ARTC

Melbourne–Brisbane
Inland Rail Alignment Study

Final Report July 2010

Appendix E
Route Development

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1. Introduction

1.1 Background

This appendix forms a key part of the analysis to determine the inland railway optimum route from Melbourne to Brisbane within the far-western sub-corridor. In Appendix D the total study area for the inland railway was researched based on data relating to technical features of the route options: fundamental engineering data, high level environmental constraints and operational measures. These were used to establish the available route options and inform the more detailed analysis in this appendix. An initial environmental assessment and capital cost and journey time estimates for the inland route were also provided in Appendix D to guide analysis in this appendix.

1.2 Objectives

From the options presented in Appendix D for the far-western corridor, this appendix conducts a rigorous analysis and evaluation process to identify a single alignment for the inland railway.

This alignment is presented in Appendix F – Route Maps. The final alignment has been costed in Appendix J, environmentally analysed in Appendix H and operationally analysed in Appendix G.

The outcomes from these papers, in particular route distance, transit time and cost estimates to construct and operate the railway, as well as the location of the route relative to freight in the region, are incorporated into the financial and economic assessment of Inland Rail (Appendix L) and the market take up analysis (Appendix B).

1.3 Outline

The approach to the route analysis presented in this appendix firstly considers broad route selection, then progresses through to detailed alignment refinement. To narrow the plethora of options down to a single alignment option the study adopted a process where the options were analysed in stages. At each stage the options were analysed to a certain level of detail to enable key decisions to be made. The remaining options were then further analysed to enable further refinement of the route options. The stages presented in this appendix are:

- Identification of the route (section 2 of this appendix)
- Analysis of the route (section 3 of this appendix)
- Development of the alignment (section 4 of this appendix).

The analysis criteria range from environmental assessment, journey time analysis, demand forecasts, and financial and economic viability. Each section in this appendix presents the analysis conducted and the route options progressed to the following stage of analysis.

Section 2, Identification of the route, stipulates demand, overall journey time and capital cost as key criteria to assess the route options. These criteria are used to analyse the high-level route options and present a number of options for further consideration.

Analysis of the route, section 3, conducts more detailed environment, journey time and capital cost assessment of the refined route options. This analysis presents options for demand analysis and financial and economic appraisal. This assessment presents a single route option for alignment development.

Section 4, Development of the alignment conducts detailed environment, capital cost and operational analysis of more specific options related to the alignment. The issues for each alignment section are discussed and a single alignment is decided.

2. Identification of the route

2.1 Introduction

The objectives of this section of the appendix are to:

- Undertake a robust analysis of the route options
- Determine the route to be progressed for further examination in the analysis of the route (section 0).

This section divides the route into three parts and analyses the different route options for each. The preferred options are then combined to analyse the total route characteristics to determine the route to be progressed for further analysis.

The results presented in this section are preliminary results, for the purpose of route comparison only. The study proposed alignment was examined in further detail. The final results are contained in the final report and the appropriate appendix, for example capital costs can be found in Appendix J. The figures in this appendix may therefore differ from the final results.

2.2 Approach to route examination

The characteristics and details of numerous route options and sections provide a plethora of possible alternatives for the overall route between Melbourne and Brisbane. In all, there were over 50,000 possibilities. Because it was obviously not feasible to analyse each of them, the following key criteria were adopted for the purpose of route selection:

- Capital cost
- Journey time.

These criteria were used to establish a shortlist of route options to be subjected to more detailed technical, financial and economic assessment.

Journey time versus capital cost analysis

The overall route was divided into three areas: Melbourne to Parkes; Parkes to Moree; and Moree to Brisbane. Each of these areas was analysed to identify the routes that would present the best value through that area.

After all options were included on a graph of indicative journey time against capital cost, an ‘efficiency frontier’ was identified for each area. This involved identifying the set of options with the lowest capital cost for any given journey time. This set then comprised those options worthy of further consideration.

This analysis is illustrated in Figure 2-1 below.

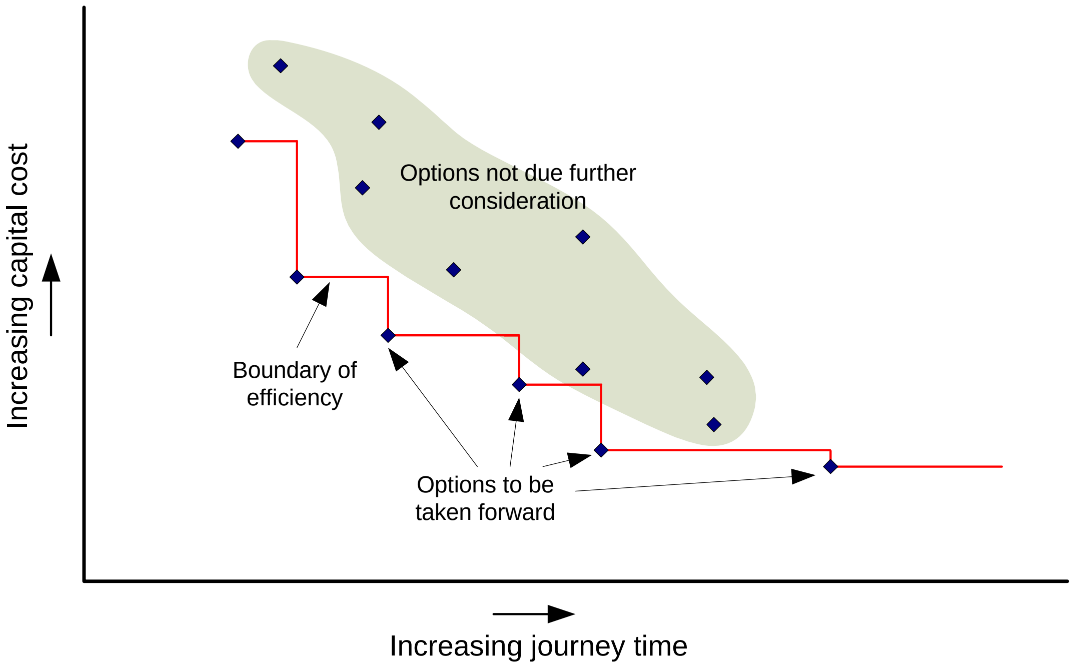

Figure 2-1 Analysis of options in each area

After conducting this analysis, further reduction of the number of options to be taken forward was achieved by eliminating similar options that could be considered variants of each other or eliminating options where the increased capital cost was clearly not justified by a marginal increase in journey time.

After indentifying the best value options in each area, Melbourne to Brisbane routes can be achieved by any combination of the selected routes from Melbourne to Parkes, Parkes to Moree and Moree to Brisbane. These combinations were identified and graphed in the same way as for each individual area, again with the boundary of efficiency identified (and shown in red at Figure 2-1) and sub-optimal options eliminated.

2.3 Melbourne to Parkes

Route through the Melbourne to Parkes area

The two key route options through the Melbourne to Parkes area were:

- The Albury route option – which either:
  - uses all existing track from Melbourne to Parkes (including the deviation at Wodonga) or
  - uses the existing line through Albury (including the deviation at Wodonga) then uses the existing lines through to Parkes, but incorporating a new direct line by-passing Cootamundra or
- The Shepparton route option which follows the existing broad gauge Mangalore-Tocumwal line via Shepparton that would require re-building and conversion to standard gauge. It would then follow the disused standard gauge line to Narrandera (a direct greenfield standard gauge track from Finley-Jerilderie would be required). From here there would be two alternatives:
  - construction of a new direct connection through to Caragabal and Forbes where it rejoins existing standard gauge track through to Parkes or

– using existing track from Narrandera to Junee where, as above, it would use the existing line to Parkes or a new direct connection from Junee to Stockinbingal (by-passing Cootamundra).

A summary level map of the route options is provided in Figure 2-2 below.

