and facilities and land required for the construction of the future HSR system. The costs comprise the following components:

- Tunnels – costs relating to the construction of tunnels along the alignment. The tunnels are generally twin tunnels; each 7.5 metres in diameter, interconnected every 250 metres with cross-passages. Full details of the proposed types of tunnel, as well as other infrastructure, are contained in **Appendix 2B**.
- Bridges – costs relating to the construction of bridges and viaducts along the alignment.
- Earthworks – costs relating to cuttings in soil or rock, embankments, fill and haulage and disposal of spoil.
- General civil works – costs relating to items associated with the development of the permanent way. This includes building retaining walls, access roads, fencing and security, noise mitigation, ground stabilisation, utilities relocation, site clearance, drainage and landscaping.
- Permanent way – costs relating to the track and its immediate surrounds.
- Signalling and communications – costs relating to signalling and communications. This includes apparatus rooms, cabling, structures (radio towers) and point ends.
- Power – costs relating to the construction of power transmission assets (includes substations and power lines to connect the HSR system to the national electricity market) and the construction of distribution assets (overhead line equipment and point end supply).
- Stations – costs relating to stations and their associated fit out. This includes equipment and plant, buildings and structures, station car park and electrical and mechanical elements.
- Depots, control centre and facilities – costs relating to stabling facilities, maintenance depots and control centres. This includes items of fit out such as property, plant and equipment, information technology systems and amenities.
- Land – costs relating to the acquisition of land along the alignment and at station, depot and control centre sites.

Construction costs associated with the alignment have been estimated by compiling the data generated by Trimble Planning Solutions' alignment planning software, Quantm, and applying an appropriate unit rate to each cost component. The unit rates were developed in a bottom-up manner by the study team's cost estimators and were benchmarked against recent domestic experience, and international experience for aspects unique to HSR construction and operation.

Cost components not quantified by the alignment software, such as stations and depots, were developed in a bottom-up manner based upon the design specifications produced by the study team. Individual unit rates for each cost type were reflective of current industry norms and applied against the appropriate units of measurement (area, volume and others). Estimates for machinery, plant and land were then added. Full details of the capital cost estimation process can be found in **Appendix 4B**.

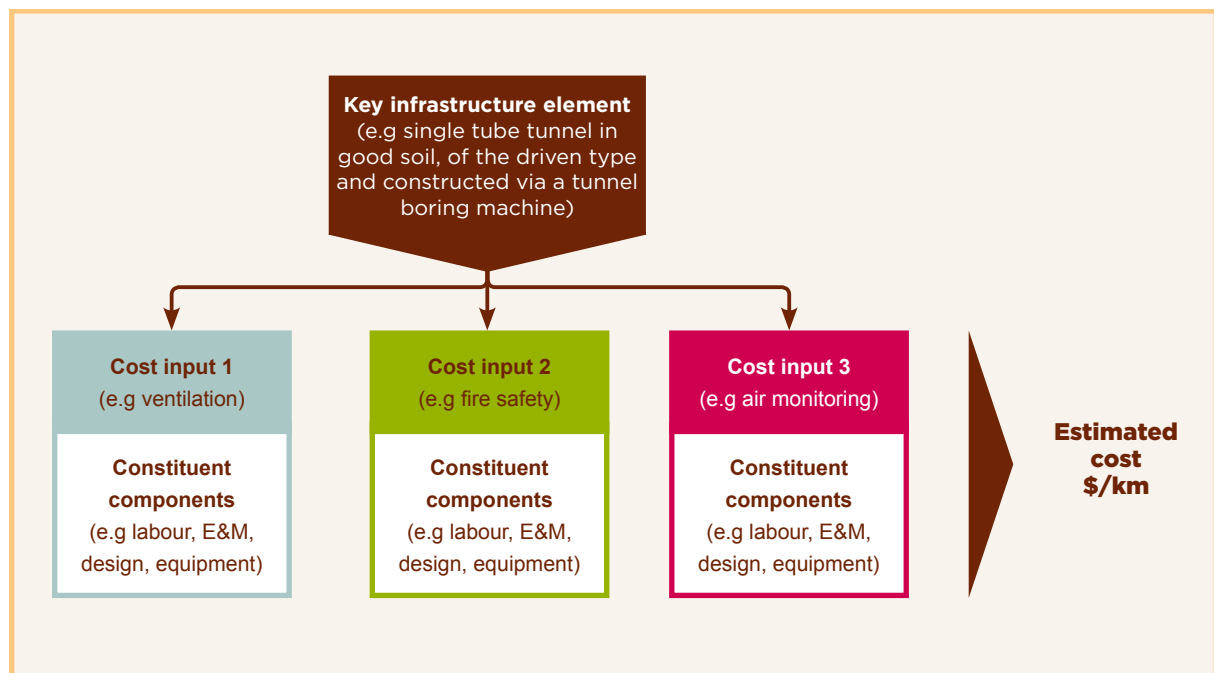
As construction costs are largely based on the quantified outputs from the alignment software, which has inherent limitations in topographical data (such as actual ground levels, broad levels of geological and hydrological information), along with conceptual design solutions, there is inherent uncertainty in the actual capital cost. This uncertainty has been addressed as part of the risk quantification process detailed in **section 7.9**.

Unit rates

Unit costs were developed for ten types of infrastructure elements including tunnels, stations and power systems in a bottom-up manner using

basic cost components such as labour, plant and materials. **Figure 7-4** illustrates the process for the build-up of a unit rate of a single tube tunnel.

Figure 7-4 Example for unit costing build-up process



Note: E&M = electrical and mechanical.

Unit rates for civil infrastructure elements were benchmarked against recent domestic projects, particularly rail, and on HSR projects internationally. Where benchmarks were not available or applicable, unit rates for infrastructure elements have been developed from first principles, with the constituent components (such as rates for supply and placement of concrete) corresponding to current domestic sales and delivery prices.

The unit rates used for tunnelling were inclusive of tunnelling equipment mobilisation and removal, tunnel excavation and lining, spoil disposal, development of cross passages, ventilation and access shafts, temporary and permanent power, ventilation and lighting, slab track and overhead catenary, as well as signalling and communications requirements. **Table 7-7** illustrates this cost build-up for a five kilometre urban twin bore

single track tunnel, using recent Australian tunnel rates and prices. Shorter tunnels would be more expensive per kilometre because of the initial establishment and equipment costs. A number of different lengths and configurations of tunnel were similarly calculated and an average rate of \$150 million (\$2012) per kilometre adopted for all tunnels across the study. In urban areas a further provision of \$20 million per kilometre was added for additional - but as yet unquantifiable - safety measures (such as additional escapes and caverns in the long approach tunnels), bringing the indicative cost per kilometre up to a total of \$170 million (\$2012) for urban tunnels.

Table 7-7 Example cost build-up of 5 km urban twin bore single track tunnel (\$2012)

Item	Sub item	Unit	Quantity	Rate	Labour	Plant	Materials	Sub-contractor	Total	
Establishment										
1.1	Setup worksite/ temporary works	Item	1	25,008,500	-	-	-	25,008,500	25,008,500	
1.2	Supply power	Item	1	550,000	-	-	-	550,000	550,000	
1.3	Supply tunnel boring machine	Item	1	86,074,400	26,400	86,048,000	-	-	86,074,400	
1.4	Setup tunnel boring machine	Item	1	697,600	580,800	116,800	-	-	697,600	
1.5	Turn tunnel boring machine	Item	1	-	-	-	-	-	-	
1.6	Supply mucking equipment	Item	1	2,686,000	66,000	2,620,000	-	-	2,686,000	
1.7	Demobilisation	Item	1	2,367,900	181,500	1,271,400	-	915,000	2,367,900	
	Indexation on the above*				42,735	4,502,810	-	1,323,675	5,869,220	
Total establishment						897,435	94,559,010	-	27,797,175	123,253,620
Tunnel works										
2.1	Excavation	m ³	594,470	70	34,630,237	5,510,643	1,619,081	-	41,759,960	
2.2	Spoil removal	m ³	594,470	78	-	46,329,029	-	-	46,329,029	
2.3	Primary support	m ²	232,321	23	1,575,000	1,050,000	2,625,000	-	5,250,000	
2.4	Waterproofing	m ²	232,321	66	-	-	-	15,402,867	15,402,867	
2.5	Segmental support	m ²	224,310	397	-	-	-	89,151,563	89,151,563	
2.6	Cross passages	No	20	107,142	225,854	342,992	184,000	1,389,989	2,142,834	
2.7	Backfill tunnel floor	m ³	65,000	300	-	19,500,000	-	-	19,500,000	
2.8	Pavement	m ²	-	-	-	-	-	-	-	
2.9	Longitudinal drainage	m	10,000	321	432,000	529,500	1,926,200	320,000	3,207,700	
2.10	Cross tunnel drainage	m ²	30,136	50	-	-	-	1,494,000	1,494,000	
2.11	Barrier	m	-	-	-	-	-	-	-	
2.12	Precast panelling	m ²	-	-	-	-	-	-	-	
2.13	Smoke duct	m ²	-	-	-	-	-	-	-	
2.14	Structures	item	1	11,600,000	3,480,000	2,320,000	5,800,000	-	11,600,000	
2.15	Services duct	m	10,000	920	-	-	9,200,000	-	9,200,000	
	Indexation on the above*				2,017,155	3,779,108	1,067,714	5,387,921	12,251,898	
Total tunnel works						42,360,245	79,361,271	2,421,995	113,146,341	257,289,851

Chapter 7 Appraisal of the commercial performance of HSR

Table 7-7 Example cost build-up of 5 km urban twin bore single track tunnel (\$2012) (continued)

Item	Sub item	Unit	Quantity	Rate	Labour	Plant	Materials	Sub-contractor	Total
Tunnel temporary services									
3.1	Power	item	2	1,600,000	-	-	-	3,200,000	3,200,000
3.2	Lighting	item	2	175,000	-	-	-	350,000	350,000
3.3	Ventilation	item	2	1,200,000	-	-	-	2,400,000	2,400,000
3.4	Compressed air	item	2	700,000	-	-	-	1,400,000	1,400,000
3.5	Pumping	item	2	1,000,000	-	-	-	2,000,000	2,000,000
	Indexation on the above*				-	-	-	467,500	467,500
Total tunnel temporary services					-	-	-	9,817,500	9,817,500
Fit out and other									
	Ventilation				-	-	-	6,000,000	6,000,000
	Fire				-	-	-	9,000,000	9,000,000
	Electrical				-	-	-	3,750,000	3,750,000
	Lighting				-	-	-	11,250,000	11,250,000
	Track				-	-	-	15,000,000	15,000,000
	Extra over for slab track				-	-	-	7,500,000	7,500,000
	Overhead line and equipment				-	-	-	9,062,500	9,062,500
	Communication and signalling				-	-	-	9,075,000	9,075,000
	Mark-up (contractor overheads, supervision, site establishment)				28,550,068	114,787,385	14,798,517	119,302,270	277,438,241
Total fit out and other					28,550,068	114,787,385	14,798,517	189,939,770	348,075,741
Total cost of 5 km tunnel									738,436,712
Average cost per km									147,687,342

Note: Totals may not sum due to rounding.

*Indexation has been applied to present cost estimates in \$2012.

A full explanation of the estimating procedure is given in **Appendix 2B**.

Unit prices for non-civil categories of infrastructure, such as electrical, signalling and communication, were cross-checked against the sales and delivery prices of these cost elements in recent domestic and international conventional rail and HSR projects.

Unit prices for land acquisitions were based on the most recent valuation of the unimproved land value within the given local government area for the given land use type, expressed as a cost per square

metre. These unit prices were sourced from the state and territory Offices of the Valuer-General (or equivalent).

The compensatory uplifts outlined in **Table 7-8** were then applied to the unimproved value of the land acquired to compensate for improvements and the fact that only a portion of the land is assumed to be acquired (not the entire property). For the purpose of this study, neither individual properties nor ownership of these properties have been considered; the uplifts have been applied at the aggregate, rather than at the specific property level.

Table 7-8 Assumptions on compensatory uplifts – HSR alignment in rural and urban settings

Land use type	Geographical setting	Compensatory uplift (multiplied by)
Residential	Rural	4
Commercial or business	Rural	4
Industrial	Rural	2
Rural (non-agricultural)	Rural	2
Agricultural	Rural	2
Other	Rural	2
Residential	Urban	10
Commercial or business	Urban	10
Industrial	Urban	5
Rural (non-agricultural)	Urban	N/A*
Agricultural	Urban	N/A*
Other	Urban	5

Notes: Compensatory uplift factors have been obtained through discussions with state road and land development authorities.

*In urban areas, rural (non-agricultural) and agricultural land uses do not occur.

Quantities

Quantities were estimated using three methods:

- Alignment civil works – within a specified alignment, Quantm identified the location and quantities of the required earthworks, retaining walls, structures and tunnels. For structures and tunnels, the software identified the infrastructure type, its length and height (or depth). The relevant unit rate was then applied on a linear basis to the length of the individual piece of infrastructure.
- Linear items applied to the alignment (such as fencing, revegetation and utilities relocation), permanent way (such as track slab and rail) and power distribution (including the overhead catenary) – costs were applied on a linear or recurrent basis along the full length of the alignment. This approach was also used where costs occurred at regular intervals along the length of the alignment, such as power distribution (auto transformers every ten kilometres) and signalling.
- Site specific requirements – where certain items (for example depots, stations, stabling yards) are required at specific locations, the associated site-specific costs for these items have been applied at those locations.

Costs relating to land include all land to be acquired for both temporary and permanent purposes, for the construction, development and operation of the preferred HSR system. This includes land for corridor preservation and the development of the alignment (approximately 10,500 hectares), stations, depots and stabling facilities, station car parks, traction power substations, tunnel ventilation and emergency ingress/egress shafts and the purchase of land to offset environmentally sensitive land or land within national parks, for a total acquisition of approximately 13,000 hectares.

Appendix 4B provides a detailed breakdown of land requirements.

Construction cost estimates

Table 7-9 summarises the risk-adjusted infrastructure construction costs for the future HSR program and its stages.

Tunnels make up 144 kilometres (eight per cent) of the preferred alignment and are the most significant construction cost element (29 per cent of total construction costs).

During the development of the preferred alignment, the cost of tunnelling in urban areas was assessed to be less than that of viaducts along existing road or rail corridors (due to the additional costs associated with land acquisitions, diversion of existing services and grade separated crossings). In addition, the use of tunnels has a significantly lower residual environmental impact in comparison to viaducts, making them the preferred method of accessing urban areas. Tunnels and bridges (including viaducts) combined represent close to 50 per cent of the total construction costs.

Costs relating to the construction of the alignment (tunnels, bridges, earthworks, general civil works and permanent way) account for 81 per cent of the future HSR program's construction costs. The remaining 19 per cent is accounted for by costs associated with land, stations, depots, power infrastructure and control systems. Details of these capital cost estimates are contained in **Appendix 4B**.

Table 7-10 summarises the risk-adjusted infrastructure construction costs by geographic sector.

Table 7-9 Risk-adjusted infrastructure construction costs (\$2012, \$billion)

Cost	Sydney- Canberra	Sydney- Melbourne	Newcastle- Melbourne	Brisbane- Gold Coast & Newcastle- Melbourne	HSR program
Tunnels	7.9	10.8	22.0	24.2	30.0
Bridges (including viaducts)	1.8	6.6	8.0	10.4	19.4
Earthworks	2.9	8.5	9.8	10.8	17.7
General civil works	1.5	4.3	5.2	5.8	8.4
Permanent way	1.2	4.2	4.6	5.1	8.1
Land	1.5	2.1	2.6	3.6	3.9
Subtotal – civil and land costs	16.8	36.6	52.3	60.0	87.5
<i>Civil and land costs per route km (\$million per km)</i>	<i>59.4</i>	<i>40.9</i>	<i>50.9</i>	<i>52.5</i>	<i>50.1</i>
Signalling and communications	0.3	0.8	1.0	1.2	1.8
Power	1.0	3.1	3.5	4.0	6.1
Stations	2.6	4.2	5.1	6.6	7.5
Depots, control centre and facilities	0.2	0.4	0.4	0.6	0.7
Total cost	20.8	45.2	62.4	72.4	103.6

Notes: Totals may not sum due to rounding differences. Table excludes project development costs.

Table 7-10 Risk-adjusted construction costs by geographic sector (\$2012, \$billion)

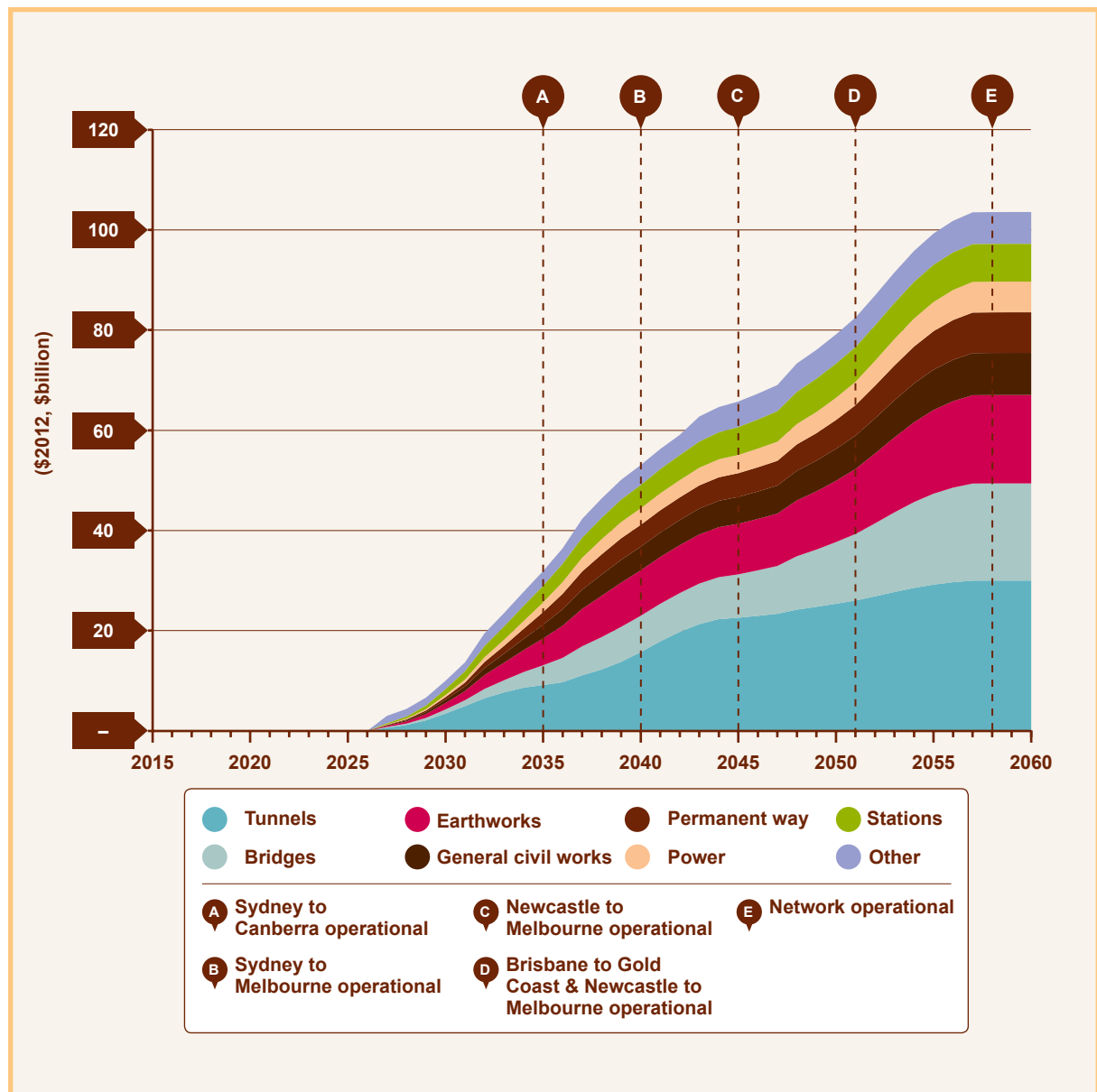
	HSR system					HSR program
	Line 1 Sydney- Melbourne		Line 2 Brisbane-Sydney			
	Sydney- Canberra (stage 1)	Canberra- Melbourne (stage 2)	Newcastle- Sydney (stage 3)	Brisbane- Gold Coast (stage 4)	Gold Coast- Newcastle (stage 5)	
Total cost	20.8	24.4	17.2	10.0	31.2	103.6
<i>Total cost per route km (\$million per km)</i>	<i>73.6</i>	<i>39.9</i>	<i>128.8</i>	<i>87.3</i>	<i>51.5</i>	<i>59.3</i>

Sydney-Melbourne accounts for 44 per cent of the total construction costs and has a significantly lower cost per route kilometre than Brisbane-Sydney (\$51 million per route kilometre compared to \$68 million per route kilometre (\$2012)), primarily due to the terrain north of Sydney requiring a significantly higher proportion of tunnels and bridges compared with that south of Sydney.

The costs presented in **Table 7-9** and **Table 7-10**, together with the project development costs outlined in **Table 7-6**, represent an estimated risk-adjusted total cost of developing a fully operational HSR program of \$114.0 billion (\$2012).

Figure 7-5 illustrates cumulative risk-adjusted construction costs over the evaluation period.

Figure 7-5 HSR program risk-adjusted cumulative construction costs (\$2012, \$billion)



Note: Other refers to land, signalling and communications, and depots, control centre and facilities.

The profile of future construction costs, and when these would be incurred across a future HSR program timeline, is primarily dependent on the implementation plan and therefore the timing of the construction of individual stages. The construction of the future HSR program is forecast to take place over a total of around 30 years with an average annual expenditure of \$3.3 billion per

year, a minimum expenditure of \$1.1 billion per year and a maximum expenditure of \$5.9 billion per year over the period (excluding development and asset renewal costs). This is further illustrated in **Figure 7-6**, which presents annual risk-adjusted development, construction and asset renewal costs for the duration of the evaluation period.

Figure 7-6 HSR program risk-adjusted annual development, construction and asset renewal costs (\$2012, \$billion)

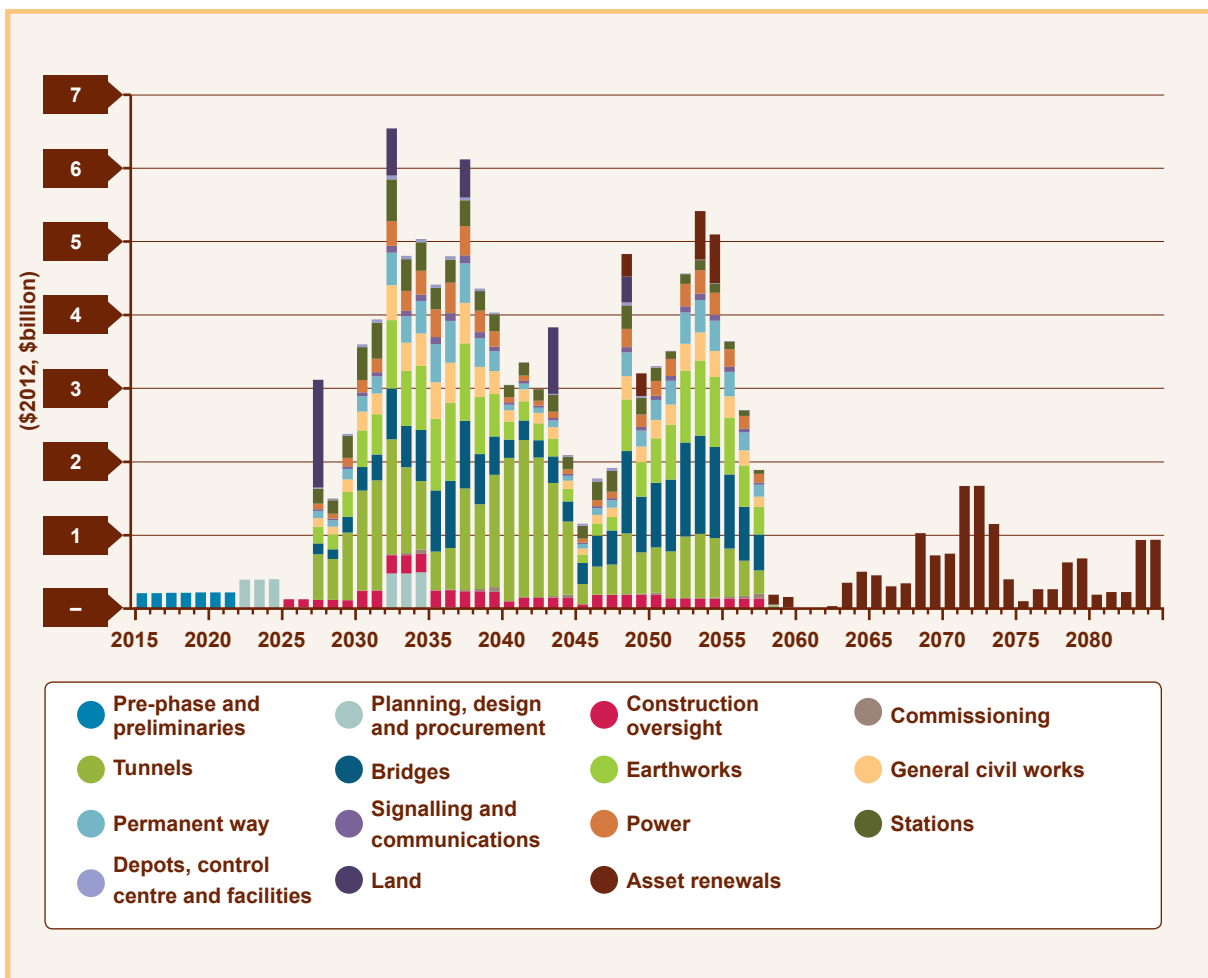
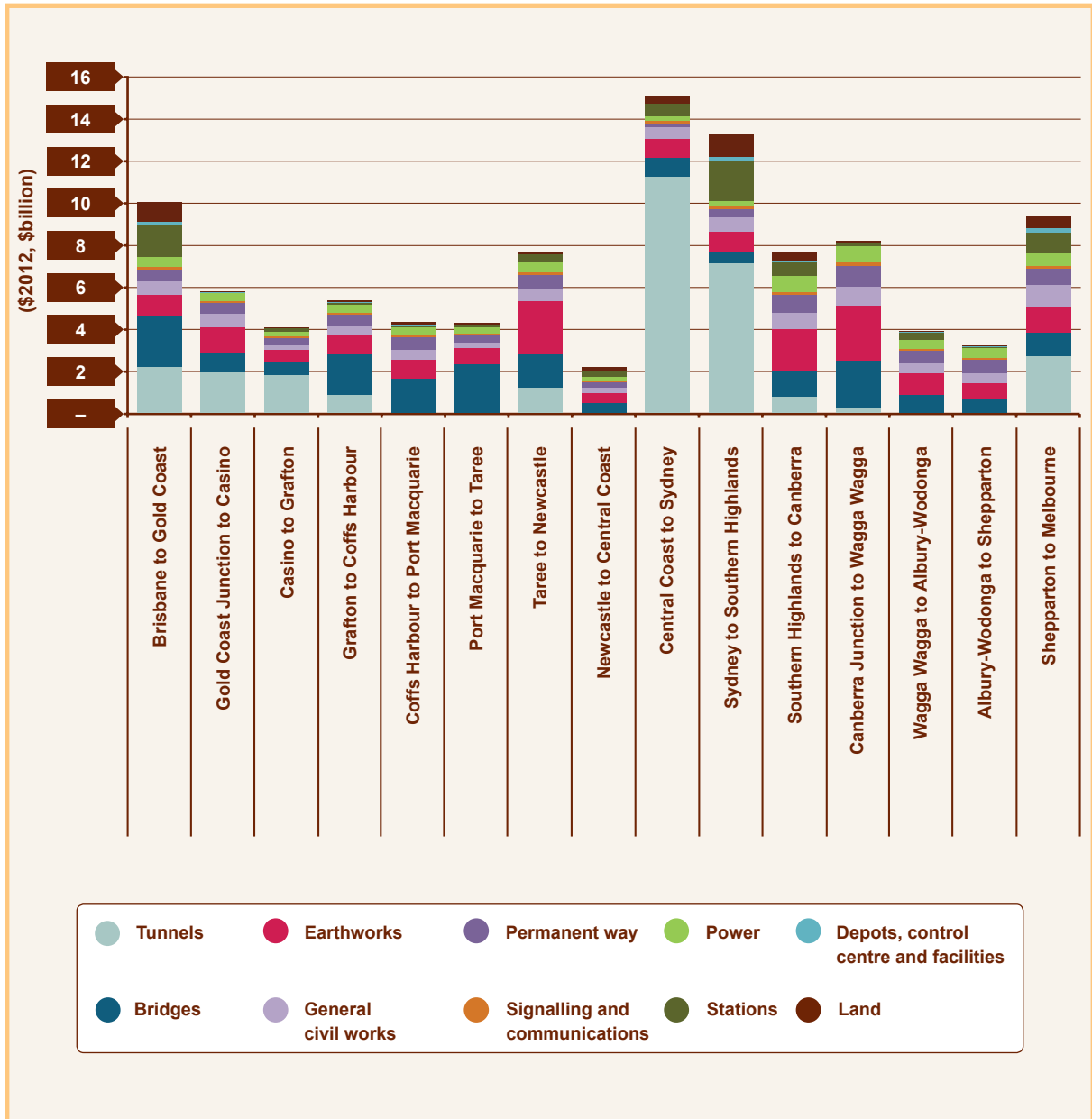


Figure 7-7 provides a segment-by-segment breakdown of construction costs for the future HSR program.

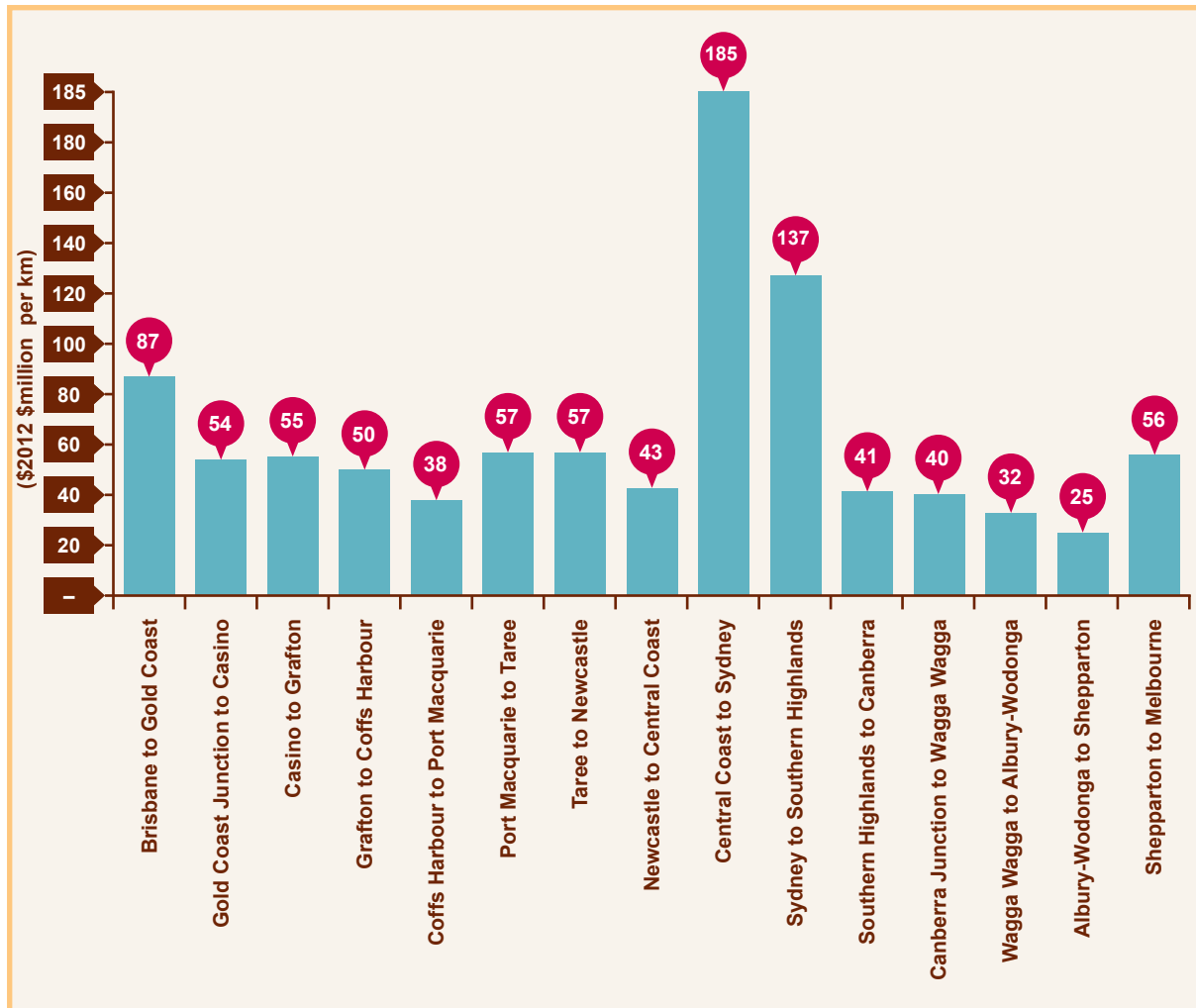
Figure 7-8 presents average construction costs per route kilometre on a segment-by-segment basis.

Figure 7-7 HSR program risk-adjusted construction costs by segment (\$2012, \$billion)



Note: The references to 'Gold Coast Junction' and 'Canberra Junction' describe the points at which the Gold Coast and Canberra spurs leave the main alignment.

Figure 7-8 HSR program average risk-adjusted construction costs per route km (\$2012, \$million per km)



Note: The references to ‘Gold Coast Junction’ and ‘Canberra Junction’ describe the points at which the Gold Coast and Canberra spurs leave the main alignment.

As illustrated in **Figure 7-7** and **Figure 7-8**, assessing the construction cost on a per route kilometre basis demonstrates that the cost of the potential stages varies significantly based on the terrain and surface development through which the alignment passes. For example, 60 per cent of the program’s tunnelling costs are incurred on the north and south approaches to Sydney between the Central Coast and the Southern Highlands; 45 per cent of the bridge costs are incurred connecting Gold Coast and Newcastle; and 35 per cent of the station costs are incurred in the Sydney–Canberra segment (due to the cost of redeveloping Sydney Central, the largest station on the network). This in turn impacts on the future HSR program’s average cost per kilometre of track constructed and the costs of applicable HSR program sectors and stages.

7.3.4 Rolling stock

The system is assumed to be serviced by a mixture of eight and 12-car train sets, with the 12-car train sets being used to operate the express services between capital cities (Sydney–Melbourne and Brisbane–Sydney express services).

Cost estimates for the train sets that have been specified for use have been established through a series of consultations with four leading high speed train suppliers. These estimates have also been benchmarked against HSR rolling stock costs from several HSR fleets in Europe and Asia.

The number of train sets required has been calculated with reference to the service plans detailed in **Appendix 2A** (which estimate the number of train sets required to meet service requirements for a given level of demand). Rolling stock is assumed to be financed through a lease arrangement.

Table 7-11 summarises the risk-adjusted rolling stock costs which have been assumed to be financed through a finance lease arrangement for the future HSR program and its stages.

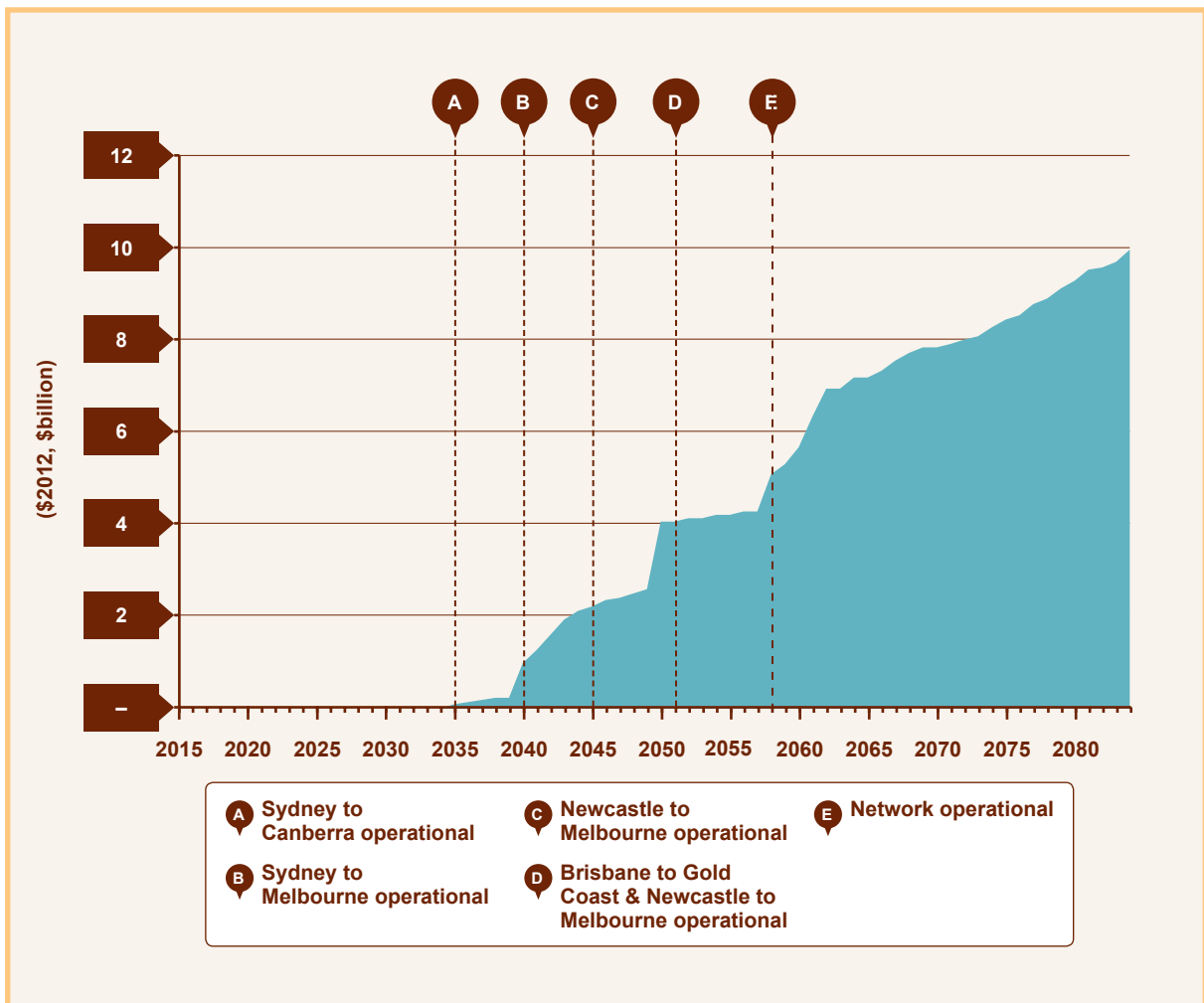
Table 7-11 Risk-adjusted rolling stock costs (\$2012, \$billion)

Cost	Sydney- Canberra	Sydney- Melbourne	Newcastle- Melbourne	Brisbane- Gold Coast & Newcastle- Melbourne	HSR program
Rolling stock	0.4	4.8	5.3	5.3	10.0

Figure 7-9 illustrates the cumulative risk-adjusted cost of rolling stock financed through finance lease arrangements over the evaluation period for the HSR program as a whole.

The total cost of \$10.0 billion (\$2012) which appears in **Table 7-11** can be seen in 2085 (the final year of the evaluation period).

Figure 7-9 HSR program risk-adjusted cumulative rolling stock purchased on finance lease (\$2012, \$billion)



Demand for rolling stock would be driven primarily by the completion of subsequent stages, the rampup of passenger demand as new routes come into operation, and the real increases in demand for travel (taking into account factors such as propensity to travel and population growth). The most significant changes in rolling stock are forecast to occur when Sydney-Melbourne and the full HSR system are completed, reflecting the additional demand that would be created at those points.

7.3.5 Revenue

The revenues available to the future HSR program include the following:

- Commercial ticketing revenue – fare box revenue from passengers travelling on the HSR system. This has been separated into revenue sourced from business and leisure passengers and from express (inter-capital only services) and regional (other services).
- Access charges – revenue received from third parties for the use of the HSR infrastructure to run commuter services.
- Car parking revenue – revenue received from car parking.
- Other revenue – revenue received from stations, including rent received from retail premises, sale of advertising space and other station revenue including naming rights, access charges received from third parties for the use of the alignment to run piping or other utilities and other miscellaneous revenue such as revenue from luggage-related services.

Revenue from on-board services such as the sale of food, drinks and merchandise has been excluded from the financial analysis as it has been assumed that these services would be provided by third parties on a cost-neutral basis to the HSR operator.

Revenue estimates have been developed with reference to demand for travel estimates multiplied by an average fare rate by passenger type for a given journey (described in detail in **Chapter 2**). Average fares for HSR business and leisure travel were designed to be competitive with, and comparable to, air fares on the main inter-capital routes. For example, the reference case assumes the average HSR single economy fare between Sydney and Melbourne would be \$141 for a business passenger and \$86 for a leisure passenger. This variation reflects the tendency for passengers travelling for business to pay more for a ticket than those travelling for leisure (a combination of the booking methods used, the higher tendency of business travellers to purchase flexible tickets, and the tendency to travel at peak times). In practice, a range of fares would be offered, targeted to market segments and influenced by seat utilisation patterns and competitive pressures, as is currently the case with the airlines. Sensitivity tests also considered fares up to 30 per cent and 50 per cent higher, as well as 50 per cent lower for two years in the context of a potential discount price campaign by the airlines. The results of these sensitivity tests are discussed further in **Chapter 8**.

Revenue from commercial development at stations and value capture opportunities is not included in this analysis, as these cashflows are not directly collected by the future HSR program and due to the more speculative nature of these cashflows. These sources of potential revenue are addressed in **section 7.5.1**.

Table 7-12 summarises total risk-adjusted revenue for the future HSR program and its stages.

Table 7-12 Total risk-adjusted revenue (\$2012, \$billion)

Revenue	Sydney- Canberra	Sydney- Melbourne	Newcastle- Melbourne	Brisbane- Gold Coast & Newcastle- Melbourne	HSR program
Commercial ticketing revenue – business – express	–	67.2	70.0	70.0	108.4
Commercial ticketing revenue – business – regional	5.9	18.8	21.1	21.3	34.4
Commercial ticketing revenue – leisure – express	–	31.5	34.0	34.0	60.0
Commercial ticketing revenue – leisure – regional	10.2	26.5	33.5	35.3	61.1
Access charges	–	–	0.2	0.3	0.3
Car parking revenue	0.4	2.4	2.5	2.6	3.8
Other revenue	0.6	5.4	5.9	6.0	9.9
Total	17.2	151.8	167.2	169.5	277.8

Notes: Totals may not sum due to rounding differences.

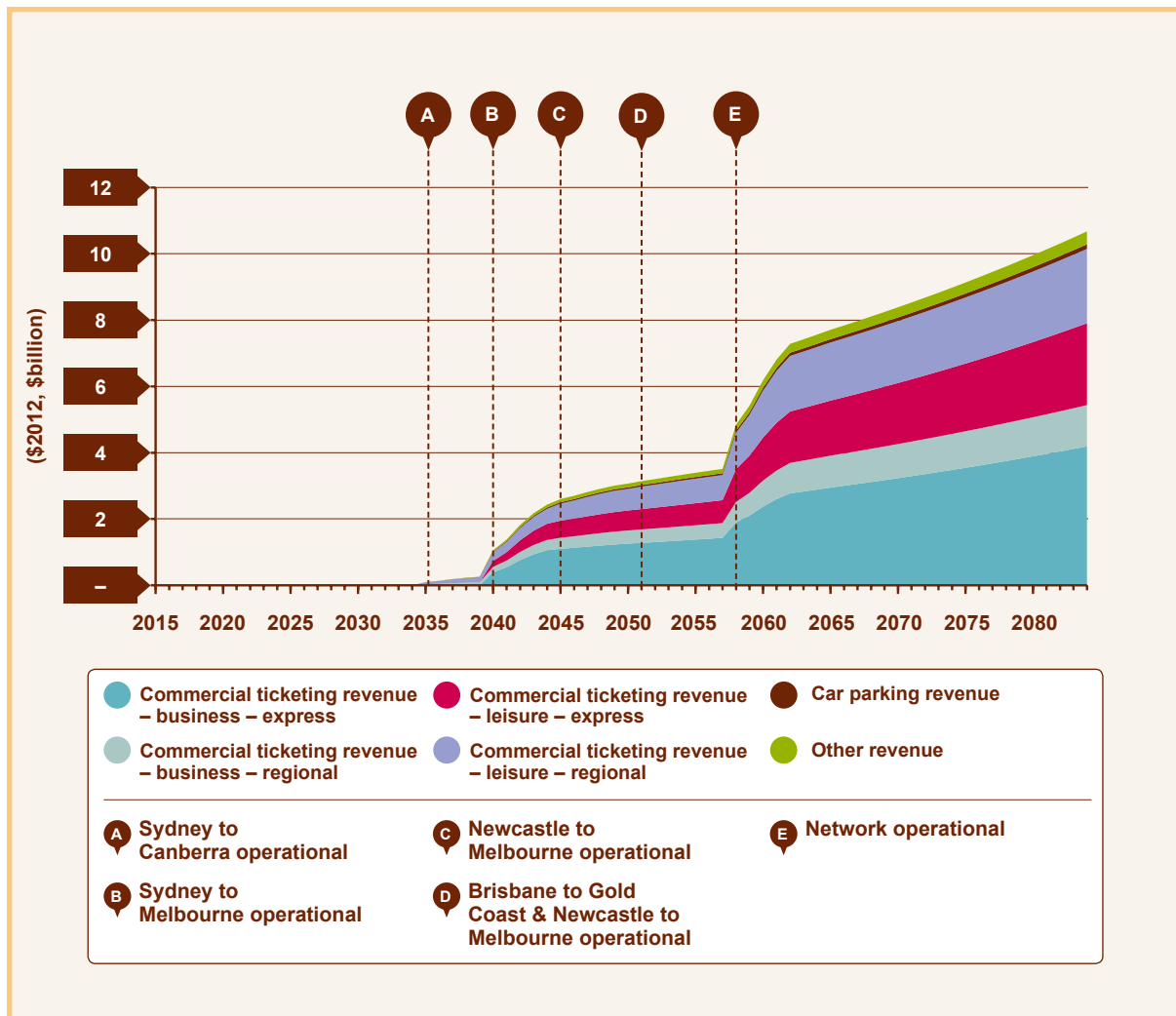
Services between Sydney and Canberra are classified as being regional services for this analysis.

This table presents the total real revenue received for the duration of the evaluation period (2015 to 2085) based on the staging assumptions outlined in **Chapter 6**.

Table 7-12 illustrates that total revenue over the evaluation period is composed mostly of business and leisure commercial ticketing sales (52 per cent and 44 per cent of total revenue respectively), with only a small proportion of revenue coming from non-fare box sources. Express services (business and leisure) represent 60 per cent of total revenue.

Figure 7-10 illustrates the timing and growth of HSR program revenue over the evaluation period.

Figure 7-10 HSR program risk-adjusted revenue by type per year (\$2012, \$billion)



As noted in **section 7.3.1**, real growth in revenue is driven primarily by new stages coming online, the ramp-up of demand subsequent to stages coming online and the real increases in demand for travel. For example, completing Sydney-Canberra or Canberra-Melbourne as stand-alone sections produces only modest revenue (\$0.24 billion and \$0.31 billion per year respectively)⁶. However, when the whole line connecting Sydney-Melbourne is completed, significant additional revenue is generated (total revenue of \$2.03 billion per year or an additional \$1.48 billion per year)⁷. The same benefit is forecast when the Gold Coast is connected to Newcastle (and the full HSR

program is delivered), with a considerable uplift in inter-capital and regional travel demand between Brisbane, Sydney and Melbourne. This reflects the ability of the future HSR program to secure additional passenger demand (as passengers will be able to travel between Brisbane, Sydney and Melbourne and vice versa resulting in the HSR system competing in new markets for demand).

In addition, and as illustrated in **Figure 7-10**, passenger demand (and in turn revenue) is assumed to ramp-up over a five year period (starting at 40 per cent in year one). **Chapter 2** provides further discussion.

⁶ For the purposes of this comparison the stages are assumed to be fully operational and ramped-up in 2035.

⁷ *ibid.*

7.3.6 Operating costs

Operating costs for the future HSR program include:

- Commercial ticketing cost of sales – costs associated with the sale of tickets (including an online presence, commissions paid and station sales).
- Car parking cost of sales – station car park operating costs.
- Infrastructure operation and maintenance – costs associated with the control and maintenance of the system.
- Traction power – the cost of energy required to power the HSR train sets.
- Train crew – the cost of staffing the rolling stock during operational periods. This includes salaries for drivers, conductors and attendants plus an allowance for on costs and training and recruitment.
- Rolling stock maintenance – the maintenance of the HSR fleet including the operation and maintenance of rolling stock depots.
- Station utilities – the utility costs associated with the running of the HSR stations.
- Station staff – the cost of staffing the HSR stations. This includes salaries for general staff, maintenance, cleaning, attendants, security and general management plus an allowance for on costs and training and recruitment.
- Station maintenance – the cost of undertaking regular maintenance on the HSR stations.
- Administration – comprises overheads and other costs related to the day-to-day management of the business.
- Insurance – premiums and other costs associated with insurances that would be required for the operation of the proposed HSR system.

Operating cost estimates have been prepared by applying unit rates (which have been determined with reference to international HSR systems and, where appropriate, local rates) to key operational metrics (train kilometres travelled, train kilowatt hours, train operational hours and the number of passengers using the system) as appropriate.

Appendix 4C provides further discussion.

The traction power costs have been calculated by applying an appropriate energy price forward yield curve to forecast energy consumption plus an allowance of 14.5 per cent for network access charges. **Appendix 5A** provides further discussion of electricity prices.

The infrastructure maintenance costs presented in this section exclude the cost of replacing the infrastructure assets at the end of their useful life (capital asset renewals). These costs are separately outlined in **section 7.3.7**.

The costs associated with the acquisition of rolling stock on finance lease arrangements, as outlined in **section 7.3.4**, have not been included in operating costs; rather, they are directly considered as part of future HSR program total cashflows (as these cashflows include both capital and financing components).

Table 7-13 summarises total risk-adjusted operating costs for the future HSR program and its stages.

Table 7-13 Total risk-adjusted operating costs (\$2012, \$billion)

Cost	Sydney- Canberra	Sydney- Melbourne	Newcastle- Melbourne	Brisbane- Gold Coast & Newcastle- Melbourne	HSR program
Commercial ticketing cost of sales	-1.2	-10.5	-11.6	-11.7	-19.2
Car parking cost of sales	-0.1	-0.6	-0.7	-0.7	-1.0
Infrastructure operation and maintenance	-2.0	-5.9	-6.6	-7.2	-9.6
Traction power	-4.4	-43.5	-47.4	-47.9	-91.7
Train crew	-1.3	-8.8	-9.7	-9.8	-17.5
Rolling stock maintenance	-1.2	-11.8	-12.8	-12.9	-23.2
Station utilities	-1.0	-1.8	-2.0	-2.5	-2.8
Station staff	-0.6	-1.3	-1.5	-1.7	-2.3
Station maintenance	-1.1	-1.8	-2.1	-2.5	-2.7
Administration	-0.9	-6.1	-6.7	-6.9	-12.0
Insurance	-0.5	-4.0	-4.4	-4.4	-7.3
Total	-14.2	-96.1	-105.4	-108.2	-189.4
Gross margin	17.3%	36.7%	36.9%	36.2%	31.8%

Notes: Totals may not sum due to rounding differences.

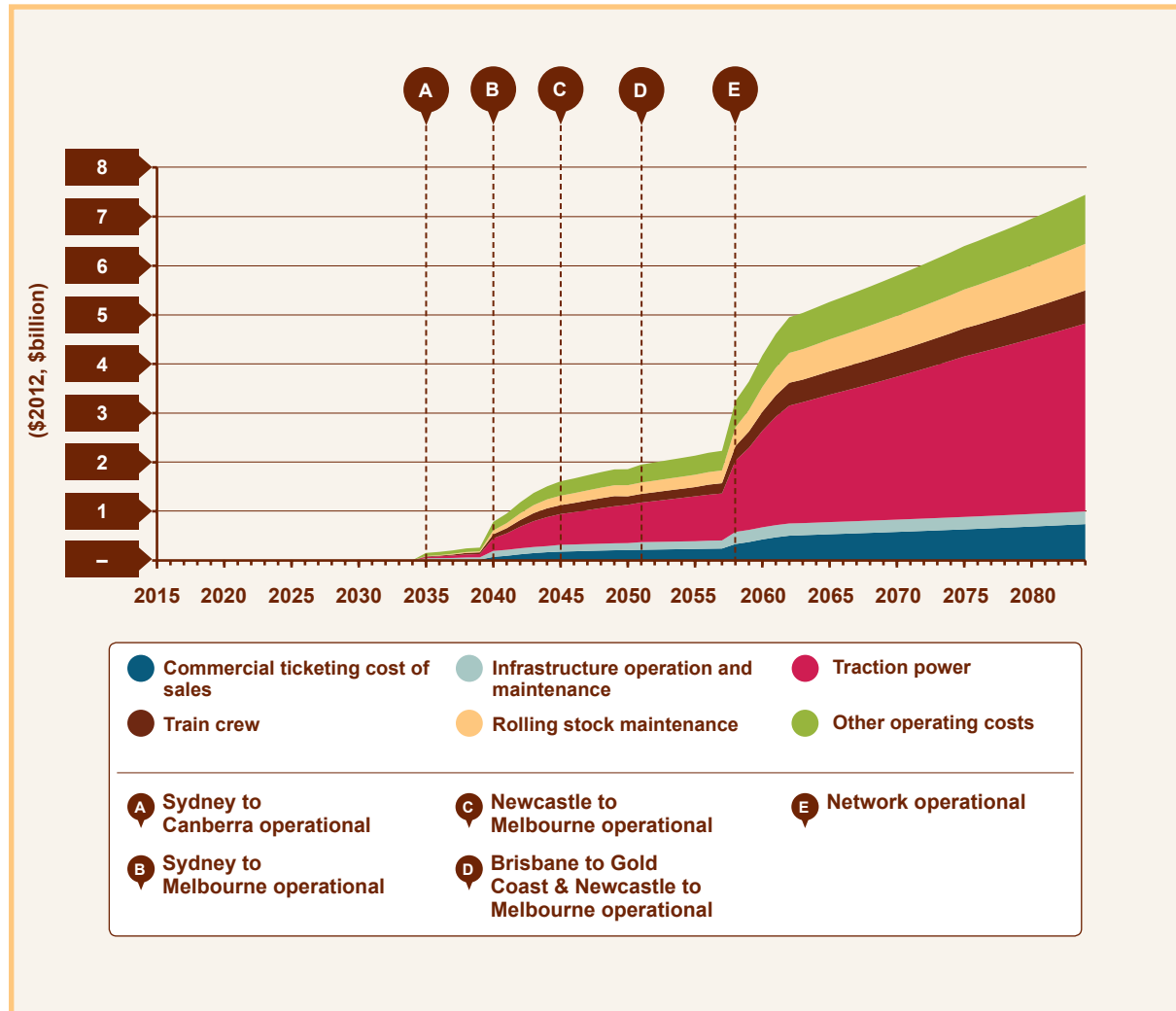
This table presents the total real operating costs for the duration of the evaluation period (2015 to 2085) based on the staging assumptions outlined in **Chapter 6**.

Traction power makes up almost 50 per cent of the forecast total operating costs for the future HSR program. The next largest operating cost is rolling stock maintenance, which accounts for 12 per cent of total operating costs.

The future HSR program and its stages have relatively high operating gross margins. The Sydney-Canberra stage has the lowest gross margin of all stages, reflecting modest stand-alone revenue and the fact that, as the first stage of the system, it is unable to leverage the demand from other segments of the system.

Figure 7-11 illustrates growth in the operating costs across the evaluation period.

Figure 7-11 HSR program risk-adjusted operating costs by type per year (\$2012, \$billion)



Future HSR program operating costs are highly variable in nature in that costs change in proportion to the volume of activity of the business. Consistent with revenue, real growth in operating costs is primarily driven by new stages coming online, the ramp-up in demand following new stages coming online and real increases in demand for travel. Given this, the most significant movements in operating costs are forecast to occur when the Sydney-Melbourne line and the full system are completed, driven by the substantial increases in passenger demand and therefore the number of services being operated.

7.3.7 Asset renewals

The costs associated with asset renewals for the future HSR program include:

- Permanent way.
- Signalling and communications.
- Power.
- Stations.
- Depots, control centre and facilities.

Asset renewal percentages are based on the specification of the asset and the asset's use within the system. Refer to **Appendix 2C** for further details.

Table 7-14 summarises total risk-adjusted asset renewal cashflows for the future HSR program and its stages, and **Figure 7-12** illustrates the profile of asset renewal cashflows over the evaluation period.

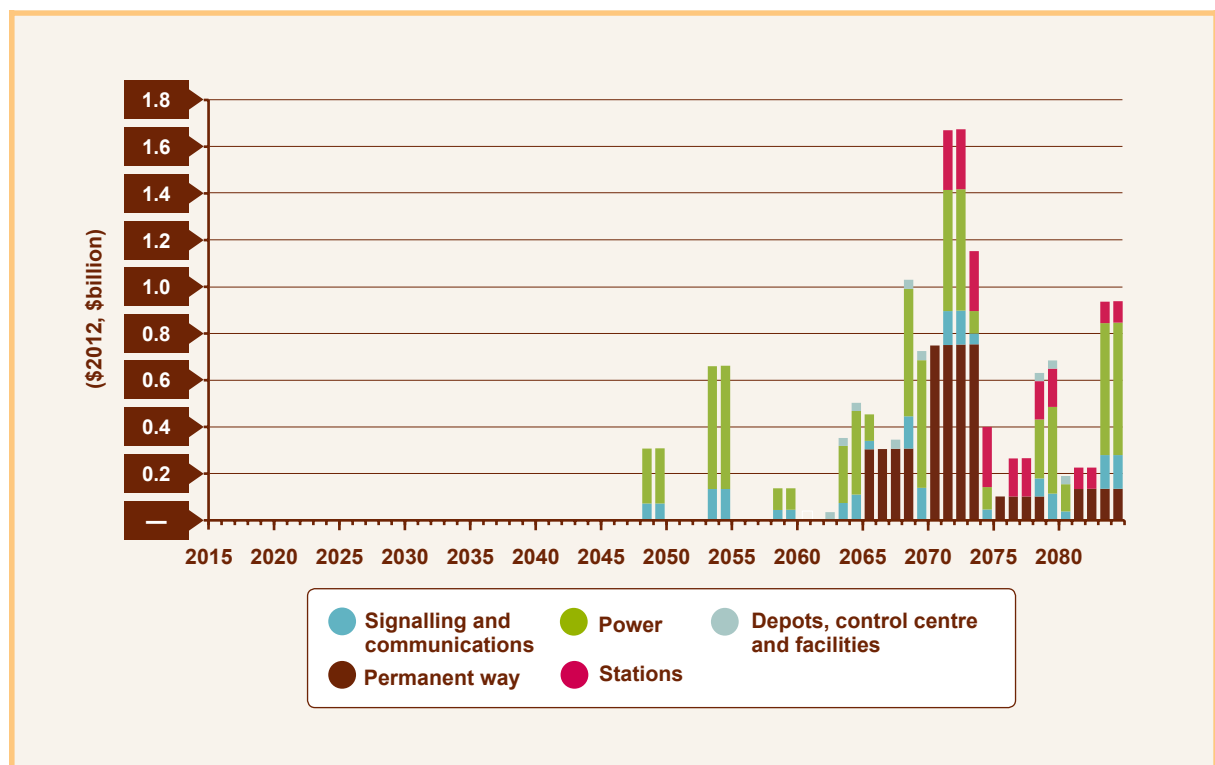
Table 7-14 Total risk-adjusted asset renewal cashflows (\$2012, \$billion)

Cost	Useful life (years)	Sydney-Canberra	Sydney-Melbourne	Newcastle-Melbourne	Brisbane-Gold Coast & Newcastle-Melbourne	HSR program
Permanent way	30	1.2	4.2	4.6	5.2	5.2
Signalling and communications	30*	0.4	1.3	1.5	1.6	1.9
Power	30*	1.5	4.7	5.1	5.6	6.6
Stations	40	1.0	1.7	2.0	2.0	2.0
Depots, control centre and facilities	30	0.1	0.2	0.2	0.3	0.3
Total		4.3	12.2	13.5	14.7	16.1

Note: Totals may not sum due to rounding differences.

*Renewed 50 per cent in years 15–16 and 50 per cent in years 30–31.

Figure 7-12 HSR program risk-adjusted asset renewal cashflows per year (\$2012, \$billion)



Asset renewals are forecast to take place a number of years post construction. For assets with a very long useful life (e.g. tunnels), no asset renewal cashflows are forecast to occur during the evaluation period; however, maintenance costs are incurred which form part of the infrastructure operations and maintenance expense detailed in **section 7.3.6**. The financial model data book in **Appendix 6D** outlines the detailed asset renewal schedules adopted.

The large spike in asset renewals around 2070 coincides with the anticipated first renewal of the Canberra-Melbourne permanent way in addition to the regular renewal activity. There is also an earlier spike around 2065 for the Sydney-Canberra sector.

Rolling stock has been assumed to be replaced at the end of its 30-year useful life by finance lease and has been excluded from the above analysis.

7.3.8 HSR program scenario and sensitivity analysis

A number of scenario and sensitivity tests were performed to determine the impact that changes in reference case assumptions would have on the financial performance of the future HSR program. The impacts of the scenario and sensitivity testing on commercial viability and economic performance are presented in **Chapter 8** and **Appendix 6B**.

The following key points should be noted from a financial performance perspective:

- Post construction, the future HSR program and its stages (with the exception of Sydney-Canberra as a stand-alone stage) are expected to generate sufficient operating income to cover ongoing operational and asset renewal costs under all but the 30 per cent increase in cost sensitivity.
- By 2065, in every scenario and sensitivity except the 30 per cent increase in cost sensitivity, the future HSR program generates significant project cashflows (i.e. revenue less operating expenses less renewal of infrastructure assets) of between \$1.1 and \$3.9 billion (\$2012) per year.
- There is an opportunity to increase the financial returns of the future HSR program by increasing fares (an increase of up to 2.2 per cent in the FIRR). However, any increases in fare assumptions will result in decreased passenger demand and has a negative effect on the economic benefits of a future HSR program.
- Changes to the underlying cost assumptions can result in significant (both positive and negative) movements in FIRR.

7.4 Commercial financing gap

The analysis in **section 7.3** highlights the following in regard to the financial viability of a future HSR program:

- The future HSR program and its individual stages would produce only a small positive financial return on investment in real terms (and this return depends on the assumed terminal value of the HSR program at the end of the evaluation period in 2085).
- Post construction, the future HSR program would generate sufficient operating income to cover its ongoing operational and asset renewal costs in nearly all scenarios and sensitivities (refer to **section 7.3.8** for further detail).

This section outlines the quantum of private sector finance that could potentially be raised on commercial terms⁸, and it identifies the commercial financing gap following the use of such private sector finance.

8 Defined as being without any government guarantees or support, and supported by the operating cashflows of a future HSR program.

7.4.1 The benefits of private finance

The use of private finance could slightly reduce the need for government funding. Although government finance can be less costly than private finance, the use of private finance (both debt and equity) can deliver value for money. A number of empirical studies show that private companies tend to be more profitable and grow faster than state-owned enterprises⁹.

The use of private finance for a future HSR program would be accompanied by financiers' specific information requirements and the management focus on the efficient use of cashflow.

Lenders' due diligence investigations would add robustness to the future HSR program's business case, and lenders would require the program to meet obligations relating to achieving its business plan targets, making debt service payments when due, providing information and complying with other financial covenants. Incurring debt is a significant contractual commitment that can result in bankruptcy if broken, and hence is an important motivator of commercial performance.

7.4.2 The likely quantum of private finance

Determining the quantum of private sector finance that might be available has been considered in the context of the following:

- Significant private sector equity investment would not be available (as the future HSR program's financial returns are well below the range required by equity investors).
- The debt-carrying capacity (or ability to access debt) of the future HSR program would be largely a function of its ability to generate cashflow.

Based on the above and the detailed analysis outlined in **Appendix 6A**, the commercial financing gap shown in **Table 7-15** has been identified for the future HSR program and for Sydney-Melbourne.

Table 7-15 Summary of the commercial financing gap – reference case

	HSR program	Sydney-Melbourne
Total capital cost (\$2012, \$billion)	114.0	49.9
Debt-carrying capacity (\$2012, \$billion)*	16.3	4.1
Commercial coverage %	14%	8%
Commercial financing gap (\$2012, \$billion)	97.7	45.7

Note: Actual outcomes in nominal dollar terms may vary considerably due to the effects of inflation.

Totals do not sum due to rounding.

* Based on a conservative debt/EBITDA multiple of 4.0 times and the future HSR's forecast cashflow profile. **Section 8.2** of **Appendix 6A** provides further discussion.

9 A Vining & A Boardman, 'Ownership and performance in competitive environments: a comparison of the performance of private, mixed and state-owned enterprises', *Journal of Law and Economics*, vol. 32, issue 1, pp. 1-33, 1989.

E Erlich, G Gallais-Hamonno, Z Liu and R Lutter, 'Productivity growth and firm ownership: an analytical and empirical investigation', *Journal of Political Economy*, vol. 102, issue 5, pp. 1006-38, 1994.

As illustrated in **Table 7-15**, only 14 per cent of the future HSR program could potentially be funded via private debt. The Sydney-Melbourne line would be capable of supporting a lower proportion of debt, as it has lower earnings before interest, taxes, depreciation and amortisation to support borrowings in comparison to the HSR program as a whole (due to the effects discussed in **section 7.3**). This analysis calculates debt-carrying capacity at construction completion (2058 for the

HSR program as a whole and 2040 for Sydney-Melbourne); the carrying capacities are therefore not directly comparable because later years have higher levels of demand due to external factors such as population growth.

Table 7-16 presents the commercial financing gap for the future HSR program and for the Sydney-Melbourne line, given a 30 per cent increase in fare yield.

Table 7-16 Summary of the commercial financing gap – 30 per cent increase in fare yield scenario

	HSR program	Sydney-Melbourne
Total capital cost (\$2012, \$billion)	114.0	49.9
Debt-carrying capacity (\$2012, \$billion)	27.4	6.2
Commercial coverage %	24%	12%
Commercial financing gap (\$2012, \$billion)	86.6	43.7

Note: Actual outcomes in nominal dollar terms may vary considerably due to the effects of inflation.

Table 7-16 illustrates that the future HSR program under the 30 per cent increase in fare yield scenario, in comparison to the reference case, would be capable of carrying more debt as a result of its increased capacity to generate cashflow.

7.4.3 Increasing the amount of private finance

As noted above, the projected low financial return on investment for the future HSR program significantly constrains the amount of private finance that it could support on a free-standing basis (i.e. without guarantees or support from government). One option to increase the amount of private finance is for governments to provide a sovereign guarantee to lenders.

