HIGH SPEED RAIL STUDY – PHASE 1
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Prepared for
Department of Infrastructure and Transport

Prepared by
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Executive summary

A strategic study on 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, on 5 August 2010.

The study is being conducted in two phases. Phase 1, undertaken between January and June 2011, has assessed the likely range of costs, identified potential corridors and stations, estimated the potential future market demand for HSR, and considered potential social and regional development impacts of a HSR network.

Phase 1 has not examined the financial feasibility of HSR on the east coast of Australia and therefore does not include a benefit versus cost analysis. Phase 2 will examine the financial feasibility of HSR, identify an optimum route alignment, refine patronage and cost estimates and investigate potential financing options. This report provides the outcomes of phase 1.

Cost estimates and risk

The risk-adjusted cost estimate for the implementation of an overall HSR network would fall within the range of $61 billion to $108 billion (in $2011) depending upon the combination of corridors selected, reflecting the level of confidence for this phase of the study.

The risk-adjusted cost estimates include land acquisition, stations and city access, maintenance and stabling facilities, power infrastructure, civil and rail infrastructure and IT and ticketing systems. They exclude client planning and procurement management costs, which are likely to be in the order of 10 to 15 per cent of the estimate. They also exclude operating costs (including a leasing cost for the rolling stock).

The land cost component for the HSR network is approximately $6 billion (in $2011). Acquiring, or otherwise preserving, the corridor in the short-term could reduce future costs by reducing the likelihood of additional tunnels as urban areas grow and preferred corridors become unavailable.

International experience suggests it is unrealistic to expect the capital cost of a HSR network to be recovered.

Corridors

Corridors short-listed for further analysis in phase 2 were:

• Coastal corridors between Brisbane and Newcastle, with potential variations around coastal cities and the Gold Coast.
• The Central Coast corridor between Newcastle and Sydney.
• The Hume Highway and Princes Highway corridors between Sydney and Canberra, via Southern Highlands.
• The Hume Highway corridor between Canberra and Melbourne, via Riverina, Murray, and with a potential route option via the Goulburn Valley.

These short-listed corridors lie within the green band shown in the following map. It is recommended that this green band define the study area for phase 2.

The short-listed corridors broadly:

• Follow the alignment of the existing long-distance rail network.
• Provide access to larger regional towns and cities along coastal New South Wales (NSW) and inland Victoria enhancing the accessibility of these areas.
• Have lower capital costs for infrastructure and land acquisition than other options.
• Have the highest net benefits of those options examined.
• Minimise potential impacts on national parks and other sensitive land uses.

Urban access in major metropolitan areas would be predominantly by tunnel. Within urban areas, the combined construction and land costs involved in tunnelling are comparable with those of surface alignments and would permit higher operating speeds and reduce environmental impact.

Regulatory frameworks exist to protect infrastructure corridors in each state and territory, although there are differences between approaches.

Stations

The following city centre station locations were short-listed for further analysis in phase 2:

• Roma Street Station and South Bank in Brisbane.
• Central Station, Eveleigh, Homebush and Parramatta in Sydney.
• Southern Cross Station and North Melbourne in Melbourne.
• Civic and Canberra Airport in Canberra.

Patronage demand analysis suggests that central business district (CBD) locations would be the major trip generator and attractor in each city. Stations closest to the CBD would generate the most demand for a HSR network.

Peripheral stations were considered for Brisbane, Sydney and Melbourne, typically located towards the urban boundary where there is good access to the arterial road network. Zones in which these stations should be considered are proposed, with the final location of periphery stations subject to the optimum alignment of HSR tunnels, availability of appropriate sites and potential transport connections.
Sydney and Melbourne airports have not been short-listed because initial patronage demand forecasts indicate most HSR demand would be for travel to the CBDs, rather than to airports. Further analysis has been recommended in phase 2 to confirm assumptions made in phase 1 regarding demand for access to air services.

The following regional areas have sufficient size and demand to warrant a regional or parkway HSR station, although other regional station opportunities may exist:

- Brisbane to Newcastle: Gold Coast, Far North Coast, Northern Rivers, Mid North Coast
- Newcastle to Sydney: Central Coast
- Sydney to Canberra: Southern Highlands, Illawarra
- Canberra to Melbourne: Riverina, Murray, Goulburn Valley

HSR demand is relatively insensitive to the precise location of regional stations if appropriate access is provided between the nearest cities or towns and the HSR station.
Cost estimates and risk for short-listed corridors

The risk-adjusted cost estimates of the individual short-listed corridors are presented below. The risk-adjusted cost estimates are expressed in terms of P10 to P90, derived from probabilistic risk analysis. The P10, P50 and P90 estimates have a 10 per cent, 50 per cent and 90 per cent chance of not being exceeded respectively.