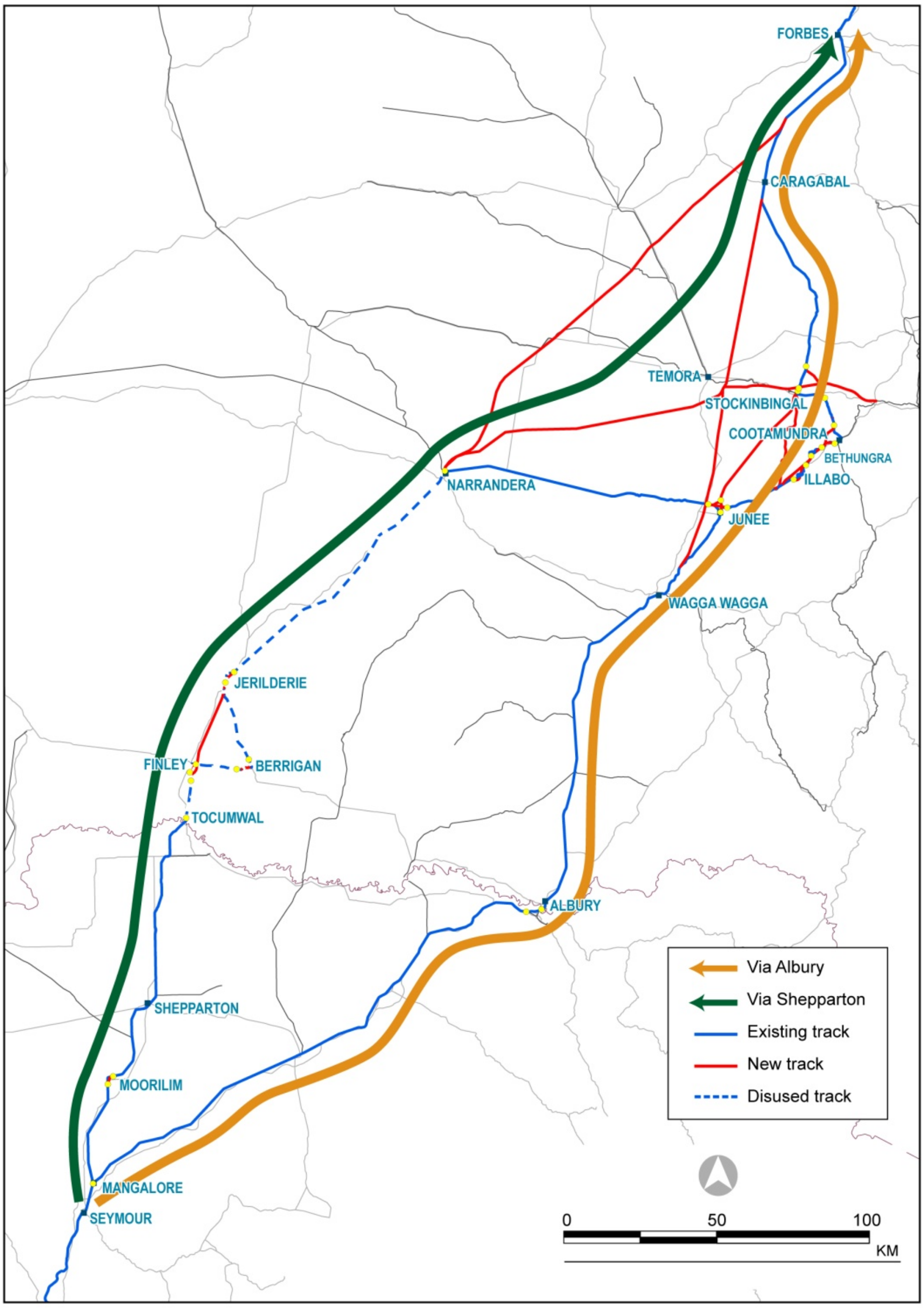

Figure 2-2 Albury and Shepparton route options

Demand assessment for the Shepparton and Albury route options

compares the key performances indicators of the Albury and Shepparton route options. In addition to these performance attributes there are no capacity issues in the medium term on either route.

Table 2-1 Melbourne to Parkes route options comparative table

Parameter	Via Shepparton to Caragabal	Via Shepparton through Junee	Via Albury (do nothing)	Via Albury (with Cootamundra by-pass)
Transit time Melbourne-Parkes (mins)(1)	516	600	590	562
Preliminary capital cost estimate Mangalore-Parkes ($million)	1,069	803	0	139
Regional demand (million net tonnes in 2030)	0.470	0.470	0	0
Route distance Melbourne-Parkes (km)	657	776	732	696
Track maintenance cost pa ($million)	19	22	21	20
Incremental access fees pa ($million) – Shepparton-Mangalore (in 2030)	0.7	0.8	0	0

Note: Routes GG01, AB14, AB01 and AB 13 respectively.

1. At assumed average speed of 88 km/h for flat and straight, and 63 km/h for high gradient and curvy.

This analysis shows that the additional demand generated by directing the inland railway via Shepparton does not justify the additional capital expenditure.

Transit time and capital cost assessment

Figure 2-3 below shows the results of analysis of a transit time and capital cost assessment for the Melbourne to Parkes area. Journey time between Melbourne and Parkes ranges between 516 and 600 minutes, with cost ranging from $0 (travelling along the existing route) to $1.1 billion. The red line on the graph indicates the ‘efficiency frontier’ where journey time and capital cost are optimised.

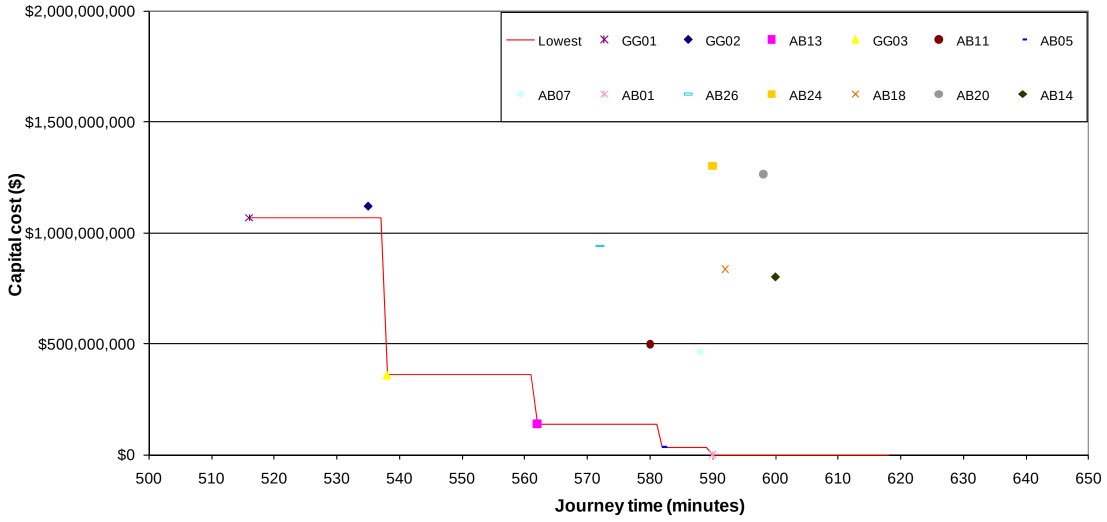

Figure 2-3 Analysis of options in the Melbourne to Parkes area

Figure 2-4 shows the data points for individual options to illustrate the Shepparton and Albury options. It shows that the Shepparton options would all be more expensive than Albury options and that the route via Shepparton and Junee is considerably slower. The exception to this is where a new corridor is constructed from Narrandera (or near Narrandera) to intersect with the Stockinbingal to Parkes corridor (for example, GG01 above). In contrast, routes via Albury all have the advantage that no capital cost would be required to Junee or beyond due to the current upgrade program on this corridor.

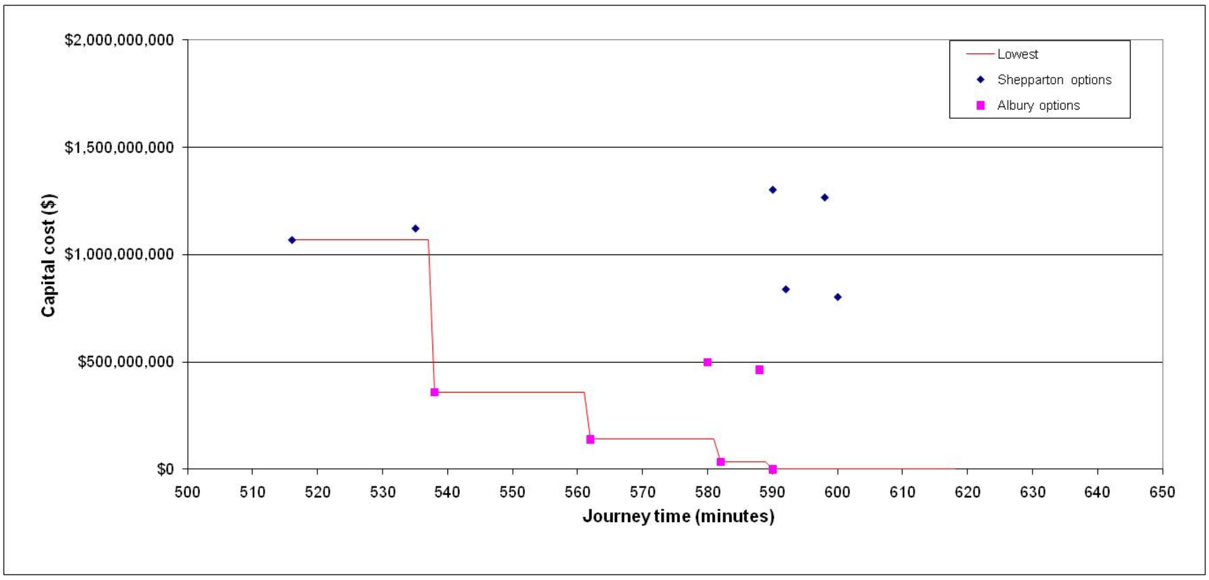

Figure 2-4 Melbourne to Parkes analysis showing Shepparton and Albury options

The options that define the efficiency frontier are shown in the table below.

Table 2-2 Preferred options from the Melbourne to Parkes area

Name	Km	Mins	Capital cost ($ million)	Comments
GG01	657	516	1,069	Route via Shepparton, with new corridor from Narrandera to near Forbes
GG03	656	538	360	Route via Albury, with new corridor from near Wagga to Caragabal
AB13	696	562	139	Route via Albury with new connection from Junee to Stockinbingal
AB05	724	582	36	Route via Albury with deviations
AB01	732	590	0	Existing corridor via Albury

Note: Preliminary results only for the purpose of route comparison.

In identifying options to go forward for further analysis, AB05 was eliminated as this option essentially consists of AB01 with some deviations. These deviations will be considered along with all other potential deviations in Section 0, Analysis of the route.

Assessment of the Melbourne to Parkes area

For the Melbourne to Parkes area, the Albury routes offer superior outcomes for the key criteria of capital costs and transit time. Though the fastest Shepparton route offered a transit time that is about 30 minutes faster, this route attracted a significant extra capital cost (adding over $900 million to the project relative to Albury alternatives). The longer Shepparton route (through Junee) would have been slower than either Albury alternatives, and it had a net extra capital cost ranging from $665-804 million (in comparison to both Albury routes); therefore, it was the least attractive of the southern route options.