Sovereign or government guarantees can take many forms, but in substance these are instruments under which the governments would guarantee lenders that it would service their debt if the future HSR program fails to do so. Government guarantees would result in a reduction in risk to investors which would ultimately allow the future HSR program to achieve higher levels of gearing.

An alternative would be for governments to provide only a guarantee of critical risks that the private sector finds it difficult or expensive to bear, particularly revenue risk.

It is important to note that the future HSR program would still be required to service its debt, which limits the amount of finance that can be obtained under such an arrangement.

The provision of a full government guarantee transfers significant risk to governments, limiting the attractiveness of providing a guarantee over the direct injection of public equity (which could be funded via governments issuing debt in their own right on potentially more advantageous terms). Accordingly, sovereign guarantees have been excluded from further analysis.

7.5 Options for closing the commercial financing gap

This section examines the following methods that might be used to close the commercial financing gap identified in **section 7.4**, before any injection of direct public grants or government equity:

- Value capture.
- Tax concessions.
- Government loans.

7.5.1 Value capture

International value capture experience

International experience shows that well integrated, thoughtfully designed and strategically located transport infrastructure can serve as a catalyst for urban renewal and higher density development in urban areas. For example, Union station in Washington DC and Grand Central station in New York City are serving as the catalysts for modern high density retail, entertainment and commercial precincts by integrating transport and renewal programs around these rail hubs. St Pancras station in London is using the introduction of Eurostar (and the consequent redevelopment of the station) to kick-start urban regeneration in a similar manner. Increasingly, public transport providers and urban renewal agencies are investigating alternative funding methods such as value capture to contribute to the cost of providing the infrastructure that helps drive urban regeneration.

Value capture programs have been widely used in the United States for over 40 years, and were introduced in California to stimulate urban renewal efforts in economically depressed urban centres. Tax Increment Financing (TIF), which is the most widely practiced form of value capture, has been introduced in 49 states and the District of Columbia¹⁰ and is used in cities and towns across the United States to help fund urban renewal and key transport projects. Under a value capture program, infrastructure investments are planned

and delivered to cause surrounding under-valued property values to increase, adding value to property that can then be taxed. Mechanisms are put in place to sequester all or some portion of the uplift in tax revenue (the ‘tax increment’) into special purpose accounts, which are then used to pay directly for, or to underwrite, financing instruments which ‘front load’ predetermined infrastructure projects. This process is sometimes referred to as ‘hypothecation’. In the United States model, hypothecation of property taxes is generally programmed for a set time frame, usually 23 to 25 years, after which time all designated improvements must be fully paid for and the full tax revenue stream reverts to the original taxing authority. In this way, value capture methods provide targeted, temporary supplements to traditional public infrastructure investment sources, such as Australian and state government infrastructure grants.

City and county governments in the United States and Canada continue to be the most prolific users of value capture, with the value capture revenue sources including:

- Property taxes.
- Sale of bonus gross floor area (GFA).
- Property transfer (stamp) duties.
- Sale or lease of air rights over public road reserves, railway corridors and other property.
- Sale or lease of surplus development sites.
- Parking levies.
- Developer contributions.
- Special rates or taxes on a defined improvement district.
- Hotel taxes.

10 Council of Development Finance Agencies, *Advanced Tax Increment Finance Reference Guide*, 2009, p. 1.

A form of value capture was also used in Australia in 1963 to partially fund the Melbourne Underground Rail Loop through the introduction of a levy which lasted for over 30 years. TIF was introduced to the United Kingdom's urban regenerations national program in 2011¹¹.

The key ingredients of a successful value capture program are under-utilised land, proximity to public transport networks and the potential for attracting increased economic activity to the transport precinct.

Application to the HSR program

As described above, well designed and implemented value capture programs are making significant contributions to transit-oriented development internationally and could make a similar contribution to the costs of the future HSR program. The best opportunities for achieving significant results from value capture in the future HSR program are at Sydney's Central station. This location has numerous complementary public transport connections, relatively low

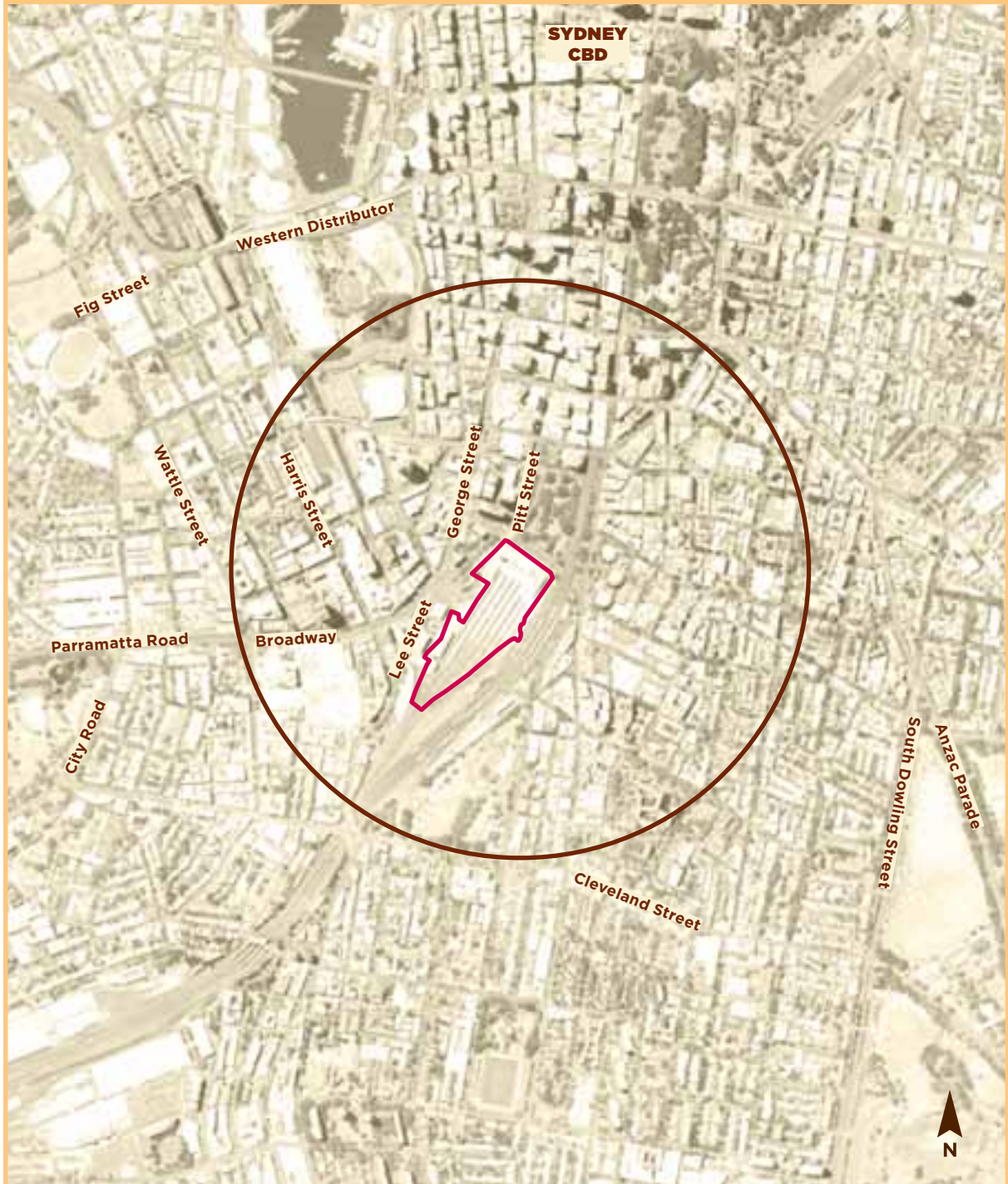
density surrounds, and would be the future HSR program's central node. Economic activity in this location would have the greatest potential to increase as a result of future government investment in an HSR program. This is because of Central station's proximity to the Sydney CBD, the Sydney Convention Centre and tourist and cultural attractions, such as the Opera House, the Rocks and Sydney Harbour. Other capital cities and regional centres with HSR stations would also benefit from value capture programs, but to a lesser extent given their comparative characteristics (including available development area and demand) to Sydney and the Central station site.

The potential for capturing value created by government investment in the future HSR program to help fund aspects of the program has been demonstrated using Sydney's Central station as a case study. The case study uses an HSR improvement district (HSRID) defined as the area within an 800 metre radius around Central station and shown in **Figure 7-13**.

11 R Lee, *The Railways of Victoria 1854-2004*, Melbourne University Publishing Ltd., 2007, p. 191.

B Cook, 'Budget 2012: Up to £150m for TIF schemes in core cities', *Regeneration and Renewal Journal*, 21 March 2012.

Figure 7-13 HSRID: Sydney Central station



KEY  Central Station  800 metre radius

The value capture revenue streams considered by this study and the rationale for capturing each source are listed in **Table 7-17**.

Table 7-17 Value capture sources and rationale

Source	Rationale
Stamp duty	Applied to residential and commercial properties sold in the future HSR improvement district above existing permitted development limits. Would require the creation of an HSRID.
Land tax	Increases in land tax revenue in excess of base case revenue in the HSRID (as a result of higher property values due to the redevelopment).
Parking levy	A new parking levy could be applied to commercial and residential developments at a rate of \$5,000/pa per space ¹² . This rate would only apply to new space constructed in the HSRID from 2030. This is intended to fund and encourage public transport use, reduce car use in the greater CBD and reduce construction costs by strictly limiting underground parking requirements.
Special rate	A special rate beginning at \$10/m ² and escalating to \$100/m ² of site area ¹³ could be applied to all properties within the HSRID. As it is based upon site area rather than GFA permitted, it would encourage consolidation of properties and higher density development. This may require change to the <i>Local Government Act 1993</i> .
Sale of vacant or underutilised government land	The sale of government-owned land in the HSRID which will have appreciated in value as a result of the redevelopment.
Sale of air rights over railway and road reserves	Allows value to be applied to underutilised property assets.
Bonus floor space	Sale of the rights to develop additional floor space over and above the current permitted density in the HSRID (e.g. planning restrictions on the height of buildings can be eased due to increased amenity and improved services such as additional public transport in the HSRID).

HSR value capture analysis

Projected demand for commercial and residential floor space based upon historic trends in the HSRID shows that the demand for space will soon exceed supply from around 2020. This finding is consistent with capacity studies undertaken by the Property Council of Australia¹⁴. Constraints to supply include existing density controls, fragmented land ownership patterns, strata title

laws and the absence of a comprehensive urban renewal program for inner Sydney.

The value capture analysis assumes that an HSR-led transit-oriented urban renewal program would unlock these obstacles and create additional supply to meet demand in the HSRID. A high level conceptual urban renewal program was conceived for land around Central station incorporating new higher density development on under-utilised

¹² Based on international experience.

¹³ Based on international experience.

¹⁴ Property Council of Australia, *Securing the commercial future of the Sydney CBD*, May 2005.

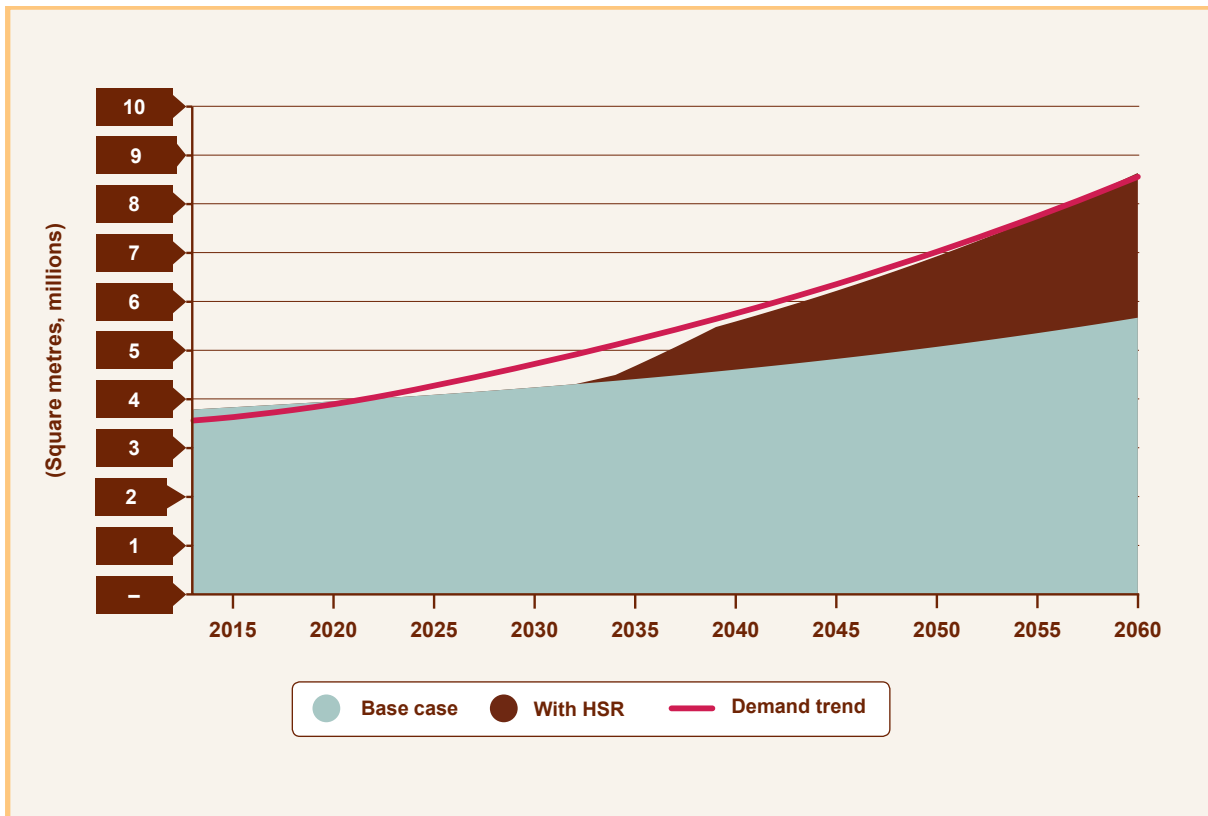
government land. The cornerstone of the program would be a new cultural and recreational amenity on a platform constructed over Central station railway yards. This amenity would replace Prince Alfred Park, an 8.8 hectare public park next to Central station, which would be redeveloped as part of a new master plan for the Central station precinct. As with similar large programs undertaken both in Australia and overseas, redevelopment at this scale would require the creation of a dedicated urban renewal authority with special powers to acquire and consolidate fragmented sites within the HSRID, as discussed in **Appendix 6E**.

The value capture calculations compare the HSR induced development outcome against three scenarios (without HSR) that represent different assumed allowable urban density between 2013 and 2060 as follows:

- High value capture scenario: assumes that the existing constraints to development continue to apply. The current floor space ratio (FSR) of 3.5 square metres of GFA for each square metre of net land area (3.5:1 FSR) would remain in place throughout the period of analysis (2013- 2060).
- Medium value capture scenario: assumes that the allowable density would be permitted to increase by approximately 14 per cent, or to 4:1 FSR from 2013.
- Low value capture scenario: assumes that the allowable density would be permitted to increase by 28%, or to 4.5:1 FSR from 2013.

This approach is illustrated in **Figure 7-14** for the medium value capture scenario.

Figure 7-14 HSRID: Sydney Central station – residential and commercial floor space - medium value capture scenario



To estimate the potential impact of an urban renewal program integrated with an HSR station, the following assumptions were applied in the land development model. These provisions would begin to take effect in 2033, two years before proposed commencement of HSR services in Sydney, and would continue throughout the period of value capture analysis to 2060.

- Bonus floor space – additional density could be acquired by property developers from the urban renewal authority by purchasing bonus floor space at a rate of \$1,250 per square metre GFA (\$2012), the currently estimated market value of GFA in the HSRID. A maximum density of 6.4:1 was assumed to apply in these cases, generating incremental density of 2.9:1 (6.4:1 – 3.5:1). The proceeds of bonus floor space sales would be diverted to a dedicated value capture account.
- Stamp duty – stamp duty generated from the sale of bonus floor space would be diverted to the value capture account. Stamp duty on resales of bonus floor space would also be diverted to the value capture account. Residential resales were assumed to occur every ten years and commercial resales were assumed to occur every 20 years.
- Land tax – land tax on bonus floor space would be diverted to the value capture account.
- Parking levy and special rate revenue – would be diverted to the value capture account.
- Government-owned land – vacant and under-utilised government-owned land next to Central station would be sold at a rate of \$1,250 per square metre GFA (\$2012) and the proceeds diverted to the value capture account. Densities on government-owned sites would vary from 10:1 to 15:1. In addition, iconic mixed-use buildings of approximately 150,000 square metres would be developed next to Central station.

Limitations of the value capture analysis

The Sydney case study applied a simplified approach to examine the order of magnitude of funding levels that could be generated from sources within the HSRID, and limitations of this analysis include:

- No analysis was undertaken to determine the wider impacts on the Sydney metropolitan region, NSW or Australia. For example, the loss of retail, residential and commercial development from surrounding areas to the HSRID as a result of the HSR station was not considered.
- The Sydney case study was limited to the HSRID and the potential displacement of growth from other parts of the Sydney metropolitan region or NSW was not examined. As such, the incremental change in revenue streams such as stamp duty measured across the state would be less than shown in **Table 7-19**.
- The analysis assumes amendments would be made to existing planning controls to facilitate development within the Sydney Central station catchment area and that these amendments would be facilitated by the introduction of HSR. As such, to the extent that these amendments would have been made irrespective of the HSR program, the revenue streams below would be lower.

Value capture potential outcomes

Table 7-18 summarises the additional residential and commercial floor space that would be generated under each scenario. Revenues generated by HSR-induced development would be paid into a dedicated value capture account, while base case revenues would continue to flow to public agencies in the normal manner.

Table 7-18 HSRID: Sydney Central station – residential and commercial floor space in 2060

	Low scenario	Medium scenario	High scenario
HSRID gross floor space (m²)			
Base case	6,308,238	5,673,655	4,658,323
With HSRID induced development	8,821,057	8,640,643	8,351,982
HSR addition to base case	2,512,819	2,966,988	3,693,658
HSRID residential dwellings (number)			
Base case	35,046	31,520	25,880
With HSRID induced development	49,006	48,004	46,400
HSR addition to base case	13,960	16,483	20,520

Note: Totals may not sum due to rounding differences.

The above table illustrates that between 2.5 million and 3.7 million square metres of additional floor space would be attributable to the HSR station, increasing total residential and commercial floor space in the HSRID by between 2.7 per cent and 2.85 per cent per year between 2013 and 2060. Around 1.2 million square metres would be generated directly from government-owned land,

with the balance coming from density permitted above the base case levels in each scenario. Between 14,000 and 20,500 additional residential dwelling units would be created compared with around 21,000 dwelling units in the HSRID today.

The results of the value capture analysis are outlined in **Table 7-19** for the three scenarios.

Table 7-19 HSRID: Sydney Central station – value capture revenue streams and associated costs – sensitivity tests (\$2012, \$billion)

	Low scenario		Medium scenario		High scenario	
	Present value	Total	Present value	Total	Present value	Total
Costs						
Planning & administration	-0.13	-0.22	-0.13	-0.22	-0.13	-0.22
Park redevelopment	-0.51	-0.64	-0.51	-0.64	-0.51	-0.64
Potential revenue streams						
Stamp duty	1.38	3.01	1.49	3.26	1.97	4.36
Land tax	0.14	0.35	0.18	0.45	0.24	0.59
Parking levy	0.21	0.50	0.24	0.57	0.28	0.67
Special rate	1.29	2.81	1.29	2.81	1.29	2.81
Government asset sales	1.54	2.11	1.54	2.11	1.54	2.11
Bonus floor space sale	1.02	2.08	1.29	2.63	1.72	3.51

The value capture program could generate significant revenue from all sources, although these amounts would only begin to flow after the urban renewal program would commence revenue-generating activities in 2033. The revenue streams should be considered individually and in differing combinations, rather than as a total, as it is highly unlikely that all these measures would be fully implemented.

The principles applied to Sydney are applicable to other capital city stations in the HSR system. The amount of revenue potential depends upon the conditions around each station, such as existing development density, zoning and development controls, market conditions, natural obstacles to development such as water bodies, flood levels and terrain, and numerous other factors.

The following indicative range of values could be generated, subject to the assumptions and limitations discussed below:

- Melbourne – 40 to 50 per cent of Sydney’s revenue, given its slightly smaller population, existing density of development around Southern Cross station, and limited opportunities to expand the urban centre due to natural and man-made obstructions.
- Brisbane – 20 to 30 per cent of Sydney’s revenue, given Brisbane’s smaller population, existing density of development around Roma Street station and the presence of the Brisbane River.
- Canberra – 10 to 15 per cent of Sydney’s revenue, given its much smaller population, current and future density restrictions imposed by ACT statutory controls, and level of HSR investment.

The above range of values has been prepared based on a high level consideration of characteristics of each site. Further analysis and detailed quantification of value capture opportunities for other capital cities would need to be undertaken to estimate these values with any precision.

7.5.2 Tax concessions

Tax concessions typically involve a reduction in corporate taxation to increase the after-tax return on investment to investors. Tax concessions come

at the cost of reduced revenue to Australian or state governments.

The future HSR program is not expected to pay significant corporate income tax during the evaluation period (due to the accumulation of tax losses from the tax depreciation of the infrastructure asset base), and, as illustrated in **Table 7-4** (which presents a summary of the future HSR program’s financial results on a pre- and post-tax basis), the payment of corporate income tax does not have a material impact on the programs FIRR or FNPV. Accordingly, it has been concluded that potential tax concessions would have no impact on closing the commercial financing gap.

7.5.3 Government loans

Finance could potentially be provided by governments to the future HSR program in the form of a loan which would have specific repayment terms, covenants and conditions. Under this option, governments would not take an ownership interest, and would instead provide the required funding under contractual arrangements.

The same limitations associated with obtaining private sector debt are applicable in this instance, in that the future HSR program’s ability to access government loans would be linked to its debt-carrying capacity. Accordingly, government loans over and above private sector finance have been excluded from further analysis.

7.6 Direct government funding

As outlined in **section 7.4**, a significant commercial financing gap exists for the future HSR program.

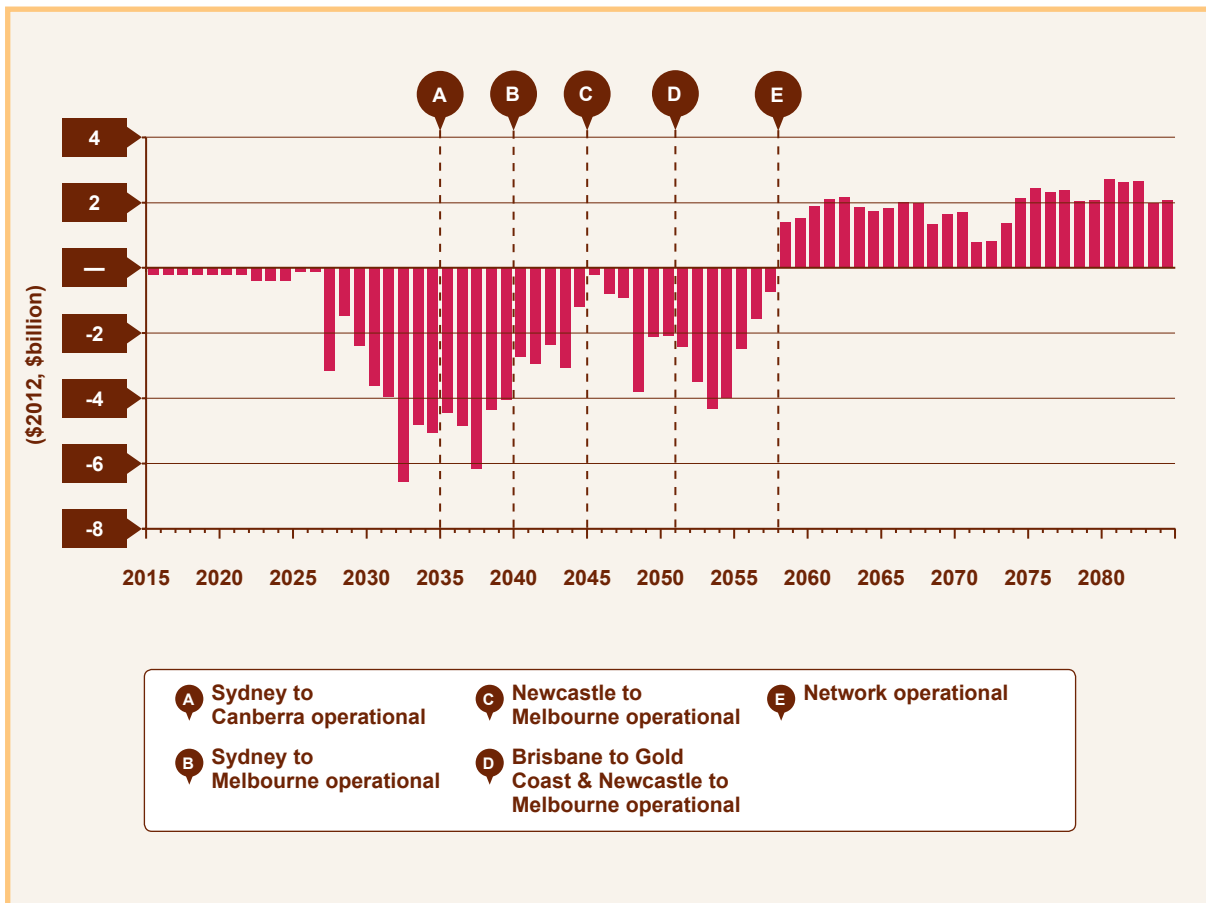
While **section 7.5** identifies a number of options that may partially close the commercial financing gap, the low commercial returns of the future HSR program mean that, even after securing private finance against program operating cashflows and tapping in to the other sources of revenue, a significant funding shortfall would remain that would be need to be met by governments.

It is assumed that governments would meet this funding shortfall via direct equity investments (the form and budgetary treatment of this investment into the future HSR program is discussed in detail in **Chapter 11**). **Table 7-15** shown earlier summarises the total government funding required after taking private sector finance into account. It is noted that the value capture potential revenue streams identified in **section 7.5.1** may materially reduce this funding requirement; however, as there is significant uncertainty surrounding the

availability of these value capture methods, value capture benefits have not been included in the figure below.

Figure 7-15 outlines total future HSR program cashflows. Negative values indicate that the future HSR program requires funding, while positive values indicate that the program is producing surplus cashflows. This figure does not make any assumptions about how the future HSR program would be funded or financed.

Figure 7-15 Total HSR program cashflows (\$2012, \$billion)



The above figure illustrates the extent to which the future HSR program’s cashflows are expected to be driven by the implementation plan, with significant capital investment being partially offset by surplus cashflows from operations once Sydney-Melbourne is fully operational.

Subsequent to the completion of the Brisbane-Sydney line, the system is expected to generate significant surplus cashflows. Accordingly, if projected traffic and revenue assumptions are met, it is expected that there would be no ongoing requirement for governments to subsidise future HSR operations.

7.7 Future sale of HSR

Assuming that the future HSR program is largely funded by government contributions, governments would have the option to sell their investment once the system was fully operational (and had a track record of generating positive cashflows).

The value that governments might extract from their investment would be determined by the valuation potential investors place on the future

cashflows from the HSR system. **Table 7-20** provides a range of valuations of the HSR system in 2065 at illustrative discount rates. The discount rate that potential investors would ultimately apply to the cashflows would be influenced by the perceived risks associated with owning and operating the HSR system.

Table 7-20 Discounted cashflow valuation of the HSR system in 2065 (\$2012, \$billion)

Discount rate (real)	8%	10%	12%	14%
Value of the HSR system in 2065 (\$2012, \$billion)	38.7	30.5	24.6	20.3

Under this option, governments may recover approximately 20 to 55 per cent of their initial investment¹⁵ based on the illustrative discount rates (as investors would only pay a price for the equity that would allow them to generate the returns they require). Subsequent to such a sale, no additional government contributions would be required (although governments would still receive the majority of the forecast value capture benefits).

7.8 Contingent liabilities

Contingent liabilities are defined as possible obligations that arise from past events and whose whole existence will be confirmed only by the occurrence or non-occurrence of one or more uncertain future events not wholly within the control of the entity¹⁶.

In the case of the future HSR program, governments would be required to make a significant upfront investment into the program and, in practical terms, would probably be 'liable' for continued investment until the first complete stage was operational and to support the operations thereafter if they did not generate sufficient returns

to cover ongoing operational costs. Accordingly, governments would have a contingent liability to support the program. However, if adverse variations in the costs and benefits forecast for that stage were to become evident or anticipated, that liability could be 'capped' by a policy decision not to proceed beyond a first stage.

It is estimated that, in present value terms, governments' contingent liability would be in the order of \$15 billion (in \$2012) upon construction commencement of the future HSR program. In estimating this contingent liability, the following assumptions have been made:

- There would be no significant transfer of investment cost or risk to the private sector.
- Capital and operating costs are forecast using the +30 per cent increase in operating and capital costs sensitivity assumptions.
- Revenue is forecast using the low economic growth scenario assumptions.
- The Sydney-Canberra stage of the system would be developed, but no other stage would be subsequently developed.

15 Calculated by taking the estimated value of HSR system (**Table 7-20**) less the value of private sector finance outstanding at the date of sale divided by the value of initial government investment into the HSR program.

16 Australian Accounting Standards Board, AASB 137, *Provisions, contingent liabilities and contingent assets*, 2010.

- The Sydney-Canberra route would operate for 30 years (the approximate life of rolling stock).

The magnitude of contingent liabilities could be managed in a number of ways including by:

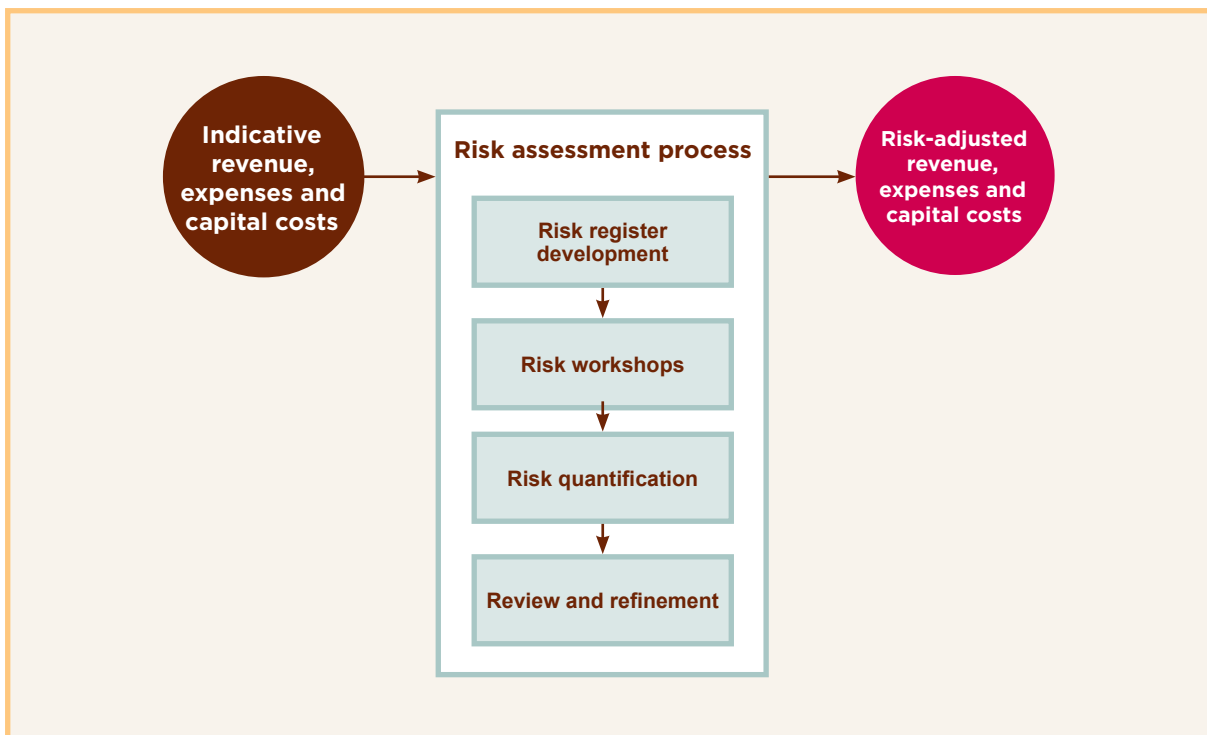
- Undertaking robust planning and scheduling.
- Entering into fixed price contracts/appropriate financial hedging arrangements.
- Obtaining appropriate insurance.

7.9 Risk assessment process

Risk is defined as the chance of an event occurring that would cause actual circumstances to differ from those assumed when forecasting future HSR program costs and revenues.

The study included a detailed risk assessment exercise which identified and quantified material risks to the future HSR program. The key inputs, stages and results of this process are illustrated in **Figure 7-16**.

Figure 7-16 Risk assessment process



The risk assessment process adjusts the indicative HSR program cost and revenue estimates by applying risk adjustments to reflect uncertainty, principally around the scope of the major construction, engineering and operational elements of the future HSR program. The risk adjustment also reflects opportunities for savings where appropriate (for instance when considering best case outcomes).

It should be noted that indicative civil construction costs represent the expected cost in \$2012 of the preferred HSR system, if it were procured as a complete system in today's market. These costs include an allowance of approximately 2.3 per cent for non-tunnel civil infrastructure and 4.0 per cent for tunnel infrastructure, embedded in the direct costs associated with the construction of civil infrastructure, and representing standard contractors' risk (i.e. the standard risk premium that design and construct contractors build into unit rates to cover typical risks within their contractual obligations).

The results of this process have been included in the results presented in **section 7.9.4** and **Appendix 6C**. As risk assessment is an ongoing process, if an HSR program were to be developed, risk would need to be continually monitored.

7.9.1 Key assumptions

Given that the future HSR program is in the feasibility stage, the risk assessment has relied to a large extent on a forward-looking approach which focuses on risks with a relatively high probability of occurrence and those that would have a material impact on the program if they were to eventuate. The identification and quantification of risk at this stage in the future HSR program is largely influenced by the study team's collective experience with similar large-scale transport construction and operations projects. However, due to the nature of risk, not all circumstances that may influence the outcomes of the future HSR program can be estimated at this stage and no allowance has been made for items which are outside the scope of the preferred system (for example, modifying the preferred route to take into account other infrastructure projects, which would attract additional cost).

7.9.2 The risk assessment methodology

The risk assessment process has been completed in four key steps:

1. Development of a risk register – a risk register has been developed based on the risks associated with comparable large-scale infrastructure projects, including from HSR projects internationally. The risk register contains a total of 59 risks, and has been provided in **Appendix 6C**.
2. Risk workshops – two risk workshops were undertaken as part of the risk assessment process. These workshops involved key study team members, Department stakeholders and specialist technical advisors discussing and validating the risk register and ultimately determining the inputs into the risk quantification calculations.

3. Risk quantification – a risk quantification process was undertaken, as described in **section 7.9.3** below.
4. Review and refinement – subsequent to the initial calculation of risk adjustments, further sessions were held with key study team members, stakeholders and specialist technical advisors to review and refine the risk register.

Further details of the risk assessment process are provided in **Appendix 6C**.

7.9.3 Risk quantification

Risk has been quantified using a three-point estimate to calculate a risk's financial impact. This involves estimation of the probability of the risk occurring and its impact in the three defined states – best, most likely and worst-case.

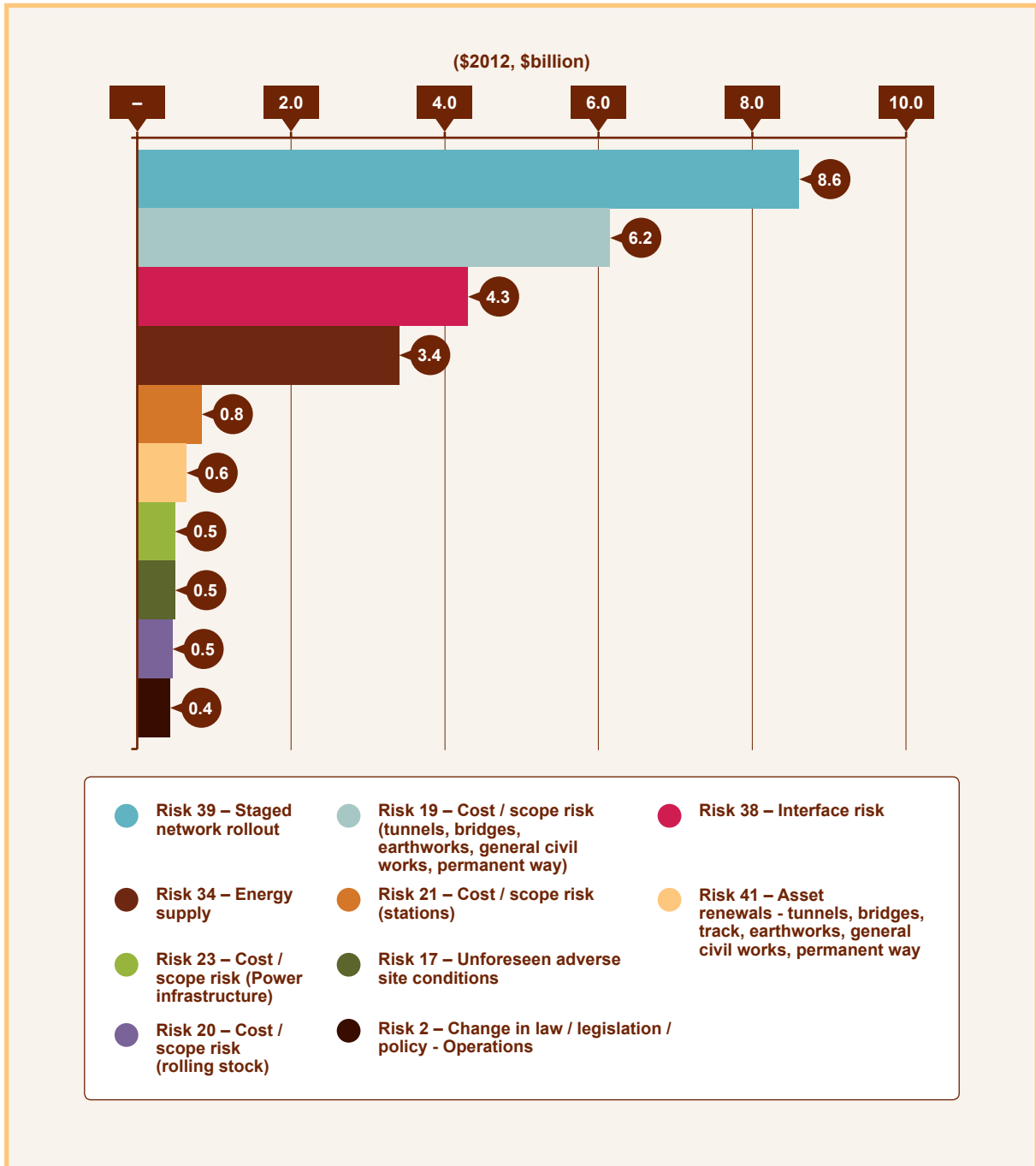
The expected value (mean) of the risk is based on the probability of the risk occurring and the sum of the products of the impact and their probabilities in each of the three defined states. The final probabilities, impacts and cost drivers were agreed in risk workshops.

Figure 7-17 outlines the financial impacts of the ten most significant quantified risks.

Further details are provided in **Appendix 6C**.

As part of the risk assessment process, a number of unquantifiable risks were identified (for instance, the risk of insufficient capacity in the construction market to deliver the program of works, encountering artefacts of cultural significance and force majeure). A risk is classified as unquantifiable when its cost impact cannot be estimated; an allowance for these risks has not been included in the study's risk-adjusted cost forecasts. It should be noted that unquantifiable risks can be significant. As such, these risks should be closely monitored during the development of the future HSR program.

Figure 7-17 Top ten risks by financial impact (\$2012, \$billion)



7.9.4 Risk-adjusted results

The financial analysis in this chapter is presented on a risk-adjusted basis, meaning that estimates have been adjusted for the expected outcomes of events that could cause actual circumstances to differ from those assumed when forecasting revenues and costs.

@RISK simulation software (which applies Monte Carlo analysis¹⁷ to approximate the frequency of certain outcomes occurring) has been used to generate probability distributions for the future HSR program to develop P10, P50 and P90 estimates. The results of this process are outlined below.

A P90 estimate is defined as an estimate where there is a 90 per cent probability that costs will be less than the estimate (or revenues will be more than the estimate). A P50 estimate is defined as an estimate where there is a 50 per cent probability that costs will be less than the estimate (or revenues will be more than the estimate). A P10 estimate is defined as an estimate where there is a 10 per cent probability that costs will be less than the estimate (or revenues more than the estimate).

Table 7-21 summarises the results of the risk assessment process for the future HSR program.

Table 7-21 HSR program risk-adjusted results (\$2012, \$billion)

Item	Risk adjustment %	Expected value	P10	P50	P90
Development costs	7%	10.4	9.5	10.4	11.1
Construction costs	13%*	103.6	92.5	103.5	115.9
Total construction costs		114.0	102.0	113.9	127.0
Rolling stock	5%	10.0	8.8	10.0	11.2
Revenue	4%	277.8	298.6	277.2	258.7
Operating costs	10%	189.4	180.1	189.2	198.9
Asset renewals	4%	16.1	14.9	15.9	18.0
FNPV**	–	-47.0	-35.2	-46.6	-58.5
FIRR	–	0.8%	1.7%	0.8%	0.0%

* The risk adjustment percentage excludes an allowance for contractors' standard risk that has been included in the indicative costs (2.3 per cent for non-tunnel civil infrastructure and 4.0 per cent for tunnel infrastructure).

** Four per cent discount rate.

The risk assessment has been conducted on the preferred system. No allowances have been made for items outside this scope or for risks deemed to be 'controllable' by the project developer. Accordingly, the range between P10 and P90 reflects potential outcomes for the preferred system only. The inclusion of an allowance for this scope risk would increase the expected value and P50 results and, given the nature of the risk, would likely increase the spread between the P50 value compared to both the P10 and P90.

It is also noted that the preferred system uses proven HSR system technology and train sets already in service that deliver the speeds and reliability assumed in other jurisdictions. This is a key factor in reducing both the absolute risk adjustment and the range between the P50 and P90 amounts.

17 A method of statistical sampling used to approximate the probability of certain outcomes by running multiple simulations that apply random variables.

In addition to the risk adjustments calculated as a result of the risk assessment process and included in the analysis presented throughout this chapter, the sensitivity analysis presented in **Chapter 8** illustrates the impact that movements in the assumed construction costs have on the economic

and financial viability of the future HSR program. The results also show that the expected value is materially consistent with the P50 results.

Figure 7-18 presents the results of the @RISK analysis for total construction costs including development costs for the future HSR program¹⁸.

Figure 7-18 Total construction costs (including development costs) (\$2012, \$billion)

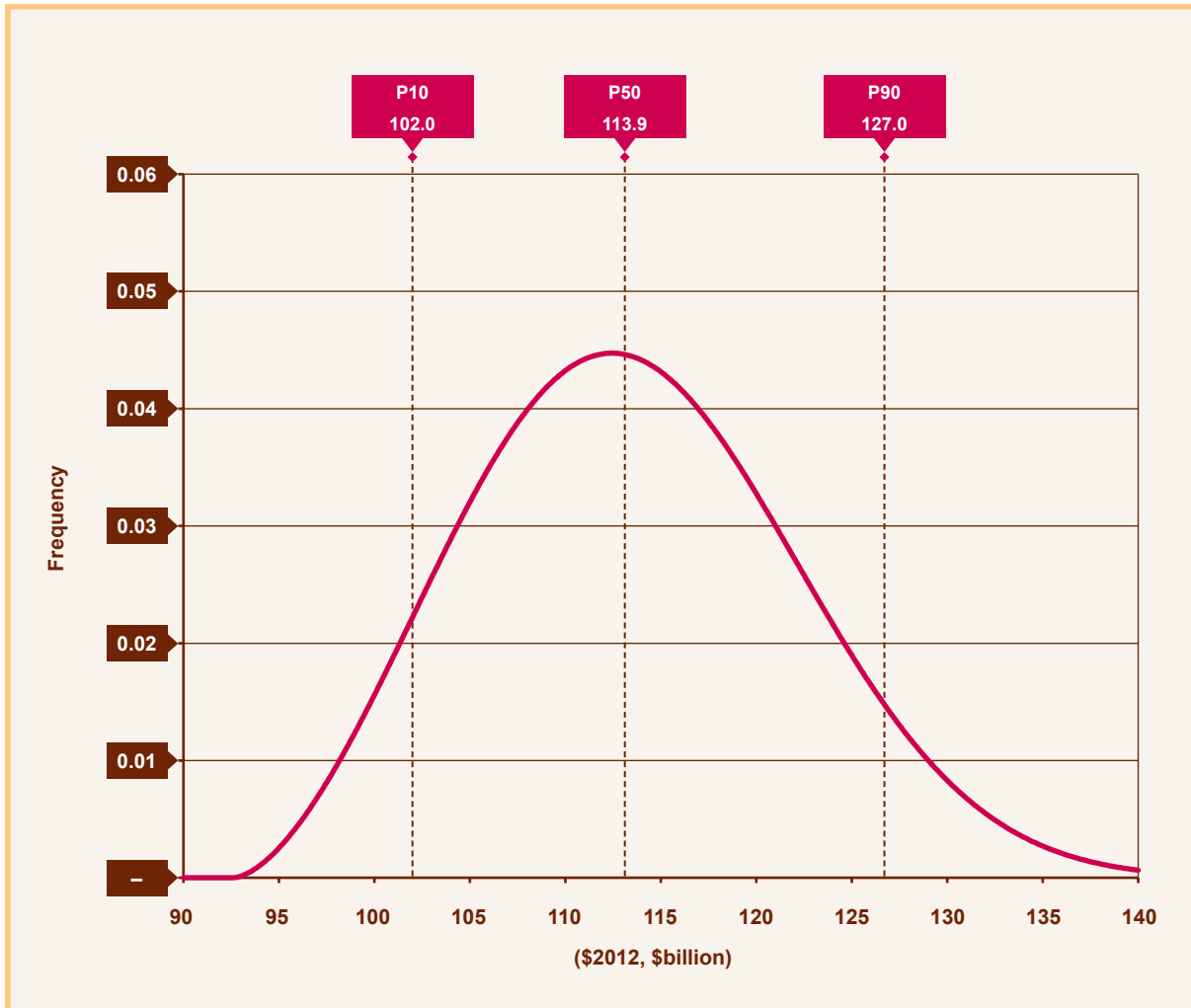


Figure 7-18 illustrates that:

- In 50 per cent (P50) of simulations, total construction costs are expected to be less than \$113.9 billion (\$2012).
- In 90 per cent (P90) of simulations, total construction costs are expected to be less than \$127.0 billion (\$2012).

The expected value of construction costs (which is the risk-adjusted value presented throughout this chapter) is \$114.0 billion (\$2012).

¹⁸ The frequency represents the likelihood of the total construction costs being within a \$1 billion band centred on the corresponding point on the curve. Thus there is a two per cent chance that the cost will lie between \$100.5 billion and \$101.5 billion and a four per cent chance they lie between \$107 billion and \$108 billion.

Figure 7-19 presents the results of the @RISK analysis for total revenue received over the evaluation period for the future HSR program.

Figure 7-19 Total revenue (\$2012, \$billion)

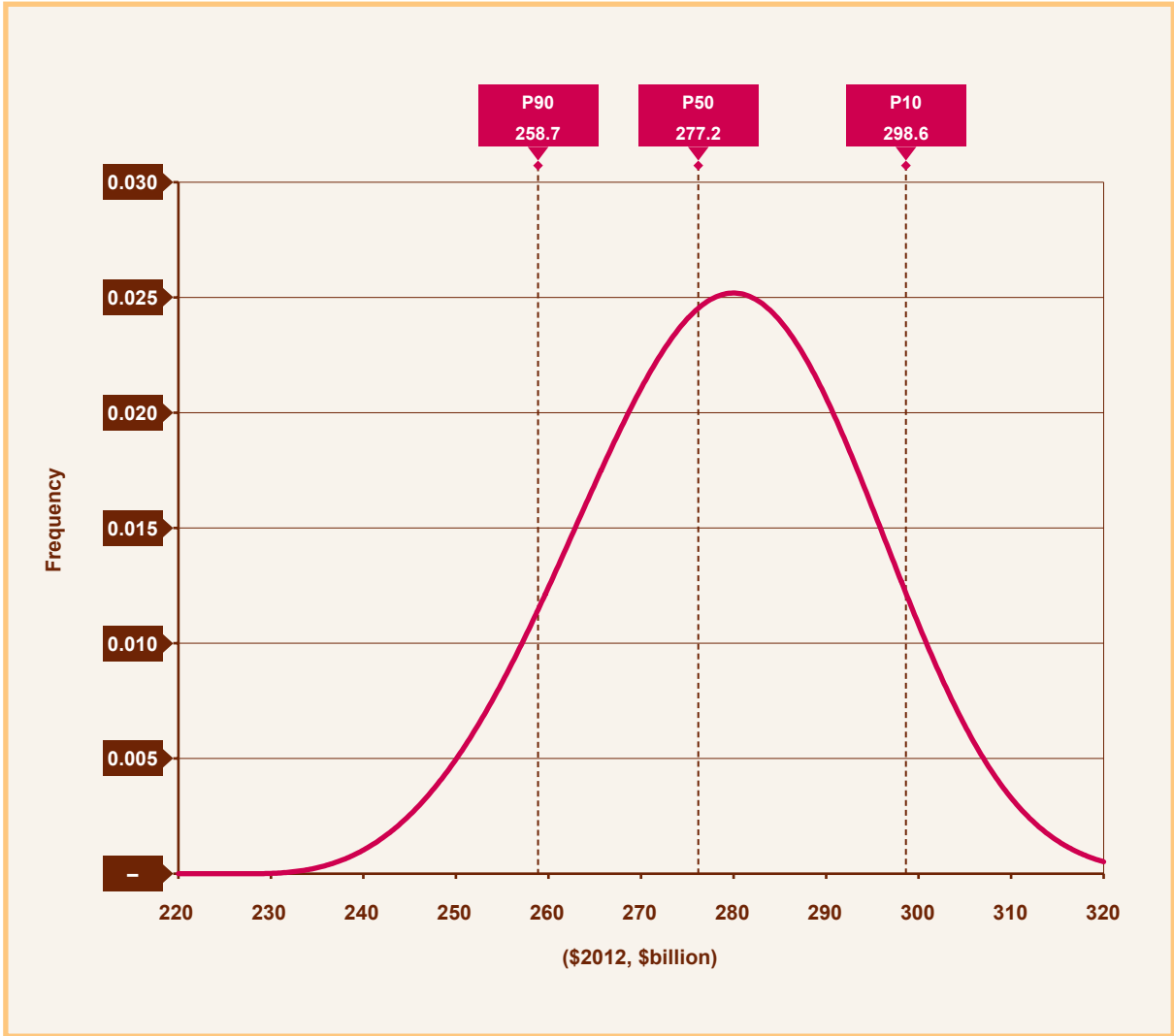


Figure 7-19 illustrates that:

- In 50 per cent (P50) of simulations, total revenue is expected to be greater than \$277.2 billion (\$2012).
- In 90 per cent (P90) of simulations, total revenue is expected to be greater than \$258.7 billion (\$2012).

The expected value of total revenue (which is the risk-adjusted value presented throughout this chapter) is \$277.8 billion (\$2012).

Figure 7-20 presents the results of the @RISK analysis for total operating costs over the evaluation period for the future HSR program.

Figure 7-20 Total operating costs (\$2012, \$billion)

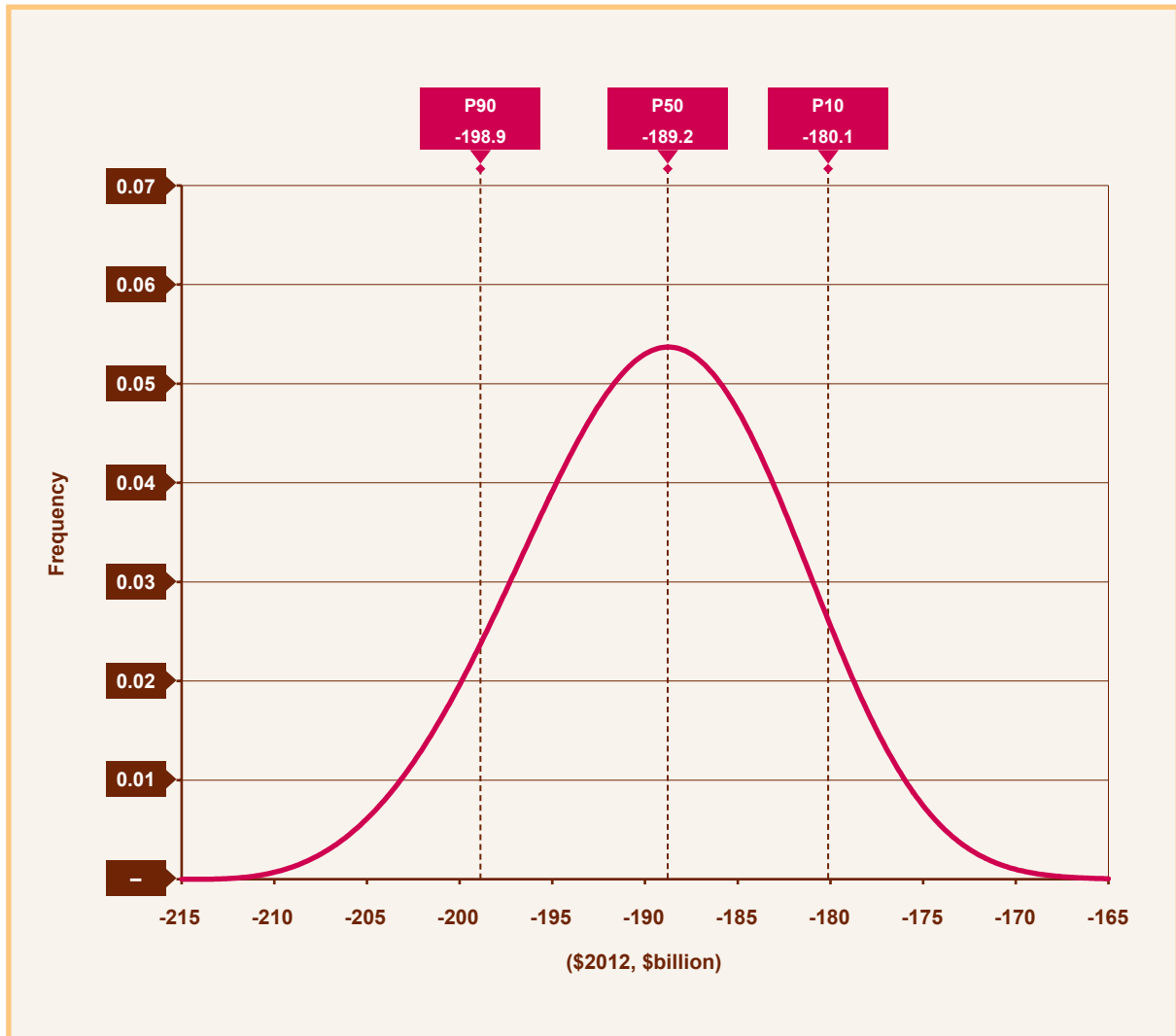


Figure 7-20 illustrates that:

- In 50 per cent (P50) of simulations, total operating costs are expected to be less than \$189.2 billion (\$2012).
- In 90 per cent (P90) of simulations, total operating costs are expected to be less than \$198.9 billion (\$2012).

The expected value of total operating costs (which is the risk-adjusted value presented throughout this chapter) is \$189.4 billion (\$2012).

Figure 7-21 presents the results of the @RISK analysis for the FNPV of the future HSR program.

Figure 7-21 HSR program FNPV (PV, \$billion, 4% cent discount rate)

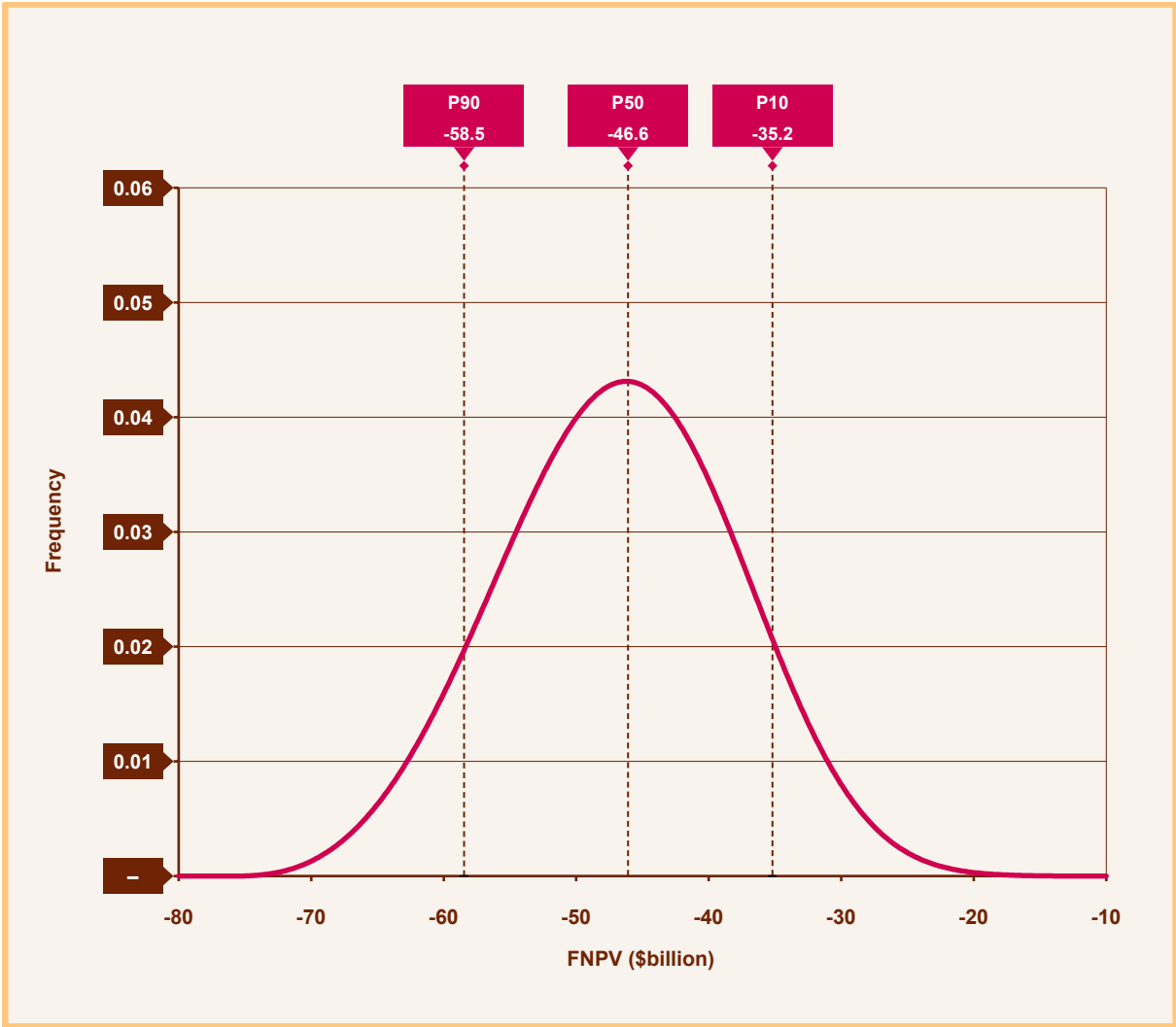


Figure 7-21 illustrates that:

- In 50 per cent (P50) of simulations, program FNPV is expected to be less than -\$46.6 billion.
- In 90 per cent (P90) of simulations, program FNPV is expected to be less than -\$58.5 billion (i.e. less negative).

The expected FNPV (which is the risk-adjusted value presented throughout this chapter) is -\$47.0 billion.

Risk adjustment summaries for each of the future HSR program’s potential stages are presented in **Appendix 6C**.

Figure 7-22 presents the results of the @RISK analysis for the FIRR of the future HSR program.

Figure 7-22 HSR program FIRR (real)

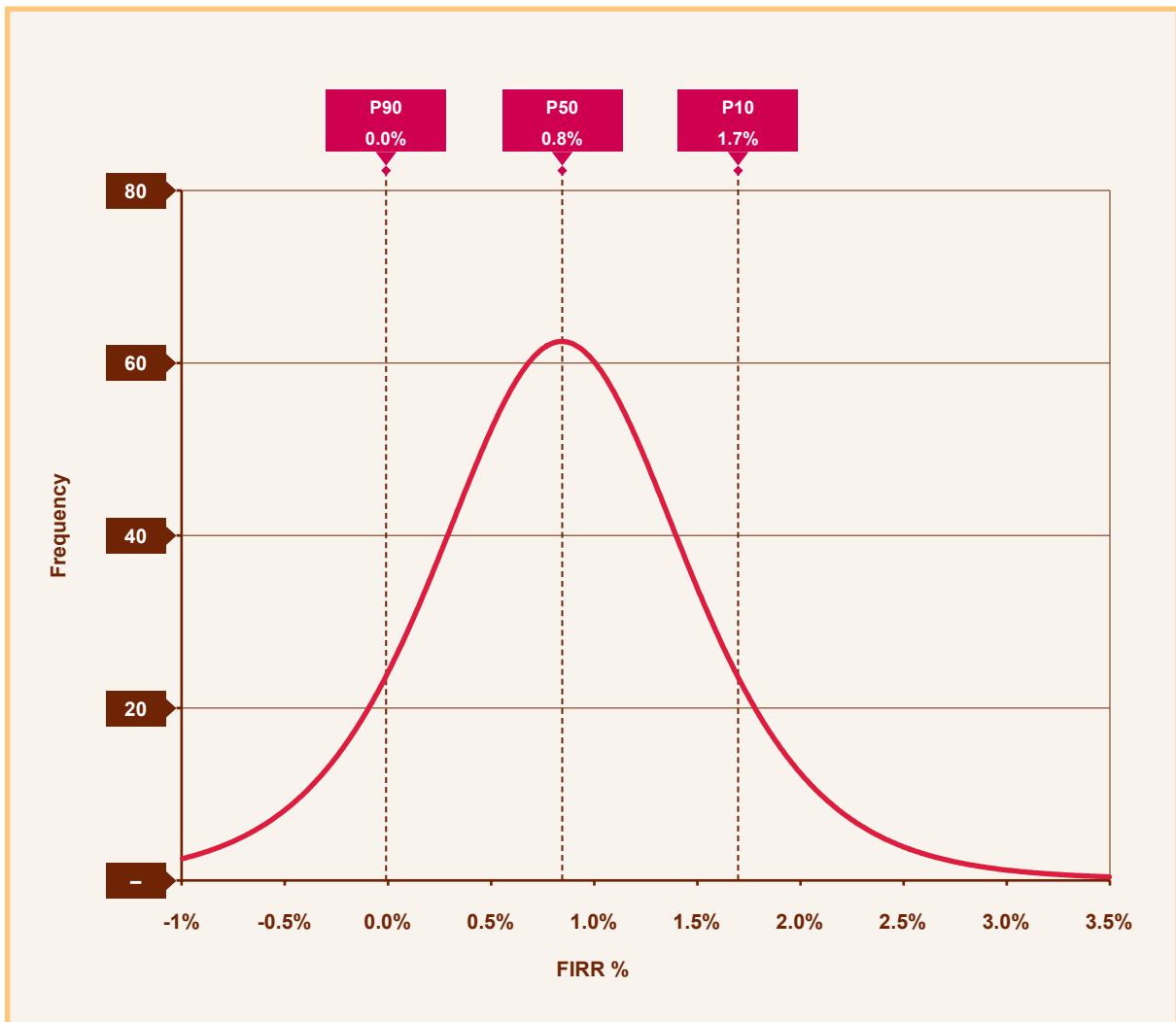


Figure 7-22 illustrates that:

- In 50 per cent (P50) of simulations, program FIRR is expected to be greater than 0.8 per cent.
- In 90 per cent (P90) of simulations, program FIRR is expected to be greater than 0.0 per cent.

The expected program FIRR is 0.8 per cent.

7.10 Conclusion

This chapter considered the following questions:

- What would be the future HSR program's costs and revenues and is the HSR program commercially viable?
- What contribution could the private sector make to financing the future HSR program?
- What is the future HSR program's projected commercial financing gap and how might this gap be closed?

In answering these questions, the following key conclusions have been reached in regard to the commercial viability of the future HSR program:

- The future HSR program and the majority of its individual stages are expected to produce only a small positive financial return on investment, well below the returns that would be required by commercial providers of debt and equity for these types of projects.
- Post construction, the future HSR program and its stages (with the exception of Sydney-Canberra as a stand-alone stage) are expected to generate sufficient operating income to cover ongoing operational and asset renewal costs. In addition, this holds true for all but one of the scenarios and sensitivities tested (the +30 per cent cost sensitivity). Given this, in all likelihood, there would be no ongoing requirement for governments to subsidise HSR program operations.
- Due to the future HSR program's low financial returns, significant private sector finance (debt/equity) would not be available or appropriate to finance the program. A considerable commercial financing gap (the difference between the total capital cost of the HSR program and the amount of financing that could be raised from the financial markets on commercial terms, based on future operating cashflows) would exist.
- Value capture has the potential to partially close the commercial financing gap through measures such as government land sales and by capturing the incremental impact that the HSR program would have on stamp duty, developments and rates in the HSR affected zones. It is highly unlikely that all of these measures would be implemented, and the ultimate benefit that value capture might have on closing the commercial financing gap is difficult to determine at this stage.
- Although value capture could contribute to closing the commercial financing gap, ultimately governments would be required to fund the majority of the future HSR program's upfront capital costs.