<table>
<thead>
<tr>
<th>Segment</th>
<th>Corridor name</th>
<th>Length (km)</th>
<th>Stations (no.)</th>
<th>Cost estimate adjusted for risk ($2011 billion)1</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>P10</td>
</tr>
<tr>
<td>Brisbane to Newcastle</td>
<td>3 Direct Corridor (via Beaudesert)</td>
<td>676</td>
<td>4</td>
<td>$ 21.7</td>
</tr>
<tr>
<td></td>
<td>3a Direct Corridor (via Gold Coast)</td>
<td>701</td>
<td>5</td>
<td>$ 24.9</td>
</tr>
<tr>
<td></td>
<td>4 Coastal Corridor (via Beaudesert)</td>
<td>701</td>
<td>7</td>
<td>$ 20.0</td>
</tr>
<tr>
<td></td>
<td>5 Coastal Corridor (via Gold Coast)</td>
<td>706</td>
<td>8</td>
<td>$ 22.2</td>
</tr>
<tr>
<td>Newcastle to Sydney</td>
<td>8 Central Coast Corridor</td>
<td>120</td>
<td>4</td>
<td>$10.7</td>
</tr>
<tr>
<td>Sydney to Canberra</td>
<td>11 Hume Highway Corridor (via Southern Highlands)</td>
<td>271</td>
<td>4</td>
<td>$10.9</td>
</tr>
<tr>
<td></td>
<td>12 Princes Highway Corridor (via Wollongong and Southern Highlands)</td>
<td>290</td>
<td>5</td>
<td>$15.0</td>
</tr>
<tr>
<td>Canberra to Melbourne</td>
<td>14a Hume Highway Corridor (via Wagga Wagga and Albury-Wodonga)</td>
<td>552</td>
<td>4</td>
<td>$19.5</td>
</tr>
</tbody>
</table>

Cost estimates for segments of an HSR network are summarised in the following graphic.

Risk-adjusted cost estimate ranges for study area segments, P10 to P90 ($2011)1

Note: The figure above is schematic only and is not to scale.

1 Combining risk adjusted cost estimates would affect the risk profile – the P10 estimate of a combination of route segments has a lower probability than the sum of the P10 estimates of the individual segments.
Forecast patronage demand

The population of the east coast states and territory of Australia is forecast to increase from 18 million people in 2011 to 28 million people by 2056. Over 100 million long-distance trips are made on the east coast of Australia each year, and this is forecast to grow to 264 million long-distance trips over the next 45 years.

On the basis of demographic forecasts, assumed fares and operational characteristics, the patronage demand forecasts suggest that by 2036, 54 million people may use an HSR network each year. Regional demand represents a significant component of total patronage, with approximately 50 per cent of travel found to be related to areas outside Brisbane, Sydney and Melbourne.

It is predicted that approximately eight million passengers could travel on a HSR network between Sydney and Melbourne in 2036, and 3.5 million passengers between Brisbane and Sydney in 2036. This equates to approximately half of the projected air market for both sectors in 2036. These forecasts assume inter-city HSR fares comparable with inter-city air fares.

Travel on HSR between Newcastle, the Central Coast and Sydney is predicted to be approximately 15 million trips in 2036, of which approximately five million would be commuting trips. These forecasts assume HSR fares between Newcastle and Sydney would be $16.50 for commuters, $30 for non-business travellers and $60 for business travellers (one-way in 2011 dollars). Between Gosford and Sydney, HSR fares are assumed to be $14.25 for commuters, $26 for non-business travellers and $53 for business travellers (one-way in 2011 dollars). Lower fares for commuters reflect a potential subsidy for these trips.

Forecast patronage demand was found to be sensitive to changes in HSR fare levels, but less so to changes in air fares, as regional travel demand, of which air travel is a relatively small component, would be less affected. Patronage was also found to be sensitive to HSR travel time, with mainly inter-city travel affected, due to the close competition with air.

The study confirmed that inter-city non-stop running times could be approximately:

- Three hours between Brisbane and Sydney and Sydney and Melbourne.
- Forty minutes between Newcastle and Sydney.
- One hour between Sydney and Canberra.