The advantages of the Shepparton route, by including more regional freight and being more suitable for double stacking, did not offset the sizable advantage of the Albury route, being the minimal capital expenditure required to achieve an almost comparable transit time.[1] In addition, it is understood that capacity of the Albury route, now being duplicated, will not be constrained for a long time.

This conclusion does not preclude a future standard gauge inland railway being established later through Shepparton which could provide extra capacity in the event the Mangalore-Junee section becomes constrained. In the event extra capacity is required for this southern section of a potential inland route, the land corridor between Shepparton-Tocumwal-Narrandera is available for potential future use, provided that the disused line from Tocumwal to Narrandera is retained.

In relation to rail servicing more of the future general freight demand from the Shepparton catchment area, arguably, if volumes continue to build, there may become an economic case for conversion of the existing broad gauge line to a significantly improved standard gauge line between Tocumwal and the port of Melbourne as this is the destination of much of this regional traffic. If such a line were to be established, it could also include a standard gauge triangle at Mangalore to facilitate fast connection for Shepparton traffic onto the inland railway for northbound journeys towards Brisbane, Sydney or Perth. High level estimates of

[1] The greatest impediment to double-stacking from Melbourne is the Bunbury Street tunnel which affects both routes equally. Further, part of the ARTC infrastructure strategy involves upgrading the current Melbourne to Sydney line (through Albury) for double-stacking by 2015/16

the cost of standardising the line between Shepparton and Mangalore including a triangle are in the range of $100-150 million.

A number of previous studies have supported the Albury route as the superior route, as discussed below.

Box 1 Melbourne to Parkes area findings of previous studies

North-South Rail Corridor Study

The study has reviewed work completed in the North-South Rail Corridor Study (NCRS) to assist in the Shepparton or Albury route decision analysis. The NSRCS found that whilst the Shepparton alternative gained marginally more regional freight (mainly 0.3-0.4 million extra tonnes of grain) through better servicing southern NSW and northern Victorian traffic, this potential extra access revenue was not deemed to offset other disadvantages including higher capital cost. It should be noted that the NSRCS assumed that the Shepparton route would use the line from Narrandera to Junee where it would rejoin the 'via Albury' route. The current study regarded the primary Shepparton route as including a new line from Narrandera to near Forbes. This gives a reduced transit time at a higher capital cost.

It was concluded in the NSRCS that the Albury route was the superior route due to it having:

- faster transit time – it has a transit time 0.8 hours faster (48 minutes) that would translate into lower operating costs
- lower capital costs – its capital cost was estimated in 2006 by Hyder Consulting as $480m lower
- an established and operable Class 1 freight line – in comparison to much of the Shepparton alternative which would have required new construction or major reconstruction of formations and full track construction; by comparison, the Albury route was likely to result in lower environmental and planning approval costs and risks.

Other studies and analysis

In response to the NSRCS, the Greater Shepparton City Council engaged Maunsell AECOM in 2007 to perform a review of the study to gain a better understanding of why Albury was considered a more attractive alternative than Shepparton. The Maunsell report suggested that:

- Infrastructure costs for the Shepparton route were possibly over-stated by $200 million (reducing the capital cost difference from the NSRCS to $280 million)
- Costs as a result of future capacity increases on the Albury route were also not considered
- Indirect economic benefits of the Shepparton route were not considered (e.g. new employment created) and there were some inconsistencies in the way economic benefits were presented in the 2006 study
- The comparison of travel times was not on a like by like basis and via Shepparton is only 8-16 minutes slower
- The potential for a capital cost contribution from the Victorian Government was not taken into account[2]
- The Shepparton route has better potential to achieve double stacking.

In 2008, a follow-up study by Sinclair Knight Merz (SKM) was commissioned by the Food Bowl Inland Rail Alliance (FBIRA), a group of 18 local councils between Mitchell Shire and Narrandera, and was project managed by the Greater Shepparton City Council. The SKM study mainly recapitulated the previous Maunsell study findings but it also provided some new analysis including findings that:

- An additional 1.4 mt of regional freight in 2008 (rising to 1.7 mt in 2020) could be attracted to rail if an efficient standard gauge alignment is established via Shepparton. SKM estimate this as an additional $30.7m revenue to the NSW Rail Infrastructure Corporation (RIC) and ARTC
- Freight users in the region will benefit from cheaper transporting costs and alternative transport options
- As a result of capturing a higher share of the freight market onto rail there is reduction in road maintenance costs from having fewer trucks on the road. This same mode shift will also generate carbon and fuel savings
- The 'Food Bowl' line will possibly provide an additional 128 direct jobs in the long run (ongoing roles). This excludes construction jobs, as these would be recognised in both the Albury and Shepparton routes

[2] Victorian Government is contributing $171m for current upgrading of the track that it already leases to ARTC between Melbourne and Albury.

Box 1 Melbourne to Parkes area findings of previous studies

- Benefits from offering double stacking for the Melbourne-Perth route (via Shepparton, Roto and Broken Hill) could be realised, given other rail track upgrades are performed.[3]
- Furthermore, the Victorian Department of Transport also made a submission to ARTC observing that previous studies have not given sufficient credit to the Shepparton route with regards to the alternative route providing:
- Additional growth benefits to the Food Bowl region
- Synergies and induced benefits from the a new rail link in the national rail network
- Potential for new rail operating and marketing strategies – i.e. as a result of double stacking.

[3] SKM 2008, Benefits from developing the Melbourne to Brisbane inland railway along the Food Bowl alignment, commissioned by FBIRA

2.4

2.5 Parkes to Moree

Route through the Parkes to Moree area

From Moree to Brisbane there are four main routes, some of which possess multiple route options. The four routes are as follows:

- Parkes to Moree via Werris Creek
- Parkes to Moree via Binnaway and Narrabri
- Parkes to Moree via Curban and Gwabegar
- Parkes to Moree via Burren Junction.

The primary route options are identified in Figure 2-5 below.

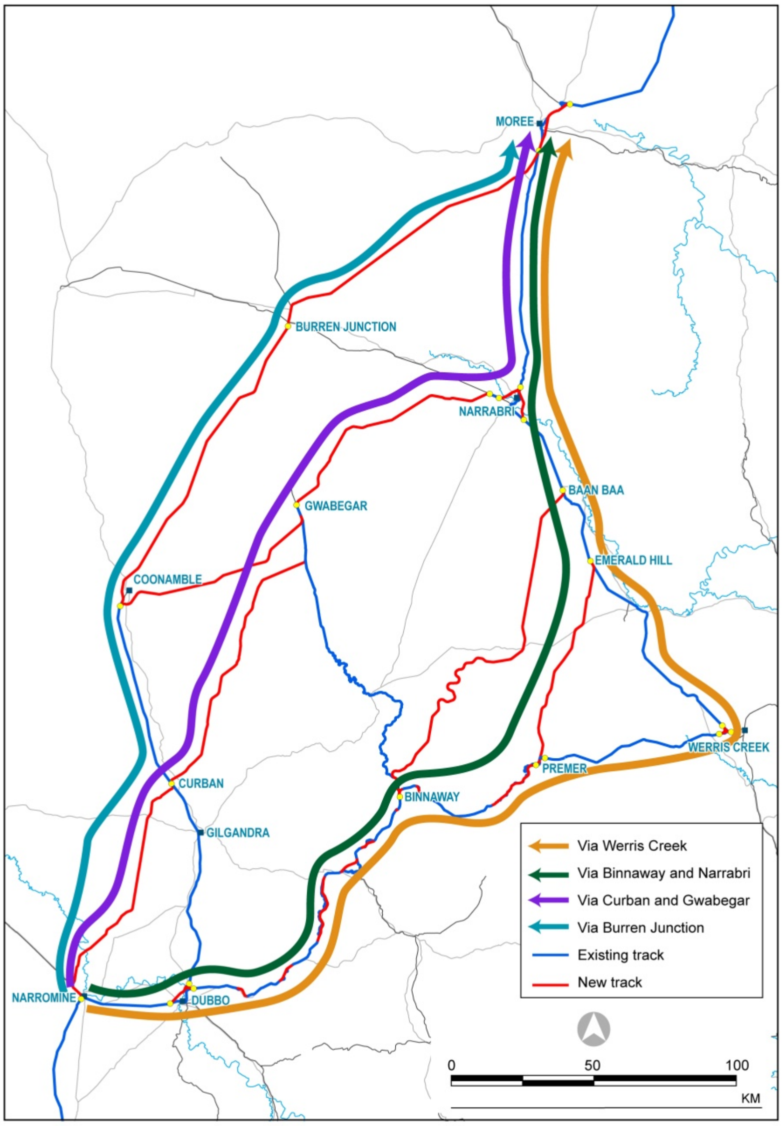

Figure 2-5 Parkes to Moree routes

Demand assessment for the Parkes to Moree route options

There were over 50 route options through central NSW (mainly between Narromine and Moree). These route options involved a mix of upgrading existing track or establishing new shorter connections to reduce transit time. Within the Parkes to Moree area, variation in regional demand did not represent a significant factor for differentiating the route options as many regional freight lines are available for connection to the inland railway, for example the railway from Dubbo to Coonamble.