8

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8

Economic appraisal of the preferred HSR system

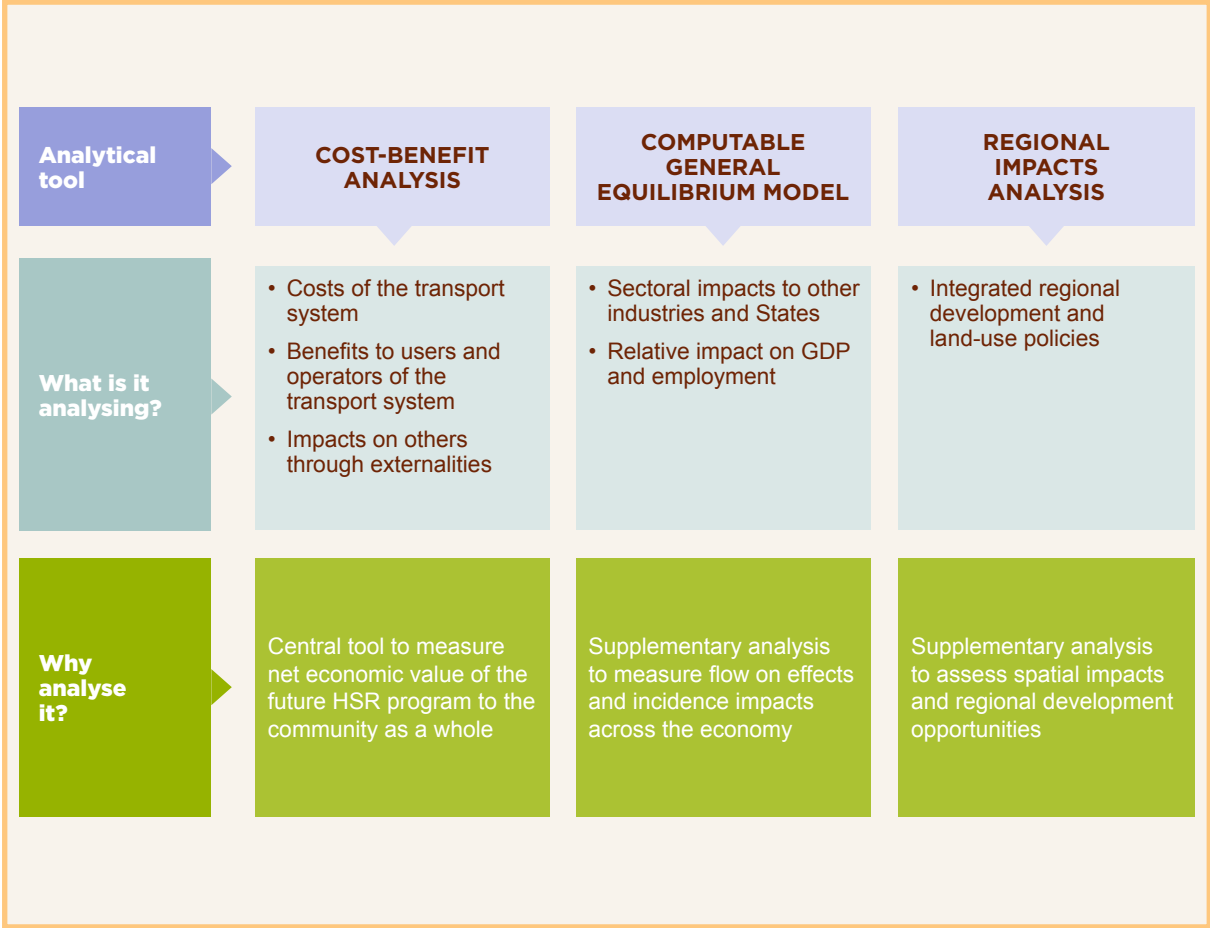
8.1 Introduction

The economic appraisal brings together demand and user benefits, revenue and costs described in **Chapters 2** and **7** to provide an overall appraisal of the economic value of the future HSR program. The overall HSR economic appraisal consists of three components, as outlined in **Figure 8-1**.

In summary:

- The **cost-benefit analysis (CBA)** seeks to provide a comprehensive assessment of the costs and benefits to users and operators of HSR that can be valued in monetary terms. It also includes an assessment of externalities, such as environmental impacts, accident cost savings and decongestion benefits. The CBA helps establish the overall economic merit of a future HSR program and, as outlined in **Chapter 6**, guides decisions on the optimal staging of the HSR program.
- The **computable general equilibrium (CGE)** analysis explores the flow-on effects to the broader Australian economy of an investment in HSR. It identifies the total (direct and indirect) economic impacts of the construction and operation of the HSR network on national and regional Gross Domestic Product (GDP) and employment.
- The **regional impacts analysis** explores the impact of HSR on regions and regional towns and cities along the preferred corridor, due to improved accessibility and assesses whether further benefits could be achieved through complementary regional development policies integrated with the implementation of HSR.

Figure 8-1 Overall HSR appraisal



This chapter focuses primarily on the CBA, which is the central tool to measure the net economic value of an investment in HSR. It also provides some discussion of likely macro-economic effects as assessed within the CGE modelling. The findings of the regional impact analysis are detailed in **Chapter 9**.

The remainder of this chapter discusses the derivation of the CBA results, the relative performance of each segment of the future HSR program and the optimal order and timing of construction and operation from an economic perspective. The likely macro-economic effects, i.e. the flow-on effects to the broader economy, are also presented and discussed.

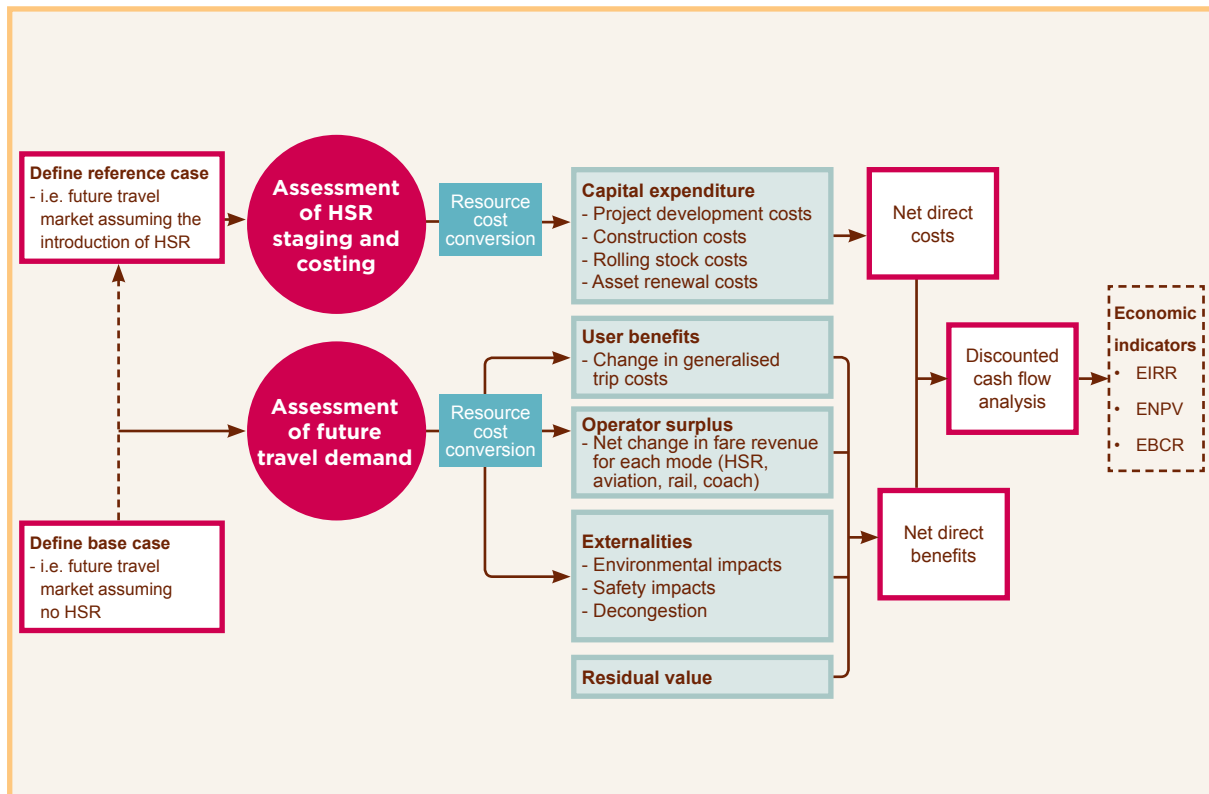
8.2 Cost-benefit analysis framework and approach

The CBA estimates the likely effects of an investment in the future HSR program, the ‘reference case’, and compares these to the ‘base case’ (i.e. the likely scenario without HSR). The difference between the two cases, measuring both costs and benefits, determines the net economic impact of the proposed HSR program.

8.2.1 Analytical approach

The overall approach to the CBA is illustrated in **Figure 8-2**.

Figure 8-2 Cost-benefit analysis framework



Once constructed, the HSR program would generate a stream of direct economic benefits, linked to the assessment of future travel demand. The total economic benefits are the sum of the net benefits internal to the transport system (user benefits and operator benefits) and those costs and benefits that are external to the transport system. These external costs and benefits, or externalities, measure the impact of HSR on the broader community, including environmental and safety impacts, and decongestion benefits.

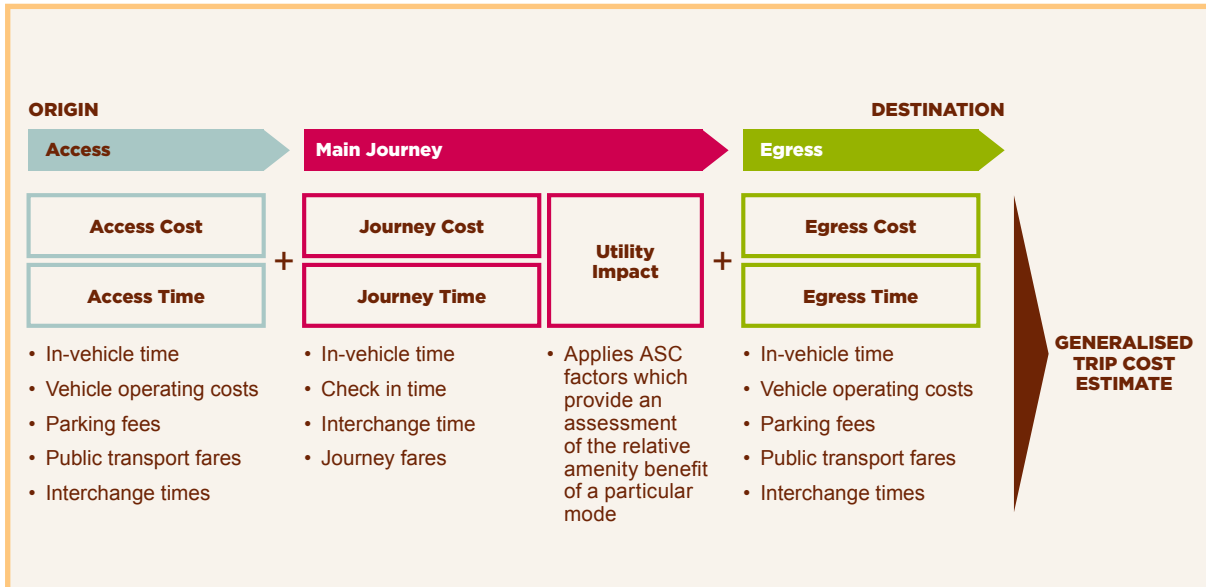
User benefits

The total economic benefit of travel on HSR is a function of how much each passenger values their trip (often termed their 'willingness to pay'). This is calculated by measuring the differences in generalised trip costs when comparing the reference case (with HSR) to the base case (without HSR).

The generalised trip cost calculations combine all journey components including travel time, waiting time, check-in time¹, access time, interchanges, fares or (in the case of private cars) perceived vehicle operating costs, as illustrated in **Figure 8-3**. It also includes a utility impact which takes into consideration the relative amenity features of a mode not captured in other variables. The calculation of the user benefits also includes the benefits generated by induced demand (i.e. new travel encouraged by HSR as opposed to travel diverted from other modes).

1 Check-in also includes time spent at the airport and flight delays.

Figure 8-3 Generalised trip cost estimation framework²



The estimated generalised trip costs have been calculated based on equivalent minutes. The changes in equivalent minutes are multiplied by a value of time to convert the benefits to dollar values. The value-of-time estimates were developed from the stated preference (SP) survey, which is described in **Chapter 2** and outlined in **Table 8-1**. Discrete values were developed for different travel purposes (business and leisure) and different journey types (i.e. short regional, long regional and inter-city).

A range of alternative Australian and international values was also considered, and a sensitivity analysis applied using the Austroads approach to estimating values of time³. As shown in **Table 8-1**, Austroads presents an alternative method for estimating the value of time based on average

wages. Applying the Austroads approach results in a relatively small (i.e. \$5 billion⁴) increase in the estimate of user benefits which has a minimal impact on the results of the analysis.

Consistent with the ATC National Guidelines, the value of time applied across the appraisal timeframe is assumed to increase in line with real growth in income⁵. Business and commuter value of time is escalated at the rate of real growth in GDP per capita, and leisure value of time is escalated at a rate of 80 per cent of the real growth in GDP per capita⁶.

2 The ASC (or alternative specific constant) identified in this figure quantifies the extent of preference (or otherwise) for a mode (i.e. HSR) over and above the measurable improvements in level of service (journeys, times service frequencies, fares, access and egress).

3 Austroads is the association of Australian and New Zealand road transport and traffic authorities. Source: Austroads, Guide to Project Evaluation, Part 4 Project Evaluation Data, Sydney, 2012.

4 Present value terms in \$2012. \$5 billion is less than four per cent of the total estimated user benefits.

5 The ATC National Guidelines supports escalation of the value of time in line with real growth in GDP per capita assuming appropriate growth rates are applied.

6 Based on the assumption outlined within the National Guidelines (Volume 5) that the value of non-work (i.e. leisure) time increased with per capita GDP with an elasticity of 0.8, and the value of work time with an elasticity of 1.0.

Table 8-1 Behavioural value of time estimates (\$2012)⁷

Trip type		Value (\$/hr)		Trip type	Value (\$/hr)
HSR study estimates					
Business	Short regional ⁸	\$38.00	Leisure	Short regional	\$9.50
	Long regional ⁹	\$81.00		Long regional	\$20.00
	Inter-city	\$57.00		Inter-city	\$14.00
Alternative estimates based on the Austroads approach¹⁰					
Business	Car, Coach, Rail	\$45.34	Leisure	Car, Coach, Rail	\$14.17
	Air, HSR	\$79.36		Air, HSR	\$17.71

Source: HSR phase 2 study estimates and Austroads¹¹.

The SP survey suggested that the long regional values of time (\$81 and \$20 for business and leisure respectively) are higher than the inter-city values of time (\$57 and \$14). It is likely that this is because the car is more frequently the mode of travel for long regional trips, and a long regional car trip is an onerous undertaking compared to a (longer) inter-city flight. Respondents may have been unable to separate the distance element of the journey from the utility (or disutility) impacts of different modes, thus assigning a higher cost to long regional trips than inter-city trips.

Aggregating willingness to pay over all users of HSR (and over time) provides an assessment of the total (gross) economic value created for users of the system by the investment in the future HSR program. The distribution of the net economic benefit created between users of the HSR system (consumers) and the operator(s) of HSR (producers) is a function of the fares charged. Ultimately the fare serves to transfer economic value from users of the system to operators.

The net benefits to the users of HSR are calculated as the difference between users' total willingness to pay and the fares actually paid.

Operator benefits

Transporting passengers consumes economic resources (such as labour and fuel). The difference between fare revenue collected and the economic cost of the resources consumed is the operator benefit (termed the producer surplus).

The costs of additional resources required for HSR need to be offset against the costs of resources saved in other modes because of the reduced demand (given the demand shift to HSR). The calculations of the operator benefits therefore take account of the change in producer surplus for each mode (i.e. HSR, aviation, conventional rail and coach).

The net economic benefits internal to the transport system are measured by adding the two components, as illustrated in **Figure 8-4**.

7 In line with the Australian Transport Council guidelines, the value of time has not been adjusted by the average rate of indirect taxation.

8 A short regional trip is defined as a trip less than or equal to 250 kilometres.

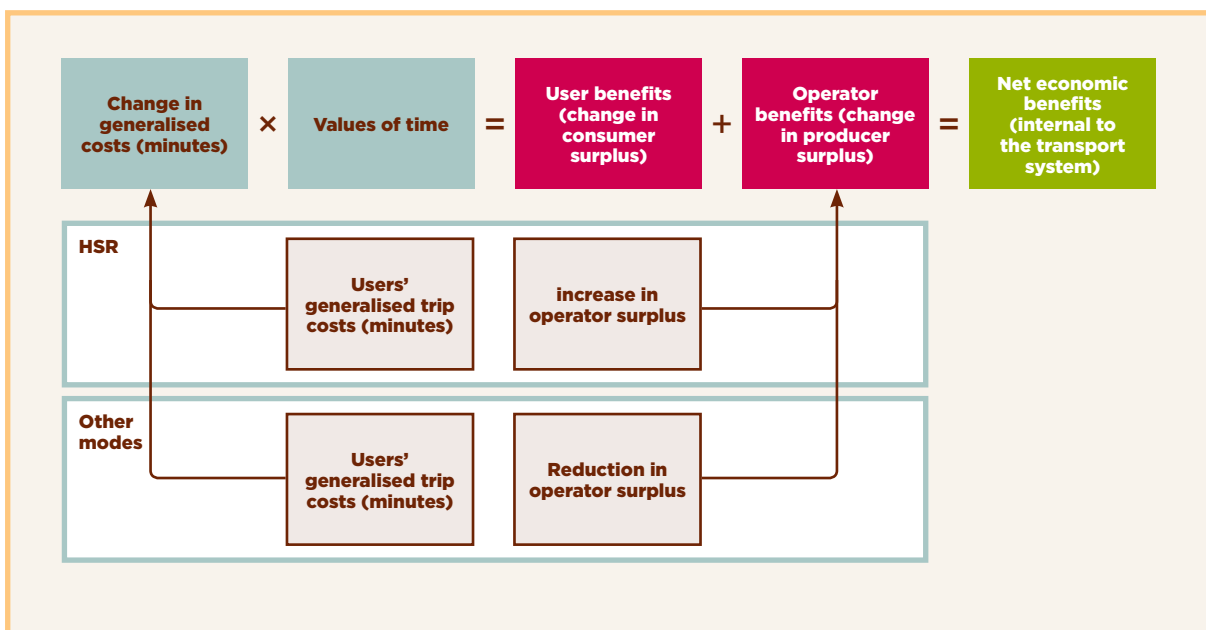
9 A long regional trip is defined as a trip greater than 250 kilometres.

10 The values of times presented here have been developed based on an assessment of average wages as per the Austroads approach. The analysis assumes the wages of business users of air and HSR is 75 per cent higher than the average and 25 per cent higher for leisure users. This is based on analysis of outputs from the SP survey outlined in **Chapter 2**.

11 Austroads, *Guide to Project Evaluation*, 2012.

- User benefits (or consumer surplus) – the benefits to the users of HSR (comprising passenger transferring from other modes and new travellers) calculated based on the difference between users’ willingness to pay for a service and the fares paid.
- Operator benefits (or producer surplus) – the net impacts to operators of the transport system, which represent the difference between the fares paid or revenue generated by a service minus the costs associated with (or resources consumed by) operating the service.

Figure 8-4 Calculation of net economic benefits internal to the transport system



Externalities

External costs and benefits, or externalities, measure the impact of HSR on the broader community and are derived from the change in passenger kilometres travelled (pkm) by mode. The diversion of trips to HSR results in a reduction in pkm on existing modes (i.e. car, rail, aviation and coach) and an increase in pkm by HSR. The additional pkm by HSR as a result of induced demand is also included in the assessment. The following external impacts are measured:

- Air pollution and noise pollution.
- Accidents.
- Urban and non-urban road network congestion.
- Greenhouse gas/carbon emissions.

Residual value

A residual value has been included to capture the remaining value of the investment in HSR beyond 2085. The residual value has been estimated based on value-in-use, i.e. the discounted value of expected net benefits beyond 2085 to 2108¹², less an annuity value for capital maintenance. When estimating the residual value, the benefits of HSR are assumed to remain constant post 2085. The capital maintenance costs have been developed based on the maintenance trends over the appraisal timeframe.

Cash flow analysis

Costs and benefits are derived as a series of cash flows, discounted back to present values, and

12 Representing 50 years from when operations of the last segment commence (i.e. 2058).

aligned to the proposed staging of the HSR program as set out in **Chapter 6**, with operations commencing in 2035 and net benefits projected forward over 50 years to 2085. Additional capital expenditure required to renew assets that wear out over that period, such as rolling stock which has an economic life of 30 years, is included in the cashflows. The CBA has been undertaken on a resource cost basis which means that taxes, such as GST, fuel excise and the carbon tax were removed.

The cashflows from the cost-benefit analysis produce three key economic indicators:

- The economic internal rate of return (EIRR) which represents the discount rate that makes the net present value of all economic cash flows equal to zero. The higher the EIRR, the greater the net economic returns achieved by a project relative to its capital resource costs.
- The economic net present value (ENPV) which is the sum of the discounted present value of the economic costs and benefits over the appraisal timeframe. An ENPV greater than zero represents a positive economic return.
- The economic benefit cost ratio (EBCR) which is the ratio of the present value of net economic benefits to the present value of economic investment costs. An EBCR greater than one implies that the net economic benefits outweigh the net economic costs, thus representing a positive economic return.

A combination of these indicators provides an overall assessment of the economic value of HSR.

8.2.2 Defining the reference case and the base case

Reference case

The reference case (or the future HSR program) is the central case for the assessment. It consists of the preferred HSR system and specifications described in **Chapters 3, 4 and 5** including estimates of capital and operating costs. It also includes demand and travel impacts outlined in **Chapter 2** and the staging profile outlined in

Chapter 6. The first year of construction was assumed to be 2027 (financial year 2028), with services on Line 1 stage 1 (Sydney-Canberra) beginning in 2035.

The introduction of the future HSR program would compete vigorously with air travel. The aviation sector is therefore likely to be the most heavily impacted by the introduction of the future HSR program. Of the 83.6 million HSR trips forecast for 2065, around 55 per cent are forecast to be diverted air trips. This would drive significant operational changes in the aviation sector.

Airline services are mobile in the sense that there are few significant sunk capital costs in servicing particular routes, and assets can be quickly redeployed to other routes. Airlines operating along key regional and inter-capital routes across the east coast of Australia already compete strongly against each other, and fare levels of many fare classes have declined over time, which suggests that airfare levels are already highly competitive on major routes.

It is not expected that airlines could, or would, respond to HSR competition by reducing their fares on a sustainable basis. Rather, it has been assumed that airlines would quickly reduce capacity, either by reducing frequencies or aircraft sizes, to locations within the HSR corridor where there is significant passenger diversion to HSR¹³. This assumption is consistent with overseas experience where, following the introduction of HSR, the airline response has generally been to reduce services on the competitive route. For example, Air France responded to the Paris–Marseille HSR network by reducing services and EasyJet exited the route. In Japan there was some limited price competition from the airlines on competing routes, although arguably the Japanese domestic airline market was less competitive than Australia's is now.

Given that airfares in Australia are already highly competitive on major routes, no sustainable reduction in airfares would be expected following the introduction of HSR. However, a sensitivity test has been included in **section 8.6.3** to assess

13 It is likely that any available capacity will be redeployed to routes outside the HSR corridor.

the impact that a two year price war between HSR and aviation would have on the economic and financial analysis results for HSR.

Base case

The base case assumes that, without HSR, travellers on the east coast will continue to rely on existing modes of transport:

- Aviation will remain the primary means of transport for long distance interstate (and some inter-regional) trips.
- Road-based travel and private vehicle usage will remain the primary mode for connections with and between regional centres.
- Public transport will play an increasingly important role in meeting travel demand within cities, served by conventional rail and bus.

For road and rail modes, the base case assumes that governments will continue to augment supply by providing infrastructure and services to meet future demand. For aviation, given the uncertainty around the future of airport capacity in the Sydney region, the base case has assumed that no additional investment in airport capacity in the Sydney basin would occur. As a consequence, the base case assumes that service levels within the Sydney region will become increasingly constrained.

As outlined within the recent Australian/NSW Government *Joint Study into Aviation Capacity in the Sydney Region*¹⁴ (hereafter referred to as the Joint Study), growth in demand for aviation services in the Sydney region is expected to double to 88 million passenger trips per year by 2035, and then double again by 2060. Sydney (Kingsford Smith) Airport does not have the capacity to meet the expected demand, leading to:

- Slower and greater unreliability in air journey times as airlines and airports are faced with higher levels of congestion.

- An increasing requirement for air passengers to shift their travel time as a result of lack of capacity at their preferred travel time.
- An increasing number of travellers who are forced to travel by other means or do not travel at all (otherwise known as unmet and/or suppressed demand).

This assumption has added complexity to the modelling of the base case to take account of the constraints at Sydney Airport. To be consistent with the assumptions outlined within the Joint Study¹⁵, the base case modelling of aviation trips through Sydney has included an additional unexpected delay factor of 11 minutes per passenger¹⁶ and a seven per cent increase in fares¹⁷.

Given the likely significance of this assumption, a sensitivity test that allowed for additional aviation capacity in Sydney was included in **section 8.6.4** to test the impacts of removing the effects of the unexpected delay and fare increases from the modelling.

8.3 Cost-benefit analysis results

The CBA was undertaken in real terms in \$2012 utilising a discount rate of four per cent with a base year of 2028¹⁸, reflecting the reference case and the base case defined above. This, taken together as a set of CBA results, is the primary case for the economic evaluation, against which various sensitivities and scenarios were run.

A four per cent discount rate has been assessed as suitable for large scale and long-life infrastructure projects such as HSR. This is consistent with international experience and the Australian Transport Council (ATC) guidelines and has therefore been adopted as the discount rate for the primary evaluation of HSR.

14 Australian Government and NSW Government, loc. cit.

15 *ibid.*

16 The 11 minutes average increase in unexpected delay over today's conditions is weighted by 3.0 within the analysis. This is consistent with Civil Aviation Safety Authority (CASA) (2007) Cost-Benefit Analysis Procedures Manual.

17 The seven per cent increase in fares represents the average disbenefit of air passengers having to change their time of travel to fit with the availability of seat capacity.

18 The base year is the year to which costs and benefits have been discounted. Consistent with the ATC guidelines, the base year is set to the year of construction commencement.

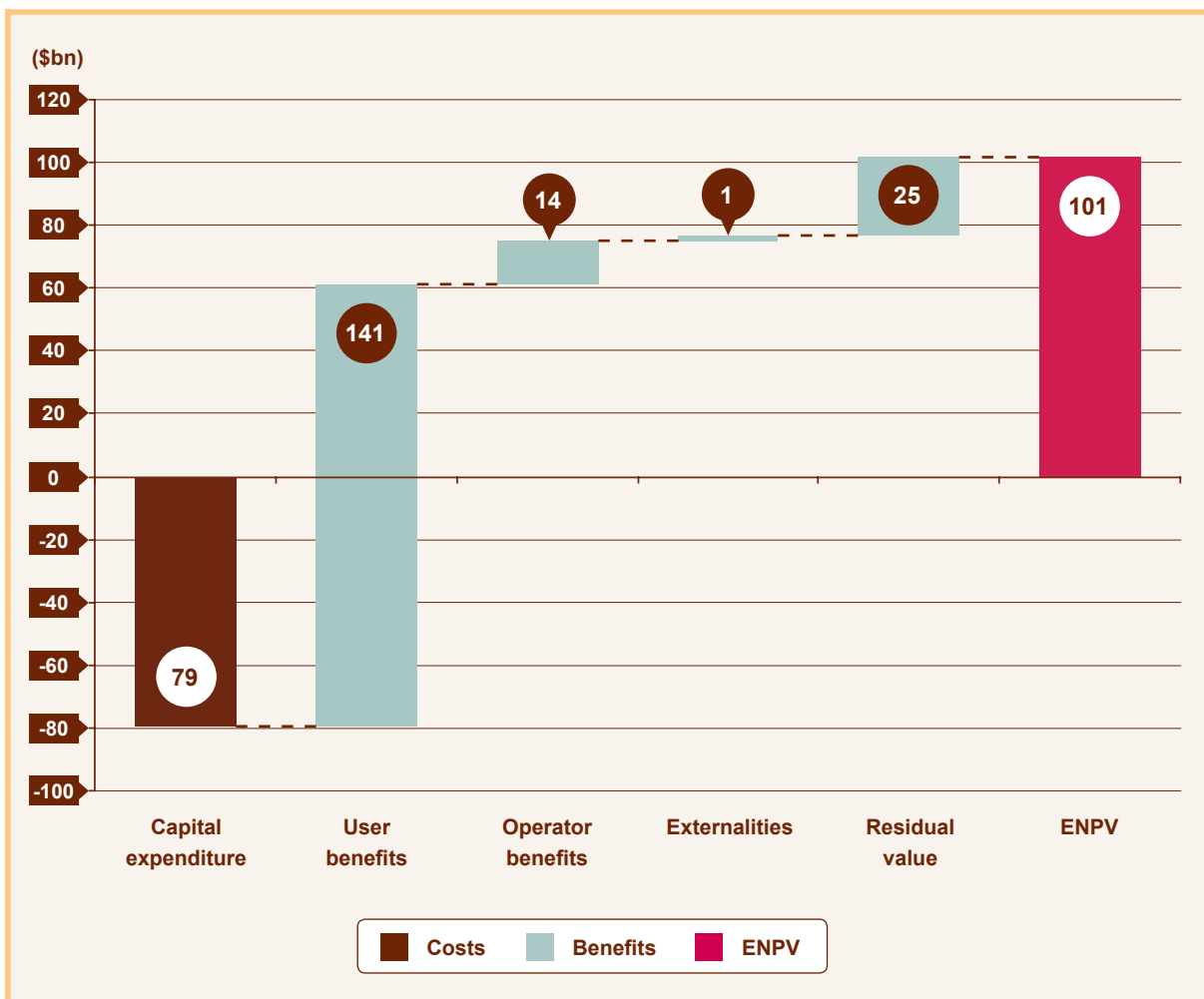
A seven per cent discount rate is also presented, as it is the typical central rate used by Australian governments and Infrastructure Australia to evaluate public sector infrastructure projects¹⁹, albeit of an order of magnitude smaller than the HSR project. A more detailed discussion of alternative discount rates is presented in **Appendix 5A**.

It is estimated that the introduction of HSR along the east coast of Australia would generate a real EIRR of 7.6 per cent and the following results in present value terms:

- User benefits of \$140.7 billion, which exceed discounted capital expenditure of \$79.3 billion.
- Fare revenue which exceeds operating costs, resulting in a positive producer surplus of \$13.7 billion.
- Net externality benefits (e.g. reduced road congestion and accidents) of \$1.2 billion.
- A positive ENPV of \$101.3 billion and an EBCR of 2.3, implying that the economic benefits of HSR outweigh the economic costs by more than double.

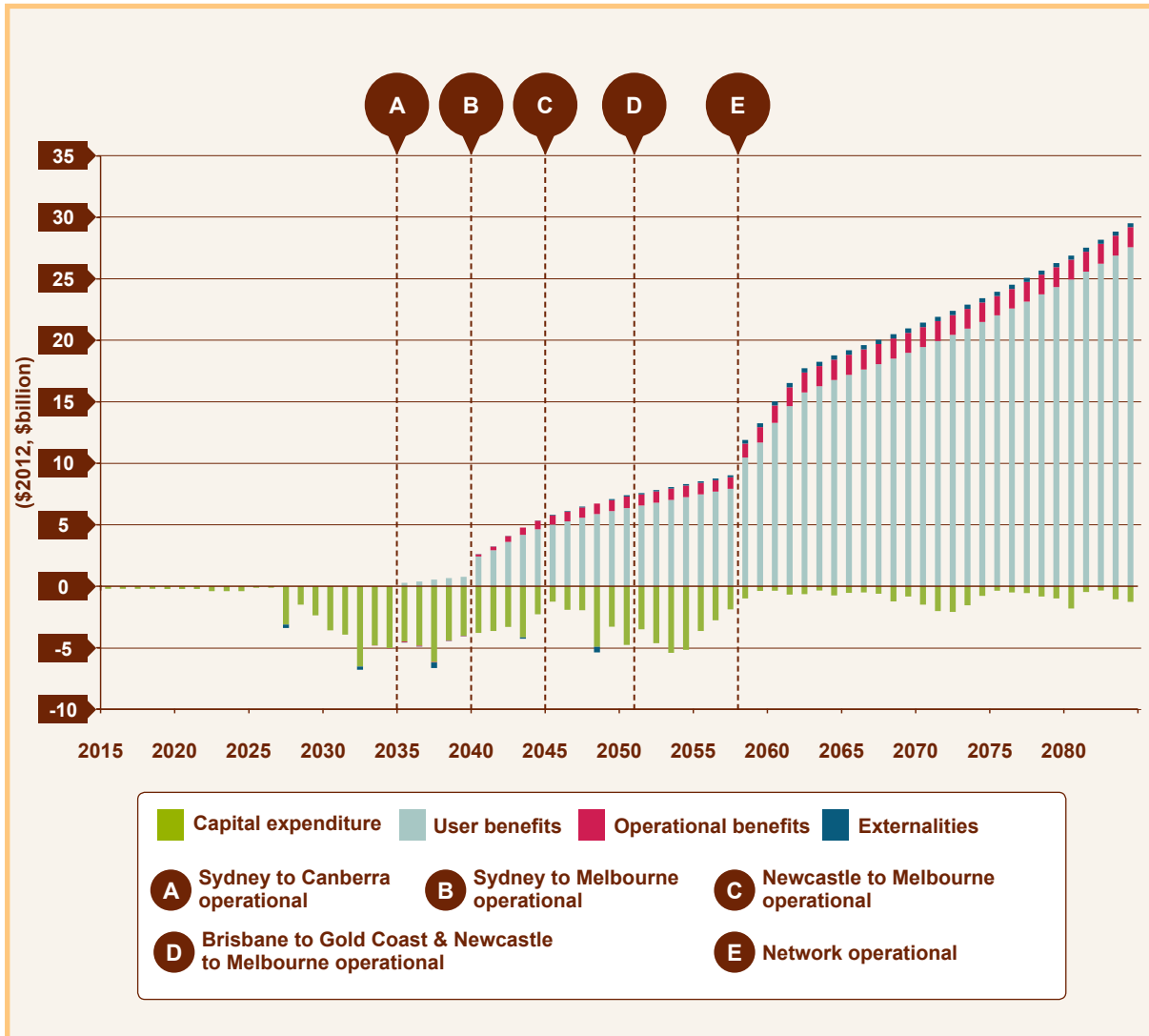
These results are illustrated in **Figure 8-5**. The economic cash flows are illustrated in **Figure 8-6**.

Figure 8-5 Reference case economic analysis results (\$2012, \$billion, present values to 2028 at a 4% discount rate)



19 Infrastructure Australia, loc. cit.

Figure 8-6 Reference case economic cash flows per year (undiscounted, \$2012, \$billion)



As illustrated in **Figure 8-6**, the capital expenditure required to construct and maintain the HSR program is followed by a large growth in benefits (including benefits to the users and operators of the transport system and externalities) which significantly outweigh the costs.

Table 8-2 compares the results of the CBA for the reference case, using both a four per cent and seven per cent discount rate.

Using a seven per cent discount rate reduces the net economic benefit, with an ENPV of \$4.9 billion and an EBCR of 1.1. In both cases, the EIRR of 7.6 per cent exceeds the discount rate.

8.4 HSR capital costs

For the purpose of the economic analysis, the capital costs of the future HSR program include project development, construction costs, rolling stock costs and asset renewal. It should be noted that the treatment of rolling stock differs in the financial analysis presented in **Chapter 7**, which assumes that the rolling stock is leased from a third party provider with the lease costs appearing as a recurrent expense.

Figure 8-7 indicates that most of the program costs are spread over the construction period of 2027 (financial year 2028) to 2058. The costs

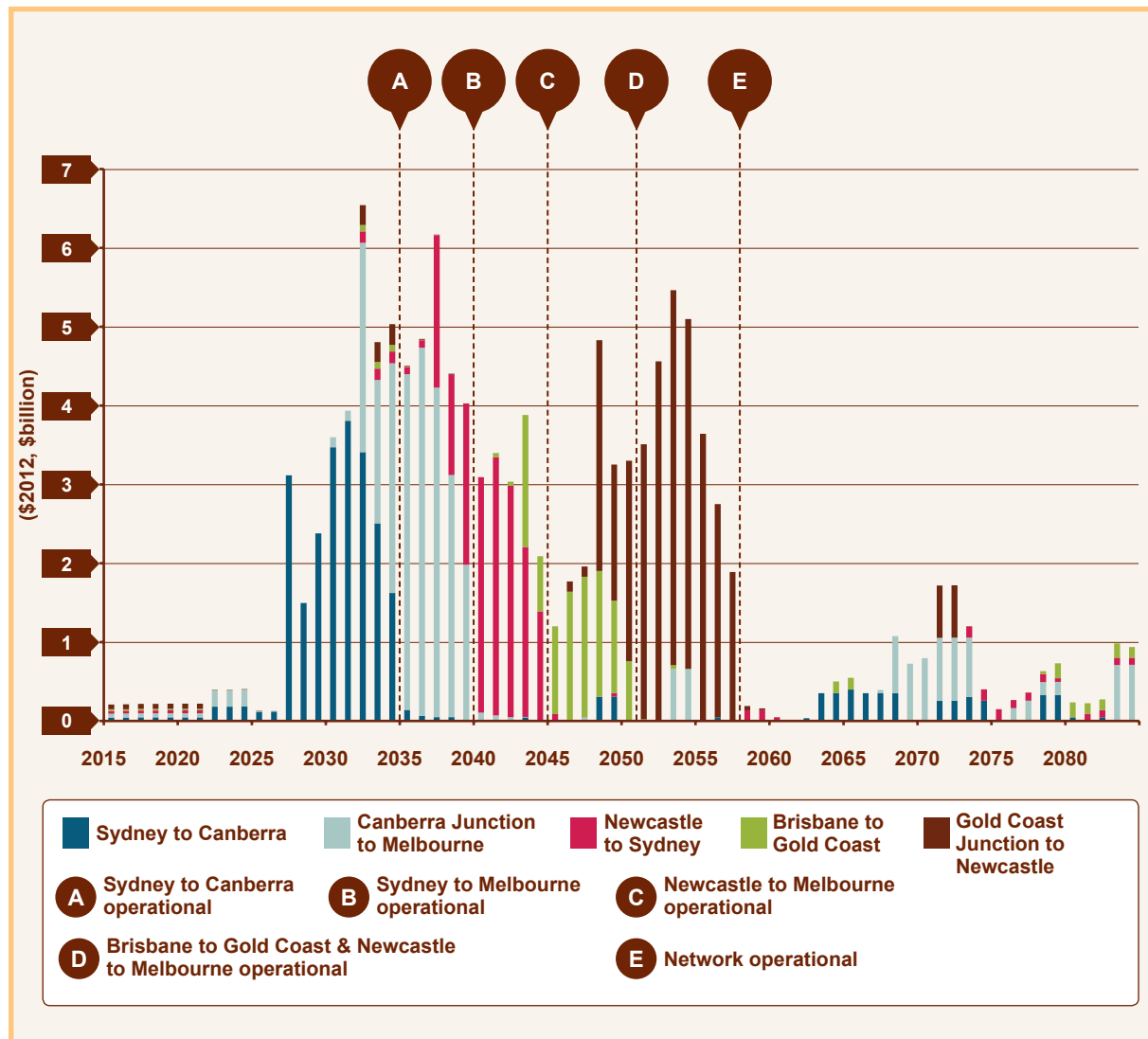
occurring after 2058 represent ongoing rolling stock costs and asset renewal. The total costs of the HSR program, in present value terms (i.e. discounted over the appraisal timeframe), amounts

to \$79 billion, of which construction of the infrastructure comprises \$63.2 billion, or almost 80 per cent of the total capital cost.

Table 8-2 Reference case analysis – summary assessment criteria (PV, \$2012, \$billion)

	4% discount rate	7% discount rate
Total costs	79.3	58.9
Total benefits	180.6	63.8
EIRR	7.6%	7.6%
ENPV	101.3	4.9
EBCR	2.3	1.1

Figure 8-7 HSR capital costs by segment (undiscounted, \$2012, \$billion)



Significant government contributions would be required to fund the construction of HSR. If taxes were increased to fund the government spending, the Department of Finance and Deregulation Handbook of Cost-benefit analysis²⁰ suggests that an adjustment for the excess burden of tax²¹ should be included with the financial costs. As discussed in **Chapter 7** the analysis does not make any assumptions in regard to how the future HSR program would be funded or financed. As such no adjustments have been included to the financial costs to cover potential taxation implications. The impacts of government investment in the HSR program, including flow on effects on GDP, are discussed in more detail in the CGE analysis presented in **section 8.8**.

8.4.1 Impact of alternative cost estimates

It is prudent to test the robustness of the results of the economic appraisal to higher or lower capital costs. Two scenarios were assessed to test the impact that alternative cost estimates would have on the economic analysis results, namely:

- Ten per cent decrease in pre-risk capital and operational costs compared to the reference case.
- Thirty per cent increase in pre-risk capital and operational costs compared to the reference case.

The impacts on the economic and financial results are shown in **Table 8-3**. Even if the costs of HSR were to increase by 30 per cent, the project still generates a positive economic result, with an EIRR of 6.0 per cent and an EBCR of 1.6 (applying a four per cent discount rate). Lower costs improve both the economic and financial return.

Table 8-3 Impacts of alternative cost assumptions on the economic and financial results (PV, 4% discount rate, \$2012, \$billion)

Measure	Reference case	Costs - 10%	Costs + 30%
Total costs	79.3	71.1	104.3
User benefits	140.7	140.7	140.7
Operator benefits	13.7	18.1	-0.1
Externalities	1.2	1.2	1.2
Residual value	25.0	25.9	22.3
Total benefits	180.6	185.9	164.2
EIRR	7.6%	8.2%	6.0%
ENPV	101.3	114.8	59.9
EBCR	2.3	2.6	1.6
FNPV	-47.0	-33.1	-97.5
FNPV (pre-tax)	-47.0	-30.5	-97.5
FIRR (real)	0.8%	1.8%	-9.8%
FIRR (real) (pre-tax)	0.8%	2.1%	-9.8%

Notes: Due to accumulated tax losses (primarily from depreciation on the infrastructure asset base), the future HSR program pays corporations tax in only some scenarios and sensitivities during the evaluation period. Where tax is not payable, the FIRR and FNPV do not differ on a pre- and post-tax basis.

20 Department of Finance and Deregulation (DOFD) (2006) Handbook of Cost-benefit analysis.

21 The marginal excess burden of tax is the additional value forgone when a tax rate is increased to fund certain government spending.

8.5 HSR benefits

As outlined in **section 8.2.1**, the stream of net economic benefits comprises three parts: user benefits, operator benefits and externalities. Each is discussed below.

8.5.1 User benefits

Total user benefit measures the overall change in 'generalised cost of travel' as a result of people using HSR compared to base case modal choices. 'Generalised cost' includes the various components that contribute to the overall cost of making a trip, e.g. the fare, the journey time and, for travel by car, the operating cost. It also includes a utility impact which takes into consideration the relative amenity features of a mode not captured in other variables (the 'alternative specific constant'). The calculation of the user benefits also includes the benefits generated by induced demand (i.e. new travel encouraged by HSR as opposed to travel diverted from other modes).

The computation of the user benefits is based on the 'logsum' or composite cost, which is an output of the procedures used for forecasting the patronage on a new mode of transport (in this case, the 'logit' model of the choice between transport modes). These computations of user benefits have been independently audited and verified using a first principles approach to estimating the consumer surplus from the area under the demand curve. One of the characteristics of the choice model used in the demand forecasts is that it will forecast a small volume of trips diverting to HSR even when the existing modes remain by far the best choice on average. While this can be observed in real life, a check on the results confirmed that these low-volume diversions did not have a material effect in aggregate on the estimated demand and benefits.

Four indicative case study examples are presented to illustrate the impact that the introduction of HSR would have on a typical journey. The case studies also outline how the user benefits are estimated. The four examples are business trips from inner east Melbourne to inner Sydney and

from outer north west Melbourne to Port Botany in Sydney, and leisure trips from Wagga Wagga to Sydney CBD and from Tumut to Parramatta. These trips account for different proportions of the HSR demand and benefits, with Melbourne to Sydney being the most important.

For business travel, the majority of user benefits (about 62 per cent) can be attributed to HSR providing a direct improvement over the existing best²² transport modes. Another 24 per cent are due to the benefit gained by having an additional mode of transport available in the corridor which, while not the best mode, nevertheless attracts a share of the travel demand²³. The remaining 14 per cent are due to the benefits attributable to induced travel demand.

For those business journeys for which the current mode is air and HSR becomes the best mode, virtually all (94 per cent) of the user benefits can be attributed to the reduced access and egress times and costs to/from the HSR city centre stations as compared with the airports.

Within the capital cities, most visitors end their trips in the city CBD and some residents start their trips in the CBD. For these trips the access/ egress distances to/from the CBD are substantially less from the HSR central stations than from the airports. Hence, there is a substantial access benefit with HSR in terms of both journey times and travel costs. Given the importance of the access/ egress benefits, the access, egress and travel time assumptions and the generalised cost formulation have been independently audited and confirmed to be reasonable.

Case study 1 illustrates a business trip from inner east Melbourne to inner Sydney. In this case study, the access journey from east of Melbourne to the CBD is much shorter than that through the CBD to the airport; this is reflected in the user benefit. Sydney Airport is closer to the CBD and the egress benefit with HSR is correspondingly less.

As illustrated in **Table 8-4**, HSR is on average 92 minutes better in generalised cost terms than air. If all air trips were forecast to switch

²² Without HSR, the mode that offers the lowest generalised cost of travel.

²³ Even if HSR is not the best mode 'on average', because individual travel preferences are assumed to be distributed around the average it will still attract some trips, as explained further in the description of the case studies.

to the better mode, this would be the benefit each would receive. With two such different modes of transport, such a simplistic forecasting methodology is unrealistic and some split of the trips between the two modes would be expected.

In the forecasting procedures, variations in individual preferences and the approximations of modelling are reflected in a distribution of generalised cost (or utility) for each mode. That is, the generalised cost is represented by an observed component (the 'average' generalised cost, as given in the case study table) plus a random, unobserved component which represents the individual variations. Consequently, rather than determining the modal allocation based on average utilities, the mode share model accounts for the utility distribution.

The consequence of this is that, in case study 1, despite HSR being considerably better than air on average in generalised cost terms, not all air trips are forecast to divert to HSR (the forecast HSR share being 70 per cent). For the 3 per cent of travellers remaining on the air services, the air generalised cost is better (lower) than that for HSR, the individual variations in the utility distribution used in the model for these particular travellers being sufficiently in favour of air to nullify the average 92 minutes generalised cost advantage of HSR.

The trips which divert to HSR are attributed a user benefit based on the difference in utility between the HSR and air modes as determined from the utility distribution. Just as the utility distribution has reduced the generalised cost advantage of HSR below the average for some trips, it also implies that there are many travellers

for whom the benefits of the HSR journey are significantly higher than the average of 92 minutes. In consequence, the overall average user benefit is forecast to be 129 minutes per trip, higher than the average of 92 minutes due to the utility distribution. Using the 2065 value of business time, this is equivalent to \$231 per trip. In addition to the diverting trips, there are benefits to induced trips on HSR.

In case study 2, a business trip from outer north west Melbourne to Port Botany in Sydney is a contrasting inter-capital trip in which the origin and destination are similarly accessible to the airport and the HSR station, and thus the access and egress benefits are not significant. In this case, the level-of-service for air and HSR is virtually identical.

In this situation, the distribution of generalised costs is such that for just under 50 per cent of trips the air generalised cost is better than that of HSR, and for the remaining trips the HSR generalised cost is better than that of air. The forecast is for a broadly equal share of trips on the two modes.

The diverting trips are attributed a benefit based on the difference in generalised cost between the HSR and air modes as determined from the utility distribution. For all of the diverting trips, the difference between the HSR and air generalised costs utility is higher than the difference in the average generalised costs (which is close to zero). The trips diverting to HSR therefore gain a significant benefit. The overall average user benefit is 73 minutes per trip, equivalent to \$133 in 2065. Again there are additional user benefits arising from induced HSR travel.

Case study 1 – Business trip from inner east Melbourne to inner Sydney

In the absence of HSR a typical business trip from inner east Melbourne to the Sydney CBD could involve:

- A taxi or park and ride to Melbourne (Tullamarine) airport.
- Check in at the airport and wait time until flight departure, and potential delays due to congestion at Sydney Airport or other unexpected factors.
- Flight from Melbourne Airport to Sydney Airport.
- Taxi from Sydney Airport to Sydney CBD.

With the future HSR program, a typical journey could consist of:

- A taxi or public transport to Southern Cross station.
- Waiting time at the station
- HSR from Southern Cross station Melbourne to Central station/Sydney CBD.
- Taxi or public transport egress from Central station to Sydney CBD.

An indicative assessment of the generalised costs (expressed in equivalent minutes) associated with each of the trips is outlined below in **Table 8-4**.

Table 8-4 Generalised cost comparison – inner east Melbourne to inner Sydney air versus HSR (in generalised minutes)

Component	Air	HSR	Difference	Commentary
Access costs ²⁴	137	71	-66	Taxi or park and ride to the airport. Taxi or public transport to HSR station.
Wait time	91 ²⁵	18	-73	It is assumed that there is no formal check-in time for HSR.
In-vehicle time	85	163	+78	
Fare (equivalent minutes)	107	105	-2	HSR fares between state capital cities have been tied to air fares for the reference case. The fares (\$146 for air and \$141 for HSR) are translated into equivalent minutes to estimate the total generalised trips costs.
Egress costs	73	48	-25	Taxi from Sydney Airport. Taxi or public transport from Sydney HSR station (Central).
Sub total	492	405	-87 (-92 ²⁶)	Difference in generalised trip costs for the average user.
Mode shares	Without HSR, 95% of trips are forecast to be by air. HSR has a lower generalised cost and is forecast to win a 70% share of the market, leaving air with 26%.			
Contribution to evaluation	Business travel between the east Melbourne area and inner Sydney (including the CBD) accounts for 5% of business travel on HSR and 5% of business user benefits.			

Note: Totals may not sum due to rounding differences.

As illustrated:

- The overall HSR/air perceived travel times, including check-in and wait time, and fares are similar (283 vs 286 equivalent minutes)
- The generalised access time to Tullamarine Airport from the inner east suburb is 66 equivalent minutes greater than that to Southern Cross station. Tullamarine is on the outskirts of the city with minimal public transport access, in comparison to Southern Cross station which is located in the CBD.
- The travel time from Sydney Airport to the CBD is 25 equivalent minutes greater than that to Central station which is located within the Sydney CBD.

24 Access and egress generalised times includes a weight on journey time of 1.4 applied in accordance with ATC guidelines, an ASC favouring public transport access to the HSR station, and fares and parking charges.

25 Air includes 22.5 minutes of additional time for check in, security, waiting for luggage, etc. which is then weighted by a factor of 2 in accordance with the ATC guidelines (equalling 45 equivalent minutes). It also includes 11 minutes of unexpected delay due to congestion at Sydney airport, weighted by a factor of 3 to reflect unreliability (equalling 33 equivalent minutes). For air and HSR there is an additional frequency-related waiting time which is also weighted by 2.

26 The alternative specific constants (ASCs) for the existing modes of transport were estimated as part of the re-scaling process, thus ensuring that the model reproduces the existing mode shares in the corridor. For inter-city trips, the ASCs for HSR were based on the modelling for the European Commission and set at five minutes in favour of HSR for business and non-business, thus retaining compatibility with the independent evidence on HSR inter-city mode shares. For long regional and short regional trips, the HSR ASCs were set relative to air and rail respectively. For non-business trips the ASC values were based on the SP: that is, 50 minutes in favour of HSR. For business trips, the ASCs for HSR were set at five minutes in favour of HSR for long regional, consistent with inter-city trips, and zero for short regional trips based on the SP.”

Case study 2 – Business trip from outer north west Melbourne to Port Botany, Sydney

In the absence of HSR a typical business trip from outer north west Melbourne to Port Botany could involve:

- A taxi or park and ride access to Melbourne (Tullamarine) Airport.
- Check in at the airport and wait time until flight departure, and potential delays due to congestion at Sydney Airport or other unexpected factors.
- Flight from Melbourne Airport to Sydney Airport.
- Taxi from the airport to Port Botany.

With the future HSR program, a typical journey could consist of:

- A taxi or public transport access to Southern Cross station.
- HSR from Southern Cross station Melbourne to Central station Sydney CBD.
- Taxi from Central station to Port Botany.

An indicative assessment of the generalised costs (expressed in equivalent minutes) associated with each of the trips is outlined below in **Table 8-5**.

Table 8-5 Generalised cost comparison – outer north west Melbourne to Port Botany, Sydney air versus HSR (in generalised minutes)

Component	Air	HSR	Difference	Commentary
Access costs	53 ²⁷	44	-9	Taxi or park and ride access to the airport. Taxi or public transport access to HSR station.
Wait time	91 ²⁸	29	-62	It is assumed that there is no formal check-in time for HSR.
In-vehicle time	85	154	+69	
Fare (equivalent minutes)	107	102	-5	The fares (\$146 for air and \$141 for HSR) are translated into equivalent minutes to estimate the total generalised trips costs.
Egress costs	27	46	19	Taxi from Sydney Airport. Taxi from Sydney HSR station (Central).
Sub total	363	364 ²⁹	1 (-4 ³⁰)	Difference in generalised trip costs for the average user.
Mode shares	Without HSR, 96% of trips are forecast to be by air. With a very similar generalised cost, HSR is forecast to win a 49% share of the market, leaving air with 48%.			
Contribution to evaluation	Business travel between outer north west Melbourne and south Sydney accounts for less than 0.1% of business travel on HSR and less than 0.1% of business user benefits.			

As illustrated:

- The overall HSR/air perceived travel times, including check-in and wait time, and fares are similar (283 vs. 285 equivalent minutes)
- The generalised access time to Tullamarine airport from the north west suburb is similar to that to Southern

Cross station, HSR has little advantage.

- The egress time from Sydney Airport to Port Botany is 19 equivalent minutes shorter than that from Central station.

27 op cit.

28 op cit.

29 The breakdown of generalised access costs is given for the journey via most accessible station (Melbourne North). However Melbourne Central (Southern Cross) station is also an option which a proportion of passengers are forecast to use and the combination of two accessible stations reduces the overall total generalised cost below that of the route via Melbourne North by 11 minutes from 375 to 364.

30 There is in addition a small alternative constant of five minutes in favour of HSR over air included in the generalised cost.

The breakdown of benefits is quite different for those business journeys for which the current mode is car and HSR becomes the better mode. The major source of user benefit is the large in-vehicle time savings that HSR offers over car, but these time savings are reduced by the additional time involved in the access and egress journeys to and from the HSR stations.

Case study 3, a business trip from Wagga Wagga to Sydney CBD, illustrates this balance. Currently, car and air modes are available, with car having the lower generalised cost. HSR would have a lower cost than both existing modes. Overall HSR is better than both existing modes by around

100 minutes, with the in-vehicle time being over 250 minutes shorter than the car journey.

For long regional trips such as these, the majority of user benefits for HSR relative to air travel arise from a reduction in the overall journey time (in which check-in, time spent in the airport and unexpected flight delays are avoided) and lower fares - HSR is assumed to be able to offer lower fares for travellers than regional aviation. Relative to car travel, most of the benefits of HSR derive from faster in-vehicle journey times. The overall saving in this case is 86 minutes per trip, equivalent to \$221 in 2065.

Case study 3 – Business trip from Wagga Wagga to Sydney CBD

In the absence of HSR (i.e. the base case) a typical business trip from Wagga Wagga to the Sydney CBD could involve:

- Driving around 450 kilometres between Wagga Wagga and Sydney CBD, with associated vehicle operating costs of around \$140.
- Or, if travelling by air – taxi or park and ride access to Wagga Wagga Airport, check-in and wait time at the airport along with potential delays due to congestion at Sydney Airport, aviation in-vehicle time, and taxi from Sydney Airport to the CBD.

With the future HSR program, a typical journey could consist of:

- Taxi or park and ride access to Wagga Wagga station.
- HSR trip between Wagga Wagga station and Central station in Sydney CBD.
- Taxi or public transport from Central station to the final destination in Sydney CBD.

An indicative assessment of the generalised costs (expressed in equivalent minutes) associated with each of the trips is outlined below in **Table 8-6**.

Table 8-6 Generalised cost comparison – Wagga Wagga to Sydney CBD air/car versus HSR (in minutes)

Component	Air	Car	HSR	Difference HSR vs air and car	Commentary
Access costs	48	0	50	air: 2 car: 50	Taxi or park and ride to both HSR station and airport. No access costs associated with car.
Wait time	136 ³¹	0	50	air: -86 car: 50	It is assumed that there is no formal check-in time for HSR.
In-vehicle time	60	343	88	air: 28 car: -255	
Fare/VOC (equivalent minutes)	71	56	45	air: -26 car: -11	The fares/VOC (\$137 for air, \$140 for car and \$89 for HSR) are translated into equivalent minutes to estimate the total generalised trips costs.
Egress costs	84	0	63	air: -21 car: 63	Taxi from Sydney Airport. Taxi or public transport from Sydney HSR station (Central).

Table 8-6 Generalised cost comparison – Wagga Wagga to Sydney CBD air/car versus HSR (in minutes) (continued)

Component	Air	Car	HSR	Difference HSR vs air and car	Commentary
Sub total	399	399	296	air: -103 (108 ³²) car: -103 (-90 ³³)	Difference in generalised trip costs for the average user.
Mode shares	Without HSR, 47% of trips are forecast to be by air and 51% by car. With a lower generalised cost than both air and car, HSR is forecast to win a 48% share of the market, leaving air and car with 13% and 36% respectively, the greater impact being on air.				
Contribution to evaluation	Business travel from the regional areas between Canberra and Albury-Wodonga, encompassing Wagga Wagga and Tumut, to Sydney CBD accounts for less than 0.1% of business travel on HSR and less than 0.1% of business user benefits.				

As illustrated:

- Compared with air, HSR has a lower overall time (wait and in-vehicle), a lower fare and lower egress cost.
- Compared with car, the in-vehicle time by HSR is over

four hours shorter, which is only partially offset by the access and egress costs for HSR. The HSR fare is also very close to the cost of using car.

For the non-business leisure segment, the majority of user benefits (about 67 per cent) are due to the benefit gained by passengers who switch to HSR despite it not having the lowest average generalised cost. This generally applies in the situation where car is currently the best mode of travel to and from regional towns. Another 24 per cent of benefits are where HSR provides a direct improvement over the existing best transport modes and nine per cent are due to the benefits attributable to induced travel demand.

The final case study 4 illustrates the components of a non-business trip from regional NSW (Tumut, south of Canberra) to Parramatta in Sydney. Car is the current preferred mode of transport

(accounting for 76 per cent of trips). HSR remains less attractive than car - while HSR has a lower in-vehicle time, it is much more expensive and there is a long access trip to the regional HSR station and a long egress trip from Sydney Central to Parramatta. However, HSR is a significant improvement over the current alternative air service (not requiring check-in and having no unexpected delay penalties, and a much lower fare). Car continues to be the most attractive option, but HSR replaces air and wins a larger share of the travel, mainly from air. The overall user benefits of this improvement are forecast to be just under 30 minutes per trip, equivalent to \$15 per trip in 2065.

Case study 4 - Leisure trip from regional NSW (Tumut, south of Canberra) to Parramatta, Sydney

In the absence of HSR a typical leisure trip from Tumut in regional NSW to Parramatta could involve:

- Driving around 400 kilometres between Tumut and Parramatta, with associated vehicle operating costs of around \$140.
- Or if travelling by air – a taxi or car to Wagga Wagga airport; check in at the airport and wait time until flight departure, and potential delays due to congestion at Sydney Airport or other unexpected factors. Flight from Wagga Wagga Airport to Sydney Airport. Taxi or public transport egress from the airport to Parramatta.

With the future HSR program, a typical journey could consist of:

- A taxi or car to Wagga Wagga station.
- HSR from Wagga Wagga to Central station/Sydney CBD.
- Taxi or public transport from Central station to Parramatta.

An indicative assessment of the generalised costs (expressed in equivalent minutes) associated with each of the trips is outlined below in **Table 8-7**.

32 There is in addition a small alternative constant of five minutes in favour of HSR over air included in the generalised cost.

33 There is in addition a small alternative constant of 13 minutes in favour of car over HSR and air included in the generalised cost, calibrated from current mode shares in the corridor.

Table 8-7 Generalised cost comparison – Tumut to Parramatta air/car versus HSR (in generalised minutes)

Component	Air	Car	HSR	Difference Air/Car	Commentary
Access costs ³⁴	159	0	161	air: 2 car: 161	Taxi or park and ride to both HSR station and airport. No access costs associated with car.
Wait time	136 ³⁵	0	50	air: -86 car: 50	It is assumed that there is no formal check-in time for HSR.
In-vehicle time	60	309	88	air: 28 car: -221	
Fare/VOC (equivalent minutes)	264	64	118	air: -146 car: 54	The fares/VOC (\$137 for air, \$140 for car and \$89 for HSR) are translated into equivalent minutes to estimate the total generalised trips costs.
Egress costs	143	0	84	air: -59 car: 84	Taxi from Sydney Airport. Taxi or public transport from Sydney HSR station (Central).
Sub total	762	373	501	air: -261 (-311 ³⁶) car: 128 (273 ³⁷)	Difference in generalised trip costs for the average user.
Mode shares	Without HSR, 76% of trips are forecast to be by car and 16% by air. With a much reduced generalised cost compared to air, HSR wins a 29% share of the market, leaving air with 1%. Car remains the lowest cost mode and retains a 63% share.				
Contribution to evaluation	Non-business travel from the regional areas between Canberra and Albury-Wodonga, encompassing Wagga Wagga and Tumut between Eastern Melbourne and Sydney CBD accounts for less than 0.1% of non-business travel on HSR and less than 0.1% of non-business user benefits.				

As illustrated:

- HSR provides better travel times, including check-in and wait time, and lower cost compared to air
- The generalised access times by rail and air are similarly long.
- The egress time and cost from Sydney Airport to Parramatta is 59 equivalent minutes longer than that from Central station.
- Car is both quicker (after allowing for waiting and access/egress times) and cheaper than air and HSR.

The process outlined in each of the case studies above was repeated for all possible combinations of trips along the corridor to estimate the aggregate user benefits associated with the introduction of the future HSR program. The resulting user benefits across the appraisal timeframe are illustrated by trip purpose in **Figure 8-8**.

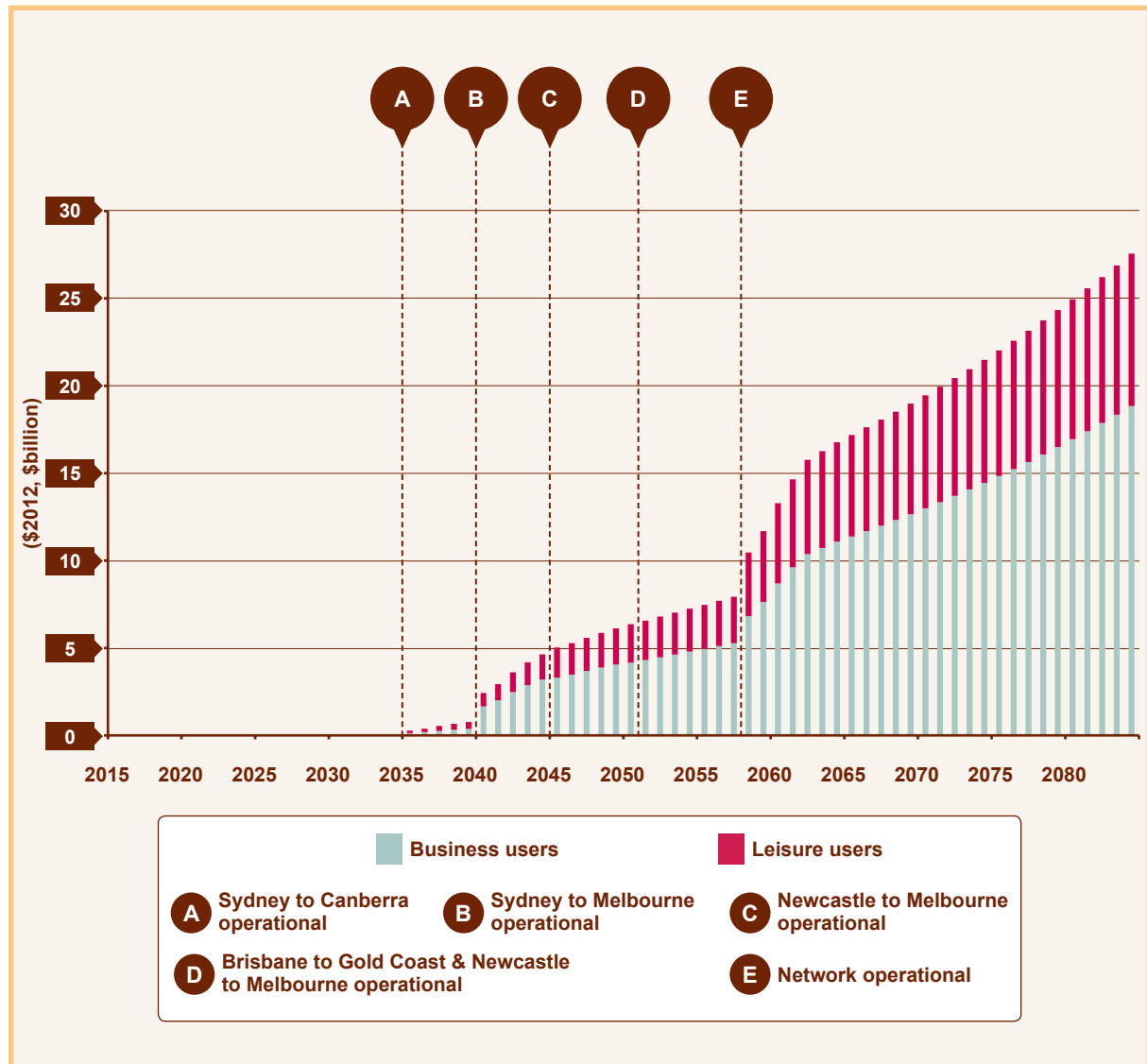
34 op cit.

35 op cit.

36 There is in addition an alternative constant of 50 minutes in favour of HSR over air included in the generalised cost, derived from the stated preference surveys in the corridor.

37 There is in addition an alternative constant of 145 minutes in favour of car over HSR and air included in the generalised cost, calibrated from current mode shares in the corridor.