Key project parameters

Key project parameters for the phase 1 study included:

- Economic analysis assumed an appraisal period of 20 years from 2036, being an indicative operational year for an HSR network.
- The network infrastructure would be a double-track standard-gauge electrified line with maximum operating speed of 200 km/h within urban areas and 350 km/h elsewhere.
- Services would initially be operated by eight car sets with the potential for train size to be increased to 12 or 16 cars as required by patronage demand, and would be a mixture of inter-city express services and regional services stopping at intermediate stations.
- Non-stop travel times between the major centres would depend on the precise alignment selected but would typically be around three hours between Brisbane and Sydney and Sydney and Melbourne and 40 minutes between Newcastle and Sydney.
- The patronage forecasts allowed for accessibility of HSR stations, as well as the relative costs, travel times and service frequencies of alternative modes.
- Non urban stations would serve major regional centres, either directly or as parkway stations. These would typically be at intervals of 70 to 100 kilometres, although closer spacing is likely if sections also carry outer-suburban regional services.
- Access from the urban boundary to city centre stations in major metropolitan areas would largely be through dedicated tunnel.
- HSR fares were assumed to be similar on average to current inter-city air fares, air travel times were assumed to be similar to current times, and HSR service frequencies were assumed to be hourly or better, depending on route and service type.
- Commuter demand modelling for the Newcastle to Sydney corridor was based on fares of $16.50 and $14.25 for Newcastle to Sydney and Gosford to Sydney respectively (one-way in 2011 dollars). Lower fares for commuters reflect a potential subsidy for these trips.
Overview of study methodology

Patronage demand forecasting

A base corridor was used to predict patronage of a HSR network in 2036, based on forecast travel demand and assumptions about competing modes.

An east coast model and a Newcastle to Sydney model were developed to address the following questions:

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

The east coast model was designed to estimate market size and mode share from the National Visitors Survey, which includes business and non-business trips over 50 kilometres between the main cities and the towns in the corridor, but excludes commuting trips.

Travel demand growth was projected as a function of future population growth in the corridor and income growth, based on techniques used by Bureau of Infrastructure, Transport and Regional Economics (BITRE). Models of mode choice and induced travel were developed using a combination of international and local evidence to estimate diversion to HSR services and the induced travel brought about by consequent improvements in accessibility.

The Newcastle to Sydney model had a similar form to the east coast model, but focussed on commuting travel. Estimates of the market size and mode shares were derived from the 2006 National Population Census.

Growth in commuting demand was then projected as a function of the future population growth projections in the corridor and growth in employment in Sydney and Parramatta. A model of commuter mode choice in the corridor was developed to estimate diversion to HSR services.

The presence of a HSR service to Sydney could substantially improve the accessibility of Sydney’s employment to the workforce resident in the corridor, encouraging a larger proportion of the workforce to commute to Sydney (or Parramatta). A model of the relationship between this propensity to commute and accessibility has been developed using the evidence of current commuting propensities in the corridor (derived from the Census).

Model outputs were benchmarked against international HSR systems and previous Australian HSR studies.

Corridor appraisal

Long-list corridors were identified within the study area to enable a broad comparison between, for example inland corridors and coastal corridors. These were selected on the basis of:

- Long-distance travel demand characteristics, including towns and cities linked by air routes. These centres include coastal cities in northern NSW and inland cities through southern NSW and northern Victoria.
- Existing transport corridors, as they tend to link regional cities and towns. These are broadly the New England and Pacific Highways through northern NSW, and the Hume and Princes Highways through southern NSW and Victoria.
- Corridors considered in previous HSR studies to provide a comparison using current population, patronage demand, environmental and engineering information.
- Major road and rail projects to identify potential synergies for inter-operability, congestion relief or shared use of corridors.
An initial appraisal assessed long-list corridors qualitatively against a number of criteria: potential development benefits, potential connectivity with other transport systems, land use and environment impacts, potential future population catchment, and indicative capital costs. Poorly performing corridors were excluded from further analysis, while the best performing were taken forward to a medium-list.

A largely quantitative appraisal of the medium-list corridors was undertaken to identify a short-list. This analysis was undertaken on corridors from city centre to city centre (including city access corridors). The appraisal compared corridors against a base corridor for each segment of the study area using four criteria: land use and environmental impacts; costs and benefits; social, economic and regional development; and policy and strategy fit.

**Station appraisal**

Four types of HSR station have been identified: ‘city centre’, ‘city-peripheral’, ‘regional’ and ‘airport’. City centre and peripheral stations serve the city and wider metropolitan areas, while regional stations connect regional communities to each other and the capital cities. Airport stations could provide access to air services for HSR passengers.