Transit time and capital cost assessment

Figure 2-6 below shows the results of analysis of the Parkes to Moree options. Journey time between Parkes and Moree has a much wider range than in the Melbourne to Parkes area – extending between 341 and 724 minutes – for a similar range in capital cost. This illustrates the variety of options in this area, with the slower but cheaper options largely using the existing corridor via Werris Creek and the faster options including large sections of new corridor in the western part of the area, via Coonamble, Burren Junction and/or Narrabri. As previously, the red line on the graph indicates the efficiency frontier.

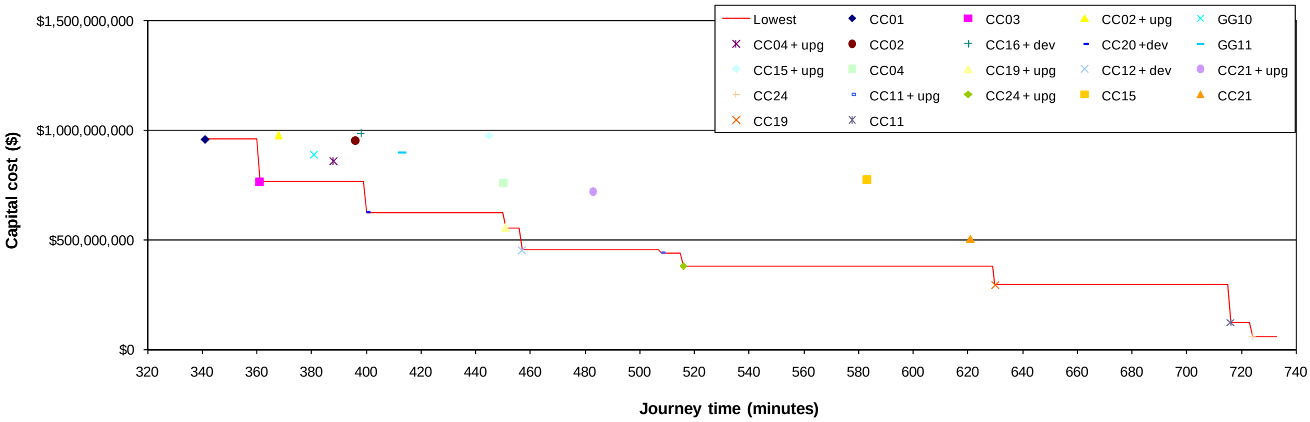

Figure 2-6 Analysis of options in the Parkes to Moree area

Assessment of the Melbourne to Parkes area

The options that define the efficiency frontier in the Parkes to Moree area are shown in Table 2-3 below.

Table 2-3 Preferred options from the Parkes to Moree area

Name	Km	Mins	Capital Cost ($ million)	Comments
CC01	503	341	960	Route via Coonamble and Burren Junction
CC03	536	361	768	Route via Curban, Gwabegar and Narrabri
CC20 + deviations	578	400	627	Existing route with new connection Premer to Emerald Hill, plus upgrade and deviations
CC19 + upgrade	594	451	557	Existing route with new connection Premer to Emerald Hill, plus upgrade
CC12 + deviations	602	457	455	Existing route with upgrade and deviations
CC11 + upgrade	678	500	444	Existing route with upgrade and deviations
CC24 +	686	516	382	Existing route with upgrade

Name	Km	Mins	Capital Cost ($ million)	Comments
upgrade				
CC19	594	630	297	Existing route with new connection Premer to Emerald Hill, no upgrade
CC11	678	716	125	Existing route with deviations
CC24	686	724	61	Existing route

Note: Preliminary results only for the purpose of route comparison.

In identifying options for further analysis, the following area routes were retained; other options were considered to be largely variants of those selected, with the variants to be subject to further analysis (in section 0):

- CC03 – the more cost effective of the faster options
- CC20 + deviations – the 'limit' to what may be achieved with a small section of new corridor (CC19 similar)
- CC24 + upgrade – a 'reasonable' Base Case to give high standard track (deviations to be considered upon selection of a route)
- CC24 – the minimum cost possible.

2.6 Moree to Brisbane

Routes through the Moree to Brisbane area

The optimal route for the section on the approach to Brisbane, between Inglewood and Acacia Ridge has been the subject of debate and significant analysis in prior inland rail studies. The Toowoomba and Little Liverpool Range area represents a considerable cost and operational challenge to an inland rail project meeting the required performance criteria. The challenge in developing an optimal route for the Inglewood to Acacia Ridge section was to balance transit time with capital expenditure. Considerable design work and analysis was performed in this region which went beyond the depth of a range of prior studies. This analysis has confirmed that almost 50% of the capital cost estimated for an inland railway is incurred over this last 26% of the route distance as the line descends from an elevation of 690 m at Toowoomba or 450 m at Warwick to 60-80 m over a horizontal distance of approximately 20-30 km.

Akin to the route through northern Victoria and southern NSW, two distinct route options existed. These were:

- The Warwick route – a new 'greenfield' route via Warwick to the existing standard gauge Sydney-Brisbane line. This could have the potential to reduce distance by providing a more direct link to the south side of Brisbane. Such a line would cross the range to the east of Warwick and traverse parts of the Main Range National Park near the NSW/Queensland border
- The Toowoomba route – a new corridor direct from Inglewood to Millmerran and Oakey, near Toowoomba, and then a new Gowrie to Grandchester link; thence using the proposed Southern Freight Rail Corridor from Rosewood to Kagaru.

A summary level map of the alignments for the route options is provided in Figure 2-7 below.

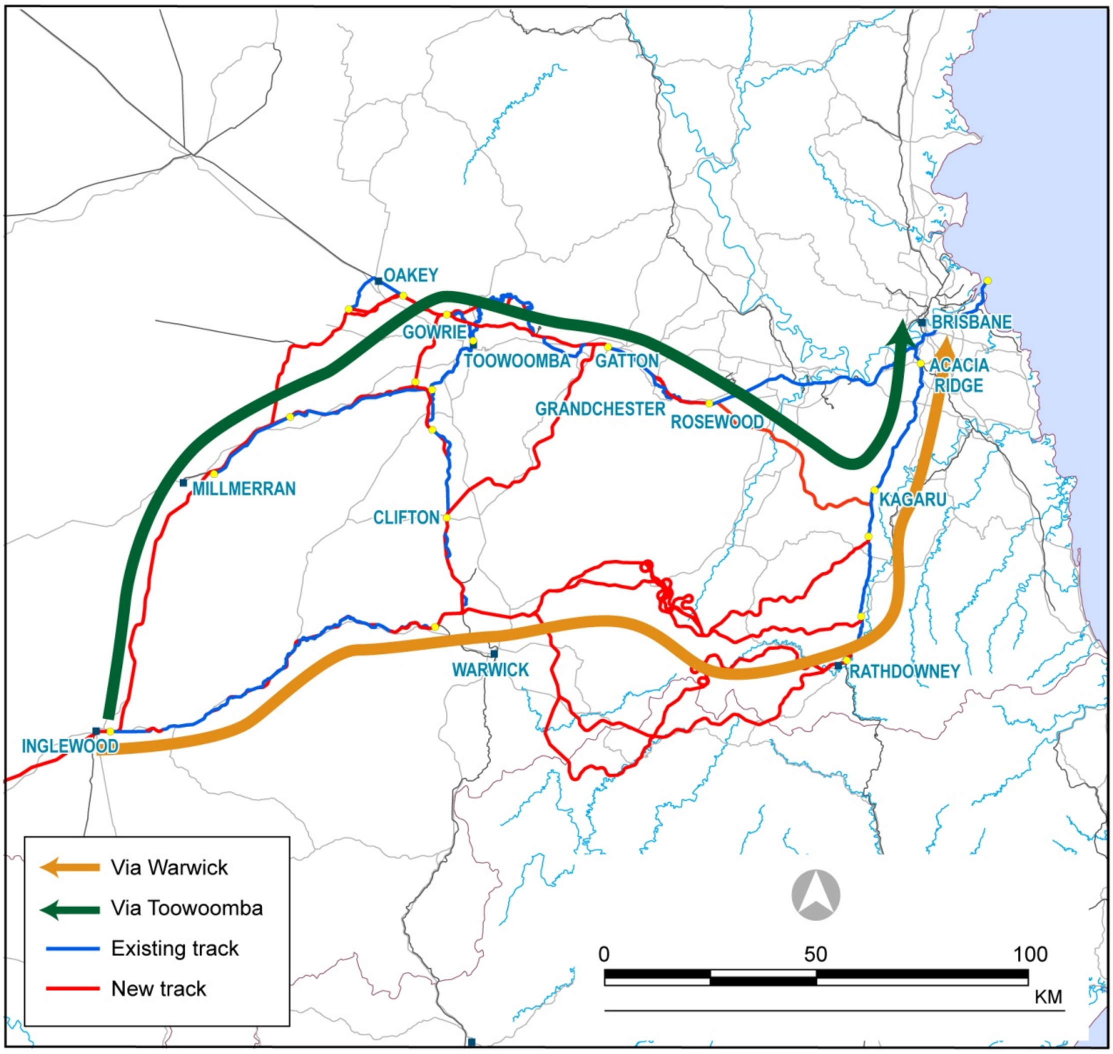

Figure 2-7 Moree to Brisbane via Toowoomba or Warwick

Demand and economic assessment for the Toowoomba and Warwick route options

Like the analysis for the Albury versus Shepparton route options, the key factors considered to optimise the route decision between Toowoomba and Warwick were the differences in capital cost, transit times, demand and economic viability.