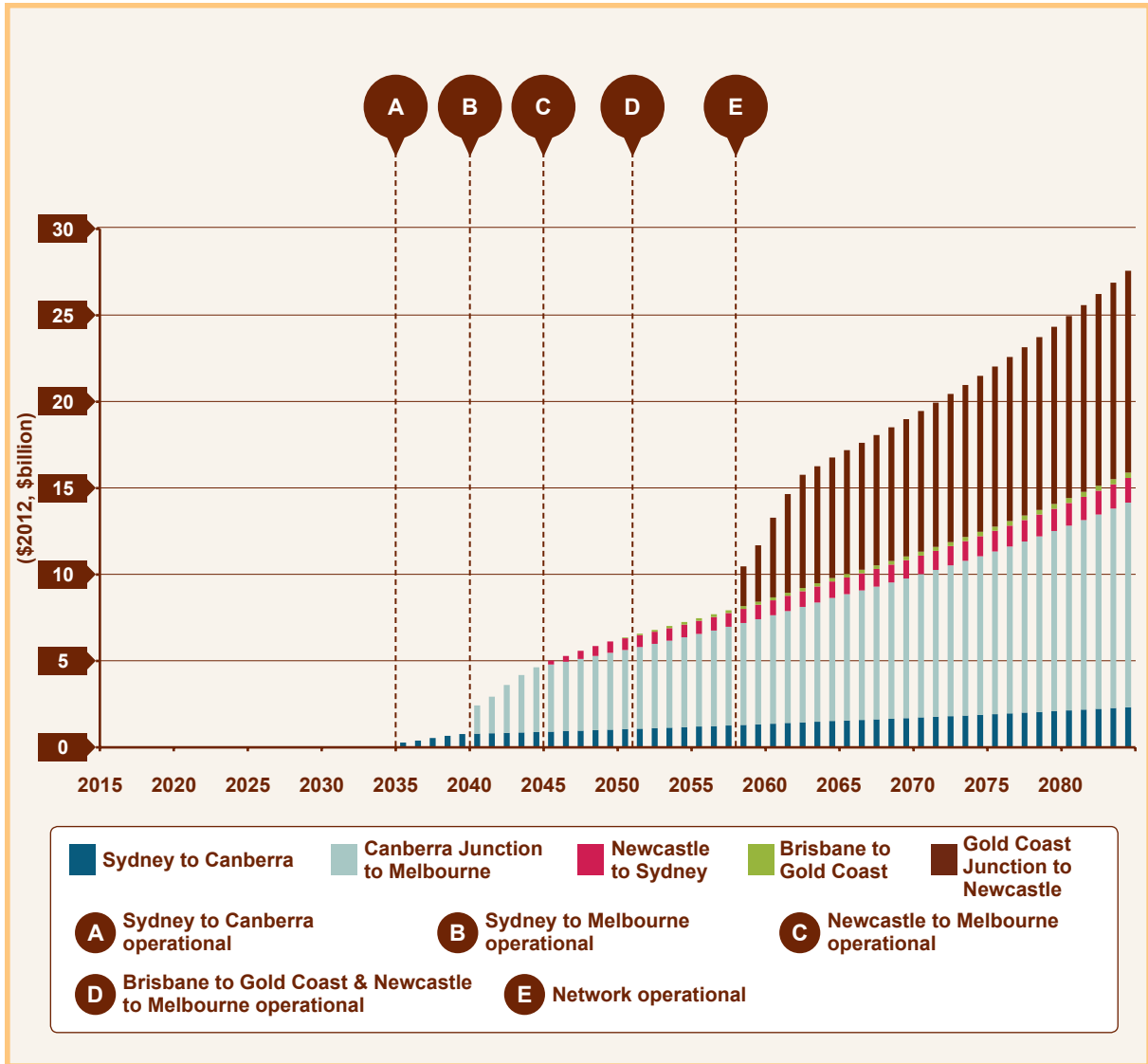
Figure 8-8 User benefits by trip purpose (undiscounted, \$2012, \$billion)



The level of user benefits generated by the future HSR program would grow in line with the growth in demand and in peoples' valuation of time savings and amenity as incomes grow. Business travel accounts for over 66 per cent of the present value of user benefits. The value of time savings per hour for business users is around four times greater than for leisure users (see **Table 8-1**).

Figure 8-9 illustrates the additional user benefits that would be generated as each stage of the future HSR program is completed. The largest increment to user benefits would be generated by the opening of Stage 2 (i.e. Canberra-Melbourne) which also completes the Sydney-Melbourne line. The completion of the system (i.e. Stage 5 – Gold Coast-Newcastle) also produces a marked increase in the level of user benefits, as it would complete the Brisbane-Sydney line and the system as a whole.

Figure 8-9 User benefit by segment (undiscounted, \$2012, \$billion)



Analysis of user benefits by market

Table 8-8 provides an indicative assessment of the average user benefits by market segment. The data is based on 2065 estimates of demand and values of time that grow in line with GDP growth.

Table 8-8 User benefits and passenger kilometres by market segment (in 2065, undiscounted, \$2012)

Trip purpose	Market	User benefits (\$billion)	HSR passenger (billion km)
Business users	Short regional	0.2	0.1
	Long regional	3.7	4.4
	Inter-city	7.6	18.2
Leisure users	Short regional	0.8	1.2
	Long regional	3.5	11.8
	Inter-city	1.6	17.5
Total		17.4	53.1

Note: Totals may not sum due to rounding differences.

Long regional and inter-city trips show the greatest impact in terms of user benefits, with inter-city trips particularly significant for business travellers. **Table 8-9** summarises present value estimates of the user benefits by market segment. In total, 94 per cent of user benefits would be generated

by long regional and inter-city trips, with short regional trips representing only a small component of the user benefits (as of demand). Inter-city business trips account for 43 per cent of the total user benefits.

Table 8-9 User benefit estimates by market segment (PV, \$2012, \$billion)

	Business users	Leisure users	Total
Short regional	1.7	7.4	9.1
Long regional	31.3	27.1	58.4
Inter-city	60.6	12.6	73.2
Total	93.6	47.1	140.7

Figure 8-10 shows the distribution of user benefits per trip by trip purpose. Both business and non-business travellers benefit from HSR to varying degrees, with benefits per trip mostly falling between \$50 and \$300. This is not confined to a small number of users experiencing very large benefits; rather, the majority of trips (76 million) experience overall trip benefits of \$100 or less, although these are mostly non-business trips and likely to be shorter journeys from regional towns to the state capital cities. The majority of business trips experience benefits of \$250 per trip or less,

although there is a significant volume of trips where benefits are around \$300 per trip, reflective of the large volume of point-to-point business traffic travelling between capital cities. The higher benefits associated with business trips also reflect the higher value of time attributed to business travel, as described previously in **Table 8-1**.

Figure 8-10 Distribution of user benefits per trip by trip purpose (\$ per trip in 2065, \$2012)

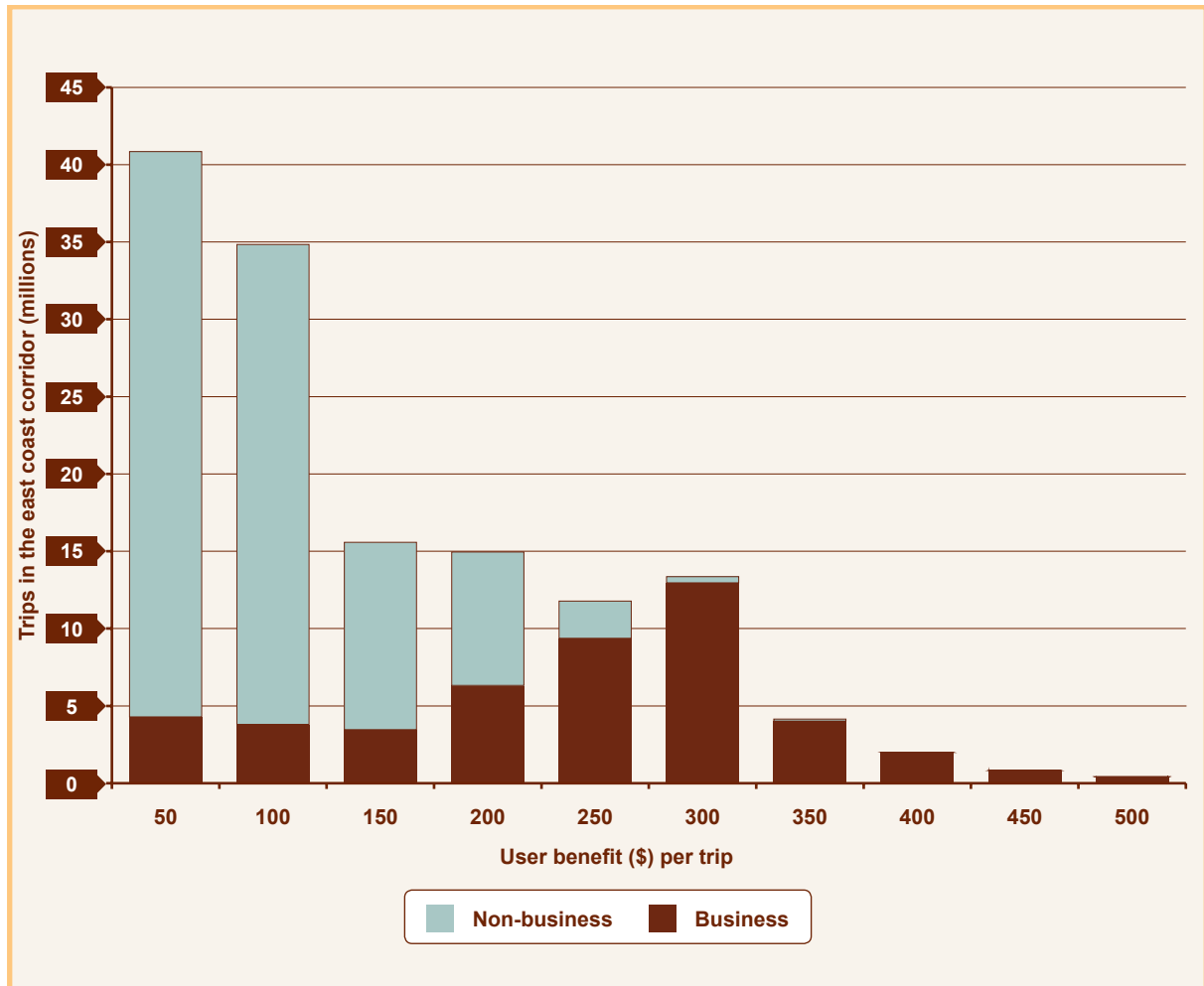


Figure 8-11 distributes the benefits per trip according to their impact on total user benefits (e.g. user benefits per trip of \$300 accounts for about \$3.8 billion of user benefits, or about 22 per cent of the total of user benefits for all trips of \$17.4 billion, as shown in **Table 8-8**). The four indicative case studies are also shown in **Figure 8-11**.

Figure 8-11 Distribution of user benefits per trip by total impact on user benefits (in 2065, \$2012)



Comparison with the ‘rule of a half’

The benefits associated with new users of transport improvements are generally calculated using the economic ‘rule of a half’. For example, if a new line is being added to an urban metro network, benefits will arise through travellers experiencing shorter journey times and less crowding on the train and at stations. These benefits will result in extra passengers using the service. The rule of a half states that the benefit accruing to diverted or new users of a transport system is on average half of that accruing to the pre-existing users.

The rule of a half involves a simplifying assumption that the shape of the demand curve is linear. For the HSR benefit estimates, the calculation of induced travel benefits does not

make the simplifying assumption (for details, see **Appendix 1E**), but it has been confirmed that the two methods give almost identical benefit estimates.

Geographic incidence of user benefits

The majority of user benefits accrue to trips to/from NSW locations, with over 60 per cent of all benefits in 2065 involving a journey with an origin or destination in NSW. **Table 8-10** presents the total user benefits (in 2065) between the trip production and attraction locations. The estimated top five journeys for scale of user benefits are Sydney-Melbourne, Melbourne-Sydney, Brisbane-Sydney, Sydney-Brisbane, and Sydney-Canberra. These are highlighted in the table.

Table 8-10 User benefits by production and attraction sectors, 2065 (undiscounted, \$2012, \$billion)

Sectors		Attraction										
		Melbourne	Intermediate	Canberra	Intermediate	Sydney	Intermediate	Newcastle	Intermediate	Gold Coast	Brisbane	Total
Production	Melbourne	-	0.45	0.24	0.13	2.01	0.04	0.02	0.07	0.02	0.14	3.11
	Intermediate	0.41	-	0.13	0.01	0.34	-	0.02	-	0.07	0.10	1.07
	Canberra	0.24	0.05	-	0.02	0.49	0.02	0.02	0.03	0.01	0.07	0.96
	Intermediate	0.52	0.01	0.07	0.01	0.19	0.00	0.03	0.03	0.07	0.19	1.12
	Sydney	2.59	0.21	0.72	0.05	-	0.05	0.02	0.69	0.34	1.16	5.83
	Intermediate	0.16	-	0.05	0.00	0.21	-	0.01	-	0.10	0.14	0.67
	Newcastle	0.03	0.02	0.04	0.02	0.13	0.01	-	0.13	0.07	0.07	0.51
	Intermediate	0.10	-	0.05	0.01	0.46	-	0.09	-	0.10	0.18	0.99
	Gold Coast	0.02	0.02	0.01	0.02	0.24	0.01	0.01	0.12	-	0.06	0.51
	Brisbane	0.27	0.06	0.12	0.13	1.52	0.05	0.07	0.24	0.14	-	2.61
	Total	4.35	0.83	1.42	0.40	5.59	0.18	0.29	1.30	0.91	2.12	17.39

Note: The total may not match the sum of the cells due to rounding.

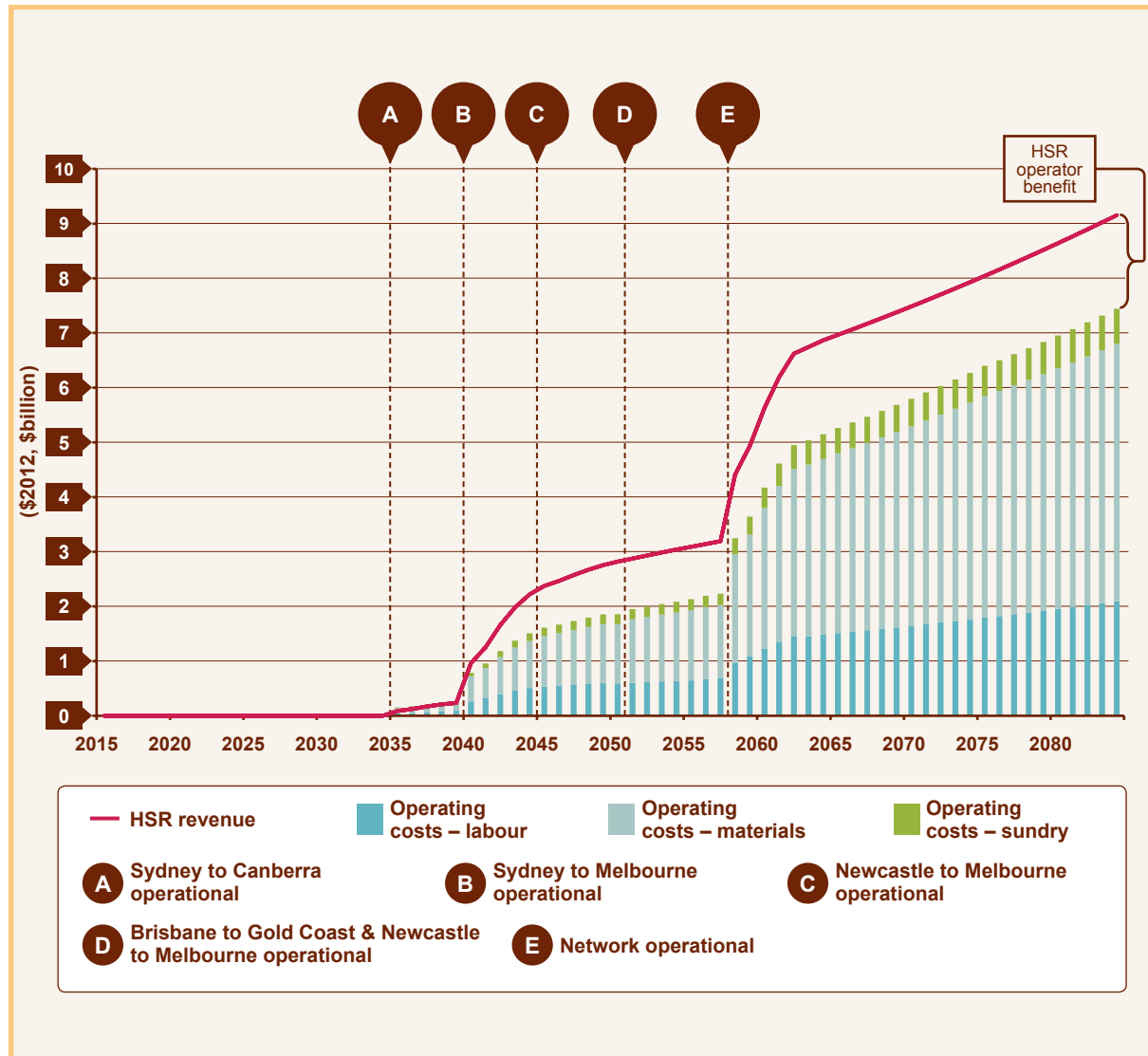
8.5.2 Operator benefits

The introduction of HSR would impact all operators of the transport system. The change in operator benefits as a result of the future HSR program measures the net fare revenue and operating costs impacts as a result of some coach, rail and airline passengers choosing to use HSR and new trips generated by HSR.

HSR operator benefits

Estimated HSR operating costs and revenue are illustrated in **Figure 8-12**. The HSR operator benefits are equal to the difference between the revenue generated by HSR services and the costs to operate the HSR system.

Figure 8-12 Entire corridor operating costs and revenue (undiscounted, \$2012, \$billion)



In almost every year of the assessment, the revenue generated by the future HSR program is forecast to be greater than the operating costs (excluding charges for capital recovery), resulting in a positive operator surplus. In 2065, for example, it is estimated that fare revenue generated by HSR would recover around 133 per cent of operating costs. HSR operator surplus has a present value of around \$14.1 billion at a four per cent discount rate, calculated as the difference between HSR revenue of \$56.3 billion and operating costs of \$42.2 billion (allowing for rounding)³⁸.

Impact on other modes' operator benefits

The introduction of the future HSR program will divert passengers away from existing modes. The analysis assumes that operators of existing modes will reduce service levels in line with the reduction in demand, thus minimising the overall impact. The estimated impact of reduced patronage on the operator benefits of each of the existing modes is outlined below.

38 Rolling stock procurement costs are included within capital works costs and not included in the operating costs outlined above. If rolling stock and asset renewal was included in as an operating expenditure, the HSR operator benefits would be reduced to \$8 billion (present value, \$2012).

Coach

The CBA assumes that a competitive coach industry results in a direct relationship between changes in coach operating costs, fares and thus overall fare revenue. As a result, the analysis assumes that the reduction in coach patronage due to the future HSR program would be met by a reduction in coach service levels and therefore operating costs. The introduction of HSR would therefore result in an overall proportional reduction in the level of coach operator benefits.

Conventional rail

Similar to coach travel, the analysis assumes that there is a direct relationship between rail fares on conventional rail services and their operating costs. A reduction in patronage is therefore assumed to result in a proportionate reduction in service levels and thus operating costs. However, conventional rail operations, particularly on the Newcastle to Sydney route where passenger trains are most likely to be impacted by the future HSR program, currently do not recover all operating costs through fare revenue. Future conventional rail operating costs are expected to be around double fare revenue. The reduction in patronage on conventional rail, as a result of HSR, therefore

results in a reduction in operator benefits, which is offset by a higher reduction in the passenger subsidy requirement. This produces an increase in net operator benefits for conventional rail.

Aviation

The introduction of HSR would compete vigorously with air travel, and it is likely that the aviation sector would be the mode most heavily impacted by the future HSR program. As discussed earlier, the analysis assumes that airlines are unlikely to compete with HSR by reducing fares, but that they would instead reduce capacity to locations within the HSR corridor where significant diversion to HSR is forecast, with a redeployment of some services to other locations at a similar level of profitability.

A summary of the impacts on existing modes is illustrated in **Table 8-11**. The overall impact on the coach and conventional rail industry is minimal, as the overall reduction in demand for these modes as a result of the future HSR program is small. The overall impact on the aviation industry operator surplus is reduced because of the base case assumption of high levels of unmet demand in Sydney.

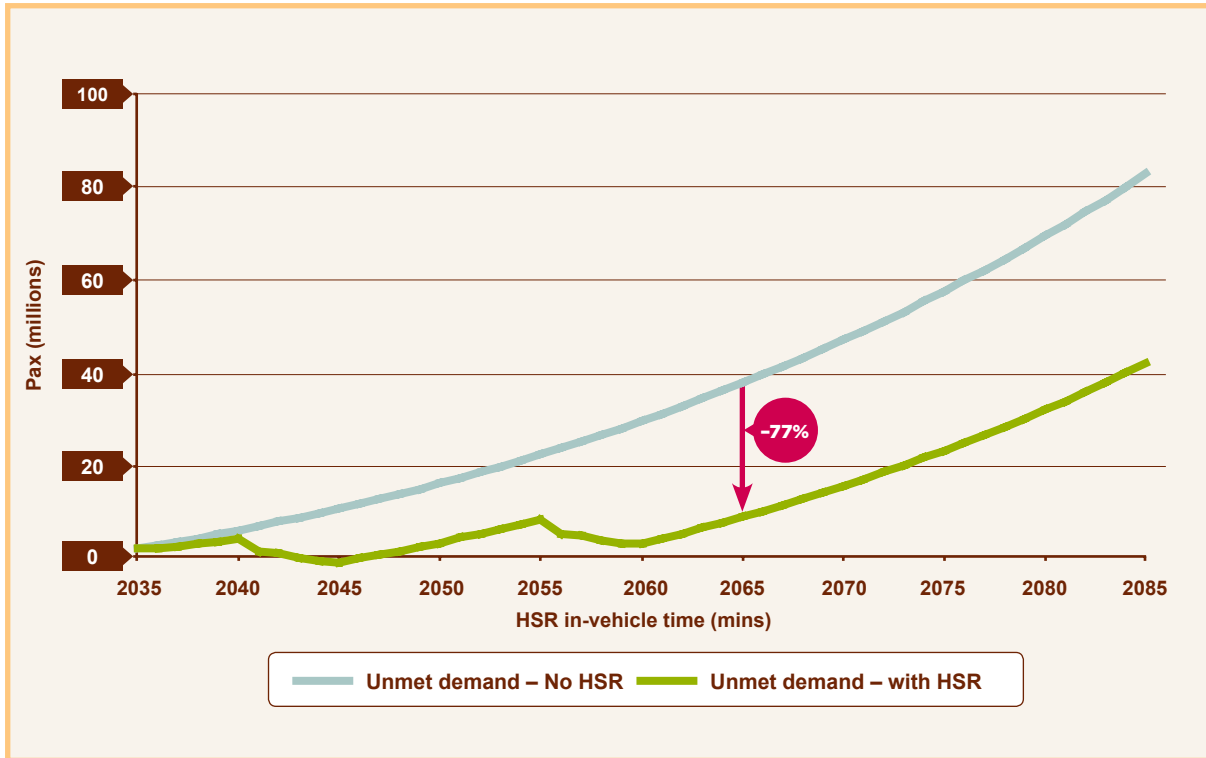
Table 8-11 Summary impacts on existing modes (PV, \$2012, \$billion, 4% discount rate)

Mode	Change in revenue	Change in operating costs	Change in operator benefits
Coach	-0.1	-0.1	0.0
Conventional rail	-0.1	-0.1	0.0
Aviation	-9.4	-8.9	-0.5

With no additional aviation capacity at Sydney Airport, even with the introduction of HSR, Sydney Airport is likely to be operating at capacity and there will be some degree of unmet demand, as illustrated in **Figure 8-13**. The analysis therefore assumes that any reduction in services through

Sydney Airport to/from destinations served by HSR is likely to be met with increases in services to other destinations, with similar revenues and profitability. This significantly reduces the impact of the future HSR program on aviation revenue and therefore aviation operator benefits.

Figure 8-13 The impact of HSR on suppressed demand at Sydney Airport



Source: Australian Government and NSW Government³⁹

If there was no unmet demand at Sydney Airport, and the reduction in demand for aviation as a result of HSR was met by a proportional reduction in services, it is estimated that the overall impact on aviation operator benefits would be relatively modest at \$1.4 billion⁴⁰.

8.5.3 Externalities

Externality effects from the impact of HSR have been measured as follows:

- A reduction in air pollution and noise pollution.
- A reduction in accidents.
- An increase in the impact of greenhouse gas/ carbon emissions, which, as discussed in more detail below, is driven primarily by the assumed aviation capacity constraints in the Sydney region.

- An increase in urban congestion, which, as also discussed in more detail below, is driven by the assumed aviation capacity constraints in the Sydney region.
- A reduction in non-urban road network congestion (i.e. decongestion).

The benefits, and disbenefits, associated with each of the impacts across the appraisal timeframe are illustrated in **Figure 8-14**.

The largest external impact of the future HSR program is from an estimated reduction in non-urban congestion. The resulting present value estimates are outlined in **Table 8-12**.

39 Australian Government and NSW Government, loc. cit.

40 Assuming an average annual operating margin of five per cent.

Figure 8-14 Externalities (undiscounted, \$2012, \$billion)

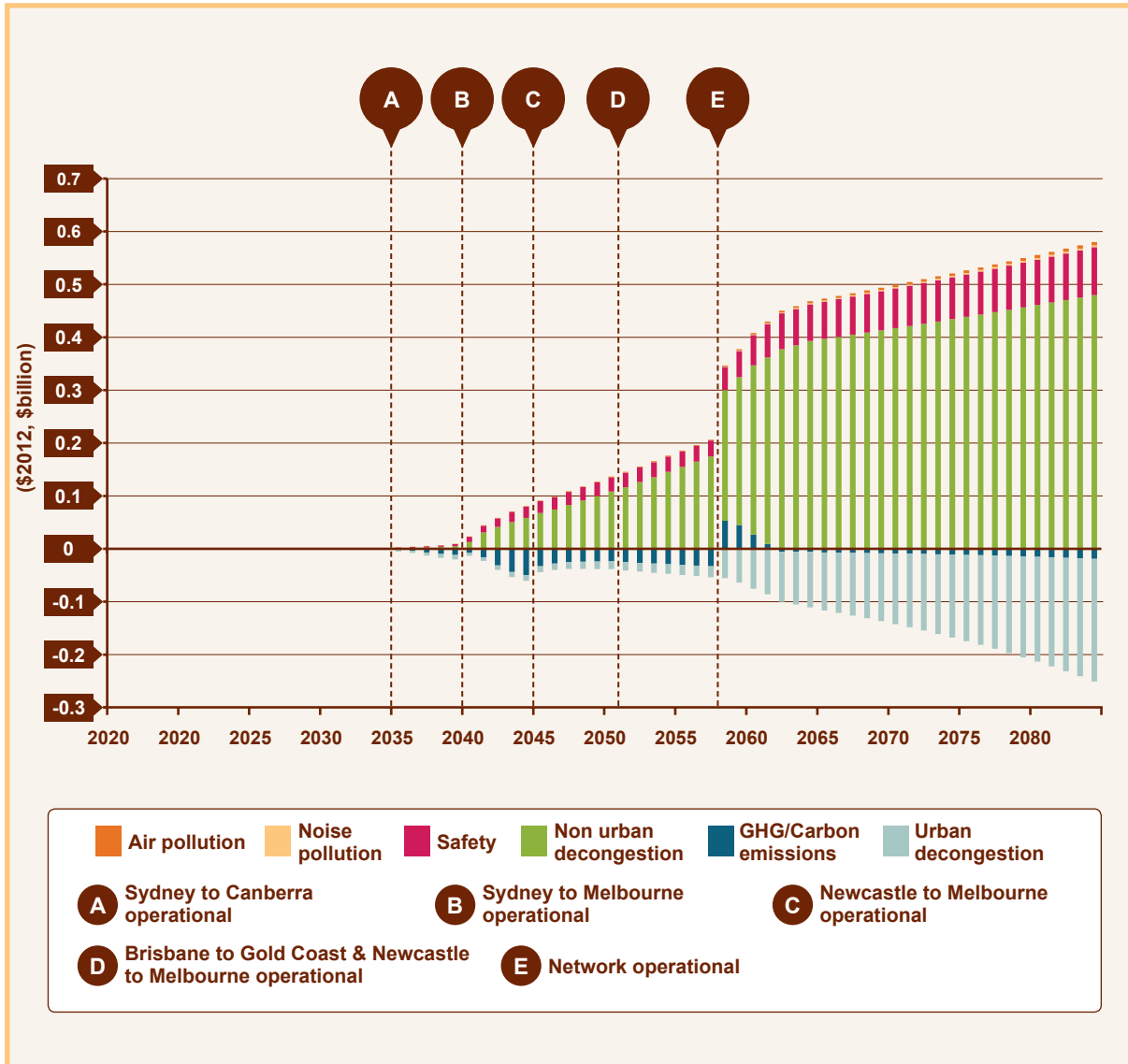


Table 8-12 Net external benefit of HSR (PV, \$2012, \$billion, 4% discount rate)

Externality	Present value (\$billion)
Greenhouse gas emissions*	-1.40
Noise pollution	0.01
Air pollution	0.03
Safety	0.56
Urban decongestion	-0.78
Non-urban decongestion	2.74
Total externalities	1.16

* Greenhouse gas emissions are calculated based on an estimate of the social cost of carbon.

Each category of externalities is discussed further below.

Environmental impacts

High speed rail produces less greenhouse gas emissions for a given transport task than existing transport modes, particularly aviation⁴¹. As a result, a shift in demand for HSR away from existing modes would result in a net reduction in greenhouse gas emissions, other things being equal, and would generate a benefit of around \$2 billion over the appraisal timeframe⁴².

However, the assumption regarding no new capacity at Sydney airport makes the assessment more complex. As discussed previously, the reference case assumes there are high levels of unmet aviation demand at Sydney Airport. The study therefore assumes that any reduction in aviation trips to/from Sydney due to the introduction of HSR would be met by an increase in aviation services to/from destinations outside the HSR corridor which was previously unmet due to a lack of capacity at Sydney Airport. This additional travel generates additional greenhouse gas emissions which offset the environmental benefits of a shift in travel from aviation to HSR, and results in a net increase in greenhouse gas emissions and a present value disbenefit of around \$1.4 billion over the appraisal timeframe.

The impact of the future HSR program on air pollution and noise pollution is relatively minimal, generating an estimated present value net benefit of \$29 million from reduced air pollution and \$13 million from reduced noise pollution.

Decongestion

A future HSR program would lead to a reduction in urban motor traffic by serving the city centre, which is the ultimate destination for many travellers (who would no longer need to travel there from the airport; instead their trip would consist of HSR plus public transport or a short

taxi ride). It would also divert travel from cars (whose journeys include an urban component) to HSR plus public transport. The reduction in urban car travel is likely to result in a reduction in congestion. However, the assumption regarding aviation capacity in Sydney generates additional urban car travel for those travellers accessing the airport that previously could not travel. When this additional travel is taken into consideration there is a net increase in urban car travel and thus a net increase in congestion, which represents a present value disbenefit of around \$783 million over the appraisal timeframe.

The decongestion impacts were estimated based on an assessment of the impact that the reduction in urban motor traffic would have on the travel environment for remaining users. Allowance was made for generated motor traffic associated with providing access to/from urban HSR stations. Non-urban road decongestion has been assessed in a similar way, by considering the impact that a reduction in non-urban motor traffic, generated as a result of car users transferring to HSR, would have on remaining users of the road network. The expected present value benefit from non-urban decongestion is \$2.7 billion over the appraisal timeframe.

8.5.4 Residual value

As mentioned previously, a residual value has been included to capture the remaining value of the investment in HSR beyond 2085. The residual value has been estimated based on value-in-use, i.e. the discounted value of expected net benefits beyond 2085 to 2108⁴³, less an annuity value for capital maintenance. The residual value of HSR is estimated to be \$25.0 billion, representing around 14 per cent of the total benefits. By 2085 the population along the east coast of Australia is estimated to be over 30 million which drives significant levels of demand for HSR and hence high user benefits and revenue and a relatively large residual value.

41 As discussed in more detail in **Appendix 5G**, the average cost impact per tonne of carbon is two times higher for aviation because airlines emit most of their greenhouse gases directly into the upper atmosphere.

42 The \$2 billion discounted benefit over the appraisal timeframe also takes into account the additional greenhouse gas emissions associated with induced demand for HSR.

43 Representing 50 years from when operations of the last segment commence (i.e. 2058).

8.6 Sensitivity to alternative assumptions

The results of the analysis present a positive economic case for the introduction of the future HSR program and reflect a number of important assumptions and expectations:

- Strong growth in the base travel market over the period before the HSR program becomes fully operational (travel on the east coast will have more than doubled from existing levels of around 152 million trips to 355 million trips in 2065⁴⁴) placing significant pressure on base-case transport networks that would rely mainly on aviation and private car.
- HSR fares would be structured to be competitive with alternative modes of transport for both business and leisure purposes. HSR fares have been set to be competitive with and comparable to air fares on the main inter-capital routes on the east coast and to remain constant after 2035.
- No additional aviation capacity in the Sydney basin, which has the effect of increasing delay and the cost of airfares, generating high levels of unmet demand for aviation travel.
- Airline services are mobile in the sense that there a few significant sunk capital costs in servicing particular routes, and assets can be readily redeployed to other routes. In line with international experience, it is assumed that airlines would adjust capacity within the HSR corridor rather than reduce price in response to the introduction of HSR.

The impacts of these assumptions on the results of the economic analysis are tested in the scenarios and sensitivities presented in this section. Implications for the financial results presented in **Chapter 7** are also tested. Further analysis is presented in **Appendix 5B** and **Appendix 6B**.

In addition, given it is customary to include factors in the demand modelling such as the Alternative Specific Constant (ASC) and egress/access weights which may favour a future HSR market share,

sensitivity testing included two scenarios to explore the impact that removing these assumptions has on the results.

8.6.1 Impact of future growth

As mentioned above, travel on the east coast of Australia is forecast to more than double from existing levels to around 355 million trips by 2065. Population and economic growth are two key drivers of demand for transport. The population and economic growth assumptions applied in the analysis have been developed to represent the ‘most likely’ case⁴⁵. However, given the long timeframe for the analysis, there is the possibility that a different outcome could prevail. Low and high growth scenarios have been developed to explore the impact that alternative growth assumptions may have on the economic case for HSR.

- The ‘low growth’ scenario assumes slower economic and population growth (relative to the reference case). This scenario results in lower overall demand for transport and thus lower demand for HSR. Per capita GDP growth rates are assumed to be 0.3 per cent per year lower than the reference case, and population growth is assumed to be 51 per cent between 2010 and 2065, compared to 72 per cent in the reference case.
- The ‘high growth’ scenario assumes that the Australian economy experiences stronger growth into the future, with high population growth. This scenario results in higher overall demand for transport and thus higher demand for HSR. Per capita GDP growth rates are assumed to be 0.3 per cent per year higher than in the reference case, and population growth is assumed to be 103 per cent between 2010 and 2065, compared to 72 per cent in the reference case.

The impacts of the alternative growth scenarios on the economic results are presented in **Table 8-13** using both four per cent and seven per cent discount rates. **Table 8-14** summarises the impacts of the alternative growth scenarios on the financial results using a four per cent discount rate.

⁴⁴ See **Chapter 2** for a discussion of the relevant market and expected growth.

⁴⁵ Future population growth is sourced from the ABS Population Projections (Series B) Catalogue Number 3222.0. The GDP projections are based on the same methodology as used in the Australian Government’s IGR. That is, long-term projections of economic growth take current economic conditions and economic forecasts as a base. Trend growth rates over the longer term are a function of population, productivity and participation (the 3Ps framework).

Table 8-13 Impact of alternative growth assumptions on the economic results (PV, \$2012, \$billion)

Measure	4% discount rate			7% discount rate		
	Reference Case	Low Case	High Case	Reference Case	Low Case	High Case
Total costs	79.3	78.4	80.7	58.9	58.5	59.5
User benefits	140.7	95.0	217.7	54.0	37.6	80.8
Operator benefits	13.7	9.8	19.4	5.6	4.1	7.8
Externalities	1.2	0.6	1.9	-0.1	-0.2	0.2
Residual value	25.0	14.6	44.7	4.3	2.5	7.8
Total benefits	180.6	120.1	283.7	63.8	43.9	96.6
EIRR	7.6%	5.9%	9.4%	7.6%	5.9%	9.4%
ENPV	101.3	41.8	203.0	4.9	-14.6	37.1
EBCR	2.3	1.5	3.5	1.1	0.8	1.6

Note: Totals may not sum due to rounding differences.

Table 8-14 Impact of alternative growth assumptions on the financial results (PV, \$2012, \$billion)

Measure	4% discount rate		
	Reference Case	Low Case	High Case
FNPV	-47.0	-56.2	-35.5
FNPV (pre-tax)	-47.0	-56.2	-32.5
FIRR (real)	0.8%	-0.8%	1.9%
FIRR (real) (pre-tax)	0.8%	-0.8%	2.2%

Notes: Due to accumulated tax losses (primarily from depreciation on the infrastructure asset base), the future HSR program pays corporations tax in only some scenarios and sensitivities during the evaluation period. Where tax is not payable, the FIRR and FNPV do not differ on a pre- and post-tax basis.

The low case scenario results in a reduction in both the economic and financial performance of HSR. As outlined in **Table 8-13**, the discounted net economic benefits of the future HSR program reduce by around 33 per cent to approximately \$120.1 billion and the EIRR is reduced to 5.9 per cent. Applying a four per cent discount rate, the ENPV is positive, equalling around \$41.8 billion; however, applying a seven per cent discount rate results in a negative ENPV of around \$14.6 billion. All ENPVs are discounted to 2028 in \$2012. As outlined in **Table 8-14**, the low case turns the real

FIRR from a small positive to a small negative, although it should be noted that the operating cash flows remain positive after 2041.

The high case scenario improves both the economic and financial performance of HSR. As outlined in **Table 8-13**, the high case scenario increases the discounted net economic benefits by a factor of 56 per cent and, as a result, the EIRR increases to 9.4 per cent. The ENPV is equally positive by applying a four per cent and seven per cent discount rate, resulting in \$203.0 billion and \$37.1 billion respectively. All ENPVs are discounted to 2028 in \$2012. Similarly, as outlined in **Table 8-14**, the high case only marginally improves the overall financial return (from 0.8 per cent to 1.9 per cent) and still leaves it well short of the requirements of commercial investors.

8.6.2 HSR fares

As previously outlined, the user benefits of the future HSR program are estimated to be \$140.7 billion, at a four per cent discount rate, representing over 75 per cent of the overall benefits. The demand forecasts are based on HSR

fare levels set to be comparable to, and competitive with, the corresponding air fares. However, the estimated HSR revenue is well below the user benefits, suggesting that HSR fares could be set higher to capture more of the user benefits as revenue. Higher fares would reduce the user benefits (as demand for the system decreases) but increase the operator benefits, in turn enabling greater recovery of the capital costs from the users of HSR and improving financial returns. The following sensitivity testing was conducted to assess the impact of increasing fares on the economic case for the future HSR program:

- All fares were increased by 30 per cent with a corresponding decrease in demand.
- All fares were increased by 50 per cent with a corresponding decrease in demand.

The impacts on the economic and financial analysis results are summarised in **Table 8-15** and **Table 8-16** respectively.

Table 8-15 Impact of increasing HSR fares on the economic results (PV, \$2012, \$billion)

Measure	4% discount rate			7% discount rate		
	Reference case	HSR fares + 30%	HSR fares + 50%	Reference case	HSR fares + 30%	HSR fares + 50%
Total costs	79.3	78.7	78.4	58.9	58.6	58.5
User benefits	140.7	122.1	111.2	54.0	46.6	42.3
Operator benefits	13.7	25.1	30.9	5.6	10.0	12.2
Externalities	1.2	0.8	0.6	-0.1	-0.2	-0.2
Residual value	25.0	24.2	23.6	4.3	4.2	4.1
Total benefits	180.6	172.3	166.4	63.8	60.7	58.4
EIRR	7.6%	7.4%	7.2%	7.6%	7.4%	7.2%
ENPV	101.3	93.6	88.0	4.9	2.0	-0.1
EBCR	2.3	2.2	2.1	1.1	1.0	1.0

Note: Totals may not sum due to rounding differences.

Table 8-16 Impact of increasing HSR fares on the financial results (PV, \$2012, \$billion)

Measure	4% discount rate		
	Reference case	HSR fares + 30%	HSR fares + 50%
FNPV	-47.0	-29.6	-20.2
FNPV (pre-tax)	-47.0	-25.0	-13.6
FIRR (real)	0.8%	2.3%	3.0%
FIRR (real) (pre-tax)	0.8%	2.7%	3.4%

Notes: Due to accumulated tax losses (primarily from depreciation on the infrastructure asset base), the future HSR program pays corporations tax in only some scenarios and sensitivities during the evaluation period. Where tax is not payable, the FIRR and FNPV do not differ on a pre- and post-tax basis.

As illustrated in **Table 8-15**, increasing HSR fares by 30 per cent results in a reduction in discounted user benefits of around \$19 billion (applying a four per cent discount rate). The reduction in user benefits is, however, partially offset by an increase in operator benefits of \$11.4 billion and the total economic return falls from 7.6 per cent to 7.4 per cent. As outlined in **Table 8-16**, the financial return improves from 0.8 per cent to 2.3 per cent with operating cashflows becoming positive three years earlier in 2038.

With 50 per cent higher HSR fares, economic returns would fall further but HSR would still produce substantial discounted net economic gains, with an EIRR of 7.2 per cent and an EBCR of 2.1 (at a four per cent discount rate). The financial return would improve further to 3.0 per cent.

While there are international examples of HSR services being priced at a premium to alternative travel options, HSR fares could not be increased to the point where fare revenue, together with other ancillary revenues, provided a financial return sufficient to fund the construction and operation of the system and substantial up-front funding from governments would be required. The analysis shows that the financial returns could be improved by higher HSR fares, but with a reduced economic return as fewer people would use the HSR system.

Finding the right balance between economic and financial returns would be a policy matter to be considered by government.

8.6.3 Aviation sector response to HSR

Of the 83.6 million HSR trips forecast for 2065, around 55 per cent are forecast to be diverted air trips. As outlined previously, international experience suggests that airlines could not or would not respond to HSR competition by reducing their fares, but that they would instead reduce capacity, either by reducing frequencies or aircraft sizes, to locations within the HSR corridor where significant passenger diversion to HSR would occur. It is likely that any reduced services would be redeployed to routes outside of the HSR corridor.

A scenario has been developed to test the impact that a two year price war between HSR and aviation would have on the economic analysis results. The scenario assumes that once Line 1 (Sydney to Melbourne) is operational the aviation sector reduces fares by 50 per cent and that HSR responds accordingly by also reducing fares by 50 per cent. The impact that this scenario has on the economic and financial results is presented in **Table 8-17** and **Table 8-18** respectively.

Table 8-17 Impact of a competitive aviation response on the economic results (PV, \$2012, \$billion)

Measure	4% discount rate		7% discount rate	
	Reference case	Competitive aviation response	Reference case	Competitive aviation response
Total costs	79.3	79.3	58.9	58.9
User benefits	140.7	141.9	54.0	54.6
Operator benefits	13.7	12.5	5.6	5.0
Externalities	1.2	1.2	-0.1	-0.1
Residual value	25.0	25.0	4.3	4.3
Total benefits	180.6	180.6	63.8	63.8
EIRR	7.6%	7.6%	7.6%	7.6%
ENPV	101.3	101.3	4.9	4.9
EBCR	2.3	2.3	1.1	1.1

Table 8-18 Impact of a competitive aviation response on the financial results (PV, \$2012, \$billion)

Measure	4% discount rate	
	Reference case	Competitive aviation response
FNPV	-47.0	-47.8
FNPV (pre-tax)	-47.0	-47.0
FIRR (real)	0.8%	0.8%
FIRR (real) (pre-tax)	0.8%	0.8%

Notes: Due to accumulated tax losses (primarily from depreciation on the infrastructure asset base), the future HSR program pays corporations tax in only some scenarios and sensitivities during the evaluation period. Where tax is not payable, the FIRR and FNPV do not differ on a pre- and post-tax basis.

As illustrated in **Table 8-17**, in terms of the economic analysis, reducing the fares charged for a service results in a transfer of economic benefits from the operator to the user. As a result the discounted operator benefits are reduced by \$1.2 billion to \$12.5 billion, while the discounted user benefits increase by \$1.2 billion to \$141.9 billion. As a result, this scenario has no impact on the overall results (i.e. the EBCR remains at 2.3 and EIRR at 7.6 per cent).

The competitive aviation response (i.e. the two year price war) has a minimal impact on the financial analysis results. As illustrated in **Table 8-18**, the FNPV is reduced by \$0.8 billion to negative \$47.8 billion. The FIRR remains the same at 0.8 per cent⁴⁶.

The analysis assumes a gradual step up of HSR demand over five years with full demand being achieved in the fifth year once operations commence. Therefore any price war at the outset

46 When rounded to two decimal places the FIRR reduces from 0.78 per cent in the reference case to 0.75 per cent for the aviation competitive response.

of HSR operations only impacts a small component of the predicted HSR demand and thus only has a minimal impact on the overall results.

8.6.4 Adding additional aviation capacity within the Sydney region

Another central assumption made in this study is that there will be no additional investment in airport capacity within the Sydney region. As a result, aviation service levels to/from Sydney would become increasingly constrained over the appraisal period. This is anticipated to result in an increase in average travel times and average fares and therefore in high levels of unmet demand. These factors impact the estimated economic performance of the future HSR program as follows:

- The increase in average door-to-door travel times and fares in the base case improves the relative attractiveness of HSR, resulting in increased demand for the future HSR program and thus increased user benefits and operator benefits.

- The high levels of unmet demand in the Sydney region reduce the negative impact that the future HSR program would otherwise have on aviation operator benefits. Any reduction in aviation demand/services as a result of the future HSR program is assumed to be offset by an increase in services to other destinations that, as a result of capacity constraints, could not otherwise operate.

A number of sensitivity tests were conducted to test the various assumptions made in respect of the aviation market. These are each explored in the following sections.

Aviation capacity

An aviation capacity sensitivity has been developed to explore the impact that additional aviation capacity within the Sydney region would have on the case for the future HSR program. The analysis of the aviation capacity sensitivity assumes that an increase in aviation capacity will remove the negative travel time and fare impacts for flights to/from Sydney. It also assumes that there will be no unmet aviation demand. The impact on the economic and financial case for the future HSR program is summarised in **Table 8-19** and **Table 8-20** respectively.

Table 8-19 Impact of additional aviation capacity on the economic results (PV, \$2012, \$billion)

Measure	4% discount rate		7% discount rate	
	Reference case	Additional aviation capacity	Reference case	Additional aviation capacity
Total costs	79.3	78.9	58.9	58.7
User benefits	140.7	120.4	54.0	46.4
Operator benefits	13.7	10.8	5.6	4.3
Externalities	1.2	8.8	-0.1	2.8
Residual value	25.0	22.6	4.3	3.9
Total benefits	180.6	162.6	63.8	57.4
EIRR	7.6%	7.1%	7.6%	7.1%
ENPV	101.3	83.7	4.9	-1.3
EBCR	2.3	2.1	1.1	1.0

Table 8-20 Impact of additional aviation capacity on the financial results (PV, \$2012, \$billion)

Measure	4% discount rate	
	Reference case	Additional aviation capacity
FNPV	-47.0	-50.6
FNPV (pre-tax)	-47.0	-50.6
FIRR (real)	0.8%	0.3%
FIRR (real) (pre-tax)	0.8%	0.3%

Notes: Due to accumulated tax losses (primarily from depreciation on the infrastructure asset base), the future HSR program pays corporations tax in only some scenarios and sensitivities during the evaluation period. Where tax is not payable, the FIRR and FNPV do not differ on a pre- and post-tax basis.

As illustrated in **Table 8-19**, the reduction in airport capacity constraints in the aviation capacity sensitivity reduces the relative user benefits of the future HSR program resulting from the reduced demand. Total discounted user benefits (at a four per cent discount rate) are around \$120.4 billion, thus a reduction of approximately 14 per cent is estimated. Similarly, total discounted operator benefits are reduced by \$2.9 billion. When combined, these factors result in a reduction in the net benefits of HSR of over \$18.0 billion, reducing the EIRR to 7.1 per cent and the EBCR to 2.1 applying a four per cent discount rate, or 1.0 with a seven per cent discount rate. The additional aviation capacity scenario reduces the FIRR from 0.8 per cent to 0.3 per cent.

Combined aviation capacity and increased fare yields

Given the assumption made for the reference case that HSR would offer fares which are comparable to and competitive with airfares, an additional sensitivity combining the removal of the aviation capacity constraints at Sydney Airport and an increase in HSR fares by 30 per cent was conducted to test how the HSR program would be affected by a less congested aviation market and by HSR being less competitive, in terms of fares, with air travel. The impacts on the economic and financial results are outlined in **Table 8-21** and **Table 8-22** respectively.

Table 8-21 Impacts of additional aviation capacity and higher fares on the economic results (PV, \$2012, \$billion)

Measure	4% discount rate		7% discount rate	
	Reference case	Aviation capacity & HSR fares +30%	Reference case	Aviation capacity & HSR fares +30%
Total costs	79.3	78.3	58.9	58.4
User benefits	140.7	103.4	54.0	39.6
Operator benefits	13.7	21.0	5.6	8.3
Externalities	1.2	7.7	-0.1	2.3
Residual value	25.0	21.7	4.3	3.9
Total benefits	180.6	153.8	63.8	54.0
EIRR	7.6%	6.9%	7.6%	6.9%
ENPV	101.3	75.5	4.9	-4.4
EBCR	2.3	2.0	1.1	0.9

Note: Totals may not sum due to rounding differences.

Table 8-22 Impacts of additional aviation capacity and higher fares on the financial results (PV, \$2012, \$billion)

Measure	4% discount rate	
	Reference case	Aviation capacity & HSR fares +30%
FNPV	-47.0	-34.9
FNPV (pre-tax)	-47.0	-31.2
FIRR (real)	0.8%	2.0%
FIRR (real) (pre-tax)	0.8%	2.3%

Notes: Due to accumulated tax losses (primarily from depreciation on the infrastructure asset base), the future HSR program pays corporations tax in only some scenarios and sensitivities during the evaluation period. Where tax is not payable, the FIRR and FNPV do not differ on a pre- and post-tax basis.

As outlined in **Table 8-21**, discounted HSR user benefits would be reduced by approximately \$37.3 billion, whereas operator benefits in present value terms would be increased by \$7.3 billion (both applying a four per cent discount rate). When combined, these factors contribute to a reduction in net benefits of HSR of \$26.8 billion. Applying a seven per cent discount rate results in a reduction in user benefits of \$14.4 billion and an increase in operator benefits of \$2.7 billion.

These factors contribute to a reduction in net benefits of around \$9.8 billion. The EBCR would also be affected, registering a reduction to 2.0 at four per cent discount rate or to 0.9 with a seven per cent discount rate. As outlined in **Table 8-22**, additional aviation capacity combined with a 30 per cent increase in HSR fares increases the FIRR to 2.0 per cent (or 2.3 per cent pre-tax), albeit still well short of the requirements of commercial investors.

8.6.5 Testing of alternative demand modelling assumptions

The demand modelling assumptions made in the reference case around the increasing value of time, alternative specific constant (ASC) and access and egress weighting were tested through three additional sensitivity tests.

Alternative specific constant

The demand modelling includes an ASC factor which quantifies the extent of preference for HSR over other modes. The ASC sensitivity removes any preferences for HSR relative to air for inter-city and long regional trips, and relative to rail for short regional trips, over and above the measureable improvements in level-of-service.

The impact on the economic and financial analysis results are summarised in **Table 8-23** and **Table 8-24** respectively.

Table 8-23 Impact of alternative ASC on economic results (PV, \$2012, \$billion)

Measure	4% discount rate		7% discount rate	
	Reference case	ASC set to zero	Reference case	ASC set to zero
Total costs	79.3	79.0	58.9	58.8
User benefits	140.7	130.7	54.0	50.1
Operator benefits	13.7	12.9	5.6	5.3
Externalities	1.2	1.0	-0.1	-0.1
Residual value	25.0	23.3	4.3	4.1
Total benefits	180.6	168.0	63.8	59.2
EIRR	7.6%	7.3%	7.6%	7.3%
ENPV	101.3	88.9	4.9	1.0
EBCR	2.3	2.1	1.1	1.0

Note: Totals may not sum due to rounding differences.

Table 8-24 Impact of alternative ASC on financial results (PV, \$2012, \$billion)

Measure	4% discount rate	
	Reference case	ASC set to zero
FNPV	-47.0	-48.6
FNPV (pre-tax)	-47.0	-48.6
FIRR (real)	0.8%	0.6%
FIRR (real) (pre-tax)	0.8%	0.6%

Notes: Due to accumulated tax losses (primarily from depreciation on the infrastructure asset base), the future HSR program pays corporations tax in only some scenarios and sensitivities during the evaluation period. Where tax is not payable, the FIRR and FNPV do not differ on a pre- and post-tax basis.

As outlined in **Table 8-23**, even though the discounted user benefits would be \$10.0 billion lower (under a four per cent discount rate), setting the ASC to zero would have a minimal impact on the EIRR, which would reduce from 7.6 per cent to 7.3 per cent under both the four and seven per cent discount rates. As outlined in **Table 8-24**, the financial return (FIRR) falls marginally from 0.8 per cent to 0.6 per cent with the ASC set at zero.

Access and egress weighting

Access and egress weighting is reduced to 1.0 under this sensitivity, as compared to the reference case weight of 1.4. Reducing the weighting reduces the benefits of HSR in comparison to air travel, but increases the benefits of HSR in comparison to car travel. The impacts on the economic and financial analysis results are summarised in **Table 8-25** and **Table 8-26** respectively.

Table 8-25 Impact of alternative access/egress weightings on the economic results (PV, \$2012, \$billion)

Measure	4% discount rate		7% discount rate	
	Reference case	Access and egress weights = 0	Reference case	Access and egress weights = 0
Total costs	79.3	79.1	58.9	58.8
User benefits	140.7	133.8	54.0	51.4
Operator benefits	13.7	13.1	5.6	5.4
Externalities	1.2	1.1	-0.1	-0.1
Residual value	25.0	23.6	4.3	4.1
Total benefits	180.6	171.7	63.8	60.8
EIRR	7.6%	7.4%	7.6%	7.4%
ENPV	101.3	92.5	4.9	2.0
EBCR	2.3	2.2	1.1	1.0

Note: Totals may not sum due to rounding differences.

Table 8-26 Impact of alternative access/egress weightings on the financial results (PV, \$2012, \$billion)

Measure	4% discount rate	
	Reference case	Access and egress weights = 0
FNPV	-47.0	-48.1
FNPV (pre-tax)	-47.0	-48.1
FIRR (real)	0.8%	0.6%
FIRR (real) (pre-tax)	0.8%	0.6%

Notes: Due to accumulated tax losses (primarily from depreciation on the infrastructure asset base), the future HSR program pays corporations tax in only some scenarios and sensitivities during the evaluation period. Where tax is not payable, the FIRR and FNPV do not differ on a pre- and post-tax basis.

As outlined in **Table 8-25**, the effects of applying a different access and egress weighting factor would have minimal impacts on the EIRR, which would reduce to 7.4 per cent with both the four and seven per cent discount rates. Similarly, the impacts on the EBCR are also minimal, decreasing to 2.2 when applying a four per cent discount rate, or to 1.0 when applying a seven per cent discount rate. As outlined in **Table 8-26**, the financial return (FIRR) falls marginally from 0.8 per cent to 0.6 per cent.

Increasing values of time (VOT)

Economic evaluation of rail and road projects in Australia do not usually use real increasing values of time in the assessment. However, given the long time horizon for the assessment of HSR, growth in the values of time over the evaluation timeframe is considered appropriate. Nevertheless, a fixed VOT sensitivity has been developed to test the impacts of this assumption. The impacts on the economic and financial analysis results are summarised in **Table 8-27** and **Table 8-28** respectively.

Table 8-27 Impact of no growth in VOT on the economic results (PV, \$2012, \$billion)

Measure	4% discount rate		7% discount rate	
	Reference case	Fixed VOT	Reference case	Fixed VOT
Total costs	79.3	79.1	58.9	58.8
User benefits	140.7	95.3	54.0	38.8
Operator benefits	13.7	13.3	5.6	5.5
Externalities	1.2	1.0	-0.1	-0.1
Residual value	25.0	13.3	4.3	2.3
Total benefits	180.6	123.0	63.8	46.4
EIRR	7.6%	6.1%	7.6%	6.1%
ENPV	101.3	43.8	4.9	-12.4
EBCR	2.3	1.6	1.1	0.8

Note: Totals may not sum due to rounding differences.

Table 8-28 Impact of no growth in VOT on the financial results (PV, \$2012, \$billion)

Measure	4% discount rate	
	Reference case	Fixed VOT
FNPV	-47.0	-48.4
FNPV (pre-tax)	-47.0	-48.4
FIRR (real)	0.8%	0.6%
FIRR (real) (pre-tax)	0.8%	0.6%

Notes: Due to accumulated tax losses (primarily from depreciation on the infrastructure asset base), the future HSR program pays corporations tax in only some scenarios and sensitivities during the evaluation period. Where tax is not payable, the FIRR and FNPV do not differ on a pre- and post-tax basis.

As outlined in **Table 8-27**, if the values of time were fixed in real terms over the evaluation period, the discounted net economic benefits would decrease by \$57.6 billion, with user benefits accounting for 80 per cent of the decrease (under a four per cent discount rate). The EIRR would also reduce from 7.6 per cent to 6.1 per cent. The EBCR is reduced to 1.6 when applying a four per cent discount rate or 0.8 when applying a seven per cent discount rate. As outlined in **Table 8-28**, the financial return (FIRR) falls marginally from 0.8 per cent to 0.6 per cent.

8.6.6 Low demand and high costs

A low demand/high cost sensitivity was developed that included a range of alternative assumptions which, when combined, result in a set of circumstances unfavourable to HSR.

The low demand/high costs scenario includes:

- The aviation capacity sensitivity (as outlined in **section 8.6.4**).
- A 30 per cent increase in pre-risk capital costs.
- Low case growth assumptions – i.e. low population growth and low economic growth.
- A 50 per cent increase in HSR fare yields.

While the combination of these assumptions may be unlikely, the results of the analysis provide a useful basis for comparison and an understanding of the potential economic performance of the HSR program. The impacts on the economic and financial analysis results are summarised in **Table 8-29** and **Table 8-30** respectively.

Table 8-29 Impact of low demand and high costs on the economic results (PV, \$2012, \$billion)

Measure	4% discount rate		7% discount rate	
	Reference case	Low demand high costs	Reference case	Low demand high costs
Total costs	79.3	101.7	58.9	75.8
User benefits	140.7	60.7	54.0	24.0
Operator surplus	13.7	18.5	5.6	7.4
Externalities	1.2	5.1	-0.1	1.4
Residual value	25.0	11.5	4.3	2.0
Total benefits	180.6	96.0	63.8	34.8
EIRR	7.6%	3.8%	7.6%	3.8%
ENPV	101.3	-5.8	4.9	-41.0
EBCR	2.3	0.9	1.1	0.5

Table 8-30 Impact of low demand and high costs on the financial results (PV, \$2012, \$billion)

Measure	4% discount rate	
	Reference case	Low demand high costs
FNPV	-47.0	-64.7
FNPV (pre-tax)	-47.0	-64.7
FIRR (real)	0.8%	0.5%
FIRR (real) (pre-tax)	0.8%	0.5%

Notes: Due to accumulated tax losses (primarily from depreciation on the infrastructure asset base), the future HSR program pays corporations tax in only some scenarios and sensitivities during the evaluation period. Where tax is not payable, the FIRR and FNPV do not differ on a pre- and post-tax basis.

The low demand/high costs sensitivity significantly reduces the estimated economic return generated by the HSR program. The increase in discounted costs combined with a reduction in overall benefits reduces the overall EIRR of the project from 7.6 per cent to 3.8 per cent. The EBCR equals 0.9 when applying a four per cent discount rate and 0.5 when applying a seven per cent discount rate.

The financial return (FIRR) falls marginally from 0.8 per cent to 0.5 per cent.

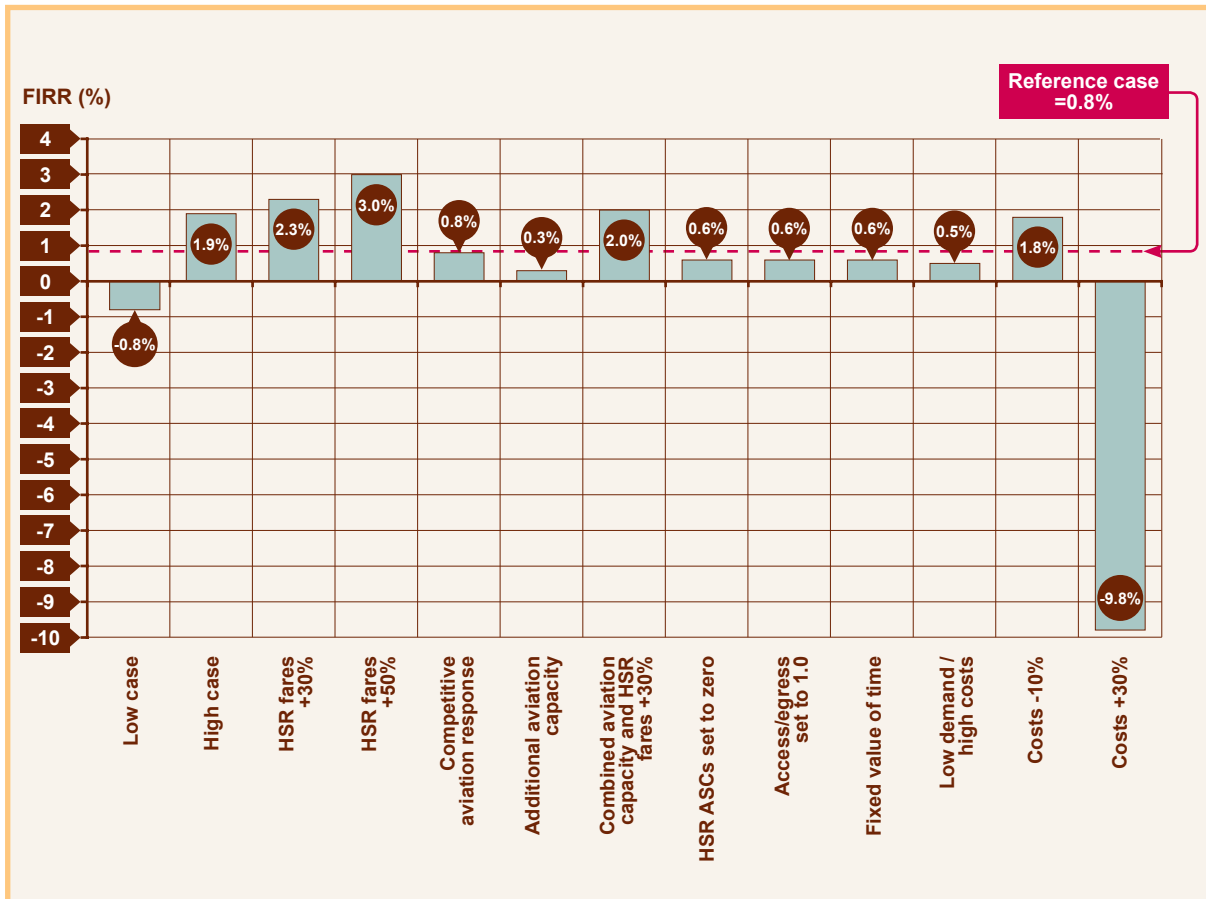
8.6.7 Summary comparison of alternative assumptions

Summaries of the impacts of the various tests on the economic and financial results are illustrated in Figure 8-15 and Figure 8-16 respectively.

Figure 8-15 Impact of alternative assumptions on the economic results (EIRR)



Figure 8-16 Impact of alternative assumptions on the financial results (FIRR post tax real)



In summary (with all dollar figures in present value terms \$2012 and applying a four per cent discount rate):

- The low demand/high costs sensitivity significantly reduces the economic return generated by the future HSR program and results in the lowest EIRR; the increase in costs combined with a reduction in overall benefits reduces the overall EIRR of the future HSR program from 7.6 per cent to 3.8 per cent. The impact on the financial return is, however, modest with the higher costs offset by the large fare increase.
- The low case scenario still generates a positive net economic benefit, with an EIRR of 5.9 per cent. However, the extent of the economic gain is reduced by around 33 per cent. The high case scenario increases the net economic benefit, with an EIRR of 9.4 per cent.
- As referred to in **Table 8-3**, increasing pre-risk capital and operational costs by 30 per cent compared to the reference case results in a reduction in the net economic benefits (EIRR of 6.0 per cent) but leads to a very large deterioration in the financial return to negative 9.8 per cent. Reducing pre-risk capital and operational costs by ten per cent results in an improvement in the economic return to 8.2 per cent and increase in the financial return to 1.8 per cent.
- Constant real values of time over the evaluation period would see the EIRR reduce to 6.1 per cent driven by the decrease in user benefits. The impact on the financial return is marginal.

- The combined aviation capacity and fare yields (consisting of the aviation capacity scenario and a 30 per cent increase in fares) sensitivity results in a reduction in net benefits of around \$26.8 billion, reducing the EIRR to 6.9 per cent. The financial return improves to 2.0 per cent.
- The aviation capacity sensitivity reduces the extent of benefits generated by the future HSR program resulting in a lower EIRR of 7.1 per cent and a lower FIRR of 0.3 per cent.
- Increasing HSR fares by 30 per cent results in a reduction in user benefits and thus a lower EIRR of 7.4 per cent. Increasing fares by 50 per cent would lower the EIRR to 7.2 per cent. The higher fares improve the financial returns to 2.3 per cent and 3.0 per cent for 30 per cent and 50 per cent increases respectively.
- The ASC sensitivity would result in a lower EIRR of 7.3 per cent compared to the reference case and would have a marginal effect on the financial results.
- The access/egress weighting sensitivity would reduce the EIRR generated by the HSR program to 7.4 per cent and would have a similarly marginal effect on the financial results.
- The competitive aviation response (i.e. a two year price war) has very little impact on the economic and financial results. Both the EIRR and FIRR remain the same.

While each of the alternative assumptions outlined above varies the extent of the economic and financial gains achieved by the future HSR program, the majority of the alternative assumptions do not generate results that would alter the overall conclusions of the economic and financial appraisals. The low demand/high cost sensitivity is the only sensitivity that generates an EIRR that is significantly lower than the seven per cent discount rate and in no cases does the financial return move above three per cent.

8.7 Staging analysis

As outlined in **Chapter 6**, the future HSR program would be delivered in stages. A staged construction would reduce average annual capital cost and allow revenue to be generated on sections of the network as they are completed. This section provides detailed results of the economic performance of each network segment and explores the economically optimal timing and order of HSR.

A CBA for each line segment in the program was undertaken to assess the comparative economic performance of each segment as if they were to commence operation in 2035 and operate on a stand-alone basis. The results for Line 1 (Sydney to Melbourne) and Line 2 (Brisbane to Sydney) at the four per cent discount rate are presented in **Chapter 6**, in **Table 6-2** and **Table 6-3** respectively, with conclusions drawn about the optimal staging of each segment of the future HSR program.

The incremental economic analysis results for each stage of the future HSR program summarised in **Table 6-4** are presented in more detail in **Table 8-31**. Summary financial results are reproduced from **Chapter 7** for comparison.

Table 8-31 Incremental economic impacts for each additional stage of the future HSR program (PV, \$2012, \$billion, 4% discount rate)

	Sydney- Canberra	Sydney- Melbourne	Newcastle- Melbourne	Brisbane- Gold Coast & Newcastle- Melbourne	HSR program
Total costs	22.2	46.5	58.6	64.3	79.3
User benefits	18.4	92.1	100.7	102.2	140.7
Operator benefits	0.2	10.3	11.3	11.1	13.7
Externalities	-0.2	0.4	0.5	0.5	1.2
Residual value	2.0	12.8	14.1	14.3	25.0
Total benefits	20.4	115.7	126.7	128.2	180.6
EIRR	3.8%	7.8%	7.3%	7.1%	7.6%
ENPV	-1.7	69.3	68.1	63.9	101.3
EBCR	0.9	2.5	2.2	2.0	2.3
FNPV	-21.5	-26.5	-35.2	-41.3	-47.0
FIRR (real post-tax)	N/A	1.0%	0.9%	0.4%	0.8%

Notes: Due to accumulated tax losses (primarily from depreciation on the infrastructure asset base), HSR pays corporations tax in only some scenarios and sensitivities during the evaluation period. Where tax is not payable, the FIRR and FNPV do not differ on a pre- and post-tax basis.

N/A denotes an FIRR significantly less than zero per cent.