For each capital city, a long-list of possible city centre and city-peripheral stations (and associated access corridors) was identified based on market proximity, transport capacity, surface land use and environmental impact. Potential city centre HSR stations were assessed qualitatively to identify a medium-list, with further analysis and assessment undertaken to identify a short-list of stations.

Potential regional and parkway stations were identified on the basis of likely patronage demand to regional areas.

**Cost estimation**

Costs have been estimated to enable the comparison of various corridor and station options (together with economic benefits and other factors). They have been based on the strategic information available at this stage of the study only and a probability assessment has been undertaken to confirm a confidence range for the estimates.

Some cost issues, such as timing or prioritisation of corridors, are common to all options and have therefore been excluded from the appraisal. Costs were also considered to be comparative against a base option, rather than absolute against a without-HSR scenario. These issues are expected to be considered in phase 2 of the study.

Costs for the comparative assessment of medium-list corridors were estimated using quantities for representative alignments and unit prices developed from actual construction project data. Station costs were estimated on the basis of predicted size, construction method and physical location. It was necessary to use a range of assumptions in preparing these cost estimates, due to the strategic level of information available for potential corridors and stations. Risk associated with these assumptions has been considered using probabilistic estimation techniques.
Further issues for consideration

While this study has recommended a study area for phase 2, it has identified five key issues that need to be resolved to refine route alignments further:

• The Newcastle to Sydney corridor (Appendix A) has significant topographical and environmental constraints. In addition, existing road and rail links are congested, particularly for rail freight. The population of this region is forecast to grow, placing additional pressures on the transport system. There are several options for integrating HSR services with the conventional inter-urban services which need to be examined in more detail.

• HSR access to Sydney’s CBD could be directly to a terminus within this vicinity, or indirectly through a terminus in either Parramatta or Homebush (combined with urban rail services). The analysis in this study indicates significant differences in the capital cost and travel demand of these two options, with a HSR station in Parramatta potentially reducing patronage demand by 10 per cent. Further analysis is required to confirm the preferred location of a HSR station in Sydney, and the potential for integrating existing and proposed urban rail services with HSR.

• Wollongong and the Illawarra Region have a significant population that may benefit from HSR services. However, the surrounding terrain makes the provision of HSR infrastructure challenging and a corridor directly serving Wollongong is likely to have more significant environmental impacts than an inland corridor via the Southern Highlands. Further engineering and environmental appraisal is required to confirm the preferred alignment in this region.

• The phase 1 study has identified an access corridor in Melbourne which passes close to Melbourne Airport. While HSR services will not provide suitable Airport Rail Link services, there are potential synergies from the joint use of an access corridor and infrastructure by HSR and the proposed Airport Rail Link services between Melbourne’s Tullamarine airport and the city’s CBD.

• This study has identified a corridor following the Federal Highway as the most suitable access corridor to Canberra, with relatively low environmental impacts, lower costs and a good strategic fit with planning frameworks. To the south and west, the corridor should follow an alignment serving the Riverina and Albury-Wodonga. These two corridors could be used to access Canberra in a ‘through’ or ‘spur’ configuration. These alternate configurations would affect the length of corridor through Canberra, the form of HSR station and may require a HSR junction to the north of Canberra. Further operational and engineering analysis is recommended in phase 2 to examine the impacts of these configurations on HSR patronage demand and costs.

Scope of phase 2

The second phase of the study will build on the first, but will be considerably broader and deeper in scope. On the basis of detailed investigations and analysis, relevant international experience and the appraisal of alternatives, the second phase will be required to provide advice on:

• The medium- to long-term projected travel market.
• HSR system options that could serve the projected travel market effectively.
• The aggregate and segmented travel demand and market shares that could be expected to be attained.
• Preferred corridor, alignment, transport product(s) and system specification.
• The optimum program for staging the physical construction of the preferred HSR system.
• The specific environmental, social, urban and regional development and economic impacts of the recommended HSR program, and the overall net cost or benefit of those impacts to Australia.
• The nature and cost of complementary access projects and their contribution to achieving the assessed performance of the HSR program.
• The financing needs, financial performance and commercial viability of the HSR program.
• Any commercial financing gap and ways of funding such gap.
• The key risks to the HSR program and its successful performance, the implications of these risks and possible mitigation measures, if any.
• The most appropriate institutional framework for governance, planning, procurement, construction and operation of the HSR program and for the implementation of integrated urban and regional development policies in the HSR corridor.
• An effective implementation plan for creating the recommended institutional framework and delivering the HSR program.

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2 Request for expression of interest for the second phase of a strategic study into the implementation of a high speed rail network on the east coast of Australia, Department of Infrastructure and Transport, June 2011.
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