The following table compares key performance attributes of the Warwick and Toowoomba route options. In addition to these performance attributes, it was established that there would be no capacity constraints for one or two decades on either route

Table 2-4 Brisbane approach route options comparative table

Parameter	Via Warwick (and Tamrookum)	Via Toowoomba*	Difference
Transit Time Moree - Brisbane (mins)(1)	345	364	(19)
Preliminary capital cost estimate Moree-Brisbane ($million)	2,279	1,826	453
Regional demand (million net tonnes in 2030)	0 (2)	10.8	(10.8)
Route distance Moree - Brisbane (km)	454	487	(33)
Track maintenance cost pa ($million)	3.44	3.71	(0.27)
Incremental access fees pa ($million) – Inglewood-Kagaru (in 2030)	0	14.9	(14.9)

Note: Routes DD26 and DD02 respectively.

1. At assumed average speed of 88 km/h for flat and straight, and 63 km/h for high gradient and curvy.

2. Due to no coal freight projected via Warwick.

The table above shows that the Toowoomba option has the added benefit of capturing additional regional freight (mainly coal) compared to the Warwick option.

Transit time and capital cost assessment

The inland corridor between Melbourne and Brisbane could not exist without a connection from North Star to Brisbane. This section would also be responsible for a substantial proportion of the capital cost of the railway. Accordingly, the first requirement for the corridor as a whole will be to establish this link at ‘reasonable’ cost.

The options identified for the Moree to Brisbane area are illustrated in Figure 2-8 below. Capital costs range between $1.8 and $3.6 billion and journey time between 326 and 425 minutes.

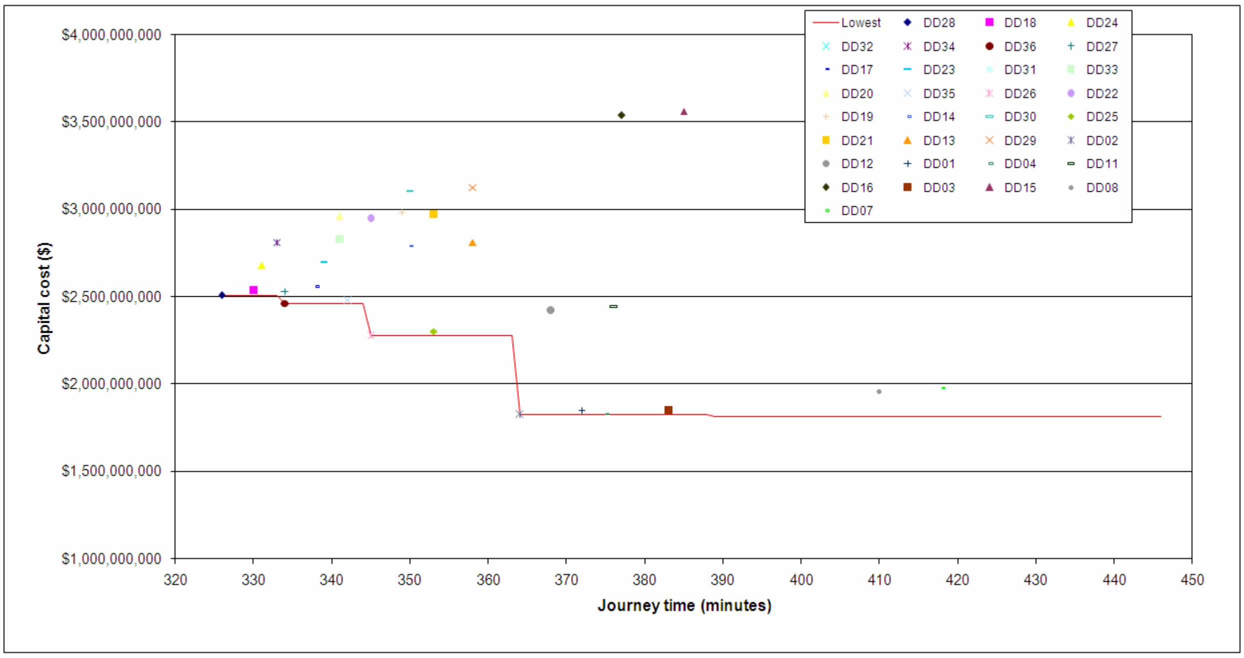

Figure 2-8 Analysis of options in the Moree to Brisbane area

A key issue was to choose whether the route of the inland railway would be via Warwick or via Toowoomba (Gowrie) - hence the figure below has been included. This graph shows identical data to the figure above except that the data points have been combined to illustrate Warwick and Toowoomba options.

It can be seen from Figure 2-9 below that Warwick options are all more expensive, but are generally faster than Toowoomba options.

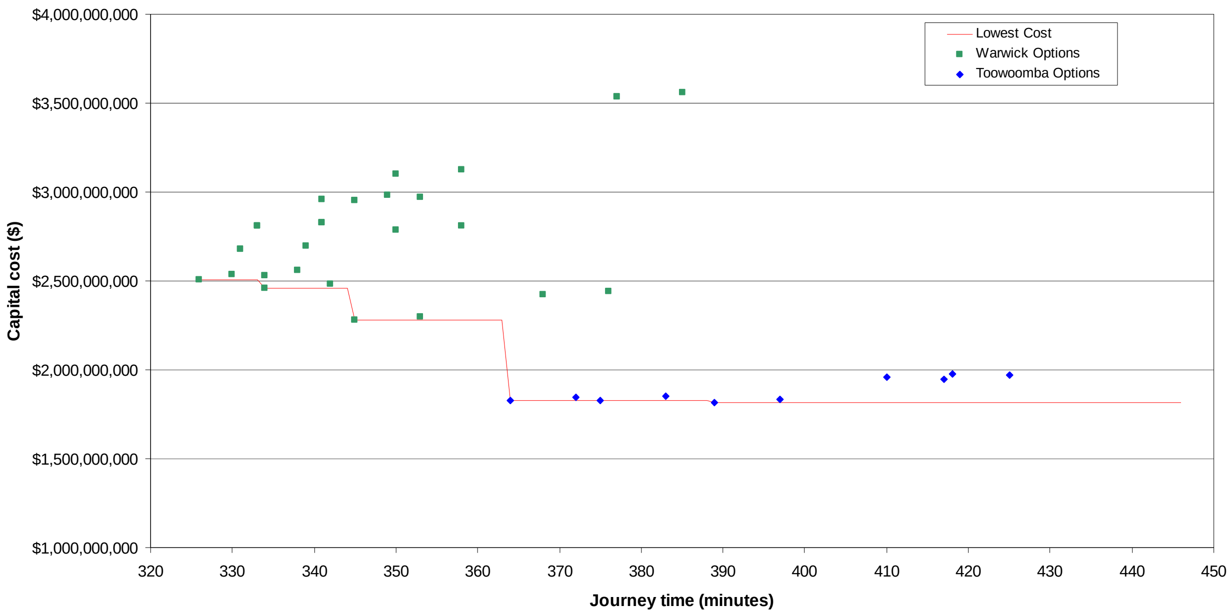

Figure 2-9 Moree to Brisbane analysis showing Warwick and Toowoomba options

The options that define the boundary of efficiency are shown in Table 2-5 below.

Table 2-5 Preferred options from the Moree to Brisbane area

Name	Km	Mins	Capital Cost ($ million)	Comments
DD28	448	326	2,507	Route via Warwick and Bromelton
DD36	444	334	2,460	Route via Warwick and Bromelton
DD26	454	345	2,279	Route via Warwick and Tamrookum
DD02	487	364	1,826	Route via Yargullen, Gowrie and Grandchester
DD06	501	389	1,814	Route via Wyreema, Gowrie and Grandchester

Note: Preliminary results only for the purpose of route comparison.

In selecting options for further analysis, one option via Warwick and one via Toowoomba were initially selected based on the transit time/capital cost analysis performed (with the other variants to be further analysed in Section 0. These were:

- Via Warwick – DD26. This is the cheapest and most cost effective of the Warwick option
- Via Toowoomba – DD02. This option is marginally more expensive than DD06, but provides a faster journey time and thus is better value for money.

Assessment of the Moree to Brisbane area

The results in the analysis above indicate that the route via Toowoomba had stronger economic merit based on its lower capital costs and the access to additional regional freight (mainly coal) than the Warwick option allows.

In relation to the relative advantages and disadvantages of both routes key differentiating factors include:

- Sections of the Toowoomba alignment have been subject to significantly more detailed design work as it is the preferred route for both QR and Queensland Transport. As such, it would be faster to progress to commencing construction.
- The route via Toowoomba (including new links from Inglewood to Millmerran) has also been preferred in separate analysis undertaken by two potential private proponents of an inland railway (GATR and ATEC). The analysis undertaken indicates that the capital cost of either a new (shorter) Inglewood to Millmerran deviation or upgrading and straightening the existing corridor via Warwick is similar. Hence given the deviation provides significant transit time saving this appears the superior route
- Cost is a significant issue in relation to the Warwick route because the descent of the escarpment requires 24 km of long viaducts and three spirals to meet the maximum ruling grade specification
- The Warwick route has some significant environmental impacts and uncertainties as it traverses national parks which create a constraint to the feasibility of this route
- In relation to regional freight, the route via Toowoomba provides a more direct connection for coal. The extent of general freight which is generated in the Toowoomba or Warwick catchments which is amenable to being serviced by a separate intra-state general freight train is uncertain. The potential is recognised for

further rail transport of coal, subject to port capacity and government policy, on a line passing near Toowoomba.

2.7 Overall route analysis

In all, there were 32 alternatives between Melbourne and Brisbane. These are graphed on the figure below, again with the red line showing the efficiency frontier.