As illustrated in **Table 8-31**, the Sydney-Melbourne (Line 1) component of the future HSR program generates the highest economic rate of return with an EIRR of 7.8 per cent. Completion of the second stage of Line 1 (Canberra to Melbourne) adds substantially to the economic return but with only a relatively small increase in the negative financial return (from \$21.5 billion to \$26.5 billion in present value terms).

The addition of Stage 3 (Newcastle to Melbourne) reduces the EIRR to 7.3 per cent. The addition of Stage 4 (Brisbane to Gold Coast) has a similar impact, with the EIRR reducing to 7.1 per cent. However, completing the system increases the EIRR to 7.6 per cent.

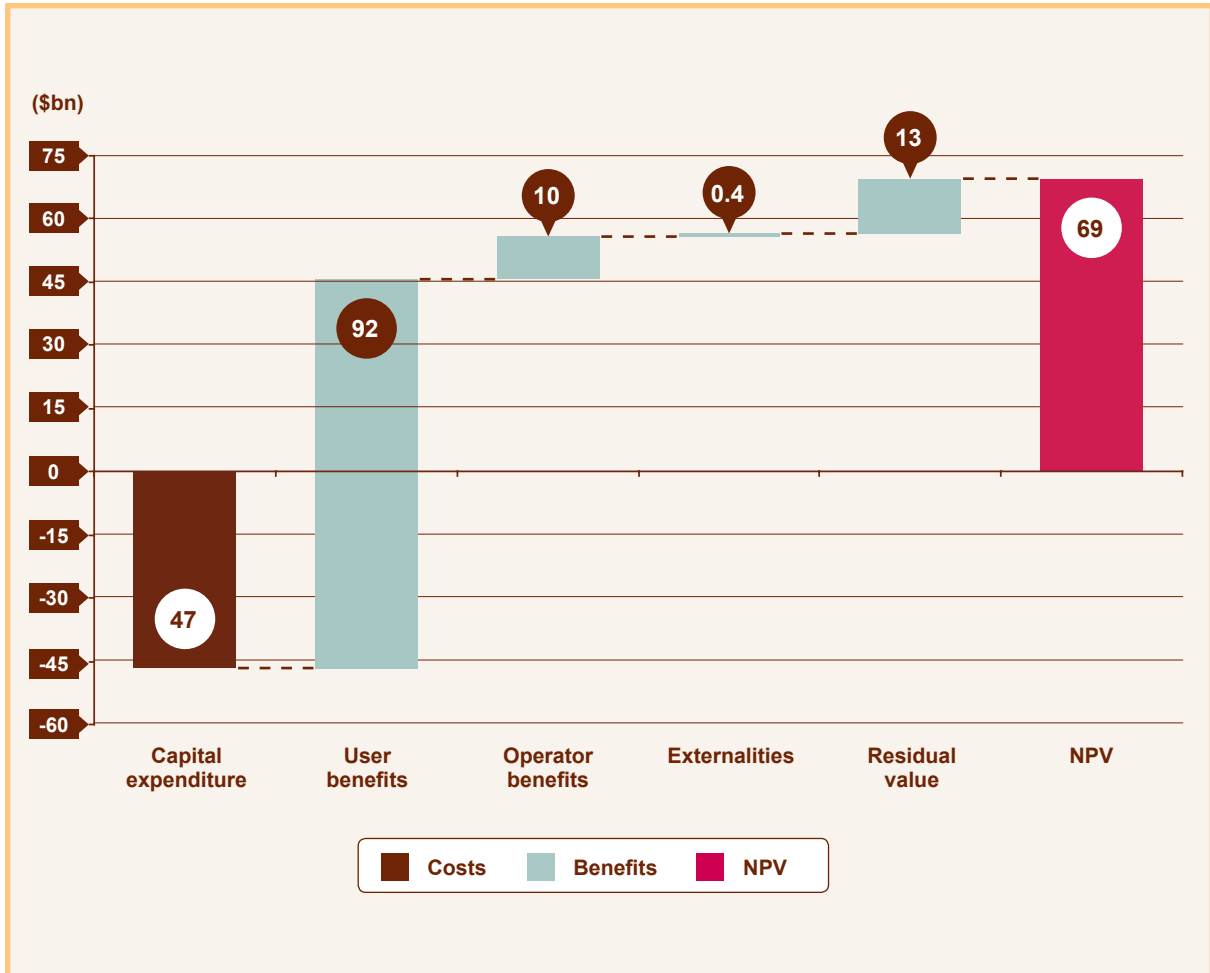
8.7.1 Analysis of the Line 1 - Sydney to Melbourne only

Given the relative performance of Line 1 (Sydney-Melbourne) in comparison to the rest of the network, a more detailed breakdown of the economic analysis and budgetary implications is outlined within this section.

Economic analysis

The summary cost-benefit analysis results are presented in **Figure 8-17**.

Figure 8-17 Economic analysis results – Line 1 Sydney to Melbourne (PV, \$2012, \$billion)



The implementation of Line 1 only (Sydney-Melbourne), applying a four per cent discount rate, is estimated to produce:

- User benefits of \$92.1 billion, which exceeds the capital expenditure requirements.
- HSR fare revenue greater than operating costs, resulting in positive operator benefits of \$10.3 billion.
- Externality benefits of \$0.4 billion.

As outlined in **Table 8-32**, Line 1 generates an EIRR of 7.8 per cent. It has a positive ENPV of \$69.3 billion, an EBCR of 2.5 applying a four per cent discount rate and an ENPV of \$6.5 billion and an EBCR of 1.2 applying a seven per cent discount rate.

Table 8-32 Summary economic analysis results - Line 1 Sydney to Melbourne (PV, \$2012, \$billion)

Measure	4% discount rate	7% discount rate
Total costs	46.5	38.9
User benefits	92.1	38.7
Operator benefits	10.3	4.5
Externalities	0.4	-0.1
Residual value	12.8	2.2
Total benefits	115.7	45.3
EIRR	7.8%	7.8%
ENPV	69.3	6.5
EBCR	2.5	1.2

The implementation of Line 1 only, with an EIRR of 7.8 per cent, provides a greater economic return than the whole HSR corridor, which generates an EIRR of 7.6 per cent.

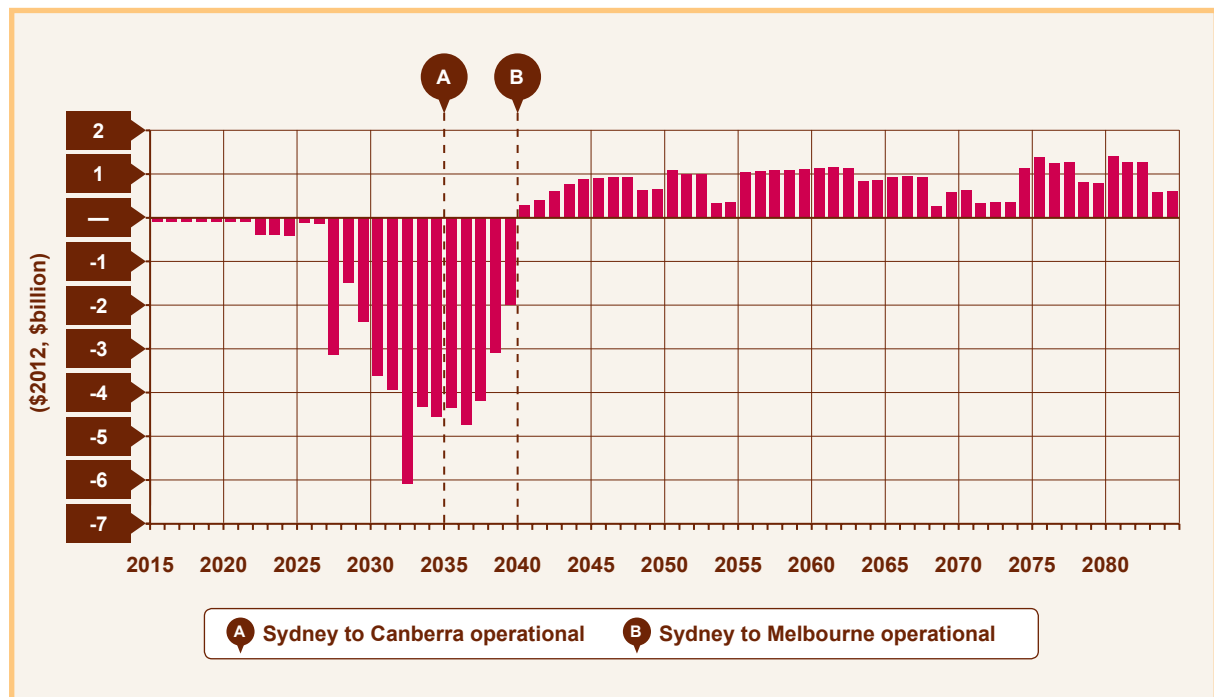
Budgetary implications

Figure 8-18 outlines the future budgetary implications for the construction of Line 1. Negative values indicate that the future HSR program requires funding, while positive values

indicate that the program is producing surplus cashflows above the costs of operation and maintenance. This figure does not make any assumptions about how a future HSR program would be funded or financed. This figure is presented in 2012 dollars.

In broad terms, the upfront capital requirements range from \$1.5 billion to \$6 billion per year over the 13 years of main construction for Line 1.

Figure 8-18 Line 1 budgetary requirements (\$2012, \$billion)



The analysis has concluded that establishing the link between Sydney and Melbourne is the first priority for any HSR line on the east coast of Australia, because it represents the best economic and financial performance. At a cost of \$46.5 billion (PV, \$2012) (including project development, construction, asset renewal and rolling stock), this sector represents a major undertaking that would in itself need to be staged. Although there are intermediate stations within each of the sectors, it would not be economically or financially justifiable to partially construct a sector to or from an intermediate station, given the relatively lower demand projected for the intermediate stations.

Canberra is the next most important city on the line between Sydney and Melbourne (after these two major centres themselves), and would be an appropriate terminus for the first stage. Sydney-Canberra and Canberra-Melbourne provide similar value for money in economic terms, but the former can be delivered at lower cost, in a shorter time period and with superior financial performance, and is therefore preferred as the first stage. However, this is only a viable option if the commitment is made to continue the line to Melbourne; a shorter Sydney-Canberra only route would not be viable on a stand-alone basis.

8.8 Flow-on effects using CGE analysis

The CBA estimates the direct costs and benefits of HSR. The dynamic computable general equilibrium (CGE) modelling⁴⁷ complements the CBA, estimating the economy-wide impacts of construction and operation of the preferred HSR program on the Australian economy.

The CGE analysis should be considered as a separate but complementary analysis to the CBA. CBA focuses on the direct impacts of the project

on transport users, transport operators and the community. CGE modelling considers the project from a multi-sectoral point of view and within a complete and internally consistent framework of the entire economy. While CBA is the main tool used for comparing projects and for investment decisions, CGE is a useful complementary analysis because it explores the possible wider flow-on impacts to sectors and regions.

A summary of the results of the CGE analysis are presented below, which focuses on the following key metrics:

- Gross domestic product (GDP) – measure of value added⁴⁸ generated by the domestic economy.
- Gross state product (GSP) – measure of value added generated by a state economy.
- Consumption – measure of final household spending, used as a proxy for living standards.
- Investment – measure of use of resources to create capital.
- Employment – measure of labour-hours employed.

The results are presented as per cent changes from baseline⁴⁹. The CGE analysis has been conducted for the reference case only.

8.8.1 Key assumptions and inputs

The CGE analysis is based on a range of assumptions and inputs as summarised below.

- Funding of HSR – the CGE analysis focuses primarily on the economic impacts of a HSR sector funded domestically with immediate domestic crowding-out⁵⁰ effects and a long-run adjustment in national savings.
- Long-run labour supply: the CGE analysis assumes that HSR does not influence the underlying supply of labour in the long-run,

⁴⁷ The model used in this study is a bottom-up, multi-regional, dynamic CGE model that contains a structural representation of the Australian economy at the state and territory level. The CGE model is first used to create a baseline projection of the Australian economy through to 2085, and then is compared to an alternate projection of the economy including the impacts of HSR.

⁴⁸ Value added is calculated by final output minus purchases of goods and services (intermediate inputs) used to make the output, or measured another way is wages plus gross profit plus indirect taxes.

⁴⁹ For example, a deviation of –1 per cent from baseline real GDP in 2085 would indicate that GDP in that year is one per cent lower than it would have been had HSR not gone ahead.

⁵⁰ Crowding out refers to the channelling of resources to a certain purpose which prevents the same resources being used elsewhere, in this case imposed by assuming a constant ratio of the current account balance to GDP.

which is primarily determined by demographic factors and technological change. Wage rates adapt over time to short run excess demand or supply in the labour market, such that long run employment impacts at the national level are negligible. However, at the sub-national level, labour can move between sectors and across regional boundaries.

- Productivity gains: the CGE analysis takes on-board assumptions about the potential gains to productivity due to HSR generated by travel time saved for business passengers. These business user benefits are assumed to be worth \$4 billion (2012 prices) in 2035 and were calculated outside the CGE modelling framework. The productivity gains average 0.17 per cent per annum and are distributed across industries according to their share in value added and use of business travel. The productivity gains are imposed on the CGE model as changes to labour productivity to reflect that time saved due to HSR enhances the productivity of business travellers. These productivity gains are based on the outputs from the demand modelling and cost benefit analysis.

8.8.2 Macro-economic impact of HSR through construction and operation

The combined effect from development and operation of the future HSR program on the domestic Australian economy through to 2085 is presented in **Figure 8-19**. This shows the annual differences in the main economic indicators. HSR is estimated to lead to GDP for the year 2085 being 0.1 per cent higher relative to the baseline. These gains to GDP flow from the productivity gains associated with time savings to business travellers.

As a major infrastructure investment project, HSR would also raise the overall level of investment in Australia. As shown in **Figure 8-19**, in 2036, HSR investment would add significantly to aggregate investment during the operational phase, with a concomitant reduction in aggregate consumption under the assumption that domestic savings are

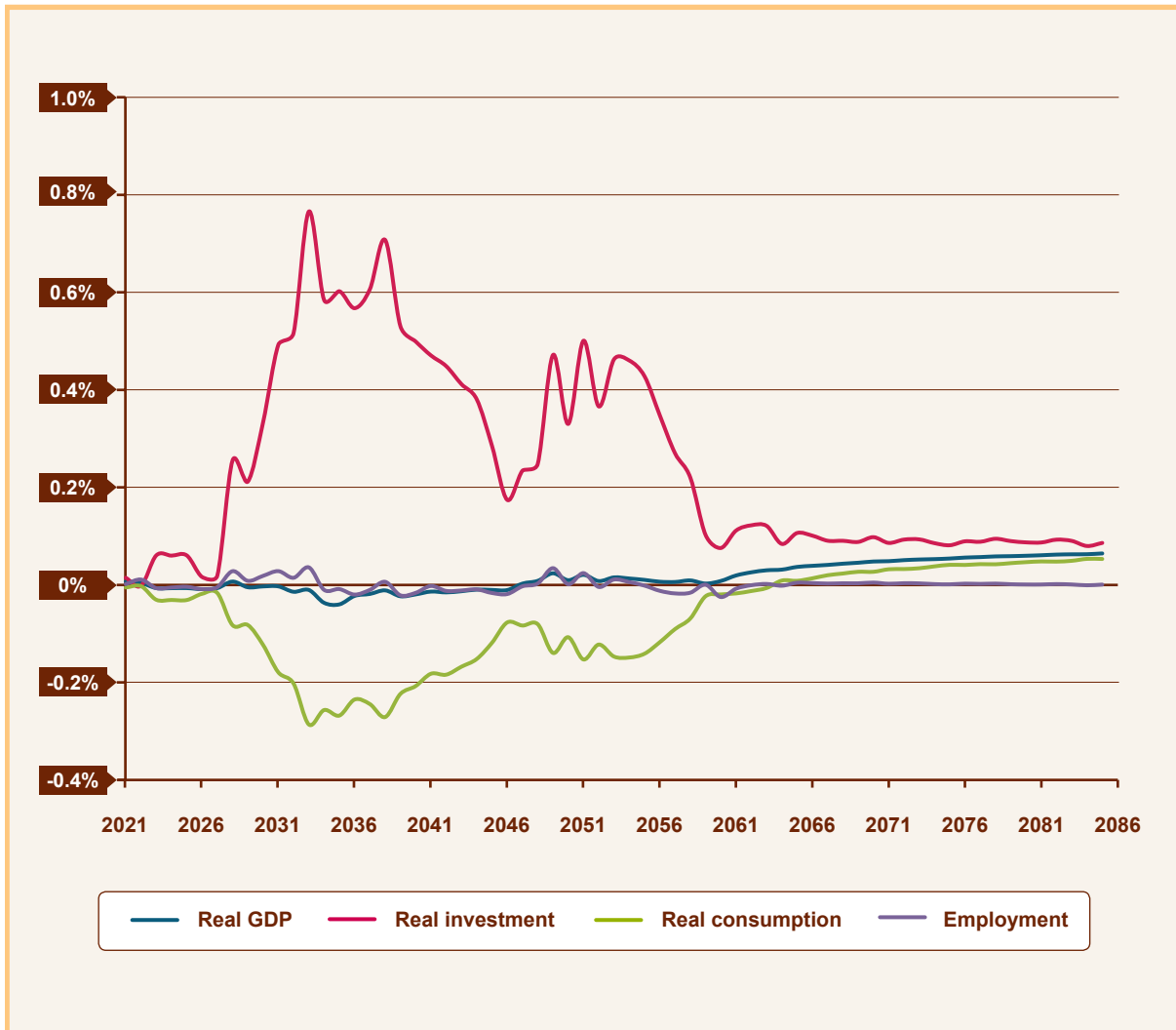
the primary source of funding. By 2056, at the close of construction, the annual total additional investment at the aggregate level is equivalent to around 0.4 per cent of the aggregate investment undertaken in Australia between 2021 and 2056.

As mentioned above, HSR is assumed to be financed by domestic savings, which can be sourced from a combination of reduced consumption and the crowding-out of other investment. HSR therefore leads to an immediate diversion of investment from other uses in the economy and a reduction in aggregate consumption. Alternative assumptions regarding the source of investment funds (for example, foreign sourcing at the margin, or funded year-on-year by tax revenue) would lead to different short-to-medium term impacts, but would have only marginal impacts in the long run.

In the absence of the assumed productivity gains, redirecting investment from other, market-generated opportunities into HSR construction leads to a fall in GDP, particularly during the early stages of construction when the operational phase (i.e. the phase that generates the benefits) has yet to begin. HSR is projected to achieve only a 0.8 per cent rate of return on capital invested. As HSR is a comparatively capital intensive sector, an Australian economy with a HSR sector is, on average, slightly more capital intensive, and the redirection of capital away from other uses with higher rates of return leads to a fall in the average rate of return on the aggregate capital stock and lower GDP until the benefits of operational phase and higher labour productivity are realised.

Other things being equal, and in the absence of productivity benefits generated by HSR, this would lower consumption possibilities and Gross National Income (GNI). However, business travel time savings generated by HSR are assumed to increase labour productivity, which over the long term drives gains in GDP as consumption recovers. This highlights the important role that productivity benefits must play in the ultimate efficacy of a HSR project.

Figure 8-19 Macro-economic impacts from construction and operation (year-to-year per cent deviation from baseline)



Real consumption is estimated to decrease during the construction of HSR (until around 2056). Post 2056, real consumption begins to increase relative to the baseline as benefits start to flow from the operation of HSR. By 2085, the cumulative impact (the undiscounted sum of the consumption impacts since the start of the analysis period) is negative (1.4 per cent below the baseline) but the year-to-year impact switches to positive by 2066. In 2085, annual consumption is about 0.06 per cent above the baseline. As investment in HSR tails-off and productivity gains flow from the operational phase, resources can be redirected back to other investment uses and to consumption, and national income (moving closely with GDP due to

the assumption of domestic financing) begins to increase and move above the baseline.

Real wages increase by 0.08 per cent relative to the baseline by 2085. The impact of shocks to labour markets are first felt in employment in the short run, with wages slow to adjust to changes in economic conditions. In the longer term, however, aggregate employment is determined by institutional and demographic factors and by technological progress, and employment in a policy simulation returns to its baseline level. The higher real wage rate observed later in the simulation timeframe is a result both of the productivity gains flowing from HSR and the higher average capital intensity of the economy.

8.8.3 Structural impacts of HSR on industries within the economy

The future HSR program is likely to affect sectors of the economy in different ways. **Figure 8-20** presents the cumulative impact on industry value added through to 2085⁵¹.

The sectors which are directly linked to the construction and operation of HSR will benefit mostly from this project through increased demand for their output. For example, the construction of HSR would provide a stimulus to the non-housing construction industry, which would in turn flow back up through the construction industry supply chain. As an example, an expansion of the non-housing construction industry will raise demand for construction materials required to build the tunnels and bridges, such as cement, and then increase the demand for inputs from the cement manufacturers leading to benefits for their suppliers. As a rule of thumb, the stimulus to industry activity diminishes proportionally as it flows back through the supply chain with the share of output linked to HSR.

However, the stimulus provided to an industry such as the non-housing construction industry through HSR program would also adversely affect some industries. Higher non-housing construction activity will require increased levels of labour, capital and materials, leading to increased pressure on the prices for these inputs. Other sectors that compete with the non-housing construction industry for these inputs, but are not directly stimulated by HSR construction activity, are likely to be adversely affected by higher input costs without the benefits of facing higher demand for their products. An example is the residential construction sector, as it is an industry

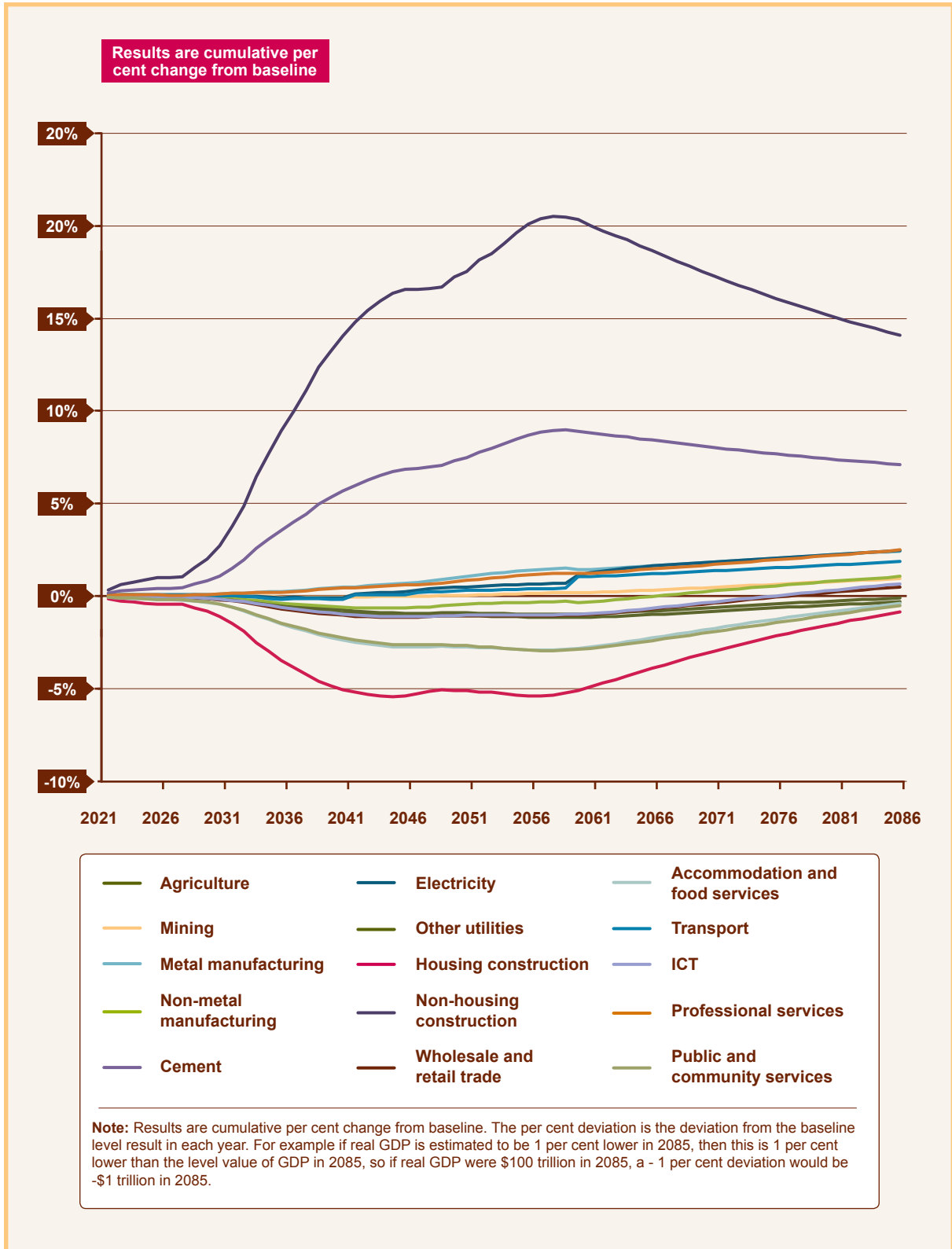
that competes directly for its primary factors and raw materials with the non-housing construction industry, but is unlikely to enjoy an offsetting lift in the demand for its output.

As the HSR program becomes operational, there will be a resultant contraction of other transport sectors as a particular passenger cohort substitutes away from (for example) air travel to HSR. The restructuring of the transport sector of the economy then leads to further sectoral impacts via the respective supply chains. In 2058 for example, the expansion in the HSR transport mode indicated by the cost benefit analysis would raise demand for electricity and require an expansion in the electricity sector to meet the additional demand, potentially leading to an increase in electricity prices and an adverse impact on other electricity-intensive production sectors and household real income.

Additionally, during construction, sectors that sell most of their output to consumers (such as accommodation and food services) will feel some additional pressure. This is due to a reduction in consumption relative to the baseline (as GDP and closely related national income fall below baseline), and national income is to some extent diverted into investment. On the other hand, suppliers of investment goods (like cranes and trucks) and some materials (for example steel) will benefit from the increased investment activity in the economy. Overall, as the economy becomes more investment and capital intensive and less 'consumption intensive' during the construction phase, the sales structure of the economy will determine that, on average, producers of capital goods will benefit and producers of consumption goods could face additional pressure.

51 Industry employment impacts follow a similar distribution to value added impacts.

Figure 8-20 Impact on real industry value added through to 2085 (cumulative per cent deviation from baseline)



8.8.4 Distributional impacts of HSR on states and the corridor region

The HSR corridor will run through 14 statistical divisions across Queensland, NSW, the ACT and Victoria. These 14 regions will receive the benefits of HSR through construction and operation. During development of HSR, the HSR corridor region will draw in resources from the rest of Australia. The construction of HSR will expand demand for construction services in these regions and raise input prices, affecting industries that compete for these materials and primary factors such as mining and manufacturing.

HSR will impact each of the Australian states differently, particularly as a result of the increased investment in the corridor during construction. All else being equal, domestic financing of HSR and an increase in investment in one state would result in a reduction in the level of investment across the remaining states (or, under alternative assumptions, an increase in foreign-sourced investment funds in other sectors). In the case of HSR under domestic financing and an assumption of a fixed current account balance to GDP ratio, the impact on each state reflects the strength of investment in, and operation of, HSR, and the concentration of industries that compete for HSR inputs or supply HSR inputs within each state.

Based on these assumptions, NSW/ACT is expected to be the primary beneficiary region from HSR construction due to the high levels of additional investment generated by the project. Simply put, a key driver of these interstate relativities during construction is the change in the share of national investment activity due to each state's role in the HSR project. The largest increase in this metric is in the NSW/ACT region of the corridor where the bulk of HSR capital expenditures occur. The expansion in NSW/ACT's investment would come at a cost to the other states, which share the burden of reduced investment in other sectors. Productivity gains are also expected to be concentrated in NSW/ACT, although there are also sufficient gains in Victoria and Queensland to yield a positive GSP impact over time. It is important to note that these results do not imply contraction in other states – rather, the negative

deviation from the baseline for non-HSR states implies a slower rate of positive growth in those regions. Furthermore, the scenarios modelled do not include (for example) other infrastructure projects that might occur in other states during the timeframe of the analysis, nor do they allow for these states to freely access additional foreign-sourced investment funds.

The increased activity in the corridor during construction of HSR draws labour into (particularly) NSW/ACT and away from other states. This leads to impacts on employment by state similar to impacts on GSP by state. Non-HSR-related sectors of the economy that require relatively high labour-shares in production will be adversely effected by the higher economy-wide cost of labour flowing from HSR, but this impact will be distributed in different ways between occupations. Occupations such as engineering and construction that will be used heavily in HSR will see higher than average increases in wages, while occupations such as those used intensively in retail trade will see lower-than-average and potentially negative impacts wage rates (compared to the baseline).

8.9 Conclusion

The following conclusions can be drawn from the economic assessment:

- Construction of an HSR system would deliver positive net economic benefits. The cost-benefit analysis estimates a real economic internal rate of return (EIRR) of 7.6 per cent on investment in the HSR program as a whole. This level of economic return would deliver a positive net economic benefit, i.e. the present value of the economic benefits exceeds the present value of the economic costs, at both a four per cent and a seven per cent discount rate.
- Approximately 90 per cent of the economic benefits (excluding the residual value) are benefits accruing to users of the system which have been derived from, and are consistent with, the demand analysis. User benefits are primarily driven by the city centre location of HSR, faster access times and less time required to check in and board, leading to a reduction in overall travel times for many users.

- Other external costs and benefits, including the potential environmental benefits of HSR, are relatively small and therefore of secondary importance in the overall assessment of benefits.
- The first line of a future HSR program between Sydney and Melbourne would deliver the strongest economic return, with an estimated EIRR of 7.8 per cent. Services would first be offered on the Sydney-Canberra section while the track from Canberra to Melbourne is constructed.
- The economic results remain robust under a range of alternative assumptions and sensitivity tests, supporting the broad conclusion that an investment in HSR on the east coast of Australia would generate a positive net economic benefit.



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9

Urban and regional development

9.1 Introduction

The objectives of this chapter are to describe how HSR has influenced urban and regional development overseas, anticipate how those experiences might shape future urban and regional development in Australia, and examine public policy and other responses for consideration in the event HSR is implemented in Australia.

In particular, this chapter seeks to answer the following questions:

- What is the likely nature and extent of HSR's impact on cities and regions?
- What factors can positively affect HSR's influence on cities and regions?
- What regional development policy and governance measures should be considered in Australia to take advantage of HSR?

In answering these questions three distinct approaches were adopted:

- A review of the available literature on the HSR experience internationally.
- An analysis of potential economic effects including agglomeration, productivity changes and complementary assets including information technology, education and health infrastructure.
- A social appraisal based on case studies.

These three approaches were consolidated into a summary urban and regional economic appraisal and used to define an integrated regional corridor development concept that could help shape future urban and regional development in Australia with HSR.

The examination of the overseas experience included the development of HSR networks in Europe and Asia, commencing with the French Train à Grande Vitesse (TGV) in 1981 and extending to the Taiwan HSR, which went into service in 2007. Factors that would influence an HSR system within the proposed east coast corridor were identified on the basis of that research and relevant theoretical and practical experiences in spatial economics, including the concepts put forward by studies in New Economic Geography¹. Case studies in representative regions and cities were then examined to postulate HSR's potential impact on urban centres and regional areas in the HSR corridor. A critical issue is the extent to which an HSR system causes development that would not otherwise have happened, or enhances development that is already occurring. On this important point the evidence is not always clear.

This chapter complements the findings of the cost-benefit and general equilibrium analysis in **Chapter 8** by considering the potential impacts at the local and regional levels in terms of population, employment and settlement patterns. The results presented are necessarily high level due to the lack of relevant quantitative retrospective analysis of major transport infrastructure projects on regional development, both overseas and in Australia. Nonetheless, sufficient evidence has been gathered to characterise the potential impacts of an HSR system on economic activity, population change and employment distribution, and to identify supportive regional development policies and programs that would be necessary to capture its benefits. Other related direct and indirect impacts, such as impacts on land use, natural features and conditions, communities and cultural resources, are addressed separately and in greater detail in **Appendix 5C**.

The potential impacts discussed are not the expected outcomes under a 'business as usual' scenario, but are predicated on a number of government policy and program interventions that have not been costed or examined in detail. These interventions would be developed as needed during the implementation phase of HSR, and would depend on the economic environment at the time.

9.2 Overseas experience of HSR

The presentation of overseas evidence of regional development experience is not uniform due to a general lack of rigorous comparative empirical research into pre- and post-HSR regional conditions across different countries. The available research is focused on Spain and France, which have a degree of similarity with eastern Australia, i.e. a concentration of population in cities, with relatively low population density in between. Some information is presented on Taiwan, whose eight-station, linear-corridor HSR connects Taipei and Kaohsiung City, the country's two largest cities. Germany's intercity express (ICE) train system is also considered. China and Japan are noted because of the extensive networks in both countries, but meaningful regional development comparisons between these nations and Australia are difficult to draw given the differences in central government control between China and Australia and differences in population density between Australia and both countries.

An emerging view that has been developing over the past 20 years is that the traditional approach to transport economic appraisal, focusing mainly on transport user benefits, misses some significant economic impacts. Work in the discipline of New Economic Geography demonstrates the link between employment density and productivity and shows how a change in accessibility can have significant economic impacts². Such an approach was applied to the Crossrail project in London

1 New Economic Geography is the study of the location of economic activity across space, using agglomeration economies to help explain why industries cluster within particular countries and regions.

2 Focused on the economic impacts of location and trade theories, e.g. Fujita, M & Thisse, J, *Spatial Competition with a Land Market; Hotelling and Von Thunen Unified*, Review of Economic Studies, Wiley Blackwell vol.53 (5), pp 819-41, October 1986; and Venables, A. et al. *Trade and Industrial Policy under Imperfect Competition*, Vol.1(3) October 1986, pp 621-672.

in 2002–2004 and to the Cologne-Frankfurt routes in Germany³, and suggests wider economic benefits that may exceed the transport user benefits⁴. The literature also suggests that the impacts of transport on productivity (beyond the valuation of transport user benefits) are real and significant and in addition to any benefits captured within the traditional transport appraisal⁵.

The international experience does not establish regional development impacts as a direct result of HSR, so the question is one of causation. The most likely reality is that observed changes in regional development are in part influenced by the introduction of HSR but are also influenced by other factors, some of which may themselves be indirect effects from the introduction of HSR.

The United Kingdom Department for Transport's published report on the history and prospects of HSR cautions against an optimistic picture. It states that, while HSR is often promoted as a mechanism to improve accessibility that will enlarge markets and increase the competitiveness and productivity of firms within a newly-connected region, 'it would be unwise to pin much faith in new railways as an engine of growth'⁶.

9.2.1 Spain

History and objectives

The first Spanish HSR line, Madrid-Seville, was built in 1992. **Table 9-1** summarises the opening year, populations, speeds, travel time and stations on the three main HSR lines from Madrid. Other lines were built between 2003 and 2008.

Table 9-1 Rail services on Spain's first HSR line

Opening year	Line (population)	Maximum speed (km/h)	Travel time (hrs:mins)	Stations
1992	Madrid (3,265,000) – Seville (703,000)	300	2:20	Madrid Puerta de Atocha, Ciudad Real, Puertollano, Córdoba and Sevilla (Santa Justa)
2007	Madrid (3,265,000) – Valladolid (313,500)	350	0:56	Segovia Guiomar, Valladolid Campo Grande
2003 Madrid-Zaragoza-Lleida; 2006 Lleida-Tarragona; 2008 Tarragona-Barcelona	Madrid (3,265,000) – Barcelona (1,615,500) – French border	350	2:30	Madrid Puerta de Atocha, Guadalajara Yebes Calatayud, Zaragoza Delicias, Lleida-Pirineus, Camp de Tarragona, Barcelona Sants, La Sagrera, Girona, Figueres-Vilafant

Sources: Population data are 2011 estimates for cities plus municipalities from www.citypopulation.de; travel times are from RENFE railway timetables.

3 G Ahlfeldt & A Feddersen, *From periphery to core: economic adjustments to high speed rail*, London School of Economics and University of Hamburg (unpublished), 2010, p. 49.

4 Colin Buchanan & Partners with Volterra Consulting, *The Economic Benefits of Crossrail*, 2007.

5 United Kingdom Department for Transport, *Wider Impacts and Regeneration*, TAG Unit 2.8, 2009.

6 T Gourvish, *The High Speed Rail Revolution: History and Prospects*, commissioned by High Speed Two Ltd, the Department for Transport, 2010.

In Spain, the impact of HSR on any one regional centre appears to depend on factors such as its size, its location relative to other regional centres on the rail line, and its location relative to the capital, Madrid. Madrid is located close to the geographic centre of Spain, but a large proportion of Spain's population is located on or close to the coast, either from Barcelona to Cadiz on the Mediterranean coast, or on the north coast from the French border to Galicia. Although the primary policy objective of HSR in Spain was to connect all the major coastal cities to Madrid with a rail journey time of not more than four hours, the first line to Seville was also intended to overcome a lack of rail capacity on the Madrid-Seville route and to achieve a policy objective of improved connections to the relatively undeveloped south of Spain⁷.

An Organisation for Economic Co-operation and Development (OECD) report notes that regional inequality increased between 1995 and 2005 in about 70 per cent of OECD countries⁸. Although HSR is not considered in the OECD paper it is worth noting the general trend in regional disparity as context for consideration the introduction of HSR. Spain was one of only eight countries which reduced disparities between larger regions and one of another group of seven countries which did so between smaller regions. Although the introduction of HSR was only one of several policy measures in Spain, it nevertheless would appear that HSR added value to a wider mix of regional policy measures.

Four main types of locations served by HSR in Spain are⁹:

- Metropolitan areas at the start and end of the line – Madrid, Seville and Barcelona are in this category.
- A large city with a terminating station – Valladolid, 162 kilometres from Madrid (straight line distance).
- Large intermediate cities – Cordoba and

Zaragoza, which are one hour 43 minutes and one hour 15 minutes, respectively, from Madrid.

- Small intermediate cities – Ciudad Real and Segovia, which are less than an hour from Madrid.

There is one example of a small city with a terminating station, Toledo, which is served by a spur line.

Findings

The two large intermediate cities (Cordoba and Zaragoza) appear to have gained most in terms of accessibility to metropolitan areas as a result of having a HSR station. Previously (and unlike Newcastle or Albury-Wodonga in the Australian context), neither of these cities had air services to the capital, and therefore access to Madrid by car was complemented by conventional rail. In contrast, the head of line cities such as Seville had faster access to the capital with air services, and the smaller intermediate cities such as Ciudad Real were much closer to Madrid and therefore had reasonable access by car, coach and conventional rail¹⁰.

Several research papers present two key findings¹¹. Firstly, large intermediate cities such as Cordoba and Zaragoza did not grow solely because of HSR access and, secondly, the presence of an HSR station did not guarantee greater local economic development. Large intermediate cities were already playing the role of the principal city within their sub-region, and an HSR station tended to reinforce that role. They also often had one or more universities with related infrastructure such as hospitals and government offices. The presence of a research university appears to be an important influence on how a HSR station impacts a town or city.

7 Invensys Rail & Oxford Analytica, *The benefits of high-speed rail in comparative perspective*, 2012.

8 OECD, *How Regions Grow*, March 2009.

9 Urena, Menerault & Garmendia, *The HSR challenge for big intermediate cities – a national, regional and local perspective*, 2009.

10 *ibid.*

11 For example, various local level studies by Bellet: see C Bellet & A Casellas, 'Infraestructuras de transporte y territorio. Los efectos estructurantes de la llegada del tren de alta velocidad en España', *Boletín de la Asociación de Geógrafos Españoles*, no. 52, 2010, pp 143-163.

Generally, it has taken ten to 15 years for the regional impacts of Spain's first HSR line to become fully realised, so only interim conclusions about the impacts of the later lines can be made at this time. The most immediate observed impacts relate to business and tourism. The large intermediate cities with an HSR station have benefited from having people transit through the city rather than flying over them. The accessibility of these large intermediate cities can also help to attract congress tourism (day return trips) and leisure tourism. For both business and leisure travel, the short-term impact has been an increase in total visitor numbers but a loss of overnight stays¹². HSR has also supported the expansion of back office activities from larger centres to intermediate centres under certain conditions. If the intermediate centres are within an hour and a half of the larger centres, commutes in both directions increase because back office jobs attract commuters from the larger centres¹³.

Conclusions from the Spanish experience

HSR can both positively and negatively influence the economic and service relationships between small, intermediate and large cities. For example, businesses in small cities can bypass the services previously obtained in intermediate cities and go directly to large cities as a result of HSR. Similarly, employers in large cities can draw employees directly from small cities because of reduced commuting times. In such examples, the intermediate cities become hubs through which small cities gain access to large cities using HSR, thus bypassing some of the services offered by the intermediate cities themselves. For example, Cordoba is a hub which gives access to both Madrid and Seville. HSR brings these two metropolitan cities closer to the smaller cities, and so some roles that were played by Cordoba, the large intermediate city, are now concentrated in Madrid and Seville.

The impacts of HSR can work in either direction. That is, some commuters travel from their residences in large cities to their jobs in intermediate or small cities (sometimes referred to as the 'reverse commute'). Other commuters prefer to live in small cities and take advantage of higher paying, more specialised jobs in large cities, bypassing jobs in intermediate cities. The actual outcomes depend upon each city's service and industry base, the presence of a university or related complementary assets, the station location and whether land could be regenerated by the station to introduce wider economic activities and job opportunities. In most cases, land close to the HSR station has been released for new development. However, comparisons with non-HSR cities are needed in order to consider whether the impacts in places like Cordoba and Zaragoza would have happened anyway without HSR.

In summary, research on Spanish HSR suggests that¹⁴:

- Large intermediate cities did not grow solely because of HSR access.
- The presence of an HSR station did not guarantee greater local economic development.
- HSR can positively and negatively influence the economic and service relationships between small, intermediate and large cities.
- It has taken ten to 15 years for the regional impacts of Spain's first HSR line to become fully realised.
- The station needs to be located close to the city centre, preferably in a location where there are established business activities.
- The ability to release land, including railway land, for mixed-use development, including offices, residential, conference facilities, public services and open space is important.

12 J Puebla, 'El tren de alta velocidad y sus efectos espaciales' *Investigaciones Regionales*, 2005. Similar impacts have been reported in China.

13 'Back office' refers to high density, low to moderate cost workplaces frequently used by call-centres, data processing centres, banks, insurance company and some government agencies to house employees.

14 Urena, Menerault & Garmendia, loc. cit.

- A city transport hub with good local, sub-regional and regional services is important.
- There need to be plans for signature architecture to address image and sense of place at each station.
- There needs to be a mix of public and private sector investment because the private sector will not invest in station precincts without a clear public sector commitment.
- A development corporation or similar organisation is needed to undertake collaborative public-private real estate development in the station precincts.

Literature on the Spanish experience of HSR also stresses the importance of good planning and strong political leadership. Local leadership played a key role in exploiting urban regeneration opportunities in Cordoba.

9.2.2 United Kingdom

Effects similar to those experienced in Spain were seen in the United Kingdom following improvements to the existing rail service and transport links that had the effect of bypassing some of the services offered by intermediate cities. Research into Birmingham's office property market found that rents were lower than in similar sized (and even smaller) centres, and that activity was low, with very little attraction of new businesses.

Interview evidence pointed to some firms closing or slimming down their operations in the city because clients could be served from London (or in some cases Manchester) thanks to better rail services. The analysis suggested that effective market areas for services based in London now included the Birmingham area because of improved transport links. This is consistent with New Economic Geography, in that it suggests that agglomeration benefits in London outweigh the costs of travel and the dispersal factors of land costs, congestion and competition within the larger urban area.

9.2.3 France

History and objectives

The first French TGV line, Paris-Lyon, was opened in 1981, primarily to relieve congestion on the main Paris-Dijon-Lyon rail line. The TGV line was then extended south to Marseilles, and other lines and extensions were built when demand was considered sufficient.

Policies to leverage HSR for development, where they exist at all, have been developed locally rather than as part of a national policy initiative. The French literature is short on data and there is little evidence to distinguish HSR-related effects from those that might have happened anyway¹⁵. For instance, cities not served by HSR often had tram systems installed instead. Where there may have been no net impact on regional development, this is more likely due to the tram and HSR having equal impacts on economic development.

However, there have been significant improvements in journey times as a consequence of the introduction of HSR, which has allowed some themes to emerge. These themes point to HSR possibly acting as a facilitator of improved economic activities, but not as a stimulator for a distressed local or regional economy.

The French HSR system has some differences from other HSR systems that make direct comparisons difficult.

Many of the routes are only partly on dedicated HSR track with normal track to start or end the journey (e.g. Paris-Geneva). In this respect France differs from Japan, Korea, Britain and Taiwan, which use exclusive HSR track for the full distance, and from Germany where there is relatively more conventional track.

15 The HSR development literature reviewed included a substantial number of unpublished French papers.

Findings

A common theme through much of the literature on HSR in France is that HSR can add impetus to regional development, but will not alone cause it. To derive a positive impact from HSR, a region needs some positive attribute or competitive advantage prior to the implementation of an HSR system. In particular, HSR has proved beneficial to towns or regions that have a relatively strong, high-end service sector whose employees tend to be tertiary educated¹⁶. Examples are higher education, hospital/medical complexes, information technology-based services, research centres, some back office activity (accounting, information technology, and human resources), science, engineering, marketing and consulting. Consistent with experience on other transport networks, centres at key nodes (for example, Lille) could be expected to derive additional benefit.

The experience of HSR services to areas that rely mainly on manufacturing, agriculture and mining has been that HSR has little impact on the key economic indicators such as employment and property values. Employees in the high-end services corridors tend to travel frequently for conferences and meetings, whereas employees in mining, manufacturing and agriculture do not travel as frequently for business purposes.

Examples of centres where there appears to have been a positive interaction between HSR and regional development include:

- Lille, on the crossroads between Paris, London and Brussels/Amsterdam. One of the main French cities outside Paris, Lille now has the largest university/medical complex in Europe and a substantial regional banking and insurance sector.
- Lyon, France's second city, is a major business and regional centre and is relatively wealthy. HSR is credited with opening up a new area for development as the old town's growth was constrained by a river and cliffs.
- Le Mans, now (post-HSR) a major centre for the insurance industry, built on insurance activity that was solely local and regional.
- Rheims, where new university campus extensions have complemented existing tertiary education. It has also become a centre for online information technology-based services and back office services (accounting, information technology, human resources).
- Marseilles, a major port and regional business/service centre, where a successful new business park and entertainment centre (Euroméditerranée) were constructed close to the HSR station.

There are also cases that show little positive, and some negative, impacts associated with the introduction of an HSR station. For example, TGV stations in Le Creusot, Montceau and Montchanin are located in declining mining areas and experienced no measurable regional development impact from the arrival of TGV. In Mâcon, business areas were set up in an attempt to attract activities that needed fast connections to Paris and Geneva, but had limited success. Regional areas in the north eastern part of France around Lille experienced 'tunnel' effects, meaning they have the negative noise and visual impacts of the HSR line running through the countryside but no direct improvements in access. Small towns without TGV stations in this area reported losses of some services to larger centres that have stations.

Another common theme in the literature is the varying success of policies designed to enhance the impact of HSR. For example, in Lille, local and regional government and business groups combined to develop several new office blocks in a rundown area (about a kilometre long) between the main Lille station and the HSR station. It was successful, although not in attracting the private sector – many of the tenants are government-controlled or government-influenced banks and insurance companies. The net employment effects in the wider region are not known. There have been suggestions that the Lille development has partly been at the expense of smaller surrounding cities.

16 Peter Hall & Chia-Lin Chen, 'The wider spatial-economic impacts of high-speed trains: a comparative case study of Manchester and Lille sub-regions', *Journal of Transport Geography* 24 (2012) pp 89–110.

In Le Mans, local government and business groups were behind a development near the station which attracted major national insurance companies. However, a similar attempt at development near the Revoltain HSR station at Valence made slow progress. Part of the problem was the station's location, which was well outside the main town.

While the French literature is generally positive, it is also clear that HSR has not always been successful in promoting regional development. Active local policies are often seen as essential to HSR-related development, though not all succeed. Lyon's post-HSR development was arguably not the result of careful planning; rather, it was a market reaction to an opportunity to escape previous constraints. Nonetheless, strong local policies are clearly desirable.

9.2.4 Germany

A study of HSR in Germany examined the high speed link between Cologne and Frankfurt and the impacts on two regional stations. Germany is, of course, much more densely settled than Australia. However, the case is analogous to Australia since the regional stations examined are in sparsely populated areas that had poor rail services prior to HSR. The two cities, Montabaur and Limburg, had relatively small populations at the time of the study (12,500 and 34,000, respectively) and were only 20 kilometres apart. This study found that the increase in market access led to economic adjustments in several indicator variables such as GDP, GDP/capita and employment within a four-year adjustment period.

An increase in GDP of 2.7 per cent in the two cities was indicated as a result of HSR when compared to the rest of the study area. The study concluded that the improvements permanently shifted accessibility patterns and represented a feasible strategy to induce permanent shifts in the distribution of regional economic activity.

9.2.5 Taiwan

History and objectives

Taiwan High-Speed Rail (THSR) opened for service between Taipei and Kaohsiung City in March 2007. The journey time between these cities was reduced from four hours to 90 minutes as a non-stop trip, or two hours for trains stopping at the eight stations along the line. THSR has attracted substantial market share from air, conventional rail and car travel.

The planning of the THSR route and stations during the mid to late 1990s coincided with a period when city development in Taiwan was in transition, with urban policies focused on the development of new cities and towns in regional areas. THSR alignments and stations that could support the development of these new cities and towns were given special consideration by the government. Apart from the THSR stations in the Taipei area, the majority of the THSR stations were located remotely from these cities and towns and needed to be linked to the existing city areas. Stations were also given specific development roles, as shown in **Table 9-2**¹⁷.

Table 9-2 Defining role of the major station designated zones

Station	Designated zone (hectares)	Planned population	City development role
Taoyuan	400	60,000	International business
Hsinchu	309	45,000	Biomedical technology
Taichung	273	23,000	Entertainment/shopping
Chiayi	135	20,000	Leisure/tourism
Tainan	300	32,000	Bio-science research

Findings

After four years of THSR operation, residential and employment growth in the three metropolises of Taipei, Taichung and Kaohsiung has remained stable. Hence, in the short term and at the macro level, significant regional development impacts have not yet occurred around the three major centres. The impact of HSR on regional development in the medium to long term is not evident as the service is still relatively new.

At the local level, development around the five large intermediate THSR stations has accelerated, particularly at Taoyuan and Hsinchu, followed by Taichung, Chiayi and Tainan in descending order of impact. The reasons for the differences in the magnitude of development are:

- The location of the stations.
- Travel connection time and cost between the station and the town.
- The existing population density and the real estate potential of the station areas.
- Local government land use and public infrastructure planning.
- The existence of flagship projects to attract population and employment.

THSR was less successful in some regional areas, particularly where stations were located away from existing regional centres. Stations located some distance from existing urban areas had the following problems:

- High connection time and cost when passengers must switch from HSR to another form of transport such as local bus or taxi service (or vice versa), causing lower incentive for HSR usage.
- Less potential and attraction for real estate development. In some cases, land use planning and infrastructure development around HSR stations over-estimated the station's ability to attract jobs and housing.
- Although development costs were lower, the influx of population and industries was lower than expected.

The planning assumptions for THSR were overly optimistic. For example, the assumption that other agencies' supporting infrastructure would be completed in a timely manner proved to be unrealistic and the majority of the rapid transit systems connecting to the HSR stations were not completed in time. This illustrates the need for complementary infrastructure and/or other services to be planned in conjunction with HSR development.

In planning for THSR, there was also little in-depth analysis of the real estate market and an inadequate grasp of problems relating to the inflow (where and when) of industries and population. In order to remedy these shortcomings, the Taiwanese Government is now developing strategies to attract population and employment into the HSR station locations.

In summary the THSR experience demonstrates that:

- Stations should be close to existing intermediate centres with good connections to other transport modes.
- In-depth marketing studies and analysis can be useful to direct location and growth opportunities.
- Development strategies can promote the inflow of population and employment to locations served by HSR.
- HSR regional stations are likely to be more successful with carefully planned integration of complementary infrastructure, such as universities, technology parks and hospitals, with HSR.
- Participation and support of the local government and its implementation capability is important.
- Excellent developers and win-win contract management promote success.

9.2.6 Conclusions from international experience

International evidence suggests that:

- HSR can both positively and negatively influence the economic and service relationships between small, intermediate and large cities.
- Large intermediate cities do not grow solely because of HSR access.
- The presence of an HSR station does not guarantee greater local economic development.
- It can take ten to 15 years for the regional impacts of HSR to be fully realised.

The international experience suggests that HSR can contribute to, but is not always a cause of, regional development. Regional centres with stable or growing populations and healthy economies appear to benefit more from the addition of HSR than stagnant or declining centres. Regional areas in Spain and France within an hour and a half of major metropolitan areas with supportive economic development programs were more likely to gain both population and economic activity with the advent of HSR. Towns with a manufacturing, mining and agricultural focus are less likely to benefit than those supporting high-end service industries. Intermediate sized areas (50,000 to 100,000+ people), equivalent to the larger regional centres along the preferred Australian east coast HSR alignment, tended to attract population from surrounding communities.

Commuters can travel both to and from regional areas, so some areas experience small gains in local jobs but, overall, regional incomes rise because of higher wage gains by commuters working in higher paying jobs in larger centres. There is also a distinction between population growth, and growth of economic activity. As Vickerman and Ulied report in their economic analysis of the impact of HSR in Europe, a ‘centralising effect of high speed rail is now a well-established impact’¹⁸. Therefore, it is quite feasible to have growth in population of a dormitory town, with limited additional economic activity within the town itself.

By encouraging businesses to cluster around HSR stations, HSR generates productivity growth. While the greatest impacts are felt in the main capital cities, regional centres also benefit, partly at the expense of surrounding areas.

In many cases, the impacts may result in a redistribution of economic activity, rather than an overall rise in activity, by increasing the concentration of activity towards metropolitan centres¹⁹. In such cases, for stagnant or declining regional towns, these impacts can accelerate their demise.

The Taiwanese experience shows that potential positive effects are unlikely to be realised if the station is located some distance from the urban area. By contrast, the Australian regional experience is more tolerant of longer distances to access services, and in most of the regional areas along the preferred alignment we have located the station close to the existing airport infrastructure, rather than in the heart of town. The locations of stations such as Port Macquarie, Coffs Harbour, Newcastle and the Central Coast have been selected with the intent of serving wider regional catchments rather than individual centres. Further details are in **Chapter 4**.

HSR would also have other direct and indirect regional consequences, including noise, intrusions into natural, rural and urban environments, and community and business severance. Those communities, businesses and rural properties that are located close to the HSR line would experience disruption and noise and visual impacts. In the case of HSR on the east coast of Australia, assessment of the impacts and appropriate mitigation measures would be included in the assessment and detailed design stages should a decision be made to proceed with HSR. The process used for the assessment of impacts of HSR is described in **Chapter 12** and in more detail in **Appendix 5C**. However, the proposed alignment for the east coast of Australia was selected to minimise these impacts, as described in **Chapter 4, Appendix 3A** and **Appendix 5C**.

18 R Vickerman & A Ulied, ‘Indirect and wider economic impacts of High Speed Rail’, in G de Rus, (ed.) 2009, *Economic Analysis of High Speed Rail in Europe*, BBVA Foundation, Spain.

19 *ibid.*

R Vickerman, ‘High-speed rail in Europe: experience and issues for future development’, *The Annals of Regional Science*, Vol 31, 1997, p. 21–38.

In particular, regional stations were located outside regional towns to avoid urban areas that would be disrupted by property acquisition, noise and visual amenity.

The impacts on regional development described throughout this section are the result of complex, ongoing processes. No clear conclusion can be drawn about where positive or negative impacts would be experienced, especially for the regional centres with HSR stations.

9.3 Issues influencing regional corridor development

9.3.1 Population and productivity

The reason that regional centres in HSR corridors benefit from improved accessibility to major metropolitan areas can be partly explained through agglomeration effects. Agglomeration refers to 'the external economies available to individuals or firms in large concentrations of population and economic activity. These arise because larger markets allow wider choice and a greater range of specialist services'²⁰. The theory of agglomeration explains how productivity improvements can be gained through improved linkages between jobs. Importantly, those productivity gains are additional to the time savings measured in traditional transport benefits. Generally used to assess the impacts of urban mass transport systems, agglomeration can be used to assess, over the longer term, how employment would respond to the change in accessibility delivered by HSR in other ways, with different types of jobs being created, and some jobs moving out and others moving in.

In essence, regional centres in proximity to major metropolitan areas are able to take advantage of concentrations of population and economic activity to exchange information and technology, thereby increasing the productivity of the HSR corridor. This is an important issue for regional Australia where the 'tyranny of distance' hampers inter- and intra-company linkages²¹. These linkages are cumulative, not singular. That is, the presence of a university or research centre augmented by HSR creates 'magnet infrastructure,'²² which 'pulls' information and people to a place that may be outside the normal bounds of communication. In the United States, for instance, places such as Davis, California or Ogden, Utah – locations with strong universities and excellent air connections – act as magnets for San Francisco (119 kilometres from Davis) and Salt Lake City (62 kilometres from Ogden), respectively. In the Australian context, examples include the redevelopment of Darling Harbour, and Honeysuckle in Newcastle²³. These initiatives can generate new circumstances for centres. Their successes are reliant on good transport links. Comparable regional centres in eastern Australia would be Canberra and Newcastle. While these policies have been uneven in their impacts there has been population growth in some places like Albury-Wodonga, which gained improved accessibility from the upgrade of the Hume Highway²⁴.

Most domestic migration 'occurs within regions or cities, rather than between them'²⁵, but inter-regional drivers are important in shaping population distribution in regional areas. These trends are particularly relevant to this study in coastal and inland cities along the east coast. Coastal cities, defined as cities within 50 kilometres of the coast with populations of 25,000 or more, generally experienced the highest national growth rates between 2001 and 2009, driven by Australians'

20 G Marsden & S Thanos, *Measuring wider economic benefits of transport: A case study in good practice for indicator selection*, Institute for Transport Studies, University of Leeds, Version 6, 5 March 2008.

21 R Stimson et al, *Regional Economic Development: Analysis and Planning Strategies*, New York: Springer 2nd ed., 2002.
G. Blainey *The Tyranny of Distance: how distance shaped Australia's history*, Sun Books 1996, Republ. Pan McMillan, 2011.

22 EJ Blakely, *Planning Local Economic Development*, Thousand Oaks, California, Sage 4th edition, 2004.

23 NSW Government Department of Planning 2005, 'City of Cities: a plan for Sydney's future', Sydney.

24 J. Daley and A. Lacey *Investing in Regions: making a difference*, Grattan Institute May 2011.

25 Bureau of Infrastructure, Transport and Regional Economics (BITRE), 2011, *Spatial trends in Australian population and movement, Report 122*, Canberra ACT.

long-held attraction to coastal living, tourism and leisure amenities, and lifestyle choices, particularly among retirees²⁶. Cities experiencing economic restructuring and job losses, such as Newcastle and Wollongong, experienced slower growth.

The second highest rates of regional population growth occurred in inland cities, classified as urban centres with populations of 25,000 or more, located more than 50 kilometres from the coast and not classified by ABS as remote or very remote. New residents to these during the same time period tended to be younger and drawn by tertiary education and jobs²⁷.

Jobs growth in inland and coastal cities on the east coast has tended to be in the service sector, with half of new residents employed in retail, accommodation and food services²⁸. This is reflective of the primary reasons people move to these areas, which are lifestyle-related, to be close to family and friends, and for retirement. Job opportunities, an important factor in regional development, ranked as the sixth most cited reason for migration from metropolitan to non-metropolitan areas in a 2004-2005 survey²⁹. As discussed below, HSR could attract a different mix of residents and higher order employment opportunities given appropriate policy responses. Forecast regional populations for centres along the preferred HSR alignment are shown in **Chapter 4**.

There will be significant future population growth in the east coast capital cities which needs to be accommodated. The CBD/inner areas of those capital cities already have high public transport mode shares for journeys to work to and from the CBD (62 per cent in Melbourne and 75.5 per cent in Sydney³⁰). CBD employment is forecast to double in these cities over the next 30 years. Given existing levels of congestion, it is unlikely that public transport capacity can be increased to fully cater for this demand from within the cities.

In that case, regional locations within two hours' travel by HSR that have capacity for increases in business growth could assist in making the metropolitan centres more globally competitive by providing less congested future growth options. This could allow regional centres to serve as secondary locations for lower-cost back office functions and new start-up businesses requiring less frequent access to the major centres. HSR and complementary infrastructure such as the national broadband network (NBN) could enable these regional centres to offer a high quality of life and less congestion without sacrificing connectivity to metropolitan areas.

Regional centres that have good transport links to capital cities can attract employment and population growth for two reasons. First, housing, schools and social amenities are usually less expensive and more accessible in non-metropolitan areas. Second, back office opportunities would likely increase in regional areas to take advantage of lower occupancy costs and wages. This is particularly true when the combination of other complementary assets is strong enough to generate the magnet effect described earlier³¹. The complementary assets that should be considered in the Australian context are identified and discussed below.

9.3.2 Complementary assets

In this study, the term 'complementary assets' refers to a number of commonly occurring assets and qualities identified in international and Australian research that can facilitate regional development. Complementary regional assets include the following:

- High speed internet, such as Australia's NBN program.
- Universities and technical education facilities.
- Hospitals and bio-medical research centres.

26 *ibid*, p. 46.

27 *ibid*, p. 54

28 *ibid*, p. 46.

29 *ibid*, p. 46.

30 NSW Government, 2010, *NSW State Plan Performance Report November 2010*.

31 BITRE 2006, 'Drivers of Economic Growth in the Greater Sydney Metropolitan Region' Working Paper 67, Prof. Ed Blakely, with Lubulwa & Bista, p. 7.

- Well developed and supportive public governance and business-to-business connections within a region and between a region and a major metropolitan centre.
- Cultural, recreational and tourist amenities that attract visitors from outside the region.
- Quality-of-life amenities and cost-of-living benefits, such as a favourable climate, affordable housing choices, access to recreational and sporting opportunities and a less congested living environment.

Overseas research has found that in some locations (such as those in Spain and France), the presence of an HSR station in combination with some of these assets has helped facilitate regional development. The extent of HSR's influence appears to be enhanced by the quality and the number of the complementary asset(s) in a given location. More and better quality complementary assets increase HSR's impact on regional development. While this may seem self-evident, it is important that government policy makers and other stakeholders consciously recognise and clearly understand a region's complementary assets when planning for HSR.

This should include an assessment of the value of the complementary assets to the region without HSR. Further, the provision of these facilities where they do not already exist in the HSR corridor would add considerable cost to government. This includes the opportunity costs associated with not providing these assets to other (non-HSR) regions. From an equity and access perspective, it can be argued that it is better for assets to be placed in centres without HSR stations. In health for instance, this would allow patients near a station to take advantage of enhanced access to metropolitan services, while those in regions without HSR would have them provided at a regional centre. This suggests that if

funds for higher level medical facilities are limited, they may be best used in rural areas not serviced by the HSR corridor rather than regional centres serviced with HSR which would allow patients access to capital city services.

9.3.3 National Broadband Network

The NBN will provide fast broadband access to all but the most remote areas of Australia, including to all the cities and towns proposed to be served by the preferred HSR system³².

The combination of high speed communication with knowledge-dependent enterprises has been shown to produce higher levels of regional employment with complementary population growth. The accelerated development of technology companies in the existing technology hubs of Silicon Valley in California and Route 128 in Boston are good examples of such growth³³.

The intersection of the NBN as an information highway and HSR as a new transport and access facilitator would be highly complementary. As a result, locations where NBN and HSR both exist would be attractive to new and growing information-based businesses, since accessibility to domestic and overseas markets would be enhanced. Where fast broadband connections are located near regional HSR stations, enhanced opportunities for regional development would also exist.

While the combination of NBN and HSR has the potential to be a powerful connection, there is also the possibility that NBN could compete with HSR, because the availability of fast broadband may reduce the need to travel.

32 The NBN program proposes to provide broadband access to Australian homes and businesses through a mix of three technologies: optic fiber, fixed wireless and next-generation satellite.

33 AL Saxenian, *The Regional Advantage: Culture of Competition Silicon Valley and Route 128*, Harvard University Press, 1996.

9.3.4 Higher and technical education

Higher education and technical training opportunities would be enhanced by HSR. HSR links would promote resource sharing and rationalisation of university resources, including teaching staff, by allowing universities to provide advanced degrees in more areas by moving academic staff quickly and easily within the

corridor. Specialised, highly-skilled staff could be transported to more distant locations than is currently practical using conventional means of travel. This would allow for more students to pursue advanced degrees in non-metropolitan settings where living costs are generally lower than in capital cities, and for companies to provide upgraded training to staff in distant locations. University offerings in towns near HSR regional stations are presented in **Table 9-3**.

Table 9-3 University curricula near regional HSR stations

Location	University	Degree offerings—near HSR stations
Grafton	University of Newcastle	Rural Clinical Campus
Coffs Harbour	Southern Cross University	Arts, business, hotel and catering management, education (secondary, technology), human services, information technology, nursing, psychology and social science.
Coffs Harbour	University of Newcastle	Rural Clinical Campus
Kempsey	University of Newcastle	Rural Clinical Campus
Port Macquarie	Charles Sturt University	Accounting, business studies, clinical practice (paramedic), creative industries, health and rehabilitation services, justice studies and social work.
Port Macquarie	University of Newcastle	Nursing, midwifery and teaching/arts double degree, Rural Clinical Campus.
Newcastle	University of Newcastle	Aboriginal studies, architecture, arts, biomedical sciences, biotechnology, business, commerce, communications, computer science, construction management, development studies, economics, engineering (chemical, civil, computer, environmental, mechanical, mechatronics, mining, software, telecommunications), fine art, finance, forensic science/law, industrial design, information science, information technology, law, mathematics, medicine, music, nursing, nutrition and dietetics, occupational health and safety, occupational therapy, physiotherapy, psychology, science, social science, social work, speech pathology, surveying, teaching (all) and visual communications.
Ourimbah (near Gosford)	University of Newcastle	Applied information technology, arts, education (early childhood, primary), fine art, food technology, herbal therapies, human nutrition, management, nursing, oral health, science and social science.

Table 9-3 University curricula near regional HSR stations (continued)

Location	University	Degree offerings—near HSR stations
Wagga Wagga	Charles Sturt University	Agriculture and wine science, allied health, animal and veterinary sciences, clinical centre and research laboratories, business, communications and creative industries, environmental science, exercise and sports science, information technology, library and information studies, medical science, nursing, policing, security and emergency management, psychology, science, teaching and education, and theology and religious studies.
Wagga Wagga	University of Newcastle	Rural Clinical Campus
Albury-Wodonga	Charles Sturt University	Accounting, adventure ecotourism, business, ecotourism, education (early childhood, middle schooling), environmental science management, international business management, marketing, occupational therapy, parks, physiotherapy, podiatry, recreation and heritage, photography, speech and hearing science, speech pathology and tourism management.
Albury-Wodonga	La Trobe University	Arts, behavioural science, business, education (primary), electronic commerce, environmental management and ecology, hospitality management, nursing, science and social work.
Albury-Wodonga	University of Newcastle	Rural Clinical Campus

Sources: <http://regionalliving.com.au/> ; <http://racs.med.unsw.edu.au/RCSWeb.nsf/page/home> and university websites

9.3.5 Hospital and medical

While higher level medical services (especially access to specialists) may be better met in the future through advanced internet services, HSR presents the opportunity to move skilled physicians, scientists and resources to the locations in need. The actual impact would depend upon the quality of the underlying hospital and medical skills in the regions, but HSR opens up additional options such as moving patients, specialists or equipment.

In summary, the proximity of regional hospitals to HSR could provide the potential for:

- Sharing specialist professionals among hospitals and clinical treatment centres so patients can be treated and recover closer to home.
- The better use of expensive equipment, as access would be faster with HSR³⁴.

Exactly how HSR would be used is likely to vary from situation to situation. In particular there is a strong potential for it to be used to transfer patients to expanded centralised facilities. This provides a better service to the patient, but may not expand local medical capacity.

34 Anchor Institutions, *Driving economic impact through alignment with regional systems*, 9 August 2012.

9.4 Social appraisal

This section considers the social dimensions of HSR on urban and regional development. It builds on themes explored in the phase 1 study, which examined the social benefits of using HSR to improve community access to key social infrastructure, to also consider the social costs and tradeoffs of HSR. It demonstrates how the social benefits, costs and tradeoffs of HSR can help shape decisions about the location and design of stations, and identifies policy issues to consider in later phases to maximise the benefits and mitigate the costs of HSR.

Detailing the type and magnitude of social benefits, costs and tradeoffs of major transport infrastructure projects, such as HSR, is a complex task seldom undertaken at the early feasibility study stage, and prior to certainty about alignments and locations. This is because the changing social patterns of communities and the longer term behaviour of populations make a definitive and meaningful social appraisal of HSR difficult to empirically detail and quantify. Adding to this complexity, HSR would be undertaken over an extended future timeframe, across multiple jurisdictions.

Given these complexities, this section summarises the key themes that would shape the social aspects of HSR in the future. **Appendix 5E** presents the full technical report on this subject. This approach is consistent with the overall strategic environmental assessment framework developed in this phase of the study (see **Appendix 5C**). Under this framework a preliminary appraisal of the environmental and social issues that would need to be investigated and assessed in detail during the planning, detailed design and construction phases of HSR. This would entail more traditional forms of quantitative social impact assessment, including consultation with regional communities.

In order to anticipate how social issues in the future could interact with the development of an HSR network in Australia, a case study approach was developed around common themes that were identified in consultation with social policy agencies. Three case studies were developed to analyse the social issues that would be likely to arise during the construction, operation and maintenance phases of HSR:

- Case study 1: Workforce and community development.
- Case study 2: Access to health and related services.
- Case study 3: Tourism, recreation and social inclusion.

These case studies also identify the types of public investments or policy interventions that would be necessary to support the development of HSR. The purpose of this appraisal is therefore to provide the results of each case study and identify the key implications of selected social issues on HSR over the coming decades.

9.4.1 Theoretical framework

The theoretical framework underpinning the case studies is based on:

- Organisation for Economic Co-operation and Development (OECD) published guidance on how to identify the wider impacts of transport infrastructure investment on development³⁵.
- The United Kingdom's Transport Analysis Guidance framework for understanding accessibility and social inclusion³⁶.
- The United Nations' Economics and Social Council Transport and Development Assessment Report which provides a framework for recognising the economic and social benefits that transport developments provide³⁷.
- Infrastructure Australia's Better Infrastructure Decision Making Guidelines, which assist government and private organisations in developing infrastructure projects and frameworks for decision making³⁸.

35 OECD, *Impact of transport infrastructure investment on regional development*, Paris, 2002.

36 United Kingdom Department of Transport, *Transport analysis guidance (TAG): the accessibility sub-objectives*, TAG Unit 3.3.6, 2011.

37 United Nations, *Achieving sustainable development and promoting development cooperation*, New York, 2008.

38 Infrastructure Australia, *Better infrastructure decision making*, Commonwealth of Australia, Canberra, 2010.

9.4.2 Themes

The key themes of this report are offered as potential criteria that would guide a future detailed social appraisal of HSR. They were developed from the theoretical framework and in consultation with selected stakeholders from 16 government agencies that have responsibility for shaping the development and implementation of social policies in the states and territories. Stakeholders were selected on the basis of their knowledge about social policy and ability to speak authoritatively about the likely future impacts of HSR on communities. Only the most significant themes that were supported by analysis of the social policy literature are presented in this section:

- Capability and capacity development of communities – this theme considers the development of a workforce that not only meets the needs of HSR, but also provides meaningful social engagement. This theme is examined through case study one.
- Improved access to vital social and other services – this theme considers the social outcomes that are generated through improved access to public services. Health and ageing services are used to provide supporting evidence of why this theme has longer term significance to communities living across the HSR system. This theme is examined through case study two.
- Enhanced inclusion of individuals and groups into the social fabric of the nation – based on ideas about equity and equality, this theme considers the benefits and costs of improving the level of inclusion for individuals and groups within communities through access to education and health services and recreational travel. This theme is examined through case study three.

Further discussion and supporting information on the social appraisal, including the full case studies, can be found in **Appendix 5E**.

9.4.3 Case study one: Workforce and community development

This case study considered the role of HSR in both workforce and community development. By drawing on ABS and other published data, the case study explored concerns that Australia's conventional rail industry workforce may not be able to meet the future needs of a world-class HSR.

Competition for labour within both the conventional rail and other industries employing similar skills would be a key issue for HSR. The development of pit-to-port freight networks to cater for the Australian resource industries would place pressure on workforce demand from within the rail industry, while other national infrastructure and resource projects would exert pressures on labour from other industries. These pressures have the potential to drive wage growth in the rail industry as well as the construction sector; however, there is significant time available to plan for this.

Stakeholders also identified HSR as a potential means of improving social outcomes in regions that have historically experienced relatively low educational attainment. The establishment of stations and operations and maintenance facilities in areas such as the Gold Coast, Newcastle and Albury-Wodonga were seen as having the potential to improve the skill levels of workers in these areas, potentially leading to a wider choice of career or employment paths for regional workers.

The accessibility to higher education institutions for both the local communities, and those currently living in metropolitan areas wishing to access regional universities, was also seen as potentially leading to positive community development and vocational opportunities. The case study concluded by discussing the need for a nationally coordinated approach to workforce development, and the importance of a detailed study exploring the labour and skills needed for implementation of HSR in greater detail.

The participation of local suppliers of goods and services (such as steel fabricators, mechanical and electrical trades for maintaining mechanical and plant and equipment) was seen as crucial in capturing economic benefits for regional communities along the corridor, notwithstanding the potential to raise costs if local suppliers are not as competitively priced as the wider market. Workforce management programs and regional procurement policies (such as Victoria’s Social and Regional Procurement Policy) have the ability to leverage benefits to regional areas through local procurement, leading to capacity building in those communities. Local supplier and procurement policies provide regional communities with the opportunity to directly receive part of the economic and social benefits from the construction and ongoing operations and maintenance of HSR. There would be a dedicated body of trained and qualified maintenance personnel at regionally

based maintenance facilities to manage the maintenance regime - including record keeping, logistics management and trend tracking - and to perform the maintenance tasks. Many of these tasks require specific high level technical skills. The number of depot staff would be dependent on the number of, and distances between, infrastructure depots. **Appendix 2C** provides details of the maintenance requirements of the HSR system.

Tradeoffs associated with pursuing benefits

Policies that are aimed at pursuing particular outcomes related to the HSR workforce, education system and social indicators through the construction, and location of stations and O&M facilities would likely entail tradeoffs of varying magnitude. Some of the foreseeable tradeoffs have been summarised in **Table 9-4**.

Table 9-4 Possible tradeoffs (Case study one)

Potential benefit	Possible tradeoff
Improved educational attainment from locating O&M facilities in areas characterised by low qualification	<ul style="list-style-type: none"> • Potential to reduce the synergistic outcomes associated with locating these facilities in areas that have an abundant supply of required skilled and semi-skilled labour • Reduced efficiency in the provision of O&M services caused by long distances from suppliers • Increased labour costs for O&M in order to attract skills from metropolitan and other locations
Regional uplift and flow on effects	
Local supplier and procurement policies aimed at building regional capacity	<ul style="list-style-type: none"> • Potential for construction costs to increase if local suppliers are not competitively priced compared to market price • Potential loss of productivity arising from the requirement to deal with local contractors that may not have the skills and expertise of other national and international providers

Source: AECOM analysis.

Policy considerations - implementing national policy coordination

A firm conclusion from consultations is the need for a nationally coordinated workforce development approach for HSR. The anticipated intra- and inter-industry competition would require states and territories to consider improving the level of

coordination in the delivery of targeted education and training that achieves national workforce results. However, this is likely to generate significant tradeoffs between current state-based arrangements delivering against local objectives and conditions, as well as those associated with supporting the skills needs of other industries.

Coordination could be driven by a skills summit, industry-specific council or coordinating body with specific authority to guide investment in education and training at a national level. The work of the summit, council or body should not only address key short and medium term issues, but also substantive longer-term policy issues. Findings have not been tested with stakeholders.

It is suggested that the summit, council or coordinating body should focus on:

- Improving education and training pathways for the rail industry workforce. This could involve:
 - Attracting more graduates into the industry, using strategies that seek to provide better linkages between education providers and communities from which graduates would be drawn.
 - Delivering strong support for training and development for existing rail industry workers with a focus on retraining.
- Improving the pathways into work and careers that:
 - Attract specialists from other industry sectors, for example risk management and customer service to move into HSR.
 - Develop people in complementary professions to create an improved and defined pathway into HSR.
 - Improve access for rail industry workers who are approaching retirement, or who have retired, to continue working in the industry.
- Enhancing the linkages between the Australian rail industry workforce and the global market. This could include strategies that seek to source workers from offshore environments where specialist skills are required³⁹.
- Increasing the level of industry-led action in the future development of an HSR workforce.

The roles and responsibilities of a national summit, council or coordinating body would need to be balanced against the current authority of state-based training bodies funded to deliver local policy objectives.

To assist the work of the summit, council or coordinating body, it would also be important to understand the severity of shortages and their

follow-on workforce impacts at a statistical area level. As such, a detailed labour market and skills study is necessary to understand the severity of the shortages and their social and economic costs on HSR. A detailed workforce study is likely to identify:

- The estimated number and type (by employment category) of labour and skills gap at each major stage of construction/operation. This would examine the periods when skills gaps are anticipated to be most severe, as well as influences from other industries (e.g. mining).
- The likely geographic location of any labour or skills shortages.
- The cost factors associated with skills gaps, including financial modelling of wage rates to determine where escalation of costs would become material.
- The length of time necessary to adequately address any labour market or skills gaps.
- The policy solutions and investments necessary to address any systematic or sustained labour or skills gaps.

The workforce study results should inform any future planning and investments relating to the development of a dedicated HSR workforce.

Case study one conclusion

Stakeholders also identified HSR as a potential means of improving social outcomes in regions that have historically experienced relatively low educational attainment. The establishment of stations and O&M facilities in regions such as the Gold Coast, Newcastle and Albury-Wodonga has the potential to improve the accessibility of higher education institutions for both the local communities, and those currently living in metropolitan areas, which, over time, can lead to positive flow-on effects. The inclusion of local suppliers was also identified as a means of improving the welfare of workers living in remote areas, not only through the construction period but also through ongoing maintenance and operation of the HSR system. However, these potential benefits need to be balanced against the potential social costs that may arise from investment in HSR.

39 RSA, loc. cit.

A need identified through the consultation process is for a nationally coordinated workforce approach to analyse any future planning and investment requirements in the development of a dedicated HSR workforce.

9.4.4 Case study two: Access to health and related services

Rural and regional healthcare systems

Rural and regional healthcare systems play an important role in delivering a diverse range of public, private and not-for-profit services to people living in non-metropolitan areas. Public health services delivered to people living in rural and regional populations include hospitals, cancer clinics, community-based services, mental health services, ambulance and other transport services and aged care services. Private health services across rural and regional areas include hospitals, nursing hospitals, general practices and medical specialists, privately funded allied health providers and aged care services. The rural and regional health sector also includes numerous not-for-profit organisations offering a range of health services and health-related support services such as transport and home-based assistance.

Local government agencies are also involved in the delivery of regional health and health-related services including maternal and child health, schoolbased health and home and community care programs.

Health providers in rural and regional areas determine the mix of services that are provided to local communities. These decisions are also influenced by service agreements with government agencies, the availability of resources such as labour, and the needs of patients within specific localities⁴⁰.

As a consequence, not all levels of services are provided in all locations (despite the longterm policy commitments of state and territory governments to the delivery of most services in regional locations)⁴¹. This means that not all patients currently have equitable access to services and expertise.

This section examines how investment in significant infrastructure (such as HSR) can improve the level of access people have to public and social health services.

Ageing population

Since 2002, the Australian Treasury's *Intergenerational Report* has considered the longer term social and economic impacts of population ageing on future generations. The population projections contained within each report (2002-2010) have identified that between 2002 and 2100, the nation's population will gradually age until the middle of the century, where it will plateau until 2101⁴².

The ABS' medium series projections (which form the basis of Treasury's projections) are presented in **Figure 9-1**. The projections show that by 2015, 15.3 per cent of the population will be aged 65 years or older. This is expected to increase to 22.8 per cent by 2055.

- The populations of NSW, Queensland and Victoria that are aged 65 years and above are similarly projected to reach 15 per cent by 2015 and increase to 23 per cent by 2055. ACT is projected to experience a lower proportion of persons aged 65 years and above than the rest of Australia, increasing to just under 20 per cent by 2055.
- The proportion of the population aged 85 years and above by 2015 is expected to be 2.1 per cent of Australia's total population. By 2055 this is expected to increase to 4.8 per cent of the population, with NSW and Victoria expected to reach the figures five per cent and 4.9 per cent respectively by 2055.

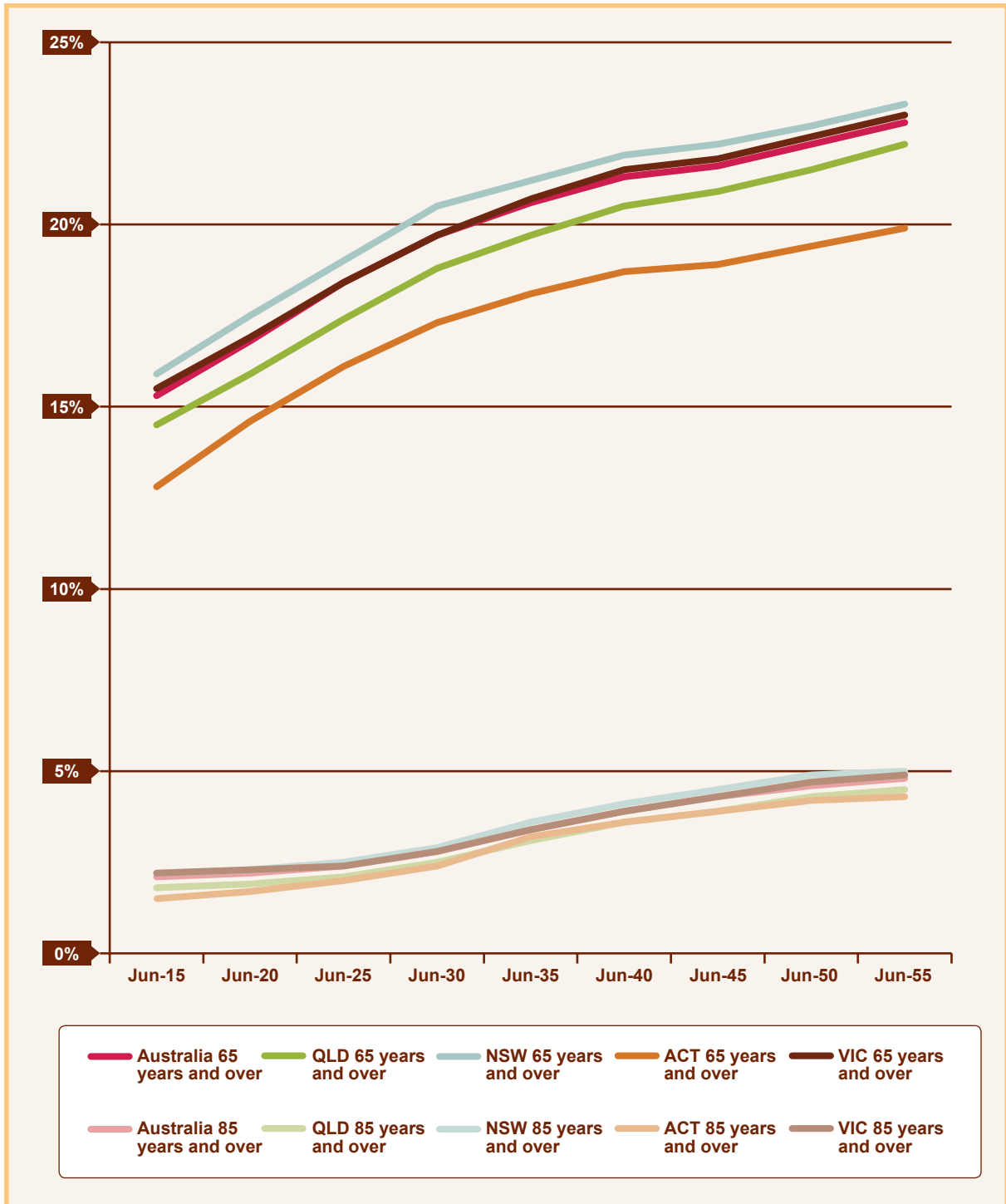
40 Victorian Government, *Rural and regional Health Plan*, December 2011.
NSW Government, *A new direction for NSW – State Health Plan Towards 2010*, 2007.

41 *ibid.*

Queensland Health, *Population projects to 2056*, Queensland and statistical divisions, 2007.

42 Treasury, *Intergenerational Report*, various years, Australian Government, Canberra, 2002-2010.

Figure 9-1 Population projections – proportion of the population 65 and 85 years and over 2015-2055



Source: ABS⁴³.

After 2030, projections suggest the proportion of people aged 85 years and above will increase more rapidly across the eastern states of Australia. For example, ACT is expected to experience 50 per cent growth in this cohort between the years 2030 and 2040. This growth will be closely mirrored by NSW and Queensland, which will experience 41 per cent and 44 per cent growth respectively over the same period.

While estimates suggest the growth rate in people aged 85 years and above will peak by 2035, it will gradually grow by 1.5 per cent until 2101. This growth will mean that a significant proportion of Australia's population will be in age cohorts that typically require high levels of health care and hospital services.

In short, an ageing population will place significant structural demographic pressure on Australia's metropolitan and regional health systems to meet the growing needs of populations. Through HSR, Australia has the opportunity to provide increased access to those people in regions served by HSR that will require health services, but cannot effectively access them due to current private and public transport arrangements.

Access to hospital and specialist services

The level of access individuals have to health facilities and services is an important contributor to the health and well-being of communities. This is because high levels of access protect and promote health within communities, as well as preventing illness from occurring in the first place. However, ensuring that all social groups and all regions have equal access to facilities and services is costly, complex and difficult to implement in a country such as Australia. For example, the Queensland Health Action Plan acknowledges:

In a number of regional areas, the size of the population is too small to attract and support enough health professionals at the level required to enable safe and sustainable services across all specialities in both public and private sectors⁴⁴.

Consultations with stakeholders have highlighted the need to continually improve the level of access communities have to health services. In particular, high quality services that are delivered in non-metropolitan regions are a way of fulfilling regional policy objectives and improving community health outcomes. Consultations have indicated that, while significant improvements have been made at the local (primary and community) health service level, it is widely recognised that many people living in regional areas are still faced with long waiting lists for elective hospital surgeries, and long lead times for access to specialist services in out-patient settings. As a consequence, many individuals living in regional areas are required to travel over night or long distances to see medical specialists or receive complex diagnostic services based in metropolitan areas.

Consultations also identified the significant impacts (usually negative) these issues have on the carers of families and friends of patients. For example, many carers living in regional areas are required to take time from paid work to assist patients attending metropolitan medical appointments. Such leave can create further hardship (both economically and emotionally) for carers of people living with chronic or severe illnesses and conditions (see also WA Carers' research on carer impacts of travel to medical appointments)⁴⁵.

Health services workforce distribution

The ability of health professionals to reach patients in their local settings is another important factor in the wellbeing of communities. Patients, especially the elderly, infirm and those suffering chronic conditions, often require face-to-face interaction with medical professionals. However, the majority (between 80 and 90 per cent) of Australia's 52,497 clinical and non-clinical workers are located in major cities (see **Figure 9-2**), placing significant travel requirements on the medical workforce to meet the needs of regional areas. Currently these travel requirements are met through air and road transport, which is often costly, time consuming and indirect.

44 Queensland Health, loc. cit.

45 L Selepak, 'Carers of people with disabilities: current issues and future trends', *Carers Monograph*, WA Carers, Perth 2012.

Figure 9-2 Regional profile of employed medical practitioners



Source: AIHW⁴⁶

While state government stakeholders acknowledge that changes in health technology and the way services are delivered will partially offset the need for health practitioners to visit regional areas, the need for health professionals to administer treatments in face-to-face settings will remain. Some health stakeholders have expressed the view that an HSR could be used to reduce the burden on medical workers who are often required to travel significant distances (using multiple modes of transport) to see patients and access facilities. HSR also offers opportunities for medical practitioners to better access multiple regions in a single day or in overnight travel settings (see Scholtz and Nieuwoudt's submission to the Australian Parliament⁴⁷).

HSR offers similar potential for medical and workforce training by offering students and medical registrars greater opportunities to receive training in non-metropolitan areas. This has the potential to expose students to a broader range of patient conditions, treatments, techniques and environments than are available in metropolitan locations.

Such benefits have the potential to improve the quality of life for travelling medical workers (and students) which are likely to generate complementary benefits for patients and carers.

46 AIHW, *Medical workforce 2010*, Australian Government, Canberra, 2012b.

47 J Scholtz & R Nieuwoudt, *Medical services in Moranbah and the impact of non-resident workers*, submission to Parliament House Standing Committee, Moranbah Medical District, September, 2011.

Social benefits of improved patient and carer experiences

Research by the Council of Australian Government (COAG) Reform Council identified that health outcomes are not equal for all Australians⁴⁸. The research suggested that for Australians living outside major cities, little improvement or worsened health outcomes are a consistent feature of the social landscape. For example, those living outside major cities had higher rates of a range of preventable diseases, lower rates of cancer survival, were more likely to have babies with low birth weights, and experienced longer waiting times for elective surgery and doctor appointments. For older Australians living outside major cities, the research further suggested that waiting times for hospital beds in residential care facilities were higher and that sub-acute care services were received at a lower rate than in major cities.

When patient satisfaction was surveyed, it was determined that people in major cities reported better patient experience compared to people in more remote areas. This was particularly evident in NSW, where a higher proportion of people outside major cities were unsatisfied with the amount of time doctors and nurses in emergency departments spent attending to their needs.

Improved accessibility to health care facilities in major cities and in major regional areas with base hospitals would have a positive impact on communities. Ease of accessibility and shorter travel times would reduce the locational boundaries currently facing communities and encourage patient movement to areas of higher health care supply, such as those in metropolitan areas. HSR has the added bonus of providing opportunities for patients to access health services (such as diagnostic services) in key regions in a single day, without the need for costly overnight accommodation expenses, or personal vehicle use. Realising such opportunities would of course be contingent on the pricing structures of regional trips, and on the level of connectedness between

neighbourhoods and HSR stations, as most stations will be located outside major regional centres.

Shorter travel time improves the experience for carers as well, allowing an efficient and accessible opportunity to accompany patients during time spent away from home. Data provided in **Appendix 5E** shows the average length of stay in hospital is between 2.4 days and 3.5 days, which is anticipated to increase as the population ages. By improving access to health care facilities, HSR provides opportunities for carers to more freely travel between facilities and their home location. This has the significant potential to minimise the financial and family costs associated with caring responsibilities.

Social costs of loss of services and expertise located in regional areas

The current healthcare workforce is characterised by an uneven distribution of specialist healthcare professionals between major cities and those areas outside major cities. Inner regional and outer regional areas have lower proportions of hospital non-specialists, specialists and other clinicians than major cities⁴⁹.

Improved transportation between major cities and inner and outer regional areas would create opportunity for patients to become more transient and seek out specialist medical care. The workforce could potentially cluster around major cities where demand is higher and access from regional areas is available. As a result of the centralisation of these services, regional areas could lose services and expertise as specialists move to major cities.

Any loss of facilities or expertise could have negative effects on community health, if patients from regional areas choose not to use HSR to access health care treatment.

48 COAG Reform Council, *Healthcare 2010-11: comparing performance across Australia*, Sydney 2012.

49 AIHW, 2012a, loc. cit.

Cost of improving community transport

Improved accessibility to health care services is reliant on the level of accessibility provided by transport infrastructure within local communities. Community and local transport networks are necessary to facilitate travel from neighbourhoods, facilities and areas where HSR stations would be located. For HSR, stations would be, in most circumstances, situated on the outskirts of cities and would require intermediary transport to and from these locations (see discussion in **section 9.2.6**).

The cost of improving community transport to promote use of HSR transportation would in most circumstances fall upon local communities. A significant level of analysis would be necessary to determine whether current local and community transport networks would meet the future service delivery objectives an HSR, and the level of investment necessary to ensure communities have adequate access to stations and health facilities.

Increased demand on major service centres

The availability of an HSR network may result in increasing demand for healthcare services in major centres. Data from the COAG Reform Council demonstrates that there is an increasing incidence of people delaying consultations with healthcare professionals due to financial costs and other barriers, such as accessibility of healthcare services⁵⁰.

If access to healthcare services were improved, it may result in patients who had not previously accessed healthcare seeking these services, in turn driving up demand. As demand increases, the cost of delivery is likely to rise over time. This is likely to place further strain on Australia's healthcare resources as the population ages.

Tradeoffs associated with pursuing benefits

The tradeoffs associated with utilising HSR as a vehicle to improve access to health and other public services are summarised in **Table 9-5**.

Table 9-5 Possible tradeoffs (Case study two)

Potential benefit/cost	Possible tradeoff
Improved access to specialist health care services	<ul style="list-style-type: none"> • Potential reduction in services and expertise in local communities • Potential for increased demand in major cities for specialised health care • Potential for increased centralisation of specialist health care around major cities • Potential increased local and community transport costs to connect individuals to stations and health care facilities/services as most stations would be located outside regional cities
Improved coordination in the delivery of services	<ul style="list-style-type: none"> • Potential loss of services and expertise in regional and local areas • Potential loss of autonomy over service delivery for health care regions

Source: AECOM analysis.

Case study two findings

This case study shows that an ageing population and the changing expectations of communities for high quality services will drive demand for health services. The ability of governments to meet this demand will be shaped by a rapidly evolving health technology sector, the ability of governments to finance (public and private) health delivery, and, importantly, the level of access individuals have to facilities and professionals.

Many people living in regional areas are faced with longer waiting lists for elective hospital surgeries, and longer lead times to see specialist services in out-patient settings than metropolitan residents⁵¹. As a consequence, many individuals are required to travel overnight or long distances to see medical specialists or receive complex diagnostic services based in metropolitan areas. This is especially problematic for older age cohorts who often require face-to-face interaction with professionals in metropolitan settings. It is also problematic for the friends and families of patients, who often face financial hardship when located in regional areas and have caring responsibilities. Furthermore, the majority of Australia's clinical and non-clinical workforces are located in major cities, placing significant travel requirements on the medical workforce to meet the needs of regional areas. Currently, these travel requirements are met through air and road transport, which is often costly, time consuming and indirect.

This case study suggests that HSR could reduce the burden on patients, carers, medical workers, and medical students who are often required to travel significant distances using multiple transport modes to access healthcare services and facilities. Although the status quo is that patients generally travel to centralised healthcare facilities, rather than the health workforce travel to regional facilities, the case study also demonstrates that there are opportunities provided by HSR to improve service delivery by enabling health workers to travel from capital cities to the rural clinical campuses currently established in most of the regional centres that would be served by a

HSR station for both training students and staff as well as treating patients. Through increased coordination and supportive policies, HSR could provide opportunities to better manage changes in demand and minimise the level of duplication occurring across services and facilities. Such coordination would require health services to be delivered through new and more effective delivery models. HSR could offer significant opportunities to reconfigure the way other public services are delivered to communities and individuals.

9.4.5 Case study three: Tourism, recreation and social inclusion

Recreation and leisure activities play an important role in promoting the inclusion of people within our communities. Involvement in leisure activities adds meaning to community life and contributes to people's overall quality of life. Recreation can encourage personal growth and self-expression, and provide increased learning opportunities not met in people's working lives.

For many people, participation in leisure and recreation (through physical activity or sport) can lead to improvements in physical and mental health. This is backed by a large body of public health research that has consistently shown that increased physical activity can lead to fewer health and mental health problems and higher productivity at work.

Participation in leisure and recreation activities can also have social benefits. It creates social opportunities by allowing people to connect and network with others. It can also contribute to family and other group based bonding⁵².

By generating increased opportunities for access to towns, regions or cities, communities can capture the health and social benefits associated with tourism. A discussion about these social benefits, as well as the costs and tradeoffs of increasing access to tourism opportunities through HSR, are outlined below.

51 AIHW, 2012a. loc. cit.

52 New Zealand Government, *National social report 2010, leisure and recreation*, Ministry for Social Development, accessed on 13 July 2012, <http://socialreport.msdc.govt.nz/leisure-recreation/>.

Current trends in tourism

Tourism is a major industry that contributed approximately 2.5 per cent or \$34 billion to Australia's gross domestic product in 2011⁵³. Tourism directly employs more than 500,000 people and is one of Australia's largest export industries, earning nine per cent of Australia's total export earnings⁵⁴. When looking at Australia's exports services only, travel (which comprises business, education-related and other personal travel) accounted for 61 per cent of Australia's total exports services earnings in 2011⁵⁵. Tourism plays a key role in regional economic development, with tourists spending 46 cents of every tourism dollar in regional areas⁵⁶.

Tourism in Australia goes beyond leisure travel, encompassing a wider 'visitor economy' that includes travel for the purposes of business, visiting friends and relatives, education and work⁵⁷.

International and domestic tourism

In the year ending 31 March 2012, Australia received 5.5 million international visitors who spent 196.6 million nights in the country. **Figure 9-3** shows that of the 5.5 million international visitors, 44 per cent of visitors came to Australia for holidays, and 25 per cent to visit friends and relatives (VFR)⁵⁸. The remainder of international visitors came for business, education and other reasons.

53 Australian Bureau of Statistics Tourism Satellite Account 2010-11 (Cat. No. 5249.0).

54 Australian Government, *Tourism industry – facts and figures – at a glance*, Tourism Research Australia, Department of Resources, Energy and Tourism, Canberra 2011a.

55 Australian Government, *Composition of Trade Australia*, Department of Foreign Affairs and Trade, Canberra 2011b.

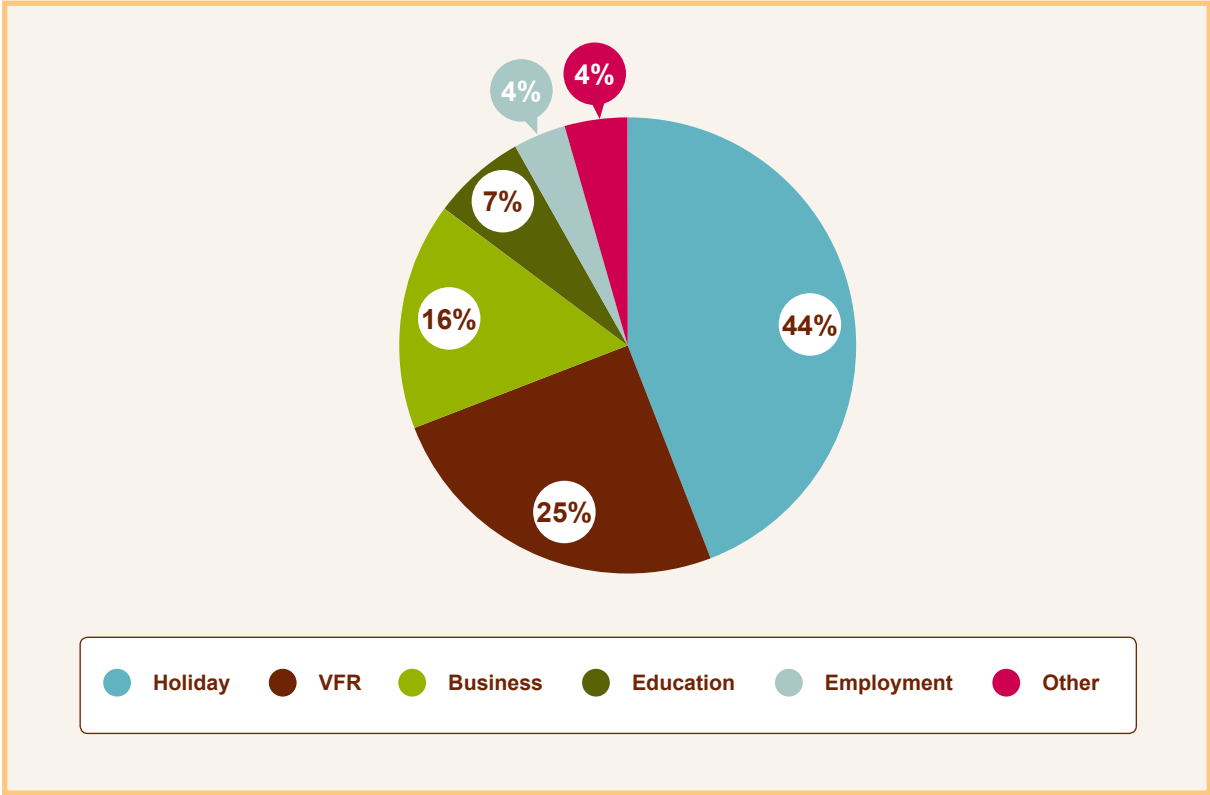
56 Tourism Australia, *Tourism 2020 – whole of government working with industry to achieve Australia's tourism potential*, December 2011.

57 Tourism Australia, loc. cit.

Australian Government, *Forecast 2012 – Issue 1*, Tourism Research Australia, Department of Resources, Energy and Tourism, Canberra 2012c.

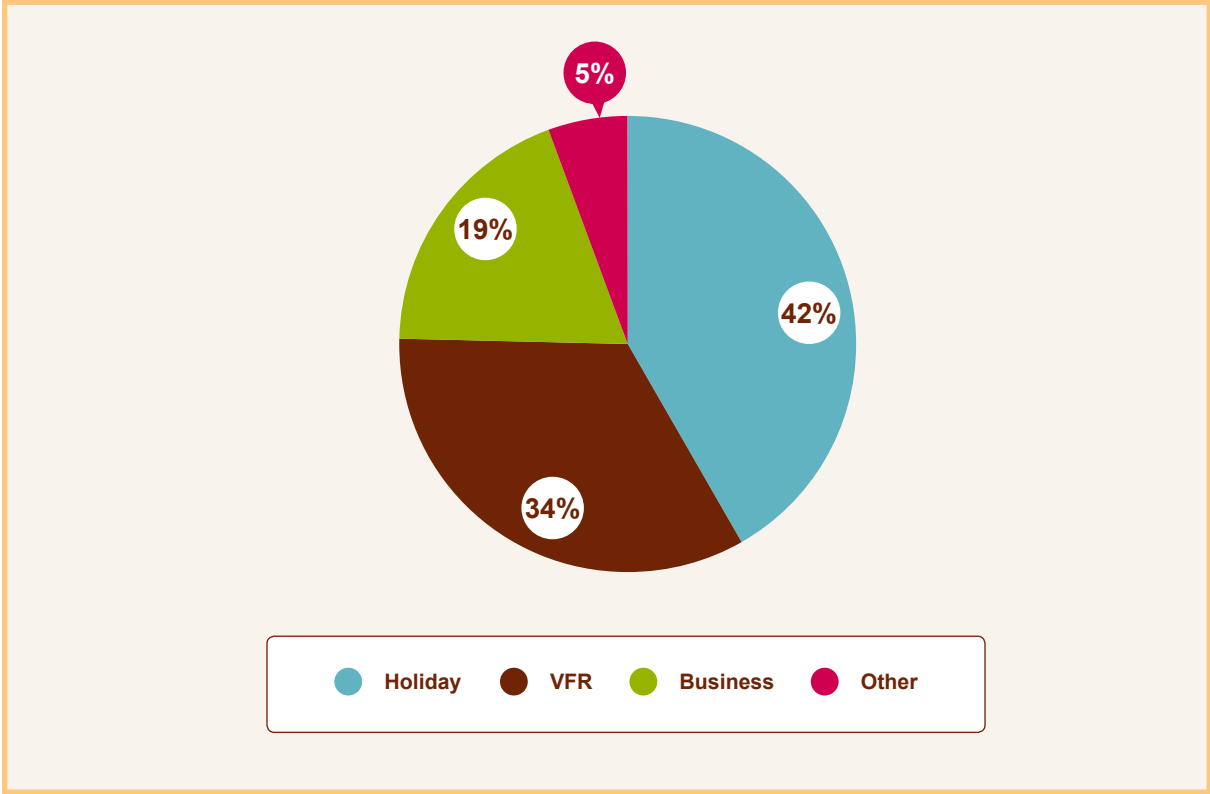
58 International visitors are those international visitors aged 15 years and over (Australian Government 2012a).

Figure 9-3 International visitors by main purpose of journey (year ending 31 March 2012)



Source: Australian Government⁵⁹.

Figure 9-4 Domestic overnight visitors by main purpose of journey (year ending 31 March 2012)



Source: Australian Government⁶⁰.

59 Australian Government, 2012a, loc. cit.

60 Australian Government, 2012b, loc. cit.

During the same period, Australia received 73.3 million domestic overnight visitors, who spent approximately 279 million visitor nights across the states and territories⁶¹. Of the 73.3 million domestic visitors, the main purpose of visit was holidays (42 per cent), VFR (34 per cent), business (19 per cent) and other (5 per cent) (see **Figure 9-4**).

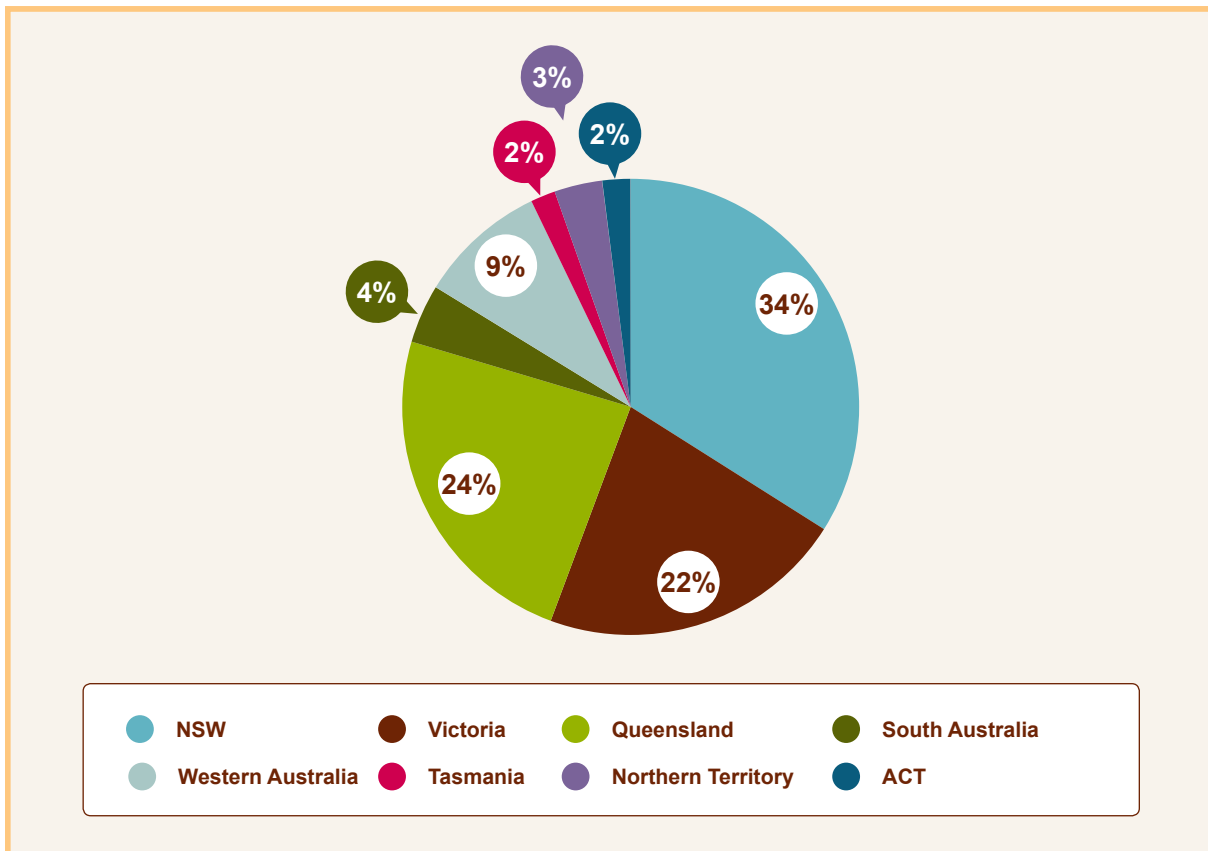
The main mode of transport used by international visitors was largely aircraft (43 per cent), followed by private rental vehicles (28 per cent). In

contrast, most domestic overnight visitors used private vehicles (69 per cent) and air transport (23 per cent)⁶².

State, territory and regional tourism

Figure 9-5 and **Figure 9-6** show that for international and domestic overnight visitors, the main travel destinations are NSW, Queensland and Victoria, accounting for 80 per cent of all international visitors and 79 per cent of all domestic visitors.

Figure 9-5 International visitors by state/territory visited – in millions and as a proportion of total visitors*



Source: Australian Government⁶³.

*Visitors by state or territory sum to more than total visitors due to stop overs. Data also relates to the year ended 31 March 2012.

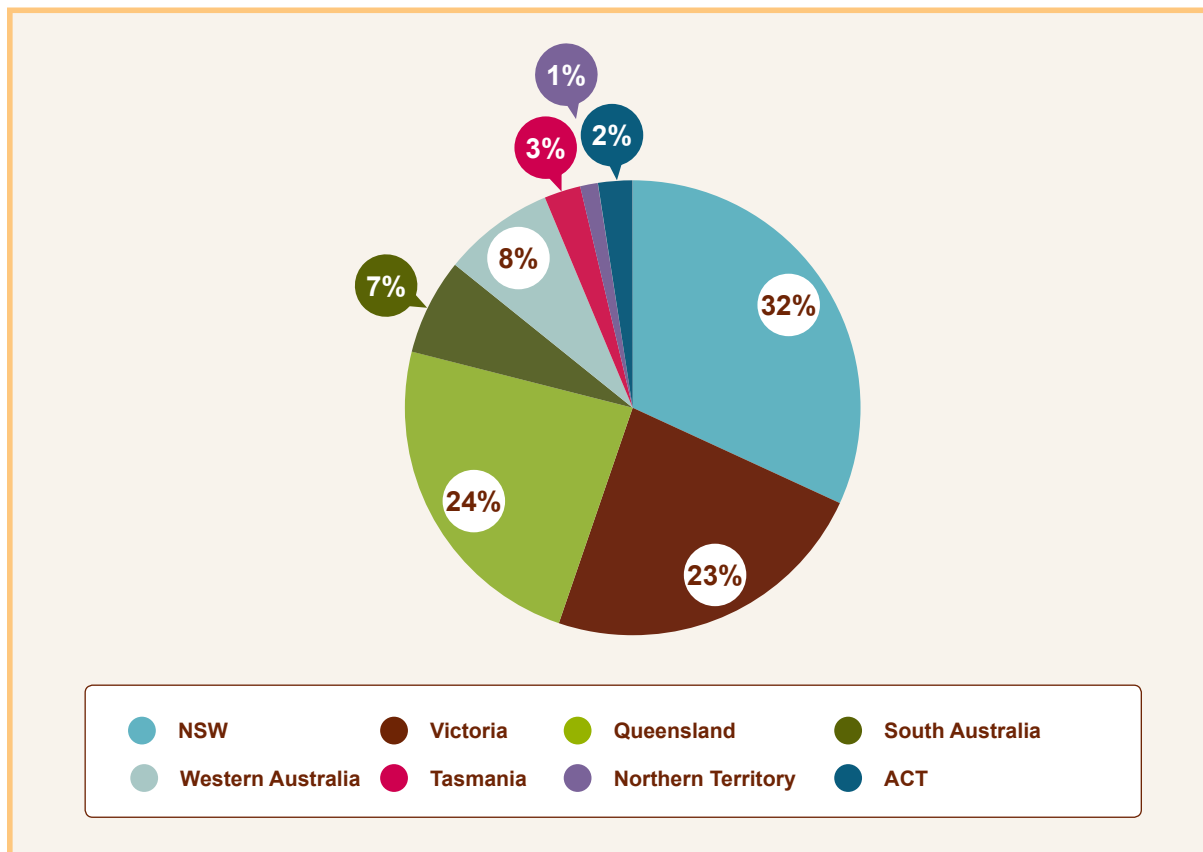
61 Overnight travel involves a stay away from home of at least one night, at a place at least 40 kilometres from home. A person is an overnight visitor to a location if they stay one or more nights in the location while travelling.

Australian Government, *Travel by Australians, quarterly results of the National Visitor Travel Survey*, Transport Research Australia, Department of Resources, Energy and Tourism, Canberra, 2012b.

62 Australian Government, 2012a & 2012b, loc. cit.

63 Australian Government, 2012b, loc. cit.

Figure 9-6 Domestic overnight visitors by state/territory visited – in millions and as a proportion of total visitors*



Source: Australian Government⁶⁴.

*Visitors by state or territory sum to more than total visitors due to stop overs. Data also relates to the year ended 31 March 2012.

Of all international visitor nights reported in the financial year 2011-2012, 79 per cent were spent in a city whereas 21 per cent were spent in a regional area. By contrast, of all domestic visitor nights, 36 per cent were spent in a city whereas 64 per cent were spent in a regional area⁶⁵.

Key destinations for international visitors were Sydney (2.6 million visitors), Melbourne (1.7 million visitors), Brisbane (900,000 visitors), the Gold Coast (740,000 visitors) and Tropical North Queensland (612,000 visitors)⁶⁶.

Research on regional travel shows that international and domestic visitors use air transport and private vehicles as their main mode of travel to regions such as the Gold Coast and Tropical North Queensland (places that enjoy good accessibility in terms of regional airports and highways)⁶⁷. In contrast, domestic visitors to areas such as the Sunshine Coast (Queensland), the Northern Rivers Region (NSW), the Mid North Coast (NSW) and the South Coast (NSW), mainly use private vehicles, followed by air travel. International visitors, however, rely heavily not only on private vehicles but also on long distance coach and rail.

64 Australian Government, 2012a, loc. cit.

65 Australian Government, 2012c, loc. cit.

66 Australian Government, 2012a, loc. cit.

67 Australian Government, *Economic importance of tourism in Australia's regions – Phase 2: large tourism-dependent regions*, Transport Research Australia, Department of Resources, Energy and Tourism, Canberra 2011c.

Mode choice patterns also vary depending on the age of the visitor. For both international and domestic visitors, rail and bus become a more important mode when the passenger is over 50 years old⁶⁸.

Social inclusion

Government support for socially inclusive communities emerged during the 1970s and 1980s in response to the changing conditions of labour markets, and the inability of welfare systems to meet the needs of more diverse populations. Since this time, there has been a growing recognition among governments that effective social inclusion requires policy action that recognises the importance of difference and diversity in closing the physical, social and economic distances between people. This recognition reflects a proactive, human development approach to social wellbeing that seeks to minimise the barriers or risks associated with divided communities⁶⁹.

Today, government interventions that ‘bond, bind and bridge people within communities’⁷⁰ are central components of many OECD countries’ policy settings. In Australia, social inclusion is a significant policy agenda of the current Government that is underpinned by dedicated programs and long-term commitments to improving the inclusiveness of communities (see www.socialinclusion.gov.au for additional information).

Analysis of the available policy research in the United Kingdom, Canada and Europe identifies that most socially inclusive policies are commonly built on five key dimensions, including:

- Valued recognition and respect for individuals and groups. This includes recognising the differences and diversity of communities, as well as the common ‘worth’ of individuals.
- The value of human development. Nurturing the talents, skills, capacities and choices of

children and adults to live a life they value and to make a contribution both they and others find worthwhile.

- Involvement, access and engagement in community life. This involves having the ability or opportunity to be involved in decisions affecting oneself, family and community, and to be engaged in community life.
- The benefits of physical and social proximity to reduce social distances between people. This includes shared public spaces and neighbourhoods.
- Promotion of material and emotional well-being. This involves the development of policies which allow people to participate fully in community life⁷¹.

These dimensions are important for understanding why nationally significant infrastructure, such as HSR, could be used to deliver socially inclusive outcomes.

Key stakeholder issues

State and territory-based stakeholders identified a broad range of themes about the role of tourism and travel in generating socially inclusive communities. These themes focus on the travel barriers from conventional trains and other transport modes currently confronting people from disadvantaged groups within society; particularly mobility impaired people (such as people who are mobility impaired and the elderly). The issues raised below identify opportunities where HSR could provide a significant improvement over conventional travel for these groups of people.

Low incidence of travel among the mobility impaired

Consultations with state-based community and planning agencies have identified that people who are mobility impaired often do not have the same opportunities to travel as others without

68 Combined Pensioners and Superannuants Association, *Closing the Transport Gap – Meeting the transport needs of transport disadvantaged people in NSW*, Sydney, 2010.

69 Australian Social Inclusion Board, *Social inclusion, a compendium of social inclusion indicators – How’s Australia faring?*, Australian Government, Canberra, 2009.

70 R Putnam, ‘Bowling alone: America’s declining social capital’, *Journal of Democracy*, vol. 6(1), 1995, pp. 65-68.

71 P Donnelly & J Coakley, *The role of recreation in promoting social inclusion*, working paper series on social inclusion, University of Toronto and University of Colorado, 2002.

those limitations. This is supported by a United States travel survey data which shows that people who are mobility impaired are significantly less likely to travel for tourism purposes than people without disabilities⁷².

The right to travel and access tourist activities is regarded as a key social right for people who are mobility impaired, their families and their carers. This right is founded in international law and supported by the Australian *Disability Discrimination Act 1992* which makes 'disability discrimination unlawful and aims to promote equal rights, opportunity and access for people who are mobility impaired' (www.heroc.gov.au/disability-rights/)⁷³.

Travel, tourism and recreation are important elements in the quality of life for all people. For the mobility impaired, their families and their carers, the opportunity to go on a holiday can be an especially important chance to relax and recuperate. However, there are currently many travel barriers facing the mobility impaired, which range from physical access issues, through to the actual cost and time associated with travel. The barriers often found in conventional rail and other existing transport modes are discussed in more detail below.

Community and local transport

The linkages between stations and people's homes were considered by all stakeholders to be fundamental elements facilitating the potential use of HSR. As outlined in **Appendix 5E**, disability-friendly community and local transport networks would be necessary to facilitate travel between neighbourhoods and HSR stations. Such connections are often vital for people who are mobility impaired and the elderly who typically do not have private vehicles and who rely on intermediary transport for connections to major public transport hubs.

Station design

Consultations in Queensland and Victoria highlighted the importance of station design in encouraging people who are mobility impaired to use HSR. Research into travel behaviour has consistently shown that the design and services offered at stations are significant factors in the tourist experiences of mobility impaired people, as well as the elderly. Security checkpoints, the length of distance between toilets and boarding gates, the use of coaches between terminals, and secondary airports with minimum facilities (and no aerobridges) are significant factors influencing the travel habits of people who are mobility impaired. The design and location of stations and the perceived level of safety at stations are also significant factors impacting on travel decisions of the elderly and the disabled. Security arrangements for stations would need to be important aspects in the future design phases of HSR.

Suitability of the train

Consultations with state agencies highlighted the problems associated with conventional train travel that could be addressed by HSR. For example, densely packed conventional trains without allotted seats, lacking sufficient leg space and containing overly restrictive armrests and seating arrangements present significant barriers to people who are mobility impaired. People with mobility impairments often have difficulties using toilet and bathroom facilities on vessels that lack wheelchair access and suitable onboard aisle chairs. For example, many short-haul flights (less than three hours) use single-aisle, narrow body aircraft, which pose great difficulties accommodating people with wheelchairs who need to access toilet facilities. By its design and nature, HSR would provide superior options for people with mobility impairments to these restrictions.

72 Open Doors Organisation, *Disability travel in the United States: recent research and survey findings*, Chicago, 2005. L Selepak, loc. cit.

The World Health Organisation (WHO) defines disability as 'any restriction or lack (resulting from an impairment) of an ability to perform an activity in the manner or within the range considered normal for a human being'.

73 Fundamental aspects of the *Disability Discrimination Act 1992* are based on the Universal Declaration of Human Rights adopted in 1948, to which Australia is a signatory. The Declaration states that 'all are born free and are equal in dignity and right' (article 1). It also declares that everyone has the right to freedom of movement (article 13) and the right to rest and leisure (article 24) (United Nations 1948).

Fares and the costs of travel

Consultations in Queensland, NSW and Victoria have commonly identified that the cost of travel would be a significant factor in HSR's ability to deliver social outcomes. Because people with mobility impairments are frequently older and have less disposable income, travel fares would need to be 'low, simple and unrestricted (not subject to restrictions such as advance purchase and minimum stay away)' to achieve maximum benefit for this travel segment⁷⁴. Cancellations, postponements and rerouting on conventional travel modes were noted as causing significant problems for people who are mobility impaired when they are travelling independently and without carers. Strict baggage allowances, such as those used by low cost airlines, do not adequately account for wheelchairs and other mobility devices used by disabled people

Reservations and ticketing

In order to attract travellers who are mobility impaired, it is important for reservations and ticketing systems to encourage participation in travel by these groups. Research undertaken at the University of Technology, Sydney on low cost travel has found that emerging trends in travel and tourism 'discourage sales through travel agents, and opt instead for distribution through their own website or through call centres'. These arrangements cause problems for people who are mobility impaired when they need to contact airlines and travel providers to ensure they can adequately accommodate their travel needs or specific physical and mental requirements. The research also suggests that people who are mobility impaired often feel 'uncomfortable' and 'intimidated' when making reservations and arrangements through internet booking systems and call centres. As a consequence, there is a strong preference for these groups to use face-to-face methods when booking travel⁷⁵.

9.4.6 Social costs, benefits and tradeoffs

This section discusses the potential social benefits and costs arising from the analysis of key data and research and the outcomes of stakeholder consultations. It also considers some of the tradeoffs that arise in pursuing social policy outcomes from HSR.

Potential benefits

Inclusion benefits

Independent research and study results suggest that HSR could also assist in closing the physical, social and economic distances separating socially disadvantaged people in regional areas. HSR could provide people living in non-metropolitan areas with better linkages than are currently offered through conventional inter-regional public transport networks. This has the potential to benefit the elderly, disabled and other mobility impaired people in regional station locations as 'many in this group feel socially excluded because they have lost an important means of maintaining their independence and connection with their community'⁷⁶.

These benefits would support people in disadvantaged regional situations that experience reduced access to private transport and the limited availability of appropriate conventional public transport. The benefits would also be realised by international and domestic travellers visiting relatives, friends and families in locations that are currently difficult, financially costly or time consuming to access.

Improved quality of life

HSR would provide the option to undertake leisure-related trips to a broader range of areas that would be 'closer' in terms of travel time. By making leisure travel easier, HSR could deliver a broader health benefit for the community and associated savings in the provision of health and mental services. This outcome is enhanced when leisure travel leads to physical activity and improved physical and mental health.

74 *ibid.*

75 *ibid.*

S Darcy, *Flying with impairments: improving airline practices by understanding people with disabilities*, Tourism Research Conference Paper, 19-23 June, Las Vegas, Nevada, 2007.

76 Combined Pensioners and Superannuants Association, *loc. cit.*

Improved quality of service

Although mature age visitors in regional areas rely on conventional public transport services, these services are limited, with the scheduling of some services leading to prolonged waiting periods for connecting services. Further, the infrequent provision of services sometimes leads to unnecessary overnight stays, which has an adverse financial impact on travellers⁷⁷. HSR could provide improved services in terms of travel time and reliability of service to areas that are currently not very accessible, particularly for daytrips. This would broaden the travel horizons of some people who would otherwise not use conventional regional services.

In comparison to conventional services, HSR would provide a more comfortable travel space and better amenities, such as toilets and catering. These are standard features of HSR overseas and are very important for mature and mobility impaired passengers and passengers with health conditions. The preference for improved quality of conventional rail service in urban areas is well established, where research has consistently demonstrated that older or less mobile passengers attach greater value to service levels than other passengers.

Potential costs

Exclusion of key regions

The outcomes of the international literature review concluded that, although HSR would offer important accessibility benefits to the areas that it serves, it may be a disadvantage to areas that do not have a station. With the introduction of HSR, tourism-related development and investment could become more heavily concentrated in those areas with an HSR station, leaving areas without a station in a relatively disadvantaged position. As Rus et al. indicate:

Transport improvements may, thus, be as likely to lead to an increase in regional disparities as they do to increasing cohesion. This is not universal or inevitable outcome; it will depend on the specific situation of the region, the initial levels of accessibility and the change in them and the existence of other policy measures which may accompany the transport improvement⁷⁸.

Costs of providing public and community transport

Access to HSR stations would be an important factor in the success of HSR in catering for the travel needs of disadvantaged groups in regional areas. For older or mobility impaired passengers, the ability move easily between the station and their destinations would also be a key factor in influencing whether this disadvantaged group of passengers use HSR.

Costs associated with accessing remote HSR stations would make its use less attractive to disadvantaged groups. Without other supportive measures, this is likely to place pressures on local authorities to meet any funding gaps associated with providing community access to HSR stations.

Loss of existing rail and transport services

The patronage results demonstrate that HSR would take passengers from existing transport services within the HSR corridor, such as CountryLink rail in NSW and privately-owned coach services throughout the network. This would reduce the demand for existing regional services and the viability of alternatives to HSR. Without supportive policies and programs, this would leave the disabled or disadvantaged further marginalised from recreational and leisure opportunities, even if they are in close proximity to an HSR station.

77 *ibid.*

78 G. Rus, I Barrón, P. Gagnepain, C. Nash, A. Ulled & R. Vickerman, 'Economic analysis of high speed rail in Europe', *Informes 2009, Economía y Sociedad, Fundación BBVA 2009.*

9.4.7 Tradeoffs

The possible tradeoffs associated with using HSR to deliver social outcomes are summarised in **Table 9-6**.

Table 9-6 Possible tradeoffs

Potential benefit/cost	Possible tradeoff
<p>Inclusion benefits</p> <p>Improved quality of life</p>	<ul style="list-style-type: none"> • Potential loss of services in areas that are not serviced by HSR due to lower patronage levels (from the opening of HSR). This could entail possible exclusion of areas adjacent to the HSR corridor but not having an HSR station. Potential shift of tourism from capital cities to regional areas and associated visitor expenditure • Potential loss of quality of life in areas adjacent to the HSR corridor but not having reasonable access to an HSR station. This could potentially include a loss of income in those areas where visitors could not easily return within the same day prior to HSR
Improved quality of service	<ul style="list-style-type: none"> • Loss of patronage in other existing transport modes • Potential financial costs to ensure stations and trains are disability friendly • Personal and local community costs of providing public and community transport

Source: AECOM analysis.

Case study three conclusion

The study explored HSR's potential role in delivering community outcomes that achieve social inclusion. Data presented in the case study on the travel patterns of international and domestic visitors shows that the most frequently cited reason for travel is to visit friends and relatives. Furthermore, most visits happen to or within the east coast states of Queensland, NSW and Victoria, with international visitors spending most of their time in a capital city, while domestic visitors spend most of their time in regional areas.

Choice of travel mode for tourism seems to vary by age bracket with more mature groups relying relatively more than younger groups on rail and bus services. Research also shows that people experiencing disability or disadvantage are often excluded from opportunities to travel and the physical and mental benefits associated with leisure.

Data on current usage of regional rail services shows that rail plays an important role in catering for the tourism travel needs of mature age visitors in regional areas. However, these conventional rail services are frequently limited and impose a significant travel burden on the mature age passenger in terms of time to get to/from the station, waiting time and accessibility issues at the station.

Findings from this study suggest that HSR would deliver improved services in terms of travel time and reliability from regional areas to regional centres and metropolitan areas. HSR would broaden the travel horizons of some people that may otherwise chose not to travel using conventional services. Yet, for HSR to be effective in meeting the travel needs of elderly and mobility impaired passengers, consideration would need to be given to policies, services, scheduling, amenities and fare structure that cater to these groups.

Finally, although HSR can have important accessibility benefits to the areas that it would serve, it would be important to consider the potential adverse effects on those areas that would not have a station. Appropriate policies and programs would be important to support any locations that were bypassed but which would benefit greatly from access to HSR.

9.5 Urban and regional economic appraisal

Implementation of HSR would significantly change accessibility between capital cities and regional centres and could provide opportunities for regional economic development. In addition to the presence of complementary assets discussed above, the ability of regional towns and cities served by HSR to take advantage of that potential would depend on:

- Supportive and aligned regional development policies at the Australian Government, state/territory government and local government levels.
- The willingness of regional stakeholders to embrace and invest in the opportunities possible with HSR.
- The availability and appropriate application of investment. Significant regional growth would require public and private sector investments to flow from capital cities into regional centres.
- Metropolitan and regional planning policies which encourage and support new development in regional centres with HSR stations.
- The timing of HSR opening in relation to broad economic trends. For example, investing in HSR as part of other economic development activities in a rising economic environment might be more effective than in a declining one.

There are clearly significant uncertainties involved in determining how these initiatives should be developed and what outcomes should be pursued. In part, they are associated with the nature and scale of the proposed HSR system and require forecasting responses and conditions many years into the future. They are also uncertain, however, because they would require responses from outside

the transport sector. They would need businesses to change how they operate, investments to switch to new locations, and tourists to change their travel patterns.

In examining the potential impact of HSR, these inherent uncertainties need to be acknowledged but should not prevent an assessment of what the regional development impacts might be. The following analysis assumes proactive and positive responses are undertaken by key stakeholders in an effort to release HSR's full potential. Two distinct impacts under these circumstances are considered:

- Improvements in productivity.
- Changes to tourist spending patterns.

9.5.1 Improvements in regional productivity and economic performance with HSR

The bulk of the productivity gains from HSR are captured in the cost-benefit analysis reported in **Chapter 8**. However, HSR could have wider economic benefits through its impact on 'effective density' by bringing places of residence and employment effectively closer together through a reduction in travel times. Effective density provides an indicator of access to jobs where the number of accessible jobs is divided by the journey time required to reach them. Benefits can then arise in a number of ways:

- It is easier to match workers to specific vacancies and to find employees with the right skills.
- It enables greater specialisation of supply leading to a more efficient production of goods and provision of services.
- It leads to knowledge flow-on (i.e. greater opportunities for formal and informal contact through increased accessibility).
- Employees have a greater choice of jobs.
- There is more competition between companies and between individuals.

As the HSR system is constructed, accessibility to major cities from areas such as the Central Coast (to Sydney) and Gold Coast (to Brisbane) would

improve, allowing employers to access a larger labour pool and employees to have a greater choice of employers. Internationally, positive economic benefits (so-called 'agglomeration benefits', as described previously) have been attributed to such impacts, and are included in the quantitative assessment of the benefits of investments in transport infrastructure. However, as noted above, because of the uncertainty of these effects in the current context, they have not been included in the core economic analysis results.

The theory of agglomeration explains how productivity improvements can be gained through improved linkages between jobs. Importantly, those productivity gains are additional to the time savings measured in traditional transport benefits. Over the longer term, employment would respond to the change in accessibility delivered by HSR in other ways, with different types of jobs being created, and some jobs moving out and others moving in.

In the following case studies a calculation is made of the change in effective density. Changes in effective density produce a short-term increase in productivity with no change in employment scale or type.

Regional case study - Newcastle

Newcastle, two and a half hours' drive north of Sydney, served as one of several case studies for this analysis. On the basis of simplified assumptions, effective density in Newcastle was calculated in a manner consistent with United Kingdom Department for Transport guidance for a base case without HSR, and for a reference case

with HSR. Effective density provides an indicator of access to jobs where the number of accessible jobs is divided by the journey time required to reach them. To apply this analytical technique to Australia, it was assumed that the change in productivity in Australian regional centres would be proportional not just to the journey time to the nearest Australian capital city, but also to employment in the Australian capital city relative to employment in London. For example, regional centres with improved accessibility to Brisbane increase their productivity by only 24 per cent of the observed change in the United Kingdom, because there are just over one million jobs in Brisbane compared to 4.5 million in London. These estimates are at best indicative, being based on a methodology and assumptions developed for the British context. A model designed specifically for Australia would have to account for local industry, densities and competing transport systems.

The analysis suggests there could be a 23 per cent improvement in effective density in Newcastle as a result of HSR. Applying a typical agglomeration elasticity of 0.07, relating changes in productivity to changes in effective density, would increase average employment productivity in Newcastle by 1.6 per cent. That in turn would increase average wages by \$720 per year and Gross Value Added by \$1,440 per year (output in Australia is broadly double earnings). With 80,000 jobs in Newcastle, that would equate to an increase in Gross Value Added of \$115 million per year, in current prices.

Sensitivity tests showed how productivity improvements might change with different scenarios, as shown in **Table 9-7**.

Table 9-7 Sensitivity of changes in productivity improvements for Newcastle to changes in appraisal assumptions

Assumptions	Productivity improvements
HSR reference case	1.6%
HSR access time (to Sydney) +20 minutes	0.8%
Agglomeration elasticity of 0.04	0.9%
Car journey time (to Sydney) +20%	2.1%
Central Sydney jobs +30%	1.9%

These results are illustrated in **Appendix 5I**.

The results are clearly sensitive to the HSR journey time and the assumed agglomeration elasticity, but increase in line with higher employment densities and slower commuter car travel, which seem likely to be realities in the future. HSR would therefore be expected to generate a modest improvement in productivity of one to two per cent for Newcastle City. The UK approach suggests that the regional centres (Albury-Wodonga, Gosford and Coffs Harbour) could gain productivity growth from HSR of:

- Between 0.5 per cent and two per cent in the short term through agglomeration impacts arising from improved access to the capital cities.
- Between four per cent and 11 per cent over the long term, as businesses change, restructure and relocate to take advantage of the opportunities provided by HSR.

To put it into context, the increase is roughly the same as the average annual increase in labour productivity in Australia over the last decade⁷⁹.

These productivity gains are entirely additional to the impacts measured within the traditional transport appraisal and would deliver significant economic gains across an Australian east coast corridor that currently comprises some 1.3 million regional residents and is expected to grow over the next 20 to 30 years. Current total wages within those regional centres are currently more than \$50 billion per year, so a short term one per cent average increase would equate to \$0.5 billion per year, and a longer term seven per cent average increase would equate to \$3.5 billion per year. These increases are not currently accounted for in national budget estimates. These results are based on current values and are not inflated over time for real productivity growth or increased employment levels.