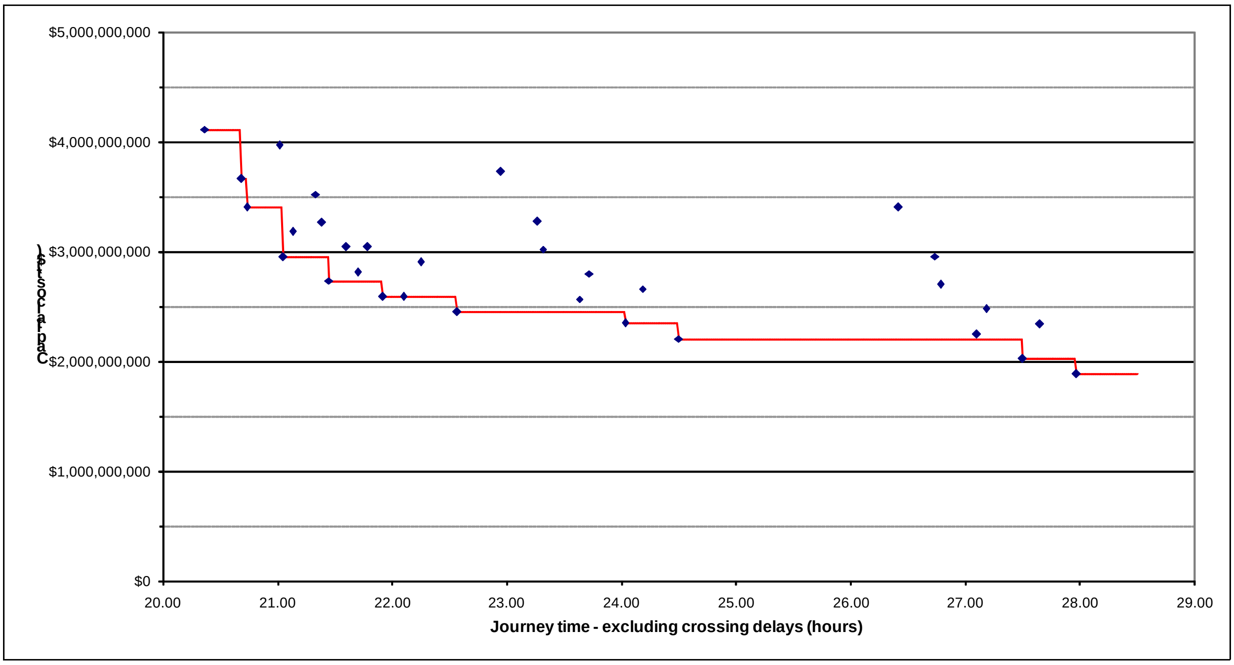

Figure 2-10 Melbourne to Brisbane routes (travel time only)

The efficiency frontier on the figure above takes a form that would be anticipated. Once a link from North Star to Brisbane is created, substantial reductions in travel time may be achieved with (comparatively) small increases in the capital expenditure. However, further reductions in travel time are achieved only with somewhat greater increases in capital expenditure.

Key findings considering different segments of journey time are:

- As transit times fall from 28 to 21 hours, the substantial gains are achieved from faster options in the Moree to Parkes area. These are, first, upgrading the existing track, then constructing a smaller deviation between Premer and Emerald Hill, then constructing a new route via Gwabegar or Coonamble. These options all pass through Albury and Toowoomba
- In this same journey time range, the smaller steps include the option of adding a direct link from Junee to Stockinbingal
- More expensive options are required to achieve a significantly faster transit time. These involve, first, moving to a Warwick route, then the route via Shepparton, then both.

Figure 2-11 below includes annotation of the graph above, showing how the route options in different geographical areas impact on the overall alignment between Melbourne and Brisbane.

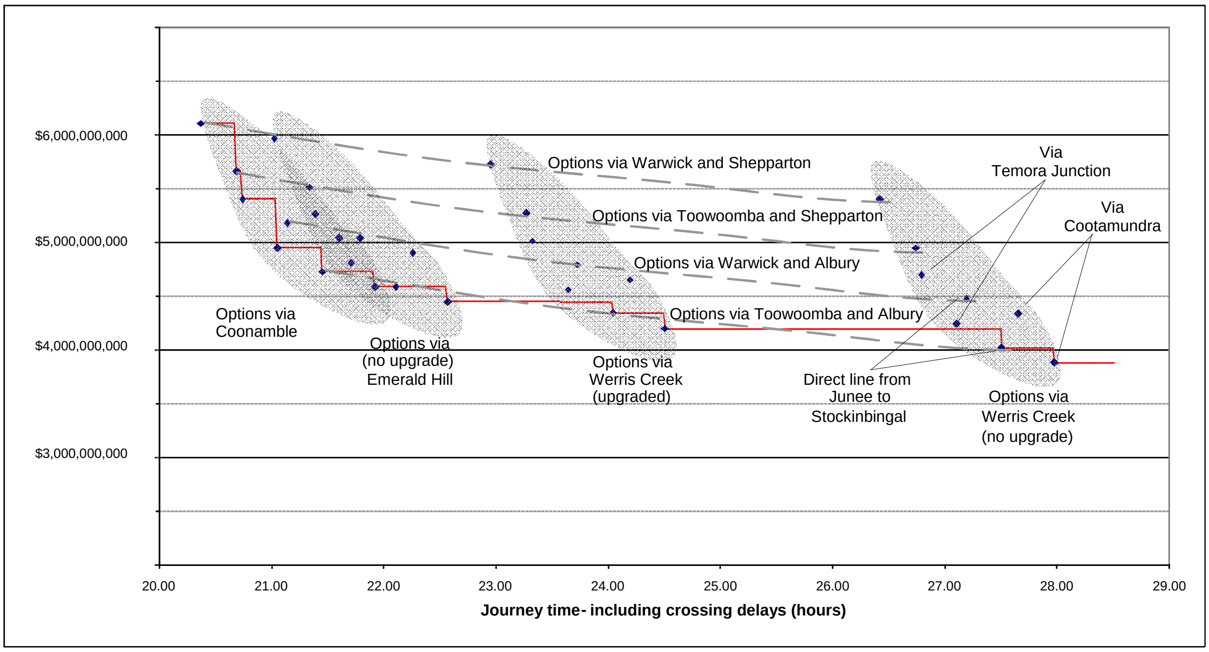

Figure 2-11 Melbourne to Brisbane routes annotated[4]

Financial and economic comparison

In the table below, economic and financial viability of the inland railway is compared considering the following route options:

- An inland railway via Albury and Toowoomba (core appraisal)
- An inland railway via Shepparton and Warwick
- An inland railway via Shepparton and Toowoomba
- An inland railway via Albury and Warwick

[4] Capital costs are preliminary and include additional project costs such as loops, client costs and environmental assessment and stakeholder management

Table 2-6 Financial and economic comparison

Scenario	(i) Financial project NPV ($ millions) Inland rail operations commence:			(ii) Economic NPV ($ millions) Inland rail operations commence:			(iii) Economic BCR Inland rail operations commence:		
	2020	2030	2040	2020	2030	2040	2020	2030	2040
Core appraisal (via Albury & Toowoomba)	-1,989.6	-655.4	-216.1	-520.4	-56.0	107.3	0.81	0.96	1.14
Inland railway via Shepparton & Warwick	-3,378.7	-1,113.7	-368.5	-2,407.1	-990.1	-344.3	0.47	0.59	0.72
Inland railway via Shepparton & Toowoomba	-3,115.5	-1,039.4	-343.1	-1,865.9	-738.5	-224.0	0.55	0.66	0.80
Inland railway via Albury & Warwick	-2,712.4	-889.8	-293.6	-1,365.8	-460.0	-88.4	0.62	0.75	0.91

As the table above suggests, financial viability would be worse under the routes via Shepparton and Warwick. This is due to the higher capital costs for those routes, which are not offset by revenue from increased demand if the route passes Shepparton. In addition, if the railway does not pass through Toowoomba, then it would not capture East Surat basin coal revenue.

In terms of economic viability, this would also be worse under the routes via Shepparton and Warwick. This is because the capital cost required increases, while the slightly shorter route length and slightly faster transit time does not produce sufficient economic benefits to offset the cost increase.

2.8 Route for further analysis

The benefits of the fastest route options did not offset the capital cost increase therefore, it was concluded that only options via Albury and Toowoomba should be taken forward for analysis.

In effect, this means that no options via Warwick or Shepparton were considered further. There was neither a sufficient demand change nor a sufficient impact on economic viability by reducing journey time to justify the additional capital expenditure in the order of $1 billion.

The routes consequently identified as requiring further analysis to determine a recommended route are depicted graphically in Figure 2-12 below. Analysis is conducted in the following section.

Figure 2-12 The inland rail routes requiring further analysis

3. Analysis of the route

3.1 Introduction

The first stage of route analysis aimed to identify a high-level route between key points along the corridor; the conclusion was that route options in the north via Toowoomba and south via Albury. However it suggests two primary route options in central NSW were preferable (plus numerous deviation possibilities along the entire Melbourne to Brisbane route).

The purpose of this section is to conduct a more detailed analysis of the route to assess the mid-section and deviation options in order to further refine the route.

The route identified in the first stage of route analysis generally comprised existing track from Melbourne to Parkes via Junee, Parkes and Narromine. Between Narromine and Narrabri the two route options were via the existing track towards Werris Creek or greenfield construction towards Gwabegar. Existing corridors would be used between Narrabri and North Star, greenfield railway to Inglewood, Millmerran, Gowrie, Grandchester/Rosewood and Kagaru (with existing narrow gauge corridors used where available). The last section from Kagaru to Acacia Ridge would use existing standard gauge track.

The results presented in this section are preliminary results, for the purpose of route comparison only. The study proposed alignment was examined in further detail. The final results are contained in the final report and the appropriate appendix, for example capital costs can be found in Appendix J. The figures in this appendix may therefore differ from the final results.

3.2 Approach to route analysis

Within the study area for these route options there were opportunities to improve the journey time by upgrading existing track or constructing deviations.

Section 3.3 presents the characteristics of the route options, which are assessed for potential environmental impacts in section 3.4. The comparative cost and journey times are presented in section 3.5 and were analysed to determine the most cost effective routes in section 3.6.

Section 3.7 establishes the fundamental route criteria to be used in the financial and economic analysis of the two route options. The demand is established in section 3.8 and the associated access revenue presented in section 3.9. Section 3.10 presents a financial and economic analysis of the two route options to determine which of the routes should be developed as the inland rail alignment.

3.3 Route characteristics

A set of assumptions and characteristics have been established to identify a ‘reference case’ with the minimum capital expenditure required to operate a Melbourne to Brisbane inland railway.

- Existing Class 1 and Class 2 track would be used where available
- Existing Class 3 or lower track would be upgraded to Class 1 track
- Train reversals would be eliminated by constructing triangles where required

- Bridges constraining operation (with severe speed restrictions) would be replaced or upgraded
- Standard gauge track would be built within the narrow gauge existing corridor, where appropriate
- Greenfield track would be built where no existing corridor exists.

The reference case assumed the use of existing track where available, to form the basis for comparison to identify the most effective improvements. It is not the proposed route as it has not been optimised to include deviations that could decrease capital cost or journey time. It was defined as a point of reference only.

It is understood that ARTC upgrades of the following sections of track are relevant to the inland railway:

- Cootamundra to Parkes (upgraded to interstate standard in 2009)
- Werris Creek to Narrabri (upgrading to allow coal freight before 2014)
- Kagaru to Acacia Ridge (upgrading to dual gauge in 2010).

3.3.1 Description of the reference case

Melbourne to Parkes

The reference case route from Melbourne to Parkes comprises existing ARTC tracks. The Melbourne to Junee section uses the existing Class 1 Main South line. The Junee to Parkes section uses the Cootamundra to Lake Cargelligo line and Stockinbingal to Parkes line.

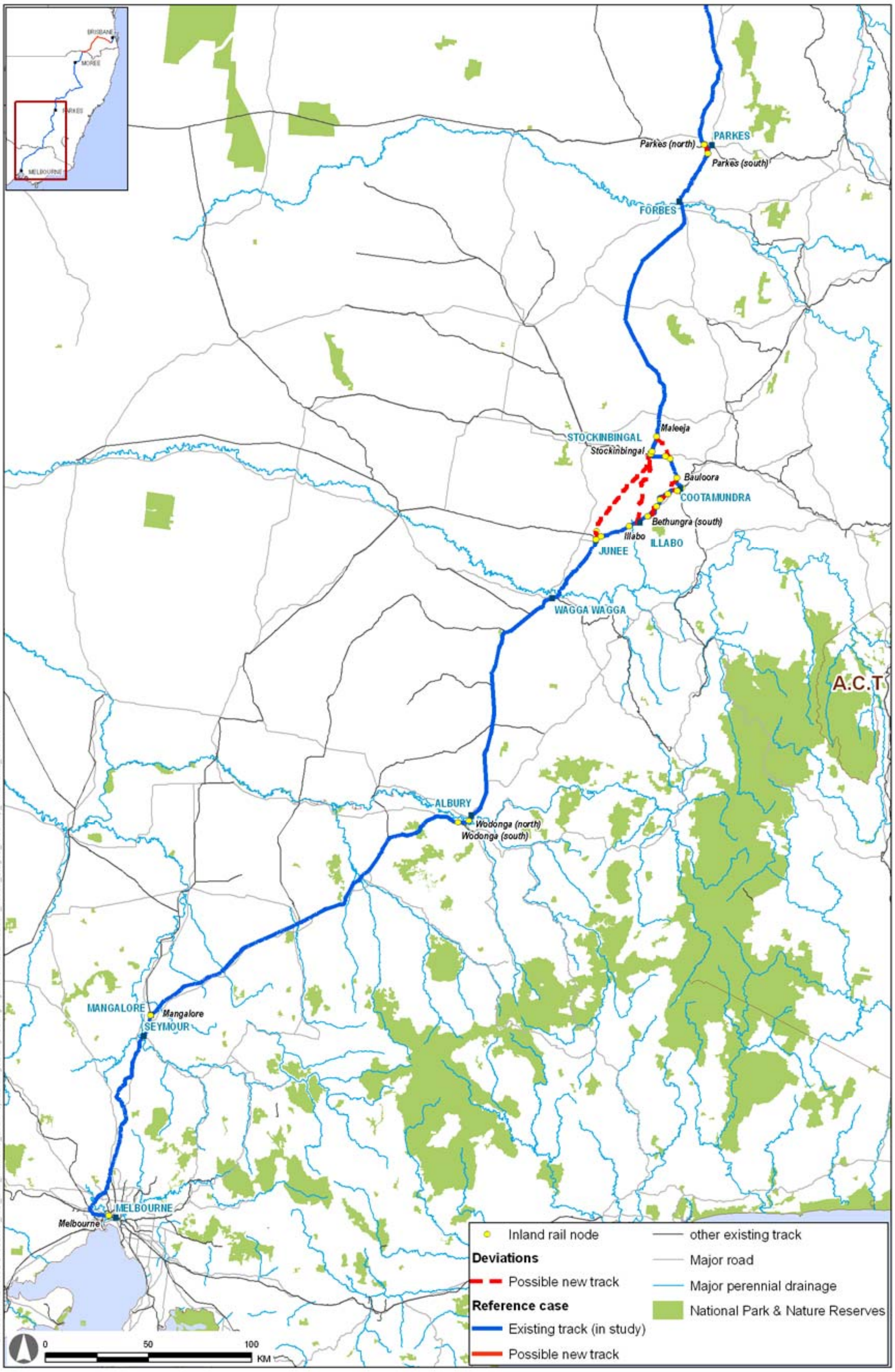

Figure 3-1 Melbourne to Parkes overview

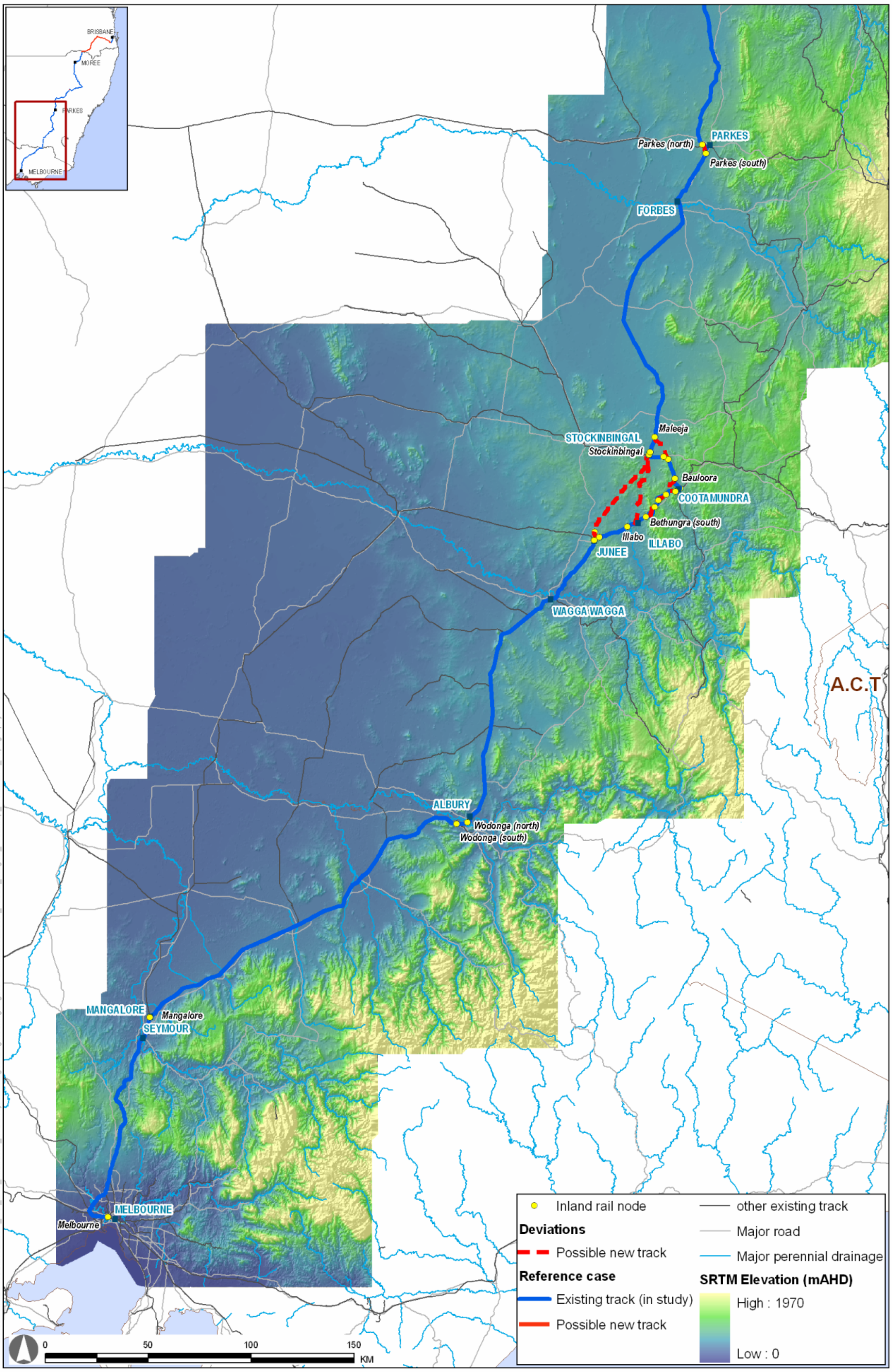

Figure 3-2 Melbourne to Parkes topography

Parkes to Moree

The reference case route from Parkes to Moree comprised existing ARTC tracks with the exception of short greenfield sections at Binnaway and Werris Creek to remove the existing reversals.