The German and United Kingdom studies show that HSR could potentially play a role in shaping where economic activity takes place along its corridors, but the extent of this role depends on the particular circumstances. For example, HSR stations can affect population movements, company locations and linkages between companies where supportive public programs and policies are in place. However, European evidence also shows that the presence of an HSR station alone is not a sufficient condition for economic development to take place, either at the local level (or close to the station) or within the sub-region in which the HSR station is located⁸⁰. A critical unresolved issue is the extent to which an HSR system causes development that would not otherwise have happened, or enhances development that is already occurring.

Where HSR increases productivity in the regional centres, it could also assist in delivering other policy objectives, such as income distribution and economic growth. In addition, there would clearly be feedback between economic growth taking place in the regions and increased demand and willingness to pay for HSR services. These increases are generated by access combined with other attributes of intermediate-sized centres

Given the time period over which HSR would be implemented, and the lengthy period over which these productivity changes take place, the build-up of productivity benefits would be considerably slower than the build-up of user benefits. Nevertheless, they would provide a counterbalance to the historic trend of migration from regional areas to capital cities and, if combined with other initiatives, could enhance regional centres as places to live and work.

79 Patrick D'Arcy and Linus Gustafsson, *Australia's Productivity Performance and Real Incomes*, Reserve Bank of Australia Bulletin – June Quarter 2012.

80 C Bellet & A Casellas, loc. cit.

9.5.2 HSR tourism links

Tourism is an important industry in Australia, generating \$94 billion in spending and contributing \$34 billion to Australia's gross domestic product in 2011⁸¹. Tourism directly employs more than 500,000 people and is one of Australia's largest export industries, earning 9 per cent of Australia's total export earnings⁸². Tourism plays a key role in regional economies with tourists spending 46 cents of every tourism dollar in regional areas⁸³.

In the year ending 31 March 2012, Australia received 5.5 million international visitors (international visitors aged 15 years and over) who spent 197 million nights in the country⁸⁴. During the same period, over 70 million domestic overnight visitors spent approximately 280 million visitor nights across the states and territories. The main purpose of those visits was holidays (42 per cent), visiting family and friends (34 per cent)

and business (19 per cent). For international and domestic overnight visitors, the main travel destinations were Queensland, NSW and Victoria, accounting for 80 per cent of all international visitors and 79 per cent of all domestic visitors.

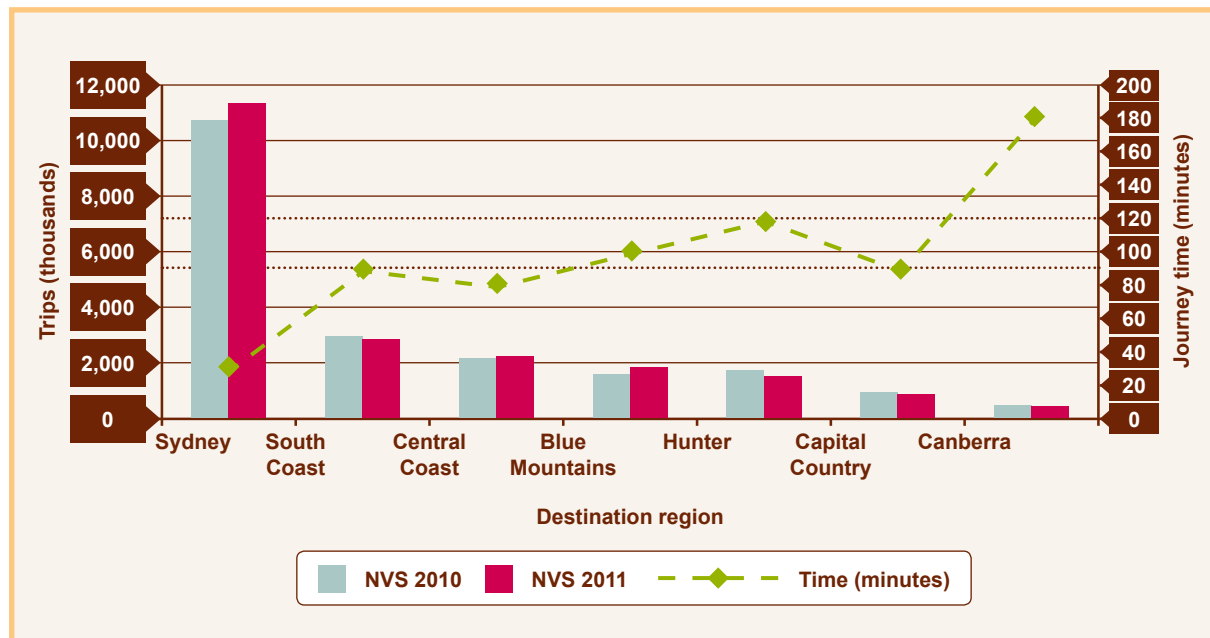
Of all international visitor nights reported in 2012, 79 per cent were spent in a city and 21 per cent were spent in a regional area. By contrast, of all domestic visitor nights, 36 per cent were spent in a city, while 64 per cent were spent in a regional area.

There are two key features of tourism in Australia which HSR has the potential to change:

- International visitors spend almost all their time in the capital cities. Some 90 per cent of international visitor time in Victoria and NSW is spent in Melbourne and Sydney.
- For day visits from the capital cities, there is a clear link between the number of visits and the journey time from the capital city.

These features are illustrated in **Figure 9-7**.

Figure 9-7 International visitor destinations



Source: Australian Government, 2012. NVS is the National Visitor Survey.

81 Australian Bureau of Statistics, loc.cit.

82 Canberra 2011a, op. cit.

83 Tourism Australia, *Tourism 2020 – Whole of government working with industry to achieve Australia's tourism potential*, 2011.

84 Canberra, 2012b, *ibid*.

HSR has the potential to change the distribution of visitor spending. This is because tourists and business travellers who currently spend most of their time in the large metropolitan centres would have greater opportunity to visit nearby regional locations. The increase in accessibility to regional areas could extend tourist stays for several days since they could retain accommodation in the central city and explore outlying areas on day trips. For example, the Mid North Coast of NSW received over 3.1 million domestic overnight visitors in the 2011-2012 period, with a visitor expenditure value of \$1.8 billion. The share of total NSW domestic visitors to the Mid North Coast region was almost 20 per cent. International tourism is significantly lower with around 125,000 visitors, who spent in the order of \$50 million in the region⁸⁵. With the short travel times to this region provided by HSR, it would be possible to attract international visitors from Sydney for day trips, with appropriate marketing, pricing and packaging of tours.

Again, the scale of the change will be highly dependent on responses from within and around the regional centres served by HSR. Proactive centres that have existing attractions and/or generate investment in new facilities would do best. Canberra, with its museums and cultural attractions, would be less than an hour from Sydney with HSR, and might be a significant beneficiary. While it is not expected that this regional redistribution would significantly boost national economic performance, it could have a significant economic impact on regional centres.

9.5.3 Supporting policy issues

HSR could become an important adjunct to, and augment opportunities for, regional development in Australia. It could enhance, but would not necessarily produce, economic development or transform localities served by HSR. If combined with effective land use and regional planning, complementary assets and supportive public policies, it could lead to population and economic growth within regional centres, but much of this growth would come from moving people and jobs from other locations within or immediately outside the region. Productivity increases could result in small increases in aggregate Australian jobs over time, in addition to those associated with the operations and maintenance of HSR.

For towns with strategies for complementary infrastructure, HSR could improve links between major cities and regional communities. HSR could also increase the utilisation of facilities such as regional universities and hospitals by expanding their effective catchments, while at the same time helping to reduce population losses from regional communities to the capital cities. It could also result in a concentration of a particular type of business in non-metropolitan areas (for example, those seeking low cost back office locations, start-up operations and emerging green technology enterprises). Through productivity improvements arising from these changes, HSR could improve the competitiveness of local companies attempting to compete in a global economy.

85 Destination NSW, *Travel to Mid-North Coast Year ended March 2012*, 2012, accessed from <http://archive.tourism.nsw.gov.au/Sites/SiteID6/objLib92/Mid-North-Coast-YE-Mar-12.pdf>.

However, establishing the required combination of policies, strategies and complementary infrastructure would not be straightforward. For regional areas seeking to maximise the opportunities presented by HSR, the local policy environment and general macro-economic conditions would be crucial. There is no generic policy that would work for all locations, and a diversity of responses would be likely to produce better outcomes. A well-placed HSR station combined with complementary assets, land available for development, zoning and planning to encourage new development, possible tax incentives for inward investment and a significant existing employment and population base would create the ideal conditions for beneficial regional development impacts to emerge.

Regional communities without an HSR station are likely to be subject to pressure from nearby centres with HSR. However, they could also benefit from HSR if they were able to develop effective connections between their facilities and the stations. In all cases, the best results would come from intelligent responses based on an informed understanding of a region's strengths and constraints, and of the nature of the likely HSR impacts in each location.

The preliminary environmental Strategic Assessment (SA) undertaken for this study and summarised in **Appendix 5C** examined the urban and regional planning factors associated with the development of the HSR preferred alignment and station locations. From this assessment, five examples emerged as representative of the kinds of urban and regional development settings likely to exist in the HSR corridor that would be affected by the project. Case studies were prepared to highlight the nature of the urban and regional planning and development issues that would emerge; these are summarised in **Table 9-8**.

Table 9-8 Overview of HSR case studies

Location	Characteristics	Assets	Strategic vision
Beaudesert	<ul style="list-style-type: none"> • Growing regional area • Connected with growing Gold Coast 	<ul style="list-style-type: none"> • Mixed agriculture and residential lifestyle area 	<ul style="list-style-type: none"> • Primarily dormitory community for increased expansion of Gold Coast and Brisbane
Coffs Harbour	<ul style="list-style-type: none"> • Regional centre with growing economy • Strong local capabilities 	<ul style="list-style-type: none"> • Attractive location • Growing population • Strong tourism 	<ul style="list-style-type: none"> • Continued balanced growth in housing retail and light manufacturing and office
Lower Hunter Region	<ul style="list-style-type: none"> • Growing population within easy access to Sydney with better transport • Strong economic base with growth in coal and related services 	<ul style="list-style-type: none"> • Natural resources • Expanding university and health sector • Growing national companies located in region that service resources • Strong back office activity already present • Tourism assets in wine and other products and services including water recreation • Lifestyle 	<ul style="list-style-type: none"> • Moving to wider economic base than resources to emphasize lifestyle, education and health • Transport infrastructure investment to facilitate greater accessibility and economic activity
Sydney Central Station	<ul style="list-style-type: none"> • Australia's largest metropolitan area • Central transport interchange for local, metropolitan and regional services • Tourist destination 	<ul style="list-style-type: none"> • Longer term growth forecast for population and employment • Business, convention and tourism trade • New convention and entertainment centre complex 	<ul style="list-style-type: none"> • Focus of future CBD growth for commercial and residential development • Major public transport investments proposed in light rail, suburban rail and bus services
Albury-Wodonga	<ul style="list-style-type: none"> • Centrally located between Sydney & Melbourne • Logistics hub • Growing region 	<ul style="list-style-type: none"> • NBN hub • La Trobe and Charles Sturt Universities • Regional hospital • Industrial land • Lifestyle 	<ul style="list-style-type: none"> • Diversified economic base • More dense cores for cities • Strengthen back office

	Constraints	Opportunities	Regional collaboration
	<ul style="list-style-type: none"> Requires better alignment of transportation in the HSR corridor along with local road and mass transit options 	<ul style="list-style-type: none"> HSR station serves growing population area Co-location of station with other mass transit options such as bus and local rail 	<ul style="list-style-type: none"> Part of sub-regional planning for South East Queensland. Well thought out long-term plan but little connection to HSR
	<ul style="list-style-type: none"> Station will increase day tourists and need for better local transport. 	<ul style="list-style-type: none"> Tourism and lifestyle 	<ul style="list-style-type: none"> State government planning with good local capacity but needs stronger long-term direction
	<ul style="list-style-type: none"> Transportation into and around in the region is overwhelmed by growth Poor internal transit system in communities 	<ul style="list-style-type: none"> Improved transportation with the arrival HSR Tourism enhancements of more visitors for day trip and some overnight stays Lifestyle 	<ul style="list-style-type: none"> Strong regional planning framework that could be built on with HSR as base for regional collaboration and links to other transport including expanded air services to national and international destinations
	<ul style="list-style-type: none"> Physical and funding constraints to much needed transport solutions Heritage and strata title restrictions to urban renewal 	<ul style="list-style-type: none"> Relatively low density around station Several large urban renewal sites are ripe for development Air rights development over railway land Possible residential relief value for metropolitan housing shortfall with improvement transport links 	<ul style="list-style-type: none"> Sydney Metropolitan Development Authority and Landcom transition to UrbanGrowthNSW could provide catalyst to enhance metropolitan strategy
	<ul style="list-style-type: none"> No formal regional planning and collaboration systems 	<ul style="list-style-type: none"> Growing population Strong education and health sectors Logistic hub Good long-term planning strategy for both localities 	<ul style="list-style-type: none"> HSR could add to current direction of cities and region but regional (and cross border) collaboration required

9.6 Integrated regional corridor development concept

The framework needed to implement an effective regional development concept for an HSR system on the east coast of Australia would require the alignment of public policies, programs and capabilities across Australian Government, state/territory government and local government agencies. Overseas experience, case studies and the nature of complementary assets on the east coast indicate that the following considerations would need to be addressed in coordinating a corridor regional development concept for HSR:

- **Alignment with local and regional planning** – HSR stations should be located in a logically determined HSR precinct. The HSR station precinct should be subject to a comprehensive master plan and infrastructure strategy integrating the HSR station at the site, precinct, town and regional planning levels.
- **Market and user-demand research** – thorough market and user-demand research would be required to understand the commercial, social and community opportunities presented by HSR. Investments in physical assets should be matched by complementary marketing and outreach strategies and programs which engage local businesses and stakeholders.
- **Tailored regional development strategies** – regional development opportunities would be unique to and should be tailored for each HSR station location. Regular stakeholder engagement would be required to achieve this objective.
- **Access** – ensuring appropriate local and regional transport networks are available to access HSR stations.
- **Complementary assets** – regional development strategies and programs built around key complementary assets provide the best opportunities for capturing and leveraging HSR's regional development opportunities.

- The most promising complementary assets include:
 - NBN.
 - Higher and technical education.
 - Healthcare and related biomedical research.
 - Tourism.

9.6.1 Regional corridor development framework

Four key tasks would be needed to implement the corridor regional development concept:

- Land acquisition and land use planning.
- Precinct and corridor master planning.
- Regional development projects and stakeholder engagement.
- Complementary HSR projects.

The regional corridor framework is aligned with the proposed governance structure outlined in **Chapter 10**, which puts the case for a new authority (the HSR Development Authority) to develop the HSR system.

Land acquisition and land use planning

The first key task influencing regional corridor development would occur when preferred sites and alignments within the HSR corridor for stations, ancillary infrastructure and the HSR route are agreed between the states, ACT and Australian Government. The HSRDA would then be created to procure the required land. At this point, the HSRDA would take over the HSR planning, preparation and program development roles previously performed by various state and territory government departments. **Chapter 11** contains further detail.

Precinct and corridor master planning

Precinct and corridor master planning in this context refers to two different scales of master planning that would need to be aligned with the HSR corridor. Precinct master planning is broad-scale regional planning undertaken by state planning authorities in conjunction with local councils in regional areas. Examples of regional

86 Queensland Department of Infrastructure and Planning, *South east Queensland Regional Plan 2009-2031*, July 2009.

87 NSW Department of Planning, *Mid North Coast Regional Strategy 2006-2031*, March 2009.

planning include the *South East Queensland Regional Plan*⁸⁶ and the *Mid North Coast Regional Strategy*⁸⁷. These regional plans can encompass many regional centres and multiple local government areas and address a wide range of regional population, employment, environmental, infrastructure and land use issues.

Corridor master planning refers to more detailed metropolitan and urban renewal planning, undertaken by state and ACT agencies such as Places Victoria in Melbourne and the Sydney Metropolitan Development Authority (now UrbanGrowth NSW Development Corporation) in NSW. Queensland, NSW, Victoria and the ACT all have existing regional and metropolitan planning and development agencies that perform similar functions for metropolitan areas and specific urban renewal sites in the major metropolitan centres. As proposed in **Chapter 11**, the corridor master planning task would be carried out by, or closely coordinated with, these agencies.

Regional development projects and stakeholder engagement

International experience discussed previously highlights the need for HSR station precincts and routes to be carefully and thoughtfully integrated within the existing urban and regional fabric of cities and regions within the HSR corridor. International experience shows that the potential commercial development opportunities and urban renewal benefits of an HSR system are generally only realised relatively close to the HSR station, but that the costs of poor planning and execution can extend for some distance within the region and reduce regional opportunities. It is therefore critical that a coordinated approach is pursued to policies, station precinct planning, land use planning and complementary access improvements between the HSRDA and existing state, ACT and local agencies.

It is apparent from the urban and regional planning case studies detailed in **Appendix 5D** and from investigations undertaken in assessing station and corridor options that regional and metropolitan planning agencies in the HSR corridor would need to update their planning strategies to reflect HSR,

and would also need to strengthen their planning and implementation capabilities to take advantage of an HSR system. It would therefore be necessary for the HSRDA to undertake early discussions with the relevant state and territory metropolitan and regional planning and transport agencies if the HSR system is approved for development.

Complementary projects

HSR can assist in economic development improvements in cases where it facilitates the integration and enhanced use of nearby complementary assets such as education, health and telecommunications infrastructure. This does not happen by chance. Local planning and leadership would be needed to achieve positive results.

Tailored projects such as forging new links between hospitals in the regional centre and metropolitan areas, attracting more students to regional campuses and other measures should be pursued.

Therefore, if a decision were made to develop an HSR system, it would be imperative that regional stakeholder organisations take advantage of HSR to:

- Develop integrated land use and economic development plans for the portion of the corridor in their region.
- Work with local governments and the private sector to maximise HSR benefits to the region.
- Act as a continuing reference group for HSR issues for regional communities.

The concept embedded in this approach is to tailor the current economic development instruments and agencies so they can integrate HSR into their programming, to maximise resources and spread benefits throughout the regions. Stakeholder engagement at the local level across the corridors should be aimed at finding synergies for communities along the route where opportunities and resources can be matched.

9.7 Conclusion

HSR can have both positive and negative impacts on the economic and service relationships between small, intermediate and large cities. The presence of an HSR station does not guarantee greater local economic development and, should positive impacts arise, it can take ten to 15 years for them to become fully realised.

A critical issue is the extent to which an HSR system causes development that would not otherwise have happened, or enhances development that is already occurring. On this important point the evidence is not always clear.

Based upon international experience and local assessments, HSR has the potential to improve the productivity of the Australian economy at the national, regional and metropolitan levels. However, changes will also result in significant permanent relocations of people or jobs both within and outside the corridor. While final outcomes for specific regions are unclear, it is expected that the benefits of HSR would be more prevalent in the major cities. Regions without an HSR station are unlikely to benefit significantly from the HSR network .

HSR could conceptually enhance regional centres as alternatives to metropolitan centres and stem the steady drift of people and jobs to the more congested and expensive capital cities. However the history of the impact of transport improvement on Australian towns is that they concentrate activity in the larger centres and create commuter towns lacking in higher level services. Without concerted efforts to the contrary, this is also a likely outcome of the introduction of HSR.

When combined with NBN and other complementary assets, HSR offers the prospect of enhancing access for regional residents to improved health, educational, cultural and sporting activities. This could make regional areas more attractive for living and/or working. In addition, there is the prospect of increased back office operations and for some start-up, knowledge-based businesses in regional areas to take advantage of lower cost housing, labour and facilities. International tourists

and visitors could also be enticed to spend more dollars in regional areas, as the areas would be more accessible. However, these benefits cannot occur without careful planning and proactive public and private investment.

International experience is mixed – there are examples of regional success but others where little difference or even declines are observed. Integrating complementary assets with HSR could have positive regional impacts but these have been associated with pre-existing complementary assets and station locations complementary to the existing regional CBDs. In Australia, it would appear that the most successful regions are likely to be those with existing high end education, health and technological sectors.

An investment of the magnitude and nature of HSR can have unintended consequences and impacts, such as causing small regional cities to lose jobs and residents to nearby regional centres with HSR stations. These negative impacts would need to be controlled and mitigated through effective regional development policies, early and careful planning to position local businesses for change, and appropriate human and capital investment in complementary assets.

HSR is not a panacea for regional development. To gain positive and sustained benefits, regional communities along the corridors would need to follow deliberate strategies. Existing strategies are not equipped for HSR, but they could be redesigned with a clearer focus, increased capacities and a high level of cooperation between Australian, state and local government agencies.

A blurred background image of a beach scene. The top half shows a blue sky with light clouds. Below the sky is a dark, out-of-focus tree. The bottom half of the image shows a sandy beach with gentle waves washing onto the shore, creating a soft, brownish-tan color palette.

10

The background of the image consists of several diagonal stripes in various shades of teal, ranging from light to dark, creating a dynamic, geometric pattern. The stripes are parallel and run from the top-left towards the bottom-right.

10

Governance and institutional framework for HSR

10.1 Introduction

This chapter sets out the preferred governance and institutional framework for the planning, procurement, construction, operation and regulation of a future HSR program.

The governance and institutional framework describes the roles of the various formal institutions, authorities or agencies that would be involved in a future HSR program. Proper governance, when combined with the relevant laws and regulations, will ensure that, if adopted, the HSR program is subject to proper public oversight, is effectively and efficiently delivered, and meets its objectives.

The specific governance arrangements for HSR would need to have regard to the multi-jurisdictional nature of a future HSR program and the aims and objectives of different governments

in supporting its development. For instance, a future HSR program would need to be planned, developed and delivered in a manner that supported its integration with other transport networks and maximised its contribution to Australia's transport capacity and connectivity. This would require close collaboration between jurisdictions and the effective coordination of future transport planning and investment at all levels of government to optimise the benefits of a potential investment in HSR.

The ACT and state governments, as well as the relevant local governments, would have particular interest in how their CBD station precincts were developed (e.g. to align with land use plans and other local development plans) and would also have specific responsibilities with respect to delivery (e.g. investment in necessary complementary infrastructure).

Determining appropriate governance and institutional arrangements requires consideration of the following two issues:

- Appropriate roles for the public and private sectors in the development, delivery and operation of a future HSR program.
- Options for the stewardship of public entities involved in the development and delivery of HSR and the roles and responsibilities of each government jurisdiction.

In addressing these questions, the following key conclusions have been reached:

- Both the public and private sectors would play a significant role in the planning and implementation of a future HSR program.
 - The Australian Government, ACT Government and the relevant state governments would need to have a central role in the planning and development of the HSR system, including securing the necessary development approvals. As public funding would dominate the financial model, the governments would be the owners of the system and would assume the key role in the specification and procurement of system infrastructure, the allocation of its capacity for transport services and the minimum service requirements. The public sector roles would be executed through an HSR delivery authority, described below.
 - The private sector would be responsible for building the HSR infrastructure under appropriate contracts. Under competitively tendered concession arrangements, the private sector would deliver train services to the public, control the movement of trains and maintain the infrastructure.
- A publicly owned HSR Development Authority (HSRDA) would be created to develop, procure and integrate components of the HSR system with other transport networks, including procuring and owning the required land.

- A single coordinating authority would be required to effectively and efficiently progress the detailed planning required to develop and procure an HSR system.
- The HSRDA would evolve into an HSR development and management authority in the operational phase, and would prepare and manage train operation concessions.
- It is anticipated that the ACT and the states would each establish a territory/state level HSRDA or similar body to coordinate and manage station developments, including the development of the station precincts.
 - A layered approach to program governance would be adopted, with ACT/state-led agencies responsible for HSR station developments, subject to national HSRDA oversight.

The issues are explored further in the following sections.

10.2 Role of the public and private sectors in a future HSR program

Role allocation and risk sharing between the public and private sectors are important considerations in the promotion, planning, financing, land reservation, land acquisition, design, infrastructure construction, transport service provision and other elements of an HSR program. Misallocation of risks and responsibilities between the public and private sectors could undermine the viability of the HSR program, add cost and delay, and/or compromise the transport objectives of a future HSR program.

In terms of the roles of the public and private sectors in a future HSR program in Australia, the study has concluded:

- The size and complexity of an HSR program would be such that governments would need to play the central role in its development, particularly in providing the necessary political mandate and support, but also by underwriting a substantial proportion of the infrastructure funding.

- Governments would own the HSR infrastructure because of the large public funding contribution that would be required.
- As infrastructure owners, the relevant governments would also need to have direct involvement and oversight of program development and delivery, and retain an ongoing role in the stewardship of the HSR sector post-construction, to ensure that publicly funded assets were effectively procured and utilised, and met their objectives.

With an initial capital cost in excess of \$100 billion, an HSR program would be one of the largest infrastructure programs ever undertaken in Australia. Its size would challenge the resources of the supplier industry, both domestically and globally, with only a limited number of organisations having the financial capacity and depth of skills and resources available to compete for very large construction or supply contracts.

To achieve value for money, governments would need to carefully package and stage the procurement to attract competitive bids for each procurement package. Governments would also need to retain some risk around integration of the components of multiple packages (as opposed to outsourcing the risk of integrating multiple system components to a single turnkey contractor), but these risks could be mitigated through rigorous technical oversight.

Governments would retain an ongoing role in the stewardship of the HSR sector post construction, to ensure the objectives and economic benefits of the HSR program were achieved. This role would involve providing oversight of HSR service delivery against agreed price and service quality metrics, while being careful to avoid constraining market agility and innovation. Governments would also be responsible for safety and environmental compliance. Further detail of the governments' role once HSR is operational is provided in **section 10.3.4**.

The private sector would be closely involved in a broad range of roles:

- Design and construction of components of the HSR infrastructure, including development of station precincts in partnership with the relevant governments.
- Supply of rolling stock (train sets) and the signalling and communications systems.
- Control and operation of HSR trains to deliver high standard transport services to the public.
- Maintenance of the HSR system.

Development of HSR stations, and associated commercial opportunities, would offer an opportunity for private finance. A public-private partnership (PPP) model is envisaged for greenfield station developments, with the private sector partnering with the relevant ACT or state government for CBD station developments.

Internationally, the private sector has a proven track record of delivering HSR rolling stock and other componentry through established global suppliers¹. Procurement would be managed by governments through a competitive tender.

HSR train services would be contracted to a private sector operator through one or more concession arrangements. The concession holder(s) would operate the train services, control the movement of trains and maintain the HSR system.

Further detail on the preferred delivery model for HSR in Australia and associated procurement and packaging options is provided in **Chapter 12**.

¹ In Europe, Alstom, Bombardier, Siemens and Talgo; and in Japan, Kawasaki, Mitsubishi and Hitachi are all involved in the manufacture of HSR rolling stock and/or systems.

10.3 Role of governments in a future HSR program

The role of governments would be to implement the necessary arrangements to protect the public interest across the life of the program and to ensure the program objectives are met. The coordination of each jurisdiction’s legal obligations, land acquisition powers and planning responsibilities in respect of HSR program planning, development and procurement, would also need to be considered to agree on a suitable implementation approach for a future HSR program.

The necessary legislative or policy initiatives for the successful implementation of an HSR program, and the possible integration with the corridor regional development approach, are other important considerations for governments. Complementary regional development policies would be highly desirable to ensure the benefits from a large public investment in HSR are maximised.

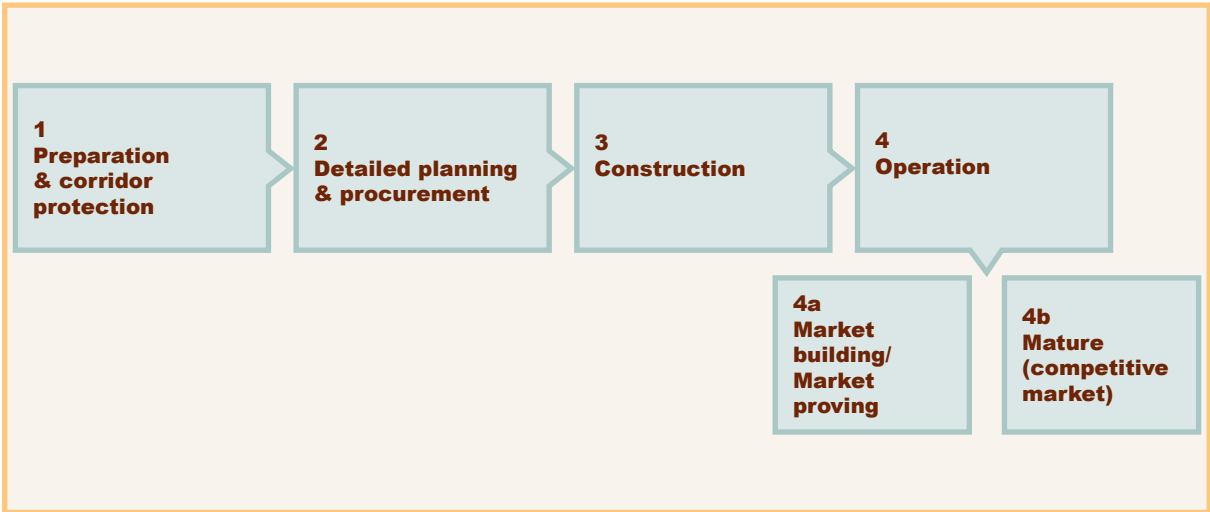
If adopted, a future HSR program would be developed in discrete phases, starting with initial feasibility studies and investigations, leading on to construction and operation of the HSR system. Four separate phases can be identified, as illustrated in **Figure 10-1**:

- 1. Preparation and corridor protection.
- 2. Detailed planning and procurement.
- 3. Construction.
- 4. Operation.

Each of the four phases would overlap as the HSR program is progressively implemented across different geographic corridors.

A distinction can also usefully be made between the early market building/market proving part of the operation phase and a subsequent period when the market becomes more mature. Governments are likely to play a more significant role when the market is relatively immature to ensure the objectives of the future HSR program are achieved.

Figure 10-1 Four phases of the HSR program



The optimal governance arrangements, and the potential roles and responsibilities of each government jurisdiction, would evolve over the life of a future HSR program and would vary across each of the four phases. The role of governments in each phase is discussed in turn below.

10.3.1 Phase 1: Preparation and corridor protection

The first phase in a future HSR program, the preparation and corridor protection phase, would provide the necessary policy foundation for the procurement, construction and operation of HSR. This phase would require alignment between the Australian, ACT and state governments on the program objectives. It would also require agreement on the mechanisms and timeframes for resolving issues, commitments to protect relevant corridors and assets, and the delivery of enabling regulation or legislation.

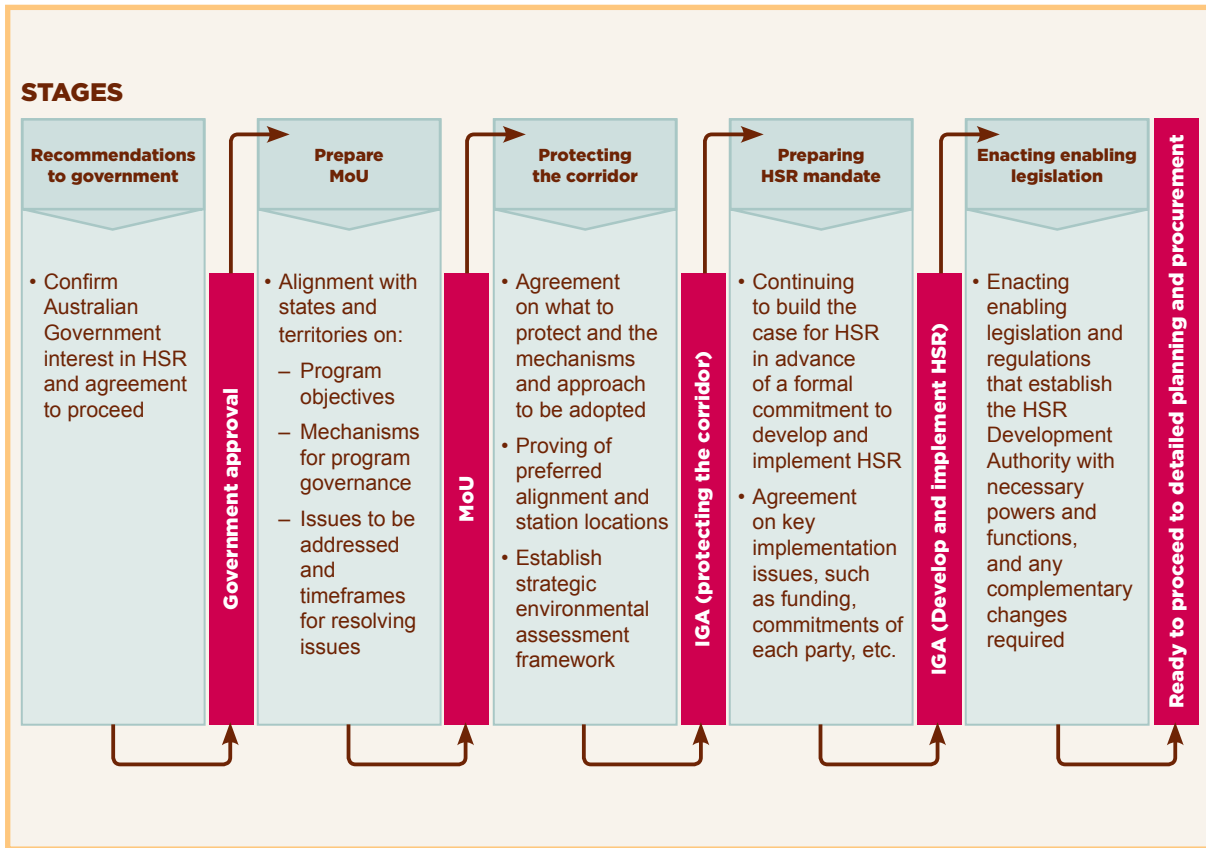
The proposed model for pursuing multi-jurisdictional agreements of the sort needed to support the HSR program is to adopt a 'gated approach' using a series of formal agreements. Each formal agreement in the process would need to be in place before progressing to the next stage, ensuring alignment of the governments at critical milestones. Five stages are contemplated in this preparation and corridor protection phase of a future HSR program, as illustrated in **Figure 10-2**.

The preparatory steps necessary to reach an agreement to implement an HSR program could be facilitated through extant multi-jurisdictional committees of the Council of Australian Governments (COAG), such as the Standing Committee on Transport Infrastructure (SCOTI) and the Transport and Infrastructure Senior Officials' Committee (TISOC). The involvement of these national committees is appropriate, as it reflects the fact that a future HSR program would account for a large portion of the national transport budget.

Five preparatory gates are envisaged before a decision to proceed to the second phase of the HSR program:

1. Confirmation of the Australian Government's interest in continuing the necessary preparatory works to inform a formal Ministerial decision to proceed.
2. A memorandum of understanding (MoU) between the Australian, ACT and state governments that sets out the road map to establish at least two formal inter-governmental agreements (IGAs) (described in the following two points).
3. An IGA to provide the policy mandate for the protection of an HSR corridor.
4. A second IGA to provide the policy mandate for the implementation of the first stage of an HSR program.
5. Legislation to provide the legal framework for the implementation of the HSR program.

Figure 10-2 Preparation and protection stage gates



The activities to be undertaken in each stage are summarised below. Subsequent IGAs would be developed to provide the mandate to implement additional stages of the HSR program.

Stage 1: Australian governments’ decision to proceed

At the conclusion of this study, recommendations to the Australian Government would be prepared by the Federal Department of Infrastructure and Transport.

The next step is to confirm the Australian Government’s interest in continuing the necessary preparatory works to inform a formal Ministerial decision to proceed. Approval may also be sought for funding of site surveys and additional environmental and engineering assessments.

Stage 2: MoU between the Australian, ACT and relevant state governments

An IGA would be required to formally commit to protection of an HSR corridor on the east coast of Australia. In advance of the IGA, an MoU would be established between the relevant governments to formalise the engagement on the HSR program and to set out the responsibilities of the parties, the process to be followed and the timelines for resolving issues.

The Australian Government would need to undertake the following planning activities prior to signing an MoU:

- Compile a summary of investigations completed and gap analysis of remaining tasks for distribution to the states and the ACT.
- Formulate a proposition to take to the ACT, Queensland, NSW and Victoria with respect to the conduct of a future HSR program.

The MoU would also establish a framework for public consultation in the lead up to a formal IGA, and would include the role of each jurisdiction, and timeframes and mechanisms for capturing and addressing issues that emerge.

Stage 3: IGA to provide a policy mandate to protect the HSR corridor

Corridor protection is the reservation of land for subsequent use in preparation for, and construction of, a major transport program. It includes facilitation of access through adjacent land during the construction phase. The aim of corridor protection is to confirm a preferred corridor (with local adaptations as necessary) and to protect future use of the corridor by rezoning, resuming, purchasing or continuing to hold land within the corridor².

Although legislative provisions and policies for corridor planning and protection vary between the various states and territories in Australia, mechanisms already exist to establish the necessary corridor protections for HSR. Details on existing legislative provisions in each jurisdiction are presented in **Appendix 7A**.

Given the long-term nature of the program and the amount of public funding needed, it would be important to ensure that the process of corridor protection was efficient and facilitated the program objectives. During this stage, the relevant governments would begin to work together on the development of HSR, with particular focus on five key issues:

1. Confirming the preferred sites and alignment for the program, including station locations and other critical infrastructure.
2. Proving those sites to be suitable through further technical investigations as required.
3. Agreeing on a ‘whole-of-government’ approach to assessing environmental impacts and the relevant conditions for proceeding with the HSR program. This may include requirements for program-specific legislation to standardise statutory planning regulations, including environmental assessments, at each level of government along the corridor.
4. Agreeing on what to protect in advance of a formal mandate to proceed with the development of the preferred HSR system.
5. Agreeing on the mechanism by which strategic sites (such as stations locations) would be protected and the responsibilities of the parties for effecting the protection.

1. Confirmation of preferred sites and alignment

While this study has had a particular focus on developing an optimal HSR system and ensuring that the alignment and station locations would optimise the performance of the system, it is entirely possible that further refinements to the HSR alignments may be made. For example, Central station in Sydney was selected over Homebush as the terminating HSR station. There may, however, be some merit in protecting options for Homebush in addition to Central, as an HSR station at Homebush could open up a number of opportunities to connect with fast commuter services from western Sydney. Although any future station at Homebush would likely be underground, some refinement of the final alignment may be necessary to support this option. These issues would need to be resolved with the states and the ACT before a final agreement could be reached on what corridors and sites to protect.

2. Technical proving of sites

Some further technical investigations, such as detailed geological surveys, site inspections and detailed environmental and engineering assessments, would be required before the preferred alignment could be confirmed. Similarly, community consultation would be undertaken in respect of the proposed alignment, with feedback factored into the consideration of the final alignment. The appropriate scope and mechanisms for undertaking the community consultation would be agreed (e.g. ‘town hall’ type discussions, web-based feedback channels) and whether consultation would be integrated with other planning activities such as the preparation of a strategic environmental assessment.

2 Refer to the *Commonwealth Land Acquisition Act 1989 Part V, Div 1, 22 (4)*.

3. 'Whole of government' approach to environmental impact assessment

A strategic environmental assessment framework is proposed and outlined in **Appendix 5C**. If adopted, actions taken in accordance with the agreed HSR program would not require separate referral and assessment under the environmental impact assessment legislation of each jurisdiction. In this phase of a future HSR program, conditions for the overall program approvals would be set for consideration by the relevant governments. Legislative requirements within each jurisdiction would be assessed as part of the strategic assessment process. The strategic assessment would bring together the outcomes of further environmental and engineering investigations and other stakeholder input (such as any refinements to the alignment to support ACT or state government objectives) in support of the preferred HSR alignment and station locations. Key findings and recommended management measures would be compiled into a draft strategic assessment document for public review.

4. Agreement on what to protect

The ultimate agreement on what to protect would include consideration of land reservations, policies in respect of adjacent land use, station locations and station classifications, and details of complementary infrastructure and access.

5. Agreement on how to protect the corridor

Agreement on how to protect the corridor would include alignment of the mechanisms for protecting each system component, and of the timing and funding arrangements for protection activity. Land resumption, purchase, holding or 'sheltering from development' decisions should include the following considerations:

- Rezoning land and restricting land use within and adjacent to the corridor to preserve the land for the future.
- Assessing the limited circumstances and conditions in which land would be purchased in advance of a commitment to HSR construction³.

Priority should be given to protecting the key urban station locations and other urban and peri-urban sections of the corridor where the alignment emerges from a tunnel, as these sites may become more difficult to acquire or use over time, due to encroaching urban development, if not protected.

As the first IGA provides the policy mandate required to protect a future HSR corridor, it should include a clear articulation of the public policy objectives to be achieved from a future HSR program. This should also include, in land use and regional development policies relevant to the preferred HSR system, an undertaking to cooperate between jurisdictions.

As well as a clear definition of the preferred HSR system and the corridor, alignments and station locations to be protected, the responsibilities and obligations of each jurisdiction for protecting the preferred station sites and alignments would be agreed, together with the timelines to be followed and the principles by which any public resources required would be allocated between them. General principles that would apply if variation to the route becomes necessary would also be agreed.

Stage 4: IGA to develop and implement a future HSR program

The fourth stage is to work towards a second IGA that commits the jurisdictions to develop and implement a stage or stages of a future HSR program. The period between the first IGA, to establish and protect HSR corridors, and the second IGA, to commit to develop and implement an HSR program, may be relatively short (i.e. up to two years) or may be many years apart.

³ For instance, where the proposed alignment creates a difficulty for the existing land owner to sell the land for a purpose that is compatible with a future HSR system and there is a genuine hardship case requiring some government intervention.

The key activities in this stage include:

- Implementing the requirements of the IGA on corridor protection.
- Continuing to strengthen the conditions for a successful HSR in advance of a formal commitment to proceed, including agreed supportive integrated transport, land use and regional development policies.
- Reaching agreement on key implementation issues such as funding and the commitments of each party.

The second IGA to develop and implement an HSR program would align the governments around the public policy objectives to be served by HSR, together with the commercial performance aims of the HSR program. For example, there are tradeoffs to be made in respect of infrastructure pricing principles, such as whether to seek to maximise financial cost recovery of infrastructure capital, or whether to price infrastructure to promote the ridership and economic benefits of HSR. Such principles should be clearly understood and agreed by the participating governments before the implementation stage.

Similarly, the IGA would also outline the minimum technical performance capability the system is intended to offer (such as maximum speeds), the agreed station stops and minimum service frequency at each station. Although the operator should have sufficient flexibility to establish optimum service patterns to meet market needs and competitive circumstances, it would be prudent for the governments to agree and clearly set out minimum service and performance expectations of the HSR system, given the large public funding commitment required.

The governments should also agree on the broad principles by which the infrastructure and train operator(s) would be procured. Although the procurement strategy would be finalised in the detailed planning and procurement phase of a future HSR program, the governments should agree on the broad principles to provide guidance to the implementing authority. This would include the anticipated principles of track capacity allocation between products of different service

types, in particular between the HSR inter-capital express and regional services, and state-sponsored fast commuter services.

The overall public governance structure to be instituted, and the organisation that would be responsible for the delivery of the HSR program on behalf of the governments (i.e. the establishment of the HSRDA discussed in **section 10.3.2**), would be agreed at this stage. An undertaking from the governments would be required to implement any enabling legislation to vest the necessary powers in that organisation and, where needed, to implement other aspects of the HSR program (e.g. to support the ongoing aspects of the strategic environmental assessment process).

Similarly, the role of each jurisdiction in the development of the preferred HSR system, including the potential for state and ACT-led station developments, would also be agreed, as would the funding commitments from each government to support the HSR program. The IGA would also confirm the agreed first route stage for construction with an anticipated earliest decision date for final commitment to its implementation.

The study found that there is merit in establishing a set of complementary and integrated transport, land use and regional development policies to capture the potential regional development benefits of HSR. Such policies have the potential to shape where people choose to work and live, and would need to be integrated with other broader government policies on regional development. Further detail has been provided in **Chapter 9**.

It would be premature to establish specific governance arrangements to facilitate the development and implementation of appropriate supporting policies until there is a commitment to construct an HSR system. Without this commitment, any initiatives to facilitate complementary land use and development policies would lack legitimacy and timelines would remain uncertain. Nevertheless, as part of the work leading up to the IGA to deliver that commitment, there would be an opportunity for the jurisdictions to reach agreement on the supporting development

policies. Although this agreement would not be essential to realise the transport objectives of HSR, an effective and consistent policy approach would be desirable to give specific policy form to the integrated regional development corridor concept. The agreed policy initiatives, or at least the guiding principles, could then be included in this second IGA.

Stage 5: Enacting enabling legislation

Following the agreement to implement an HSR program, enabling legislation would be enacted. The legislation would formally establish the public entities required to develop and deliver the HSR program, with appropriate functions and powers to deliver their objectives. It would also commit the necessary funding, as agreed between the jurisdictions, to allow the entities to establish contracts to further develop and procure the system.

The introduction of Commonwealth legislation and complementary state and territory government program-specific legislation would help to harmonise an approach to the large volume of planning regulations the program would likely face. It is not anticipated that program-specific legislation would be required prior to a formal commitment to implement an HSR system (that is, not before the second IGA), since the activities required to protect the HSR corridor can be accommodated within the existing legislative framework of the jurisdictions.

10.3.2 Phase 2: Detailed planning and procurement

The second phase of a future HSR program, the detailed planning and procurement phase, would involve completing all of the detailed planning work required before procurement could begin, and then undertaking the procurement. Details of the proposed approach to procurement are outlined in **Chapter 11**.

Once a mandate existed to implement the preferred HSR system on the east coast of Australia, a publicly owned HSRDA would be created to develop, procure and integrate the HSR system, including procuring and owning the required land. A single coordinating authority would be required to effectively and efficiently progress the detailed planning required to develop and procure an HSR system. The HSRDA would evolve into an HSR development and management authority in the operational phase and would prepare for and manage train operation concessions.

The HSRDA could be wholly owned by the Australian Government or jointly by the Australian, ACT and relevant state governments⁴.

The HSRDA would coordinate all aspects of the HSR program as it progressed through detailed preparation and procurement and into construction. The authority would need to be staffed by a team with professional infrastructure development management experience, including international expertise, and would not be established until there was a clear commitment and mandate to build a first stage of the preferred HSR system. The HSRDA would take over the planning, preparation and program development roles performed up to that point by Australian, ACT and state government departments.

The introduction of legislation would establish the HSRDA with all of the necessary powers and functions required. It would set out the constitution, objectives, powers and responsibilities of the HSRDA and agreed funding arrangements. The HSRDA would be the primary public entity responsible for implementation of the HSR program over the final three phases.

⁴ As an example, the AustralAsia Railway Corporation was established to develop and procure the Alice Springs to Darwin railway and was jointly owned by the South Australian and Northern Territory Governments.

In the detailed planning and procurement phase, the HSRDA would be responsible for finalising the system specification and scope of the approved HSR stage. It would also finalise all necessary approvals and proceed to procure necessary land and strategic sites and assets.

The HSRDA would also update and finalise the procurement and packaging strategy for the HSR system components and prepare high level designs and technical performance specifications in sufficient detail to draw up the specific design and construct (D&C) and other contracts to be put to the market.

Stations

The ACT and state governments would be expected to take a leading interest in developing HSR station precincts, particularly in respect of the CBD stations. For instance, Central station is a primary hub for Sydney's existing transport network, and its redevelopment to accommodate HSR could impose on other transport operations, including potentially major disruptions during construction. It could therefore be anticipated that the NSW Government would expect to take a lead role in the redevelopment of Central station to ensure that the HSR station was integrated with other complementary developments, such as suburban rail and light rail feeder services, buses and taxis.

It is therefore anticipated that NSW would establish a NSW HSRDA, or similar body, to coordinate and manage developments in the entire Central station precinct, including the development of the HSR station at Central. Similar arrangements are anticipated for the other states in respect of their CBD station developments. The peripheral and regional stations could be managed directly by the HSRDA as greenfield station developments, where appropriate, or included in the scope of the state development authorities.

A layered approach to program governance would be adopted, with ACT/state-led agencies responsible for HSR station developments subject to oversight from the Australian/joint HSRDA.

The Australian/joint HSRDA would provide the overall policy and technical framework for development of the integrated HSR system, and the ACT or state HSRDA would be obliged to comply with design specifications in respect of the station redevelopment, including HSR design capacity, enabling technology and systems. The requirements of the integrated HSR system would take precedence over local design considerations. Notwithstanding the central oversight, there would still be opportunities for strong local input into station design.

There would likely be a need for effective remedies if program timelines for stations were not met (i.e. if delays in respect of station redevelopment had the potential to delay the HSR program). It may be prudent for enabling legislation to require a high degree of transparency around any HSR-related activities led by a state or territory agency, with specific obligations and reporting requirements, and perhaps also step-in rights for the national HSRDA, should any state or territory activities put the HSR program schedule and/or budget at risk. This would be necessary to allow the HSRDA to properly manage risk and to effectively coordinate the overall program.

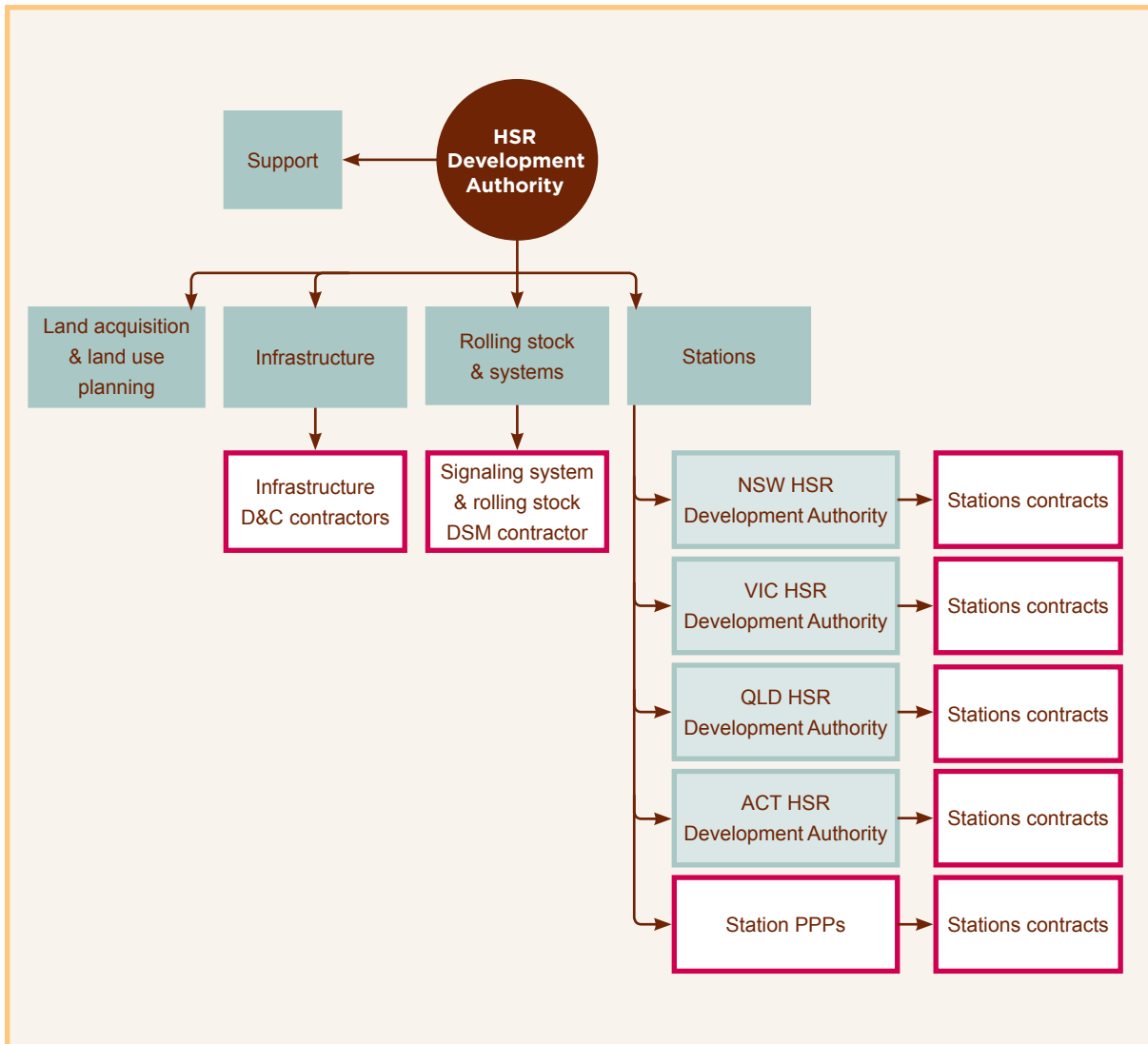
The HSRDA and the ACT and state governments might choose to collaborate on value capture initiatives, such as commercial exploitation of retail space in and around the station precincts and more broadly. The benefits of those initiatives may be directed to the HSR program as a future revenue stream with details to be agreed as part of the overall financial and funding framework.

The national HSRDA could be structured into four core divisions, each with responsibility for undertaking the detailed planning required in advance of formal procurement:

- Land acquisition and land use planning.
- Infrastructure.
- Rolling stock and systems.
- Stations.

A support division would provide commercial and contractual support in addition to legal, finance and other corporate services. An example of a possible HSRDA organisational model is presented in **Figure 10-3**.

Figure 10-3 HSRDA organisational model (detailed planning and procurement phase)



Safety

Safety regulation would be administered through the National Rail Safety Regulator. Prior to construction, appropriate technical and design standards for HSR based on proven international practice would be established, and validation and verification procedures developed to ensure that actual construction and procurement were consistent with the standards. The standards would be held by the HSRDA; the National Rail Safety Regulator’s role would commence during the

development of concept design, and would be to ensure that the systems, processes and procedures were in place to deliver and operate the HSR system safely. This role would continue through the detailed design phase to operations. Prior to commencing operations, the HSR rail operator would need to establish an appropriate safety management system and satisfy the regulator it had the appropriate safety expertise and systems in place to commence operations.

Funding

There are a number of options for funding the HSRDA. Traditionally, the Australian Government has sought to deliver major nation building infrastructure projects either through the states and territories or, where it is to take the lead role, through a governance structure that is financially and legally separate from government, but where the government maintains (at least initially) a controlling ownership interest.

The Australian Government's financial reporting framework classifies publicly controlled entities into three sectors: the General Government Sector (GGS), Public Financial Corporations (PFC) sector and Public Non-financial Corporations (PNFC) sector. The sector to which an entity is assigned has a significant bearing on how any government funding is reported. The focus of the federal budget is the GGS.

While the terms on-budget and off-budget are to be avoided, the classification of an entity as belonging to the GGS, rather than the PFC or PNFC, has a significant impact on both the timing and potential magnitude of any budgetary impacts⁵.

From a budgetary perspective, there are four options for governments to fund the future HSR program, although ultimately, the ability to access these options will be determined by the underlying commerciality and profitability of the program⁶.

These options are:

1. Direct budget funding.
2. Investment in a separate corporation with legal responsibility and accountability for the HSR program.
3. Financing through loan or similar arrangements.
4. A combination of these.

Direct funding

Direct capital grant funding may be provided for construction, either through state and territory payments and/or through Commonwealth Own Purpose Payments. This is the most likely funding mechanism if the viability of the future HSR program is such that the Australian Government is unlikely to recover its costs.

Investment in an HSR specific vehicle

The second option would be to provide an equity cash injection into an HSR vehicle in exchange for an entitlement to future profit. Provided the vehicle was part of the PNFC, any cash transferred could be offset by a corresponding asset (an investment) at the GGS level, and would therefore not have a fiscal impact for the GGS. The NBN Co provides a recent example of such an arrangement. From a budgetary and reporting perspective, the benefits of this arrangement are that the cost to the budget would not be fully reflected upfront (i.e. during the construction phase), since only the incremental cost to the budget would be shown (e.g. only interest and equity payments, rather than the full construction cost). The classification of the HSR vehicle as part of the PNFC would be consistent with the classification of most publicly owned rail infrastructure providers, both in Australia and internationally.

5 Refer for example, the Parliamentary Library Background Note titled *'The national broadband network and the federal government budget statements'*, dated 13 January 2012.

6 There is also the possibility that the Australian Government and relevant state/territory governments may agree direct state/ACT government funding.

For this structure to apply, the future HSR program would need to be established under a separate legal and financial entity; the entity would need to be a market operator; and there would need to be a reasonable expectation that the initial investment would be recovered. The financial assessment indicates that a future HSR program would make a small positive return on investment in real terms, and so there would appear to be an arguable position for the HSR vehicle to be classified as a PNFC.

Loan finance

A third option would be to provide loan finance to an HSR vehicle, with associated repayment terms, covenants and conditions. Under this option, governments would not take an ownership interest; rather, the funding would be provided under contractual arrangements. Similar to an equity investment, the provision of loan funding does not impact upon underlying cash and fiscal balance (although any concessionality in the loan would be recognised). For a loan arrangement, there would have to be a contractual requirement for the HSR vehicle to repay the funds with set repayment arrangements. Furthermore, there would have to be a reasonable expectation that the vehicle would be able to meet its repayments as and when they fell due. This would most likely be fulfilled through a repayment regime that drew on revenue collected from the HSR, similar to the arrangements in place on various toll roads in Australia. If not, the funding would likely be classified as a grant. To the extent that any loan is provided on concessional terms (e.g. zero interest loans), the full impact of the concessionality (when compared to a market rate of interest) would be recognised upfront in government accounts, which would then be unwound over the life of the loan.

Combination of funding options

A combination of the above options may also apply, either through the provision of more than one source of funding (e.g. investment funding and direct grant or subsidy funding) or by disaggregating the future HSR program into segments or entities that are separately funded through alternative sources.

The preferred approach is to establish the HSRDA as a PNFC, and based on the analysis outlined above, there is an argument for such classification (given that it is expected to produce a small real return and that this treatment is consistent with other jurisdictions). This would allow the Australian Government to commit agreed funding in the budget cycle and for the HSRDA to retain flexibility to spend the funds across budget years linked to the program milestones. Funding would be provided from the Australian Government as an equity injection to the HSRDA.

As the forecast financial return is marginally positive at this stage, there is a risk that revisions to the financial forecasts during subsequent reviews of the business case may result in the future HSR program not satisfying all of the tests to be classified as a PNFC, which would limit the financing flexibility of the HSRDA⁷.

⁷ In particular the ‘market producer’ test that the entity must produce goods or services for the market and be a potential source of profit or gain to their owners.

10.3.3 Phase 3: Construction

The construction phase would incorporate the construction and delivery of the preferred HSR system and would be expected to take at least seven years to complete the line between Sydney and Melbourne (as set out in the draft implementation plan in **Chapter 12**). Over this period, the HSRDA would be responsible for:

- Oversight of the various contractors.
- Independent verification and validation of system designs and progress against milestones.
- Coordination with the relevant government authorities.
- Integration of HSR procurement packages and system components.
- Specification and procurement of the rolling stock.
- Preparation of train operations and maintenance concession agreement(s) and procurement of the concessionaire(s).
- Reporting to the responsible ministers and parliament.

The HSRDA organisational model would largely remain the same as the model established for the detailed planning and procurement phase, but would require institutional strengthening in regard to drawing up the train operating concessions.

It is expected that the train operations and maintenance concessionaire would be in place at least 18 months in advance of the date of commencement of operations, to allow time to hire and train a workforce, to establish operational systems including a safety management system, and to obtain all necessary approvals and licences to operate. Compliance with existing environmental legislation and regulatory controls would be included as a condition of contract for construction contractors and would similarly form part of the concession agreement with a train operating company.

10.3.4 Phase 4: Operation

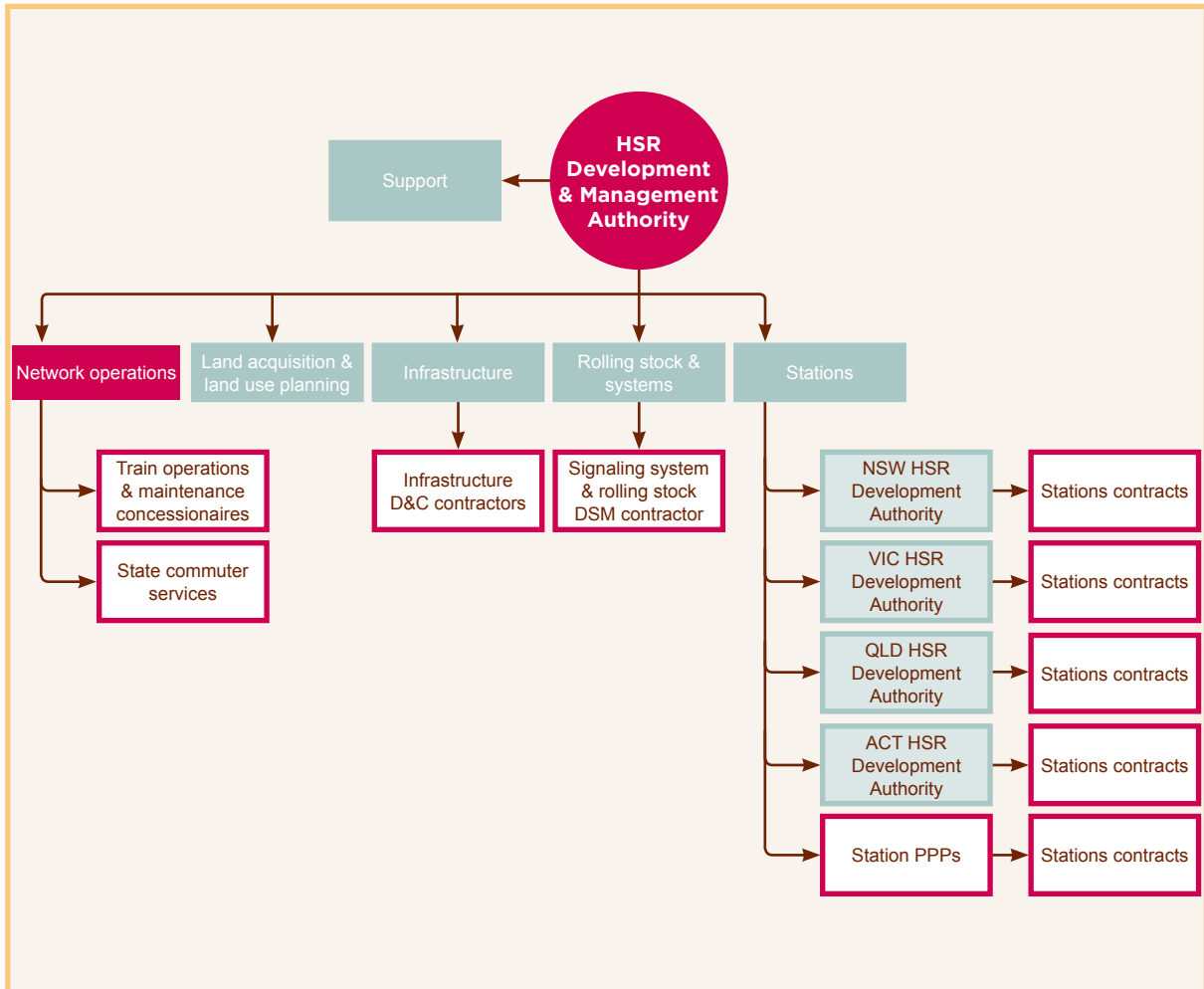
The operation phase would see the commencement of HSR operations, with the train operations and maintenance concessionaire taking operational control of the preferred HSR system (including train control and infrastructure maintenance functions) and providing transport services. The operations phase would also involve the creation of connections with existing transport services in each jurisdiction and, if desired, a regime for the states to run fast commuter services on those train paths not required for HSR inter-capital express and regional services.

The HSRDA would evolve into the HSR development and management authority (HSRDMA) to take on responsibility for the oversight of train operations and maintenance concession contracts, although initially it would also continue to manage the construction of the remaining stages of the HSR program.

The skills and expertise required to manage concession contracts would be different from those required to oversee construction and systems procurement contracts and it would be necessary for the HSRDMA to bring in additional skills. For instance, effectively managing concession contracts, including the associated performance regime, requires an understanding of how rail operations work, the key performance metrics of HSR operations and the drivers of those metrics, and an understanding of customer needs and the competitive environment of the rail operator. These are quite different skills from managing tunnelling and rail construction contracts.

Figure 10-4 shows a potential organisational model for the HSRDMA.

Figure 10-4 HSRDMA organisational model (operations phase)



As the construction activities were completed, the procurement functions of the HSRDA would diminish and the ACT/state HSRDAs would be wound up, and an HSRDMA established.

An issue to be considered in the staging of the future HSR program is the potential loss of skills and expertise between stages, if stages of the HSR program do not run back to back (i.e. with the next stage overlapping with, or running directly after, the previous stage). This would be an issue for both the HSRDMA and the supplier industry generally.



11



11

Procurement and delivery structures for HSR

11.1 Introduction

This chapter presents the preferred delivery model for the procurement, construction and operation of a future HSR program. This model establishes the most appropriate structural model for the delivery of HSR services and the preferred procurement options for the delivery of the HSR system.

The chapter is structured into three sections, covering:

- The assessment of alternative structural options.
- The preferred procurement options.
- A comparison of the preferred delivery model for HSR in Australia with the various international examples of HSR.

11.2 Preferred delivery model for a future HSR system

Given the large amount of public funding required, it is important that the governance and institutional structures support the likely public interest objectives of a future Australian HSR program.

The central aim must be for HSR to deliver an effective and affordable transport service to customers. Other objectives would likely include ensuring that transport markets are efficient, and that transport systems are integrated and networked and contribute to regional and urban development.

There is a range of options for structuring the delivery of the preferred HSR system to achieve these objectives. Options include¹:

- The separation of infrastructure components of the preferred HSR system from the transport services supply, in terms of ownership and/or management (described as ‘vertical separation’).
- The separation of components of the preferred HSR system on either a geographic or product basis (described as ‘horizontal separation’).

Competition issues, including the role of contestability in the provision of HSR services, either through competition for concession rights or direct competition between service suppliers, are central to deciding the most effective delivery options. These are discussed in the following section.

11.2.1 Competition and contestability issues

Intermodal competition (or the threat of competition) from air and car travel would generally act as a strong binding constraint on HSR fare and service levels across most core HSR market segments. As a consequence, there is unlikely to be a requirement for economic regulation of HSR services, i.e. the control of HSR price and service levels, to constrain the potential for the HSR operator to exercise any monopoly power.

Even with strong competition from other modes, there may be additional efficiency benefits achieved by encouraging competitive pressures in the supply of HSR services. The naturally high barriers to entry for a new HSR operator wishing to compete with an incumbent HSR operator suggest that consideration has to be given to how to ensure ongoing supply-side competition in the delivery of HSR services in Australia.

Head-to-head competition between HSR lines in Australia is unlikely to be commercially or economically justified within any reasonable

timeframe, given that one integrated HSR system would provide all of the capacity Australia requires for the foreseeable future.

An open access regime to facilitate multiple HSR operators competing for the same markets on the same rail system is probably not practical, given the already great challenge of encouraging a train operating company to commit to creating a sustainable transport business in a greenfield market. It is probably also unnecessary because of the competitive pressure from other transport modes already mentioned. Therefore, vertical separation of train control and infrastructure maintenance from train operations would not be necessary to facilitate non-discriminatory access of competing train operators.

Competition for the market, i.e. competition for the right to provide certain services on an exclusive basis for a defined period, would be the most effective means of encouraging competitive pressures in the supply of HSR services and in meeting governments’ objectives for the HSR program. A concession model is typically the mechanism used to deliver competition for the market.

Where the services are commercially viable, the successful bidder would pay governments for the right to operate the concession; where they are not, governments would need to pay the successful bidder to operate the concession. The concession agreement ensures that train services that use publicly financed infrastructure deliver public interest objectives (such as minimum service levels) while having sufficient commercial freedom and agility to compete successfully with the other transport modes. There is a range of possible concession models, with the variations related to the responsibilities of, and degree of risk passed to, the concession holder. Further discussion of train operations concessions is provided in **section 11.3.3**.

1 Vertical separation in this context refers to the separation of a rail organisation by function (e.g. operations and infrastructure). Horizontal separation refers to the separation of a rail organisation by geography (e.g. by state or region), by line of business (e.g. urban operations from regional operations) or by product (e.g. inter-capital from suburban services).

Although governments would likely own the HSR system because of the large public financial contribution required, a broad range of options exists for how the delivery of HSR services could be structured. These options are outlined below.

11.2.2 Vertical separation options

The various vertical (or functional) separation options would vary the scope of public and private sector participation in the development and operation of the preferred HSR system. The scope of potential roles is as follows:

- Acquire and own land – in all cases it is assumed that an entity owned by the Australian Government and possibly the ACT and relevant state governments would acquire and own the land to support the preferred HSR system.
- Design and build the HSR system – constructing the track, structures, signalling and electrical infrastructure.
- Maintain the HSR system – maintaining the track, structures, signalling and electrical infrastructure.
- Operate the HSR system – controlling the movement of trains through the system.
- Operate train services – the delivery of train services in a particular market or markets.
- Supply trains – the supply of rolling stock, which may also include finance and/or maintenance of the equipment.

Some of these roles may be bundled together to facilitate optimal packaging and procurement outcomes, which are discussed further in **section 11.3**.

In terms of public/private sector participation, there are three broad options for developing and operating the HSR system – public, private or a combination of public and private sectors. Within each broad option, there are various sub-options, as

outlined in **Figure 11-1**. The list of sub-options in **Figure 11-1** is not exhaustive but covers the main combinations observed in the market today.

Public HSR delivery options

Under the vertically integrated public HSR option (1a), a publicly owned HSR corporation would be created to develop, build and operate the preferred HSR system. The corporation may be owned jointly by the relevant state and territory governments and the Australian Government². The HSR corporation would acquire land, build the HSR system and procure rolling stock utilising traditional public sector procurement approaches. The corporation would also operate and maintain the HSR system and operate train services. Components of construction and maintenance could be outsourced to private sector contractors, but the public sector enterprise would manage and operate the train services.

Alternative vertically separated options could be contemplated which would create public agencies to deliver different components of the system, and which would allow a greater degree of focus and specialisation. Option 1b contemplates an HSR development authority (HSRDA) to construct the preferred HSR system, a separate HSR system manager to operate and maintain the system, and one or more HSR train operating companies to operate the train services.

The ‘pure’ public HSR options perform relatively poorly in terms of likely competitiveness and potential for innovation. Although intermodal competition would exert competitive pressure on publicly owned train operators, lack of competition on the supply side may lead to a less efficient and less customer focused outcome than alternative structural options allowing contestability of train operations. This conclusion is supported by general experience in transport operations in Australia and by international experience. Historically, Australia’s publicly owned railways have been characterised by relatively low productivity, high

² A relevant historical example is the National Rail Corporation which was created to operate interstate rail freight services and was initially jointly owned by the Australian, NSW and Victorian Governments.

Figure 11-1 HSR vertical separation options

HSR Delivery Models	Acquire & own land	Design & build the HSR network	Maintain the HSR network	Operate the HSR network	Operate train services	Supply trains
1. PUBLIC HSR						
1a. Vertically integrated	HSR Corporation					
1b. Vertically separated	HSR Development Authority	HSR Network Manager (ARTC equivalent)		HSR Train Operating Company(ies)		
2. PRIVATE HSR						
2a. Vertically integrated	HSRDMA*	HSR 'Design Build Operate Maintain' concession(s)				
2b. Vertically separated (dual concessions)	HSRDMA*	HSR 'Design Build Operate Maintain' concession		HSR 'Operations' concession(s)		
3. PUBLIC-PRIVATE HSR						
3a. Public operator-maintainer	HSR Corporation					HSR fleet supplier
3b. Public infrastructure manager	HSR Infrastructure Corporation				HSR 'Operations' concession(s)	
3c. Public landlord-maintainer	HSR Infrastructure Corporation			HSR 'Operations' concession(s)		
3d. Public landlord	HSR Delivery Authority	HSR 'Operate/Maintain' concession(s)				

*HSR Development and Management Authority

costs and poor service quality³. Freight railways have been progressively separated and privatised. Passenger railways still in public ownership in Australia are bureaucratic, inefficient and currently undergoing major reforms and there is likely to be little public appetite to establish a new public sector train operator⁴.

Although there would be an option to commence operation with a public operator and privatise once the HSR system matured, as has been the case for HSR train operations in some countries such as Japan, there would seem to be little need for such an approach. This option would forego the benefit of leveraging private sector expertise, experience and incentive structures to tackle competitive private sector airlines in the early phase of HSR operations. Concession arrangements for private sector operators could be structured to manage risks in the start-up phase, particularly the market risks, and there would be no compelling need to commence operations with a public operator. Therefore, a pure public delivery model (option 1) is not desirable and was not considered further.

Private HSR delivery options

Under the vertically integrated private HSR option (2a), a private concession (or concessions) would be established to design, build, operate and maintain the preferred HSR system. Private finance could also be utilised but would depend on, among other things, how the public financial contributions were structured. It has been assumed that a publicly owned HSRDMA would need to be established to procure the land necessary to support the development of the preferred HSR system.

As with the public HSR delivery options, alternative vertically separated options could be contemplated that would allow different organisations to deliver different components of the system. Option 2b contemplates an

HSR concession to design, build and maintain (DBM) the HSR system. One or more additional operations concessions would be established to operate the system (i.e. controlling the movement of trains through the network) and the service (i.e. delivering train services). A variation to this model would see the DBM contractor also operate the system (i.e. control the movement of trains), which may have some merit if there are multiple operations concessions over the system.

The purely private HSR options transfer construction, maintenance, operations and investment risks to the private sector. The operating railway is handed back to governments at the end of the concession period(s). A number of factors make this type of contract problematic in the case of an HSR program on the east coast of Australia:

- It would not be feasible to privately finance the full infrastructure investment, given the inability of train operations to provide a commercial return on infrastructure costs.
- The sheer size and complexity of a future HSR program would preclude most prime contractors (both domestic and international) from carrying the infrastructure delivery risk on their balance sheet.
- Substantial public funding would be required, necessitating governments' responsibility to ensure the HSR program meets public interest aims through oversight and stewardship.
- Wider public interests include a need to integrate the preferred HSR system with state transport systems and state infrastructure.

Therefore, a purely private HSR delivery model (option 2) is not appropriate and was not considered further.

³ Productivity Commission, *Progress on Rail Reform*, Inquiry Report, April 2000.

Williams, Greig and Wallis, *The Results of Railway privatisation in Australia and New Zealand*, Transport Papers, World Bank, 2005.

⁴ RailCorp, the passenger operator in NSW, is currently undergoing major reform. In May 2012, the NSW Government announced major reforms to tackle middle management inefficiency and bureaucracy – see *Sydney Morning Herald* 19 May 2012. Queensland Rail, the passenger operator in Queensland, also recently announced the commencement of reforms with a proposal to reduce corporate and support areas by 500 personnel (see Media Statement, the Minister for Transport and Main Roads, Hon Scott Emerson, Tuesday, 11 September 2012).

Public-private HSR delivery options

A range of hybrid options contemplate different roles for the public and private sectors. Option 3a is similar to the integrated public HSR option, except that the fleet is supplied through a private third party rolling stock supplier, similar to PPP fleet arrangements that presently exist in some Australian urban railways.

Options 3b to 3d respectively provide an expanded role for the private sector. Option 3b contemplates a publicly owned HSR infrastructure corporation that would build, operate and maintain the HSR system. However, a private concession, or concessions, would be established to operate the HSR train services. Option 3c is similar to Option 3b but with the operations of the system (i.e. the control of the movement of trains) undertaken by the private sector train operator. Option 3d still has the publicly owned HSRDA responsible for building the preferred HSR system, but the private sector train operator would be responsible for both control of the movement of trains and maintenance of the system infrastructure.

The most promising vertical options for the delivery of the preferred HSR system provide for public delivery of the HSR infrastructure with transport services provided by private companies. Even with public delivery of the infrastructure, letting a single turnkey contract may not be feasible. Some unbundling of the infrastructure into multiple contracts would be required. Other variations include the extent to which system operations (i.e. the movement of trains), infrastructure maintenance and rolling stock supply are bundled with the operator(s) of train services or with alternative suppliers.

A detailed assessment of the packaging and procurement options would be required before a preferred delivery model could be finalised, as discussed in **section 11.3**.

11.2.3 Horizontal separation options

In addition to vertical (functional) separation of components of the HSR system, a range of horizontal separation options may also be contemplated, typically either by geography or product (service). In the context of an Australian HSR system, the most promising options for geographic separation relate to sectors which cover the major market pairs:

- A north concession (Brisbane–Sydney).
- A south concession (Sydney–Canberra–Melbourne).

Given public delivery of the HSR infrastructure network, the horizontal separation options are concerned with the delivery of train operations and other functions. Separate train service operators in the north and in the south could each operate on their respective systems as vertically integrated operations (i.e. with each operating train services, controlling the movement of trains on their systems, and possibly also maintaining their systems). In such circumstances there would be a need for a joint operations area (such as Central station in Sydney) with common use access areas. For the HSR system services (i.e. train control), it would be possible to separate into north and south operations with a co-located area at Central station in Sydney.

Although providing for separation of north and south concessions would add some operational complexity and cost, for instance by having to establish multiple control centres or possibly a joint facility, it would be feasible. Given the recommended staging is that Sydney–Melbourne should precede Brisbane–Sydney, this option would permit a separate competition to be run for the north concession.

Options also exist to segment concessions by product or service type. This study has identified three types of potential HSR product that would exist on both the north (Brisbane–Sydney) and south (Sydney–Canberra–Melbourne) lines:

- Inter-capital express services.
- Inter-capital regional services.
- Commuter services.

These services could be further segmented into north and south concessions. Separate market or product concessions would allow greater market focus and access to specialist skills and services. For example, an airline company might be a strong candidate for a concession that aligned HSR regional services with its air operations, whereas commuter HSR operations might be more attractive to an urban rail operator. As with geographic separation options, the additional benefits of multiple concessions would need to be weighed against the potential loss of synergies between operations and the additional cost and complexity (e.g. multiple control responsibilities, duplication of facilities, having to share station facilities).

In the context of the preferred HSR system, separation of commuter services from inter-capital express and regional services would seem most merited. There are strong operational and marketing synergies between the inter-capital express and regional services in either of the north or the south segments, though less synergy between the two segments themselves. By contrast, commuter services would have different characteristics and different economics to the inter-capital express and regional services, requiring different rolling stock and likely requiring ongoing state government financial support. It might therefore be desirable to structure a commuter concession in a different way from an inter-capital express/regional concession (e.g. involving train operations only with a shorter concession term).

Where the vertical delivery options provide for system operations to be undertaken by a train operations concession, with multiple product-based train operations concessions (that is, separate commuter and inter-capital express/regional operators), the inter-capital express/regional operator should control the movement of trains on the system. This arrangement reflects this operator's wider span of operations and dominant role.

The commuter operators would be given access under an access agreement with the inter-capital express/regional operator.

As was the case with the vertical separation options, a detailed assessment of the packaging and procurement options would be required before a preferred delivery model could be finalised, as discussed in **section 11.3**.

11.3 Procurement and packaging strategy of the preferred HSR system

The procurement strategy for the preferred HSR system would need to take into account its staged implementation and ensure that the HSR program could be procured cost effectively and efficiently to deliver the best value for money. Critical questions are:

- What package of assets and services should be procured in any single contract?
- What procurement model is most suitable for delivery?

11.3.1 Procurement considerations

As indicated in **section 11.2.2**, a private financing solution for the procurement of the preferred HSR system would not be feasible, due to the high capital costs, the absence of sufficient commercial return to recover capital costs, and the significant construction, delivery and demand risks.

With respect to the procurement of infrastructure assets for the preferred HSR system (broadly comprising tunnels, bridges, earthworks and permanent way), the size and scale of the works for any of the stages envisaged as a whole would be outside the delivery capacity of major industry participants, both locally and globally. 'Delivery capacity' relates to the ability to:

- Carry the risk of delivery on a balance sheet.
- Access appropriate levels of parent company financial support.
- Carry sufficient insurance.
- Secure the depth and availability of skilled personnel and other relevant resources.

Delivery of the infrastructure works as a single, integrated package is therefore unlikely to generate sufficient market appetite to generate effective competition among contractors. The infrastructure assets package would therefore need to be further split to create sub-packages that would be attractive to the market.

Contractors in the Australian market have demonstrated a capacity to deliver projects of \$1-2 billion. This package size has therefore been adopted for analysing the procurement options for the preferred HSR system, although it is acknowledged that at the time of procurement the market may have the capacity to deliver larger packages, likely in consortia with international contractors. A judgement would need to be made at the time of going to market.

In addition to infrastructure assets, there are a number of other core network components including signalling systems, stations, rolling stock and asset maintenance. Some components of the HSR system, such as signalling and safe working systems and rolling stock, would require specialised technological expertise and products. Only a few global companies supply the advanced signalling systems and/or rolling stock suitable for HSR. This would suggest that, where feasible, these components should be packaged and procured in a separate competition, rather than form an element of a larger civil engineering tender, where the ability to create competition between bidding consortia would be constrained by the limited number of these specialist technology suppliers.

11.3.2 Core works packages

Construction of the preferred HSR system would be undertaken in stages, with the core components in each stage procured through the following works packages:

- Infrastructure asset packages (broadly comprising tunnels, bridges, earthworks and permanent way) would be split and procured in a number of sub-packages of a size and scope that is attractive to the market and which would facilitate strong competitive bidding, generally through design and construct (D&C) contracts.
- Signalling systems and rolling stock would be delivered as a combined design, supply and maintain (DSM) contract, then leased from the HSRDMA to the concession operator.
- Stations and maintenance would be delivered as a set of PPP contracts, combined where possible, but likely to be separated at major city stations.

Infrastructure assets

As the size of the infrastructure asset procurement (estimated at a risk-adjusted cost of approximately \$20 billion (in \$2012) for the Sydney-Canberra stage alone) is too large to be delivered as a single integrated package, it would need to be split and procured in a number of sub-packages. **Appendix 7A** provides a summary of the proposed infrastructure assets sub-packaging solution for Sydney-Canberra, which comprises 11 infrastructure sub-packages (including three tunnelling packages).

The preferred approach would be for the infrastructure assets sub-packages to be delivered as individual D&C contracts. The rationale for this approach is as follows:

- As the scope of works and risks for each sub-package are expected to be definable and well understood, fixed price models (i.e. D&C) and competitive tensions should deliver best value. Given the relatively high number of sub-packages, the HSRDA would need to impose a high degree of both technical and performance specification in the D&C contracts to ensure consistent and interoperable standards between sub-packages.
- Key risks relating to land acquisition, planning and environmental approvals would be retained by governments in all procurement options. Other risks (such as constructability) are expected to be well understood and able to be assessed by contractors. As such, risk can be effectively transferred to the party best able to manage that risk, which supports the use of a D&C model.
- International and domestic market interest is likely to be significant for each sub-package, which should create competitive tensions and

enable governments to drive value for money through the tender process. A D&C model is well understood by the contractor market.

- A D&C model involves a shorter and less complex procurement process relative to the other procurement options, such as design, build and maintain (DBM), given the more limited scope (e.g. excluding infrastructure maintenance and operations) and more limited risk transfer (e.g. construction risks only).

Procuring multiple sub-packages of works would create significant and complex interface risks between contracts. For instance, there are interfaces between the individual 'geographic' works packages, between infrastructure works and technology systems, and between stations contracts. These risks would inevitably be retained by governments irrespective of the delivery model for each sub-package.

To mitigate this risk, governments, through the HSRDA, would need to retain a strong technical capability to effectively specify interface standards and oversee delivery of the D&C contracts. Under this model, governments are effectively taking on the role of systems integrator and would need to second, or contract, world class systems integration expertise to manage the interface risks in the contracting strategy. Procuring a future HSR program using proven technology and contemporary international standards and protocols of the time would also help to mitigate this risk.

Signalling systems and rolling stock

Modern train control and signalling systems rely heavily on digital communications and in-cab equipment, compared with historical systems, which relied almost exclusively on track-side infrastructure. The Australian Rail Track Corporation (ARTC) is currently implementing a communications-based signalling and safe-working system across its national rail freight network. Interfaces between the train control and signalling systems, the communications systems and the rolling stock are considered one of the biggest system integration risks in the procurement of the preferred HSR system.

By packaging the signalling systems and rolling stock together, this key risk (including rolling stock commissioning and acceptance risk) is likely to be substantially, if not entirely, transferred to the private contractor. There would also be significant commissioning efficiencies, given the train control and signalling systems and rolling stock would be developed in conjunction with each other.

Reflecting the unique nature of the signalling works and rolling stock package, the preferred procurement option is a DSM contract, as opposed to a design and supply (D&S) contract. The rationale for this approach is that:

- Linking supply and maintenance for a significant part of the rolling stock's life encourages a whole-of-life approach by the contractor. A DSM model would likely drive the best value for money outcome, since contractors would be inherently incentivised to reflect the maintainability of the system in its design.
- The signalling systems and rolling stock components are likely to offer significant opportunities for contractor involvement in terms of market innovation in all aspects of the respective technical solutions. Delivery models that access innovation from multiple parties through a competitive process should deliver the most innovation. A DSM model would achieve this outcome.
- The choice of signalling system would need to ensure it does not constrain flexibility and/or competitive tension for future signalling procurements in subsequent stages of the HSR program. One approach would be for the HSRDA to specify a signalling performance requirement based on open architecture systems, such as European Train Control System Level 2. This would facilitate interoperability with hardware from other suppliers utilising the same protocols, thereby ensuring multiple suppliers could bid for signalling systems procurements for later HSR program stages.

The HSRDMA would procure the train control and rolling stock assets, with the rolling stock being subject to a finance lease arrangement to fund the supply component of the DSM contract. The HSRDMA would lease the train control system and novate the rolling stock finance lease and maintenance arrangements (under the DSM contract) to the train operations concessionaire.

Stations

Greenfield stations

The optimal approach would be for the greenfield stations to be delivered as multiple PPPs. The PPP model would be structured to include responsibility for designing, building (including station fit-out), financing and maintaining (but not operating) the station over a period of 20 to 25 years. The PPP model would likely be based on a form of access charge. The rationale for a PPP approach is:

- The stations package, including maintenance, offers one of the few opportunities to capture private finance for the HSR program. Experience indicates that there is market appetite for PPP stations in Australia (e.g. Southern Cross station in Victoria).
- A PPP model would deliver enhanced value for money through the private contractor and financier driving optimum on-time and quality performance, and through synergies created by bundling the relevant design, construction and maintenance services.

There should be benefits from procuring and constructing the non-CBD greenfield stations for the initial stage of construction as part of a single PPP contract, given they are likely to have a common risk profile (specific civil works), synergistic benefits (such as reduced preliminaries and overheads) and potentially reduced interface risks (with one contractor responsible for all stage stations). Greenfield stations within a stage (e.g. Sydney South and Southern Highlands stations in the Sydney-Canberra stage) would be packaged together and procured using a PPP model. Revenue to fund procurement would come from station access charges paid by the train operating concessionaire and other possible cash flows such as car parking. There might

be benefits in further splitting the greenfield stations into individual sub-packages, as it could facilitate increased competition and open up the development opportunity to smaller construction firms. This decision can be made by the HSRDA at the procurement stage based on contemporary market conditions.

CBD stations

With respect to the CBD stations, such as Central station in Sydney, a broader set of considerations would come into play, including the redevelopment of existing stations and connectivity with existing transport systems, links to broader station precinct development and the broader operational and development objectives of the state and ACT governments. The CBD brownfield station redevelopments would be separately packaged and procured as an alliance, D&C or DCM contract, subject to the technical, interface and risk attributes of the works, particularly the interface with Central station and associated train operations.

Property and commercial development opportunities may exist above and around stations. This revenue would be maximised by implementing a 'precinct planning' approach to new stations that focuses on maximising land development and uses at each station and integration of stations within those precincts.

Inclusion of property development with the stations package needs to be assessed on a case-by-case basis. On the one hand, property and commercial development could be best pursued separately from the PPPs, based on the following:

- The skills required to undertake property development activities differ from those required to design, construct and commission large rail transport infrastructure projects.
- The financing requirements and bankability of returns differ between infrastructure projects and property development projects.
- Separation of a PPP, which is integral to the operation of the HSR, from commercial development encourages the complete focus of the PPP contractor.

However, there is a countervailing view that including the property development opportunities with the station works package would allow for better assimilation of the station and the development around it, particularly where the development is integral to the operation of the station. In addition, inclusion of skilled property specialists in the design and construction of the stations can ensure that the value of the property development opportunities is maximised.

At this stage, the option for including property development opportunities should be left open. The viability and optimal form of a PPP solution for the greenfield HSR stations should be subject to a robust value for money assessment by the HSRDA at the time of going to market.

11.3.3 Train operations concessions

Train operations concessions would be offered to the market and would combine:

- The operation of train services, including the operation of stations.
- Control of the movement of trains.
- Maintenance of the infrastructure assets.

Maintenance of the rolling stock, signalling equipment and control centres would be the responsibility of a separate DSM contractor. Although the DSM contract would be held by the HSRDA, it would be structured to facilitate delivery of the contractor's maintenance obligations in collaboration with the train operations concessionaire.

Governments should preserve the option, but not assume the obligation, to award separate concessions for combined inter-capital express/regional operations north and south of Sydney, with the potential for a company to bid for both concessions.

Allocation of track capacity between inter-capital express/regional concession holders and commuter operations would be the responsibility of the HSRDMA. Track capacity for commuter services would be negotiated by the HSRDMA with each

state and territory, and the inter-capital express/regional HSR concession holder would provide access to the HSR network (i.e. would provide agreed train paths) for the commuter operator as set out in its concession agreement.

The rationale for the proposed approach is:

- An effectively structured concession should facilitate a value for money transfer of ongoing operational, maintenance and commercial risks to the operator. In addition, a concession arrangement has the advantage of a shorter fixed term (of around ten to 15 years) compared to alternative privatisation models, which would permit governments to more frequently test the market and capture the benefits of competition between potential contractors.
- It is unlikely that the concession holder would assume the full revenue risk associated with HSR operations until the system is proven. There may, however, be concessionaire interest in a mechanism to share a degree of revenue risk where competitive tension for the concession contract drives it. Given revenue risk offers governments the best opportunity to incentivise appropriate operator behaviours, including in respect of improved customer service, a concession structured to share a degree of revenue risk would be preferred.
- Procuring the infrastructure assets and maintenance and train control services as part of the train operating concession would materially reduce interface complexities as it creates a single point of accountability for day-to-day operation of the preferred HSR system, even if the operator subcontracts components of maintenance to specialist maintenance companies.
- Creating institutional structures that would allow for separate concessions north and south of Sydney provides the option of effective competition for services provision on the later north stages of a future HSR program. Separating commuter concessions allows specific arrangements to be established with state and territory governments for their delivery, without compromising the delivery of competitive commercial inter-capital express/

regional HSR services. Allowing operators to bid for multiple concessions allows the market to determine the optimal number of operators on the HSR network.

The proposed train operations concessions would be structured on a 'net cost' basis. That is, the operator would take both revenue and cost risk and would bid for the concession on the basis of the net cost (after forecast revenue is deducted from forecast costs). In the early stages of the preferred HSR system delivery, it would be necessary for the revenue risk to be primarily underwritten by government, given its greenfield nature, but with incentives for the operator to build demand, innovate and deliver high quality services. Governments may choose to set maximum fares for specific fare types (such as economy class) and minimum service levels to ensure their substantial investment in HSR delivers the intended public benefits.

The concession agreement would be structured so that commercial revenues from the HSR operators would cover their train operating costs, the network operations and infrastructure maintenance costs, and make a contribution to capital costs. The rolling stock would be procured through the DSM contract and leased by the HSRDMA to the concession holder on a commercial basis. Commercial revenues from the concessions would not be able to fund the full costs of the infrastructure capital, but an access charge would be imposed, similar to the model that applies in Japan. The concession arrangements would need to strike a balance between providing profit incentives to the concession holders and maximising the financial recovery of the public investment in infrastructure.

11.4 Comparison with international models for HSR

Across the globe, there is no single, well established governance and institutional model for HSR. Differences in constitutional, industry and market structures prevent the simple translation of approaches from other jurisdictions to Australia.

The preferred HSR system identified in this study has been developed specifically for the east coast of Australia, based on Australian circumstances and parameters. However, given the similar policy dimensions and economic challenges of HSR in Australia and other countries, it is not unexpected that many of the features of the preferred HSR system are also found in countries where HSR has been adopted. This section compares the governance and institutional model for the HSR program in Australia with the institutional models for operating HSR services in other countries (see **Table 11-1**). Further details of international case studies are presented in **Appendix 7A**.

In all the overseas examples presented, the government owns the HSR infrastructure, having viewed HSR as public infrastructure of national importance and/or contributed substantially to its funding. In virtually all cases, the government has also retained an ongoing role in the stewardship of the sector. The study recommends the same approach be adopted by governments for the delivery of the preferred HSR system.

In most overseas cases, HSR infrastructure is administered on behalf of the government by a state-owned entity, although there are exceptions. In the United Kingdom and Netherlands, private managers hold the concessions, while in Japan, responsibility has been devolved to private train operating companies through a lease-style agreement. For Australia, it is proposed that the delivery and management of the system be undertaken by a government-owned HSRDA, which would evolve during the operational phase into a delivery and management authority (HSRDMA).

The seven European Union (EU) countries with HSR lines listed in **Table 11-1** are all obliged to provide third party access to trains that cross international boundaries of member states, in accordance with EU Railway Directives and single market principles. In practice, third party HSR train kilometres are currently a very minor proportion of the total in any country compared with the dominant HSR operator, except in Belgium, where the services of four member states' HSR companies (in some cases joint ventures of member states) converge in Brussels. Only Germany provides third party access to domestic HSR routes, but no private third party HSR operator has yet entered the market. Fast commuter-type services also use HSR lines in Germany (as part of the state-owned rail operator's product offering) and in the United Kingdom, on the HS1 track (operated by a commuter concession company).

The study proposes that Australian HSR concessions not adopt an EU-style access regime but instead concede exclusive rights to provide the defined service groups, though the structure would be consistent with some overlap at a few stations (such as Newcastle) between long-distance and commuter concessions.

To facilitate the open access arrangements, the EU countries operating HSR have separated infrastructure operations and maintenance from train operations by creating separate infrastructure companies.

In Germany, the network company is a subsidiary of the state-owned rail operator, but in most cases separate state-owned companies have been established. In France, the train control and maintenance of the network is contracted by the infrastructure company back to the dominant state-owned train operator. In France, the United Kingdom, Japan, China and Taiwan, the dominant train operating entity is responsible for train control and infrastructure maintenance either directly, under concession or under contract. For Australia, this would also be the preferred approach, realised through a concession structure that would include devolution of day-

to-day responsibility of both train control and infrastructure maintenance.

Although state-owned train operating companies dominate in most of the countries with HSR, all those countries had a dominant state-owned national rail passenger operator before the introduction of HSR. Given the competence and experience (and political power) of those existing companies, the assumption of responsibility for operating HSR fell naturally to them (or to subsidiary companies). In Australia, where no single substantial or dominant long-distance passenger rail transport supplier exists, the award of concessions to properly qualified private companies to operate trains is recommended.

The preferred model for Australia is perhaps closest, though not identical, to the Japanese model for new HSR lines. In Japan, a single state-owned entity, JRJT, is responsible for the development and strategic management of the HSR network, but operation of train services, control of the movement of trains and maintenance of lines is carried out by (mainly) private sector train operating companies serving particular high speed routes on an exclusive basis, for which they pay JRJT a fee to use the line.

For Australia, it is proposed that an HSRDA (which would evolve into an HSRDMA) be established to develop and manage the HSR network, but that the operation of train services, including control of the movement of trains and maintenance of lines, be concessioned to a private sector train operating company to serve a specific route on an exclusive basis. In Australia's case, the option to develop separate concessions north and south of Sydney should be preserved.

Table 11-1 Features of institutional frameworks for the preferred HSR system on the east coast of Australia and for international HSR systems

	Preferred Australian model	France	Germany	Great Britain (HS1)	Italy	
HSR lines ownership	Public	Public	Public	Public	Public	
HSR network administration	HSRDA (state-owned)	RFF (state-owned)	DB Netz (state-owned)	HS1 Ltd (private)	RFI (state-owned)	
HSR network operations (train control function)	Contracted by HRSDA to dominant train operations concessionaire	Contracted by RFF to dominant train operations entity (SNCF)	DB Netz	Contracted by HS1 to national network operator (Network Rail)	RFI	
HSR network maintenance	Contracted by HRSDA to dominant train operations concessionaire	Contracted by RFF to dominant train operations entity (SNCF)	DB Netz	Contracted by HS1 to national network operator (Network Rail)	RFI	
Third party infrastructure access rights for HSR trains	No	For international trains of member states (EU law)	For international trains of member states (EU law)	For international trains of member states (EU law)	For international trains of member states (EU law)	
HSR passenger train operations	Private concessions: <ul style="list-style-type: none"> • Inter-capital express south • Inter-capital express north • Commuter by state (3) 	Dominated by SNCF (state-owned) Plus a few international trains using track access rights	Dominated by DB Fernverkehr (state-owned) Plus a few international trains using track access rights	International HSR services operated by Eurostar (state-owned) Domestic fast services by Southeastern (private concession)	Trenitalia (state-owned) NTV (private open access operator)	

Source: Compiled from multiple sources, including Beckers et al., *Long-Distance Passenger Rail Services in Europe: Market Access Models and Implications for Germany*, Discussion Paper No. 2009-22, OECD/ITF, December 2009.

	Belgium	Netherlands	Spain	Japan	China	Taiwan
	Public	Public	Public	Public (new HSR lines)	Public	Public
	Infrabel (state-owned)	Infraspeed (private)	Adif (state-owned)	JRTT (state-owned) leases lines to train operating companies to manage	Joint venture companies (typically majority-owned Ministry of Railways, plus provincial governments)	THSRC (initially private but now public following government take-over in 2009)
	Infrabel	Infraspeed	Adif	Contracted to train operating company by lease agreement	Ministry of Railways (the national railway manager)	THSRC
	Infrabel	Infraspeed	Adif	Contracted to train operating company by lease agreement	Ministry of Railways	THSRC
	For international trains of member states (EU law)	For international trains of member states (EU law)	For international trains of member states (EU law)	No	No	No
	Several state-owned operators of international HSR trains Thalys Eurostar, Fyra, DB Inter-city Express (ICE), TGV	Two concessions: • NS Hi Speed (state owned) until 2015) • HAS (NS/ KLM joint-venture) until 2024	Renfe Operadora (state-owned)	Three private and one state-owned companies serving different routes/regions	Ministry of Railways	THSRC • 35 year concession for train operations • Separate 50 year concession for station area redevelopment

11.5 Conclusion

The following key conclusions have been reached in regard to the preferred delivery model for a future HSR program:

- A publicly owned HSRDA would be established to develop and manage the HSR system, but the operation of train services, including control of the movement of trains and maintenance of lines, would be concessioned to the private sector to serve a specific route on an exclusive basis.
- The option to develop separate concessions north and south of Sydney should be preserved.
- Construction of the preferred HSR system by the HSRDA would be undertaken in stages, with the core system components in each stage procured through the following works packages:
 - Infrastructure asset packages (broadly comprising tunnels, bridges, earthworks and permanent way) would be split and procured in a number of sub-packages, of a size and scope that is attractive and manageable to the market and that would facilitate strong competitive bidding, generally through a number of D&C contracts.
 - Signalling systems and rolling stock would be delivered as a combined DSM contract, and then leased from the HSRDMA to the concession operator.
 - Stations and maintenance would be delivered as a set of PPP contracts, combined where possible, but likely to be separated at major city stations.



12

The background of the page features several diagonal stripes in various shades of teal, ranging from light to dark, creating a modern, geometric pattern. The stripes are parallel and run from the top-left towards the bottom-right.

12

Implementation plan

12.1 Introduction

This chapter describes how the preferred HSR system could be implemented.

It includes key decisions required, when they would be made and by whom, from the initial decision to proceed through to commencement of operation of the first stage of Line 1 (Sydney–Canberra). Similar procedures envisaged for the remainder of Line 1 (Canberra–Melbourne) and for Line 2 (Brisbane–Sydney) are described in outline. The chapter draws upon the conclusions from:

- Chapter 6** Staged delivery.
- Chapter 7** Appraisal of commercial performance.
- Chapter 8** Economic appraisal of the preferred HSR system.
- Chapter 10** Governance and institutional framework for HSR.
- Chapter 11** Procurement and delivery structures for HSR.

Financial and economic analysis detailed in **Chapters 7** and **8** indicates that, to create a viable HSR, Line 1 between Sydney and Melbourne

would need to be established as the first priority. This would be a major undertaking in terms of planning, construction, testing and commissioning and, based on current industry experience, would itself need to be divided into discrete stages.

The implementation plan is illustrated in two figures: **Figure 12-1** shows in detail the plan to realise the first operating stage between Sydney and Canberra, while **Figure 12-2** shows the plan for completion of the preferred HSR system between Brisbane and Melbourne.

The plan is based on the construction timing detailed previously in **Figure 6-2** which assumes an opening date of the first stage between Sydney and Canberra by 2035. This would require establishment of the High Speed Rail Development Authority (HSRDA) by 2019.

The plan is organised as follows:

- Establishing governance arrangements.
- Line 1 procurement and operation.
- Line 2 procurement and operation.

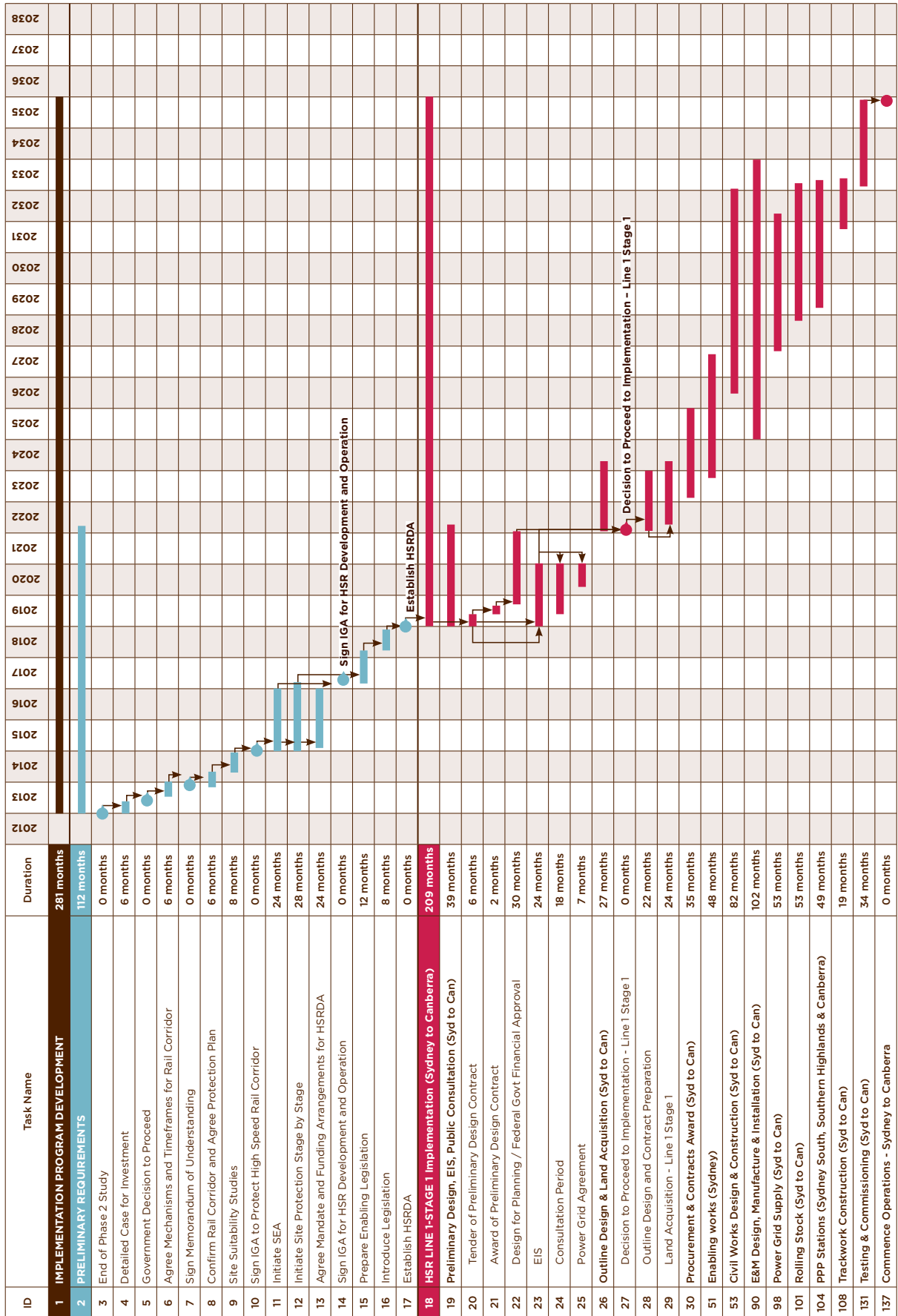


Figure 12-1 Detailed implementation plan for stage 1 (Sydney-Canberra)

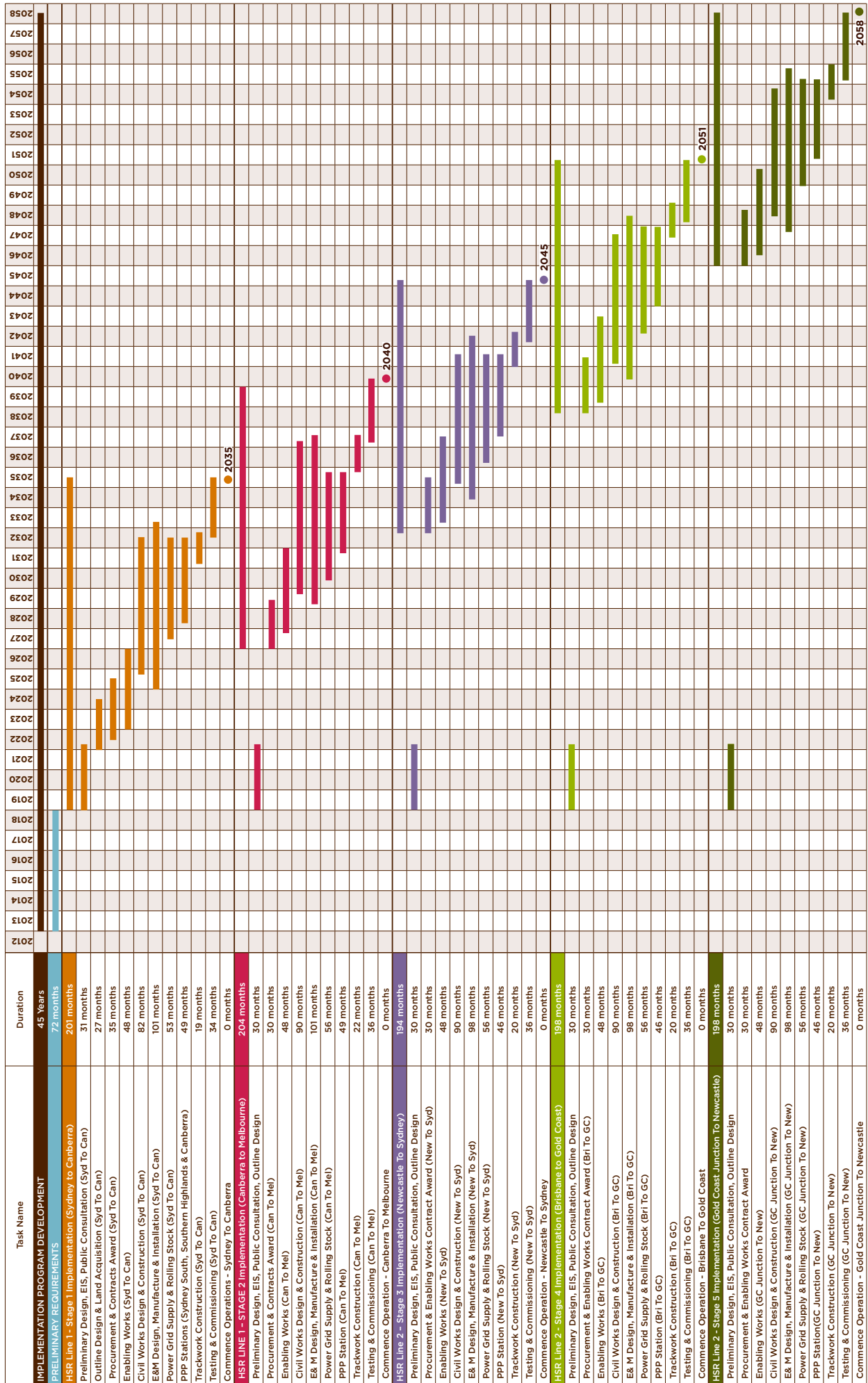


Figure 12-2 Outline implementation plan for preferred HSR system

12.2 Establishing governance arrangements

12.2.1 Scope

The governance arrangements would be established in five stages as discussed in **section 10.3.1 of Chapter 10**, which describes the parties to the necessary agreements and their roles. The key stages during this period are:

1. Confirmation of the Australian Government's interest in continuing the necessary preparatory works to inform a formal Ministerial decision to proceed.
2. A memorandum of understanding (MoU) between the Australian, ACT and state governments that sets out the road map to establish at least two formal inter-governmental agreements (IGAs).
3. An IGA to provide the policy mandate for the protection of an HSR corridor.
4. A second IGA to provide the policy mandate for the implementation of the first stage of an HSR program.
5. Legislation to provide the legal framework for the implementation of the HSR program.

12.2.2 Stage 1 – Decision to proceed (six months)

The first step following completion of the HSR study would be to confirm the Australian Government's and the state and territory governments' interest in continuing the preparatory steps towards an HSR program and finalising the factual basis that would support a future policy decision. Prior to any Australian Government decision on whether to proceed, engagement with the states and the ACT would be needed to identify potential issues and ascertain the inclination of the states and the ACT to support a multi-jurisdictional program. Six months have been allowed in the program for this decision-making process.

12.2.3 Stage 2 – Prepare MoU (six months)

Following the Australian Government's decision to proceed and consultation with the Queensland, NSW, ACT and Victorian Governments, the proposed signatories to the IGA would need to establish interim arrangements to allow key planning activities to commence. As proposed in **Chapter 10**, the MoU would be signed to allow planning and development work, including corridor protection, to commence. **Section 10.3.1** identifies the tasks and activities that would be required during this period. The Australian Government, the ACT Government and the relevant state governments would need to make resources available to support the joint working arrangements necessary to develop the MoU, including the funding arrangements for this development phase. Existing IGAs could be used to facilitate this process. The MoU is a key early deliverable that would facilitate much of the work required to establish the necessary governance framework for the implementation of HSR. An early decision required by all parties would be whether further work needs to be commissioned prior to agreement of the MoU. Six months is programmed after the decision to proceed to develop and sign the MoU.

Finalising the MoU would initiate a number of activities including:

- Site investigations.
- Preparatory work for corridor protection.
- Preparation of the IGAs.
- Establishment of the strategic assessment (SA) framework.

The Federal Department of Infrastructure and Transport, and the transport agencies in each state and territory, would seek funding through an HSR New Policy Proposal. The proposal would cover funding to conduct site testing, compensation or lease fees payable for site access during site testing and land acquisition, funding for rezoning activities, and top-up funding for additional SCOTI and Working Group roles that could arise through the implementation of HSR should this process be pursued. Each jurisdiction would follow its own budget process for funding, with standard budget rules determining the process in each jurisdiction.

12.2.4 Stage 3 – Establish the first IGA and protect the corridor (14 months)

After signing the MoU, the third stage comprises the work necessary for the states and the ACT to establish an IGA to protect the HSR corridor and associated strategic sites and assets. The aim of corridor protection is to protect future use of the corridor for HSR by rezoning, resuming, purchasing or continuing to hold land within the corridor.

As indicated in **section 10.3.1**, the procedures for corridor protection currently vary by jurisdiction and it would be necessary to establish how the HSR corridor would be secured along its entire length. Confirmation of the final corridor alignment would be subject to site suitability studies, including geological surveys.

While the implementation of HSR would be staged, it would be necessary to protect the entire length of the corridor from land uses that would be incompatible with a future HSR program. The structure of the authority responsible for developing HSR would influence which governments (Australian, state or ACT) would lead which components of the site suitability activities and at which stage. Fourteen months have been allowed for completion of the detailed IGA to protect the corridor following signature of the MoU.

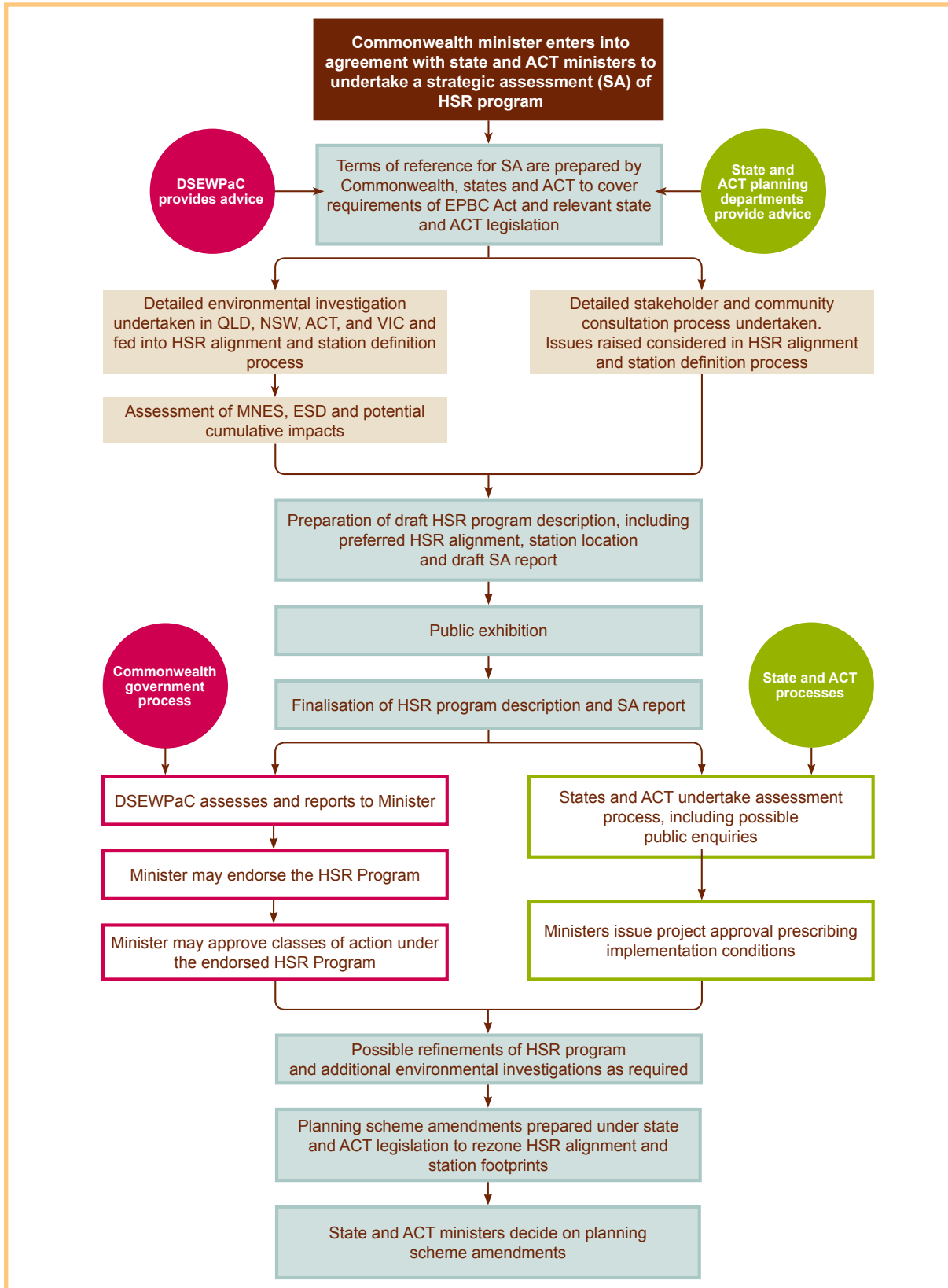
There are adequate powers within Commonwealth, state and ACT legislation to gain access to land for site study purposes. Therefore, this activity could commence immediately upon completion of the IGA. However, preparation for site investigations could commence earlier, through procedures established by the MoU. State and ACT jurisdiction agencies would take responsibility for arranging property access under existing legislation, for investigations, and for procuring and managing contractors conducting the site works. Site surveys and analysis work undertaken during site suitability studies would form the basis of environmental assessments and government budgeting and approval processes.

Environmental assessment

Part 10 of the *Environment Protection and Biodiversity Conservation Act 1999 (Cth)* (EPBC Act) provides an appropriate vehicle for integrating the assessment of environmental impacts of the HSR program under a strategic assessment.

Figure 12-3 outlines the concurrent processes, at both Australian Government and state/ACT government level, that could be applied to the environmental assessment of the preferred HSR system and to enable protection of the corridor. Undertaking a strategic assessment would facilitate collaboration between governments to ensure that environmental issues, including matters of national environmental significance, are considered early in the planning phase. The strategic assessment provides for approval of classes of action taken in accordance with an endorsed Program and any further state-specific approvals would also be facilitated by this process, allowing the various state and ACT assessment and approvals processes to progress concurrently. These processes are described in **Appendix 5C**. The proposed MoU and IGA should allow for and endorse the scoping of a strategic assessment under the EPBC Act.

Figure 12-3 Establishing the strategic assessment framework



12.2.5 Stage 4 – Prepare HSR delivery strategy and second IGA (27 months)

During this stage, protection of the corridor would commence. At the same time, the HSR delivery strategy would be prepared. This would include confirmation of:

- Objectives of the HSR program.
- Minimum technical performance requirements.
- Agreement on the first stage (Sydney–Canberra) to be implemented.
- Service characteristics (including stations to be served and minimum frequencies, acknowledging operator prerogative to meet market needs).
- Principles for procurement.
- Role of each jurisdiction in development of the proposed HSR system.
- Governance structure.
- Legislative requirements.
- Funding.

Preparation of the second IGA would represent a substantial undertaking and would require a number of years to complete. Twenty-seven months have been allowed for this stage in the implementation program in **Figure 12-1**. Corridor protection would need to be undertaken in stages according to the overall program, and 28 months have been allowed for completion of this activity.

12.2.6 Stage 5 – Assessment and approvals (36 months)

The introduction of Commonwealth and complementary state/territory project-specific legislation, where necessary, would aim to harmonise an approach to the large volume of transport and planning regulations relevant to the project.

Establishing HSRDA

The HSRDA would manage both the procurement of the construction necessary to establish Lines 1 and 2, and the letting and management of the concession(s) to operate HSR services.

The key decision required would be whether to proceed with the implementation of Line 1. This would include the completion of the financial and environmental approvals.

Preparatory work for implementation

Prior to formal approval and a decision to proceed with Line 1, the following tasks would need to be undertaken:

- Concept design on which to base financial estimates and environmental assessments and approvals.
- Environmental approvals in accordance with the strategic assessment process outlined above.
- Consultation associated with environmental approvals.

Thirty-six months have been allowed for these activities. Intensive consultation would be undertaken with stakeholders and community (including landholders) during the development of the concept design, and then as required or appropriate during the strategic assessment and environmental approvals processes.

12.3 Delivery of Line 1 Sydney-Melbourne

12.3.1 Line 1 stage 1 – Sydney-Canberra

Following the decision to proceed to implementation, the key activities required to deliver stage 1 of Line 1 are:

- Design for procurement of detailed design services and construction contractors.
- Securing any further site-specific environmental planning approvals.
- Land acquisition.
- Procurement.
- Enabling works.
- Main construction works.
- Electrical and mechanical systems.
- Power supply.
- Rolling stock.
- Testing and commissioning.

As shown in **Figure 12-1**, these activities are not entirely sequential and some overlap would be achievable.

Preliminary design and land acquisition

The preliminary, or client reference, design would need to be sufficiently developed to allow contracts to be let for the design and construction of both the enabling and main works. This activity would commence immediately upon establishment of the HSRDA. The HSRDA would act as client for this design development. Thirty months have been allowed for this activity. Any further site specific environmental licences required for construction would be obtained during the detailed design. Consultations with landowners regarding access for entry to properties or for agricultural operations, fauna passage and site specific noise mitigation would also occur during the detailed design.

Land acquisition would then commence, phased in accordance with the program for letting the construction contract packages. Two years have been allowed for land acquisition associated with stage 1 of Line 1.

Procurement

Procurement has been grouped into the following categories:

- Enabling works.
- Main construction works.
- Electrical and mechanical systems.
- Power supply.
- Rolling stock.

Enabling works

The first set of works packages to be released would be for the enabling works, which prepare the corridor to receive the main railway works. These works would take four years to complete for Sydney-Canberra. Given a decision to proceed with construction of the HSR, execution of these works could overlap with the early part of the main construction works.

Main construction works

Construction of the main works for the railway between Sydney and Canberra would be the first construction works undertaken. The program is based on recent overseas experience, including in Spain and Taiwan, where the civil infrastructure works were constructed using contract packages of approximately 30 kilometre lengths. Twelve packages have been defined between Sydney and Canberra, which could be let on a rolling program over a period of 14 months. The procurement strategy envisages that the major stations including Sydney and Canberra would be let as PPP contracts through HSRDAs for NSW and the ACT.

Electrical and mechanical systems

The early procurement of railway systems such as power supply, signalling and communication would be important to facilitate an integrated approach to implementation of the railway and to ensure the detailed design takes into account the systems requirements. Specification of the systems design would therefore form part of the preliminary design process. Completion of the systems design would be followed by procurement of the systems provider, systems manufacture, depot construction and installation over a period of eight and a half years.

Power supply

Since HSR would be connected to the national power grid, sufficient lead time would be required to finalise supply agreements and make the connections. The power grid agreement would need to precede the decision to implement stage 1, with procurement of supply programmed to begin five and a half years after the decision to proceed, and before the testing and commissioning phase.

Rolling stock

Rolling stock procurement would commence six and a half years after a decision to proceed, and would run in parallel with the procurement of the power supply, which itself would have a significant lead time. Both rolling stock and power supply procurement would precede the testing and commissioning stage. Four and a half years have been allowed for this activity.

Concession to operate

The HSRDMA would need to ensure the concession to operate would be in place at least 18 months before the commencement of stage 1 operations. This period would allow the operator time to hire and train its workforce, establish operational systems and obtain necessary licences to operate.

Testing and commissioning

The final stage before operation of the railway is testing and commissioning of the operational systems with the rolling stock. This would be expected to take up to three years.

Stage 1 operation

Completion of the stage 1 program as outlined above would lead to the train operator assuming control of the HSR system and running the first trains in revenue service between Sydney and Canberra in 2035.

12.3.2 Line 1 stage 2 – Canberra-Melbourne

Commencement of construction of the Canberra-Melbourne stage of Line 1 could begin once the main construction works between Sydney and Canberra are complete. Stage 2 activities that could take place in parallel with the completion of stage 1 include:

- Land acquisition.
- Client reference design and contract preparation.
- Contract procurement.
- Systems design and procurement.

An overlap of stage 1 and stage 2 activity of eight years is shown in **Figure 12-2**. The component stages of the program are the same as for Sydney-Canberra. Pursuing the activities as set out above for stage 1 would lead to stage 2 (Canberra-Melbourne) being operational by 2040.

12.4 Delivery of Line 2 Brisbane-Sydney

At the same time as overseeing the introduction of operations between Sydney and Melbourne, the HSRDA could commence procurement of Line 2. Given the scale of the construction activity required, it is unlikely that construction of both Line 1 and 2 would occur simultaneously. However, some overlap in the overall delivery programs for both lines is feasible. Activities for Line 2 that could be completed while Line 1 is under construction include:

- Concept design and environmental approvals in accordance with the strategic assessment framework.
- Consultation.
- Completion of funding and financing arrangements.
- HSRDA client reference design for procurement.
- Contract procurement.
- Enabling works.
- Detailed design.

This is demonstrated in **Figure 12-2**, which shows that the design and construction period for Line 1 stage 2 and for Line 2 stage 1 overlap by a year. During this period, the detailed design for Line 2 could commence.

The program has also been designed to provide three stages of construction between the principal population centres:

- Newcastle-Sydney via the Central Coast.
- Brisbane-Gold Coast.
- Gold Coast-Newcastle.

The order of completion would be dependent upon circumstances at the time. In terms of infrastructure procurement, the steps required would be the same as for Line 1 and are shown in **Figure 12-2**. On this basis, Brisbane-Sydney could be operational by 2058.

12.5 Conclusion

This chapter has provided a step-by-step plan for implementation of the preferred HSR system. The economic and commercial appraisal was based on an opening year of 2035 for stage 1 and this plan illustrates how this would be achieved. The appraisals in **Chapter 8** also considered the impact of accelerating the program by five years. The feasibility of accelerating the program would depend initially on whether the governance arrangements could be established more quickly than shown in **Figure 12-1**. The immediate next step following completion of the HSR study is to confirm the Australian Government's interest in continuing the necessary preparatory works to inform a formal Ministerial decision to proceed. An early task following the government decision to proceed would be to review and confirm the program for the delivery of the HSRDA. The potential to shorten the timeframe of the delivery program following the establishment of the HSRDA would be dependent on funding, design approvals and contract procurement activity.

List of acronyms

Acronym	Definition
ABS	Australian Bureau of Statistics
ACT	Australian Capital Territory
ACTPLA	ACT Planning and Land Authority
ASCs	Alternative Specific Constants
ATC	Australian Transport Council
ATP	Australian Technology Park (Sydney)
BCR	Benefit Cost Ratio
BLTIP	Brisbane Long Term Infrastructure Plan
BITRE	Bureau of Infrastructure, Transport and Regional Economics
CAPEX	Capital Expenditure or cost
CBA	Cost-Benefit Analysis
CBD	Central Business District
COAG	Council of Australian Governments
CGE	Computable General Equilibrium
CPI	Consumer Price Index
DBI	Victoria's Department of Business & Innovation
D&C	Design and Construct
DBM	Design, Build and Maintain
DEED	Department of Employment, Economic Development & Innovation
DPCD	Department of Planning and Community Development
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communities
EBCR	Economic Benefit Cost Ratio
EBIT	Earnings Before Interest and Tax
EIRR	Economic Internal Rate of Return
ENPV	Economic Net Present Value
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
ESD	Ecologically Sustainable Design

List of Acronyms and Glossary list

Acronym	Definition
ESDD	Environment & Sustainable Development Directorate
FIRR	Financial Internal Rate of Return
FNPV	Financial Net Present Value
GIS	Geographic Information System
GDP	Gross Domestic Product
GNI	Gross National Income
GSP	Gross State Product
GST	Goods and Services Tax
HSR	High Speed Rail
HSRDA	High Speed Rail Development Authority
IA	Infrastructure Australia
IGR	Intergenerational Report
IRR	Internal Rate of Return
LGA	Local Government Area
MNES	Matters of National Environmental Significance
MCA	Multi-Criteria Assessment
NPAT	Net Profit After Tax
NPV	Net Present Value
NSW	New South Wales
NVS	National Visitor Survey
OPEX	Operational and maintenance costs
PPP	Public-Private Partnership
PV	Present Value
RAAF	Royal Australian Air Force
RDV	Regional Development Victoria
RDA	Regional Development Australia
ROC	Regional Organisation of Councils
TfNSW	Transport for New South Wales
TRA	Tourism Research Australia
SEQ	South East Queensland
SEQRP	South East Queensland Regional Plan
VKT	Vehicle Kilometres Travelled

Glossary list

Term	Definition
Agglomeration	Agglomeration effects relate to the productivity benefits that some firms derive from being close to other firms and to large markets and labour pools. These benefits are external to the firm and / or industry and therefore lead to reduced costs to the firm.
Cost-benefit analysis	An analytical tool that can be used to assess the benefits and costs of a proposal.
Commercial financing gap	The difference between the total capital cost of the HSR program and the amount of financing that can be raised from the capital markets on commercial terms.
Computable General Equilibrium (CGE)	Computable general equilibrium analysis identifies the total (direct and indirect) economic impacts of a proposal on GDP and employment. The CGE analysis explores the flow on effects to the economy.
Consumer Price Index	A consumer price index (CPI) measures changes overtime in the price level of consumer goods and services purchased by households.
Corridor	A transportation corridor is a (generally linear) tract of land in which at least one main line for transport, be it road, rail or canal, or utility has been (or will be) built.
Dataset	Geographically referenced information that can be located and displayed on GIS maps.
Discount rate	The interest rate at which future values are discounted to the present and vice versa.
Door to door	Combines the experience of a long distance journey with the connecting trip to and from the office or home to the HSR station. It is usually associated with total door to door costs and amenity of travel.
Earnings Before Interest and Tax	This is equal to sales revenue minus cost of sales and depreciation.
Elasticity	A mathematical measure used in economics to describe the strength of a casual relationship between two variables. An elasticity value can be interpreted as the percentage change in the dependent variable in response to a one per cent change in the independent variable.
Financial internal rate of return	The discount rate at which the net present value of project cashflows is equal to zero.
Financial net present value	The present value of project cashflows. The present value of project cashflows is derived by discounting future cashflows by an appropriate discount rate.

Term	Definition
Generalised Trip Cost	Generalised trip costs are the sum of money price (i.e. fares and/or perceived vehicle operating costs) associated with a trip along with any additional costs to complete the door-to-door journey (such as journey time, waiting time, check-in time, access time, interchanges, and the mode-specific qualitative factors encompassed by the ASC) valued at money price.
Geographic Information System (GIS)	A highly accurate, geographically based information management and mapping system which combines and organises electronic data, maps and aerial photography.
Gross Domestic Product	The market value of all final goods and services produced within a country in a given period.
Gross margin	A measure of operating profitability (excludes interest and depreciation):
Gross margin=(revenue - cost of sales)/ revenue*100%	Department of Sustainability, Environment, Water, Population and Communities
Gross State Product	The market value of all final goods and services produced within a state or territory in a given period.
High Speed Rail	A conventional wheel on rail public transport service with trains travelling at 250 km/h or faster.
HSR program cashflows	Cashflows relating directly to the design, construction and operation of the HSR network. This excludes financing and non-cash items such as depreciation.
Induced travel demand	The phenomenon that after supply increases, more of a product is consumed; hence as more transport infrastructure and/or services are supplied, more travel demand is generated or induced.
Internal Rate of Return	The rate of return that makes the net present value of all cash flows (both positive and negative) from a particular project equal to zero. Commonly used to evaluate the desirability of investments or projects.
Level of service	A measure used by traffic engineers to determine the effectiveness of elements of transportation infrastructure. Level of service is most commonly used to analyse highways by categorizing traffic flow with corresponding safe driving conditions. The concept has also been applied to intersections, water supply and public transport supply.
Maglev	Derived from magnetic levitation, maglev is a system of transportation that suspends, guides and propels vehicles, predominantly trains, using magnetic levitation from a large number of magnets for lift and propulsion.
Matters of National Environmental Significance	As defined under the EPBC Act

Term	Definition
Mode choice model	A mode choice model is a mathematical model based on the behavioural principle that a traveller will choose the travel mode that yields the greatest satisfaction or utility. A common approach is the use of a logit model, which allocates demand among various modal options based on the relative perceived travel cost or time of each mode.
Multi-criteria analysis	A collection of tools to assist decision-making where the aim is to promote a number of different objectives or criteria.
Net Present Value	The present value of project cash flows. The present value of project cash flows is derived by discounting future cash flows by an appropriate discount rate.
Net profit after tax	This is equal to sales revenue minus cost of sales, depreciation, interest and taxation.
Nominal	Estimates inclusive of inflation (escalation). Denoted as (\$M nominal).
Pair-wise comparison	Refers to any process of comparing entities in pairs to judge which of each entity is preferred, or has a greater amount of some quantitative property.
Perceived cost	The cost that is perceived by the user. For example, car drivers may perceive the fuel costs associated with travel but exclude other factors such as repairs and maintenance.
Program	Suite of appraised initiatives to be delivered within a specified timeframe and sequence.
Qualitative assessment	Relative measure of impact or value based on ranking or separation into descriptive categories such as low, medium, high; not important, important, very important; or on a scale from 1 to 10.
Real	Estimates in dollars as at 1 July 2012. Denoted as (\$M 2012).
Resource cost	Resource cost represents the opportunity cost of resources used, measured from the point of view of society as a whole. Resource costs typically exclude “transfer” factors such as excise (i.e. fuel excise), taxes (i.e. GST or payroll tax), subsidies, and profit margins.
Risk adjusted estimates	Estimates that have been adjusted for the expected outcomes of events that would cause actual circumstances to differ from those assumed when forecasting revenues and costs. The risk adjusted estimates presented in this Report are equivalent to the mean expected outcome, unless otherwise stated.
Route	Physical pathway connecting two locations for a particular mode. In land transport, a route consists of a continuous length of infrastructure (road, rail line).
Specialised Centre	Areas containing major airports, ports, hospitals, universities, research and business activities that perform vital economic and employment roles across a wide area.

Term	Definition
Stated Preference Survey	A stated preference (SP) survey is commonly used in the transport sector to gain an understanding of peoples' (preferred) travel choices and behaviours and the factors that influence their decisions by asking them to choose between a number of travel options with varying price and service levels.
Strategic fit	Extent to which objectives of a proposed initiative align with objectives and policies of the government as set out in strategy and other documents.
Strategic planning	High-level planning involving fundamental direction-setting decisions. Narrows down the types of options that will be pursued. Involves consideration of present and future environments. Asks questions such as: 'Are we doing the right thing?' 'What are the most important issues to respond to?' and 'How should we respond?' Balances many competing considerations including value judgements, subjective assessments and political considerations. Involves iteration, stakeholder consultation and analysis.
Transport system	<p>For a particular jurisdiction,(or multi-jurisdictional setting), comprises the following elements:</p> <ul style="list-style-type: none"> • Relevant transport networks – sets of routes that provide inter-connected pathways between multiple locations for similar traffic. • Transport use sub-system – people, goods and vehicles / wagons / etc. Using the network. • Regulatory and management sub-system – regulatory regime and systems for managing the traffic that uses the network (including access arrangements, registration and licensing, traffic management centres and intelligent transport systems). • Transport operating environment e.g. land-use development patterns that generate traffic on the transport network. • Physical environment e.g. geographic features, climate, air quality, and social environment e.g. accessibility, amenity, liveability.
Value capture	Refers to a type of public financing where increases in private land values generated by public investments are all or in part “captured” or recouped by the public sector.
Vehicle kilometres travelled	The distance travelled by motorised vehicles
Vehicle operating cost	The cost of operating a vehicle, including fuel, oil, tyres and repair and maintenance costs.