The Parkes to Dubbo section would use the Class 2 Parkes to Narromine line and the Class 2 Main West line.

Between Dubbo and Binnaway the Class 2 Dubbo to Coonamble line, Class 2 Troy Junction to Merrygoen line and Class 2 Wallerawang to Gwabegar line would be used, with a greenfield section to remove the reversal at Binnaway.

The Binnaway to Moree section would use the existing Class 2 Binnaway to Werris Creek line, with a new greenfield section to remove the reversal at Werris Creek, and the Class 1 Werris Creek to Mungindi line.

Maps of the area showing an overview of the route and the terrain follow. A hydrology map of the area has also been included due to the potential for flooding in the area.

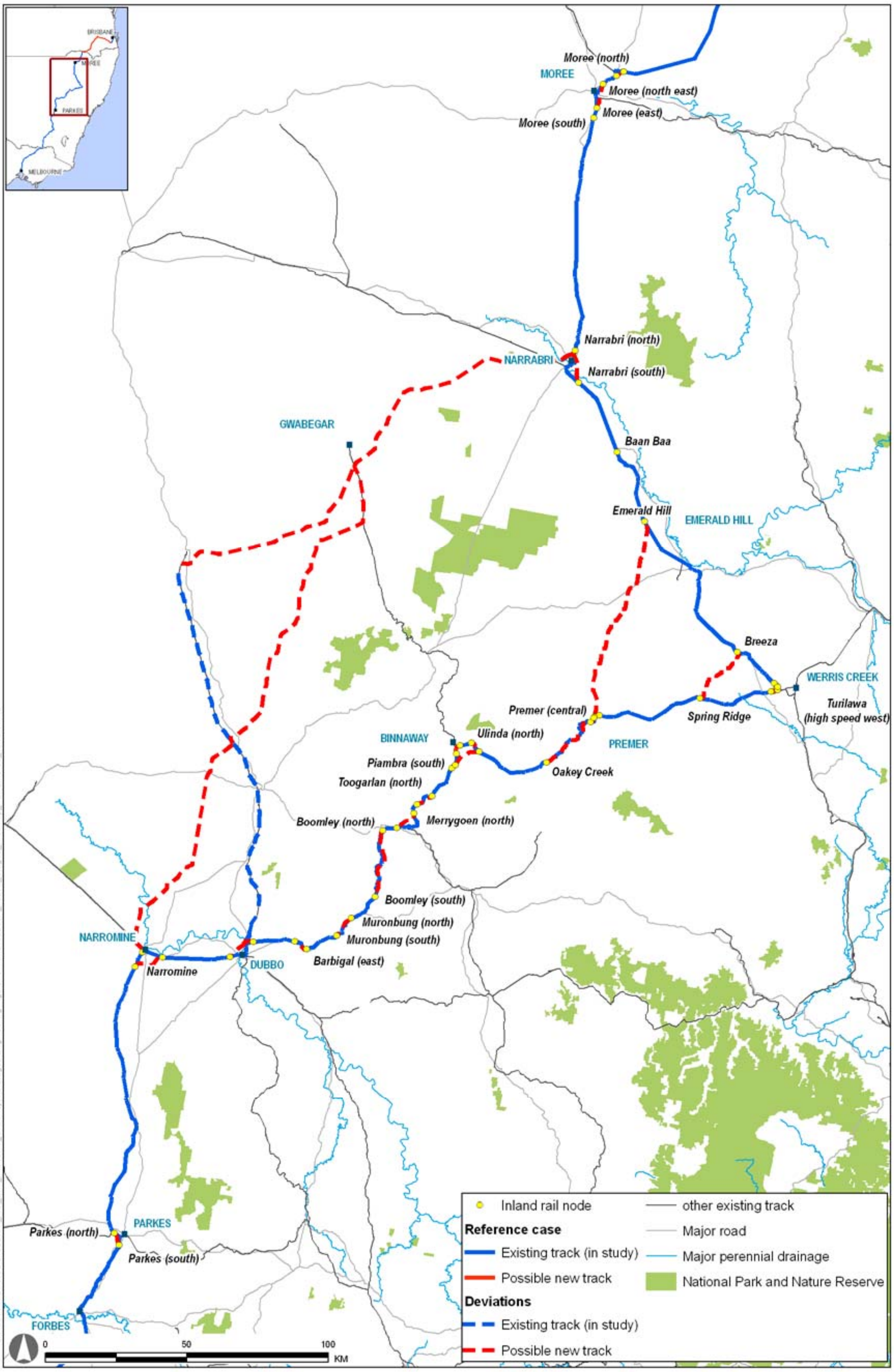

Figure 3-3 Parkes to Moree overview

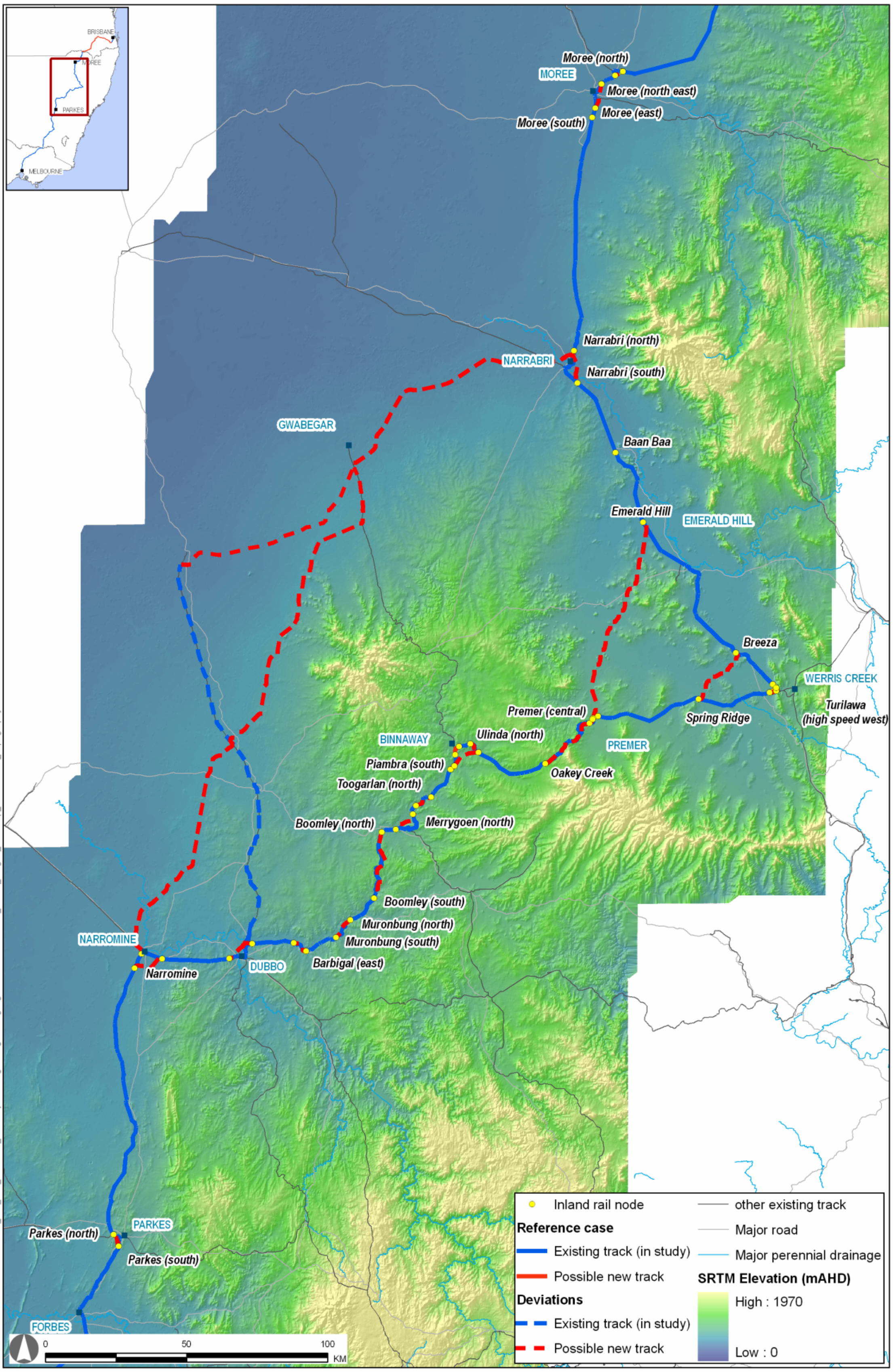

Figure 3-4 Parkes to Moree topography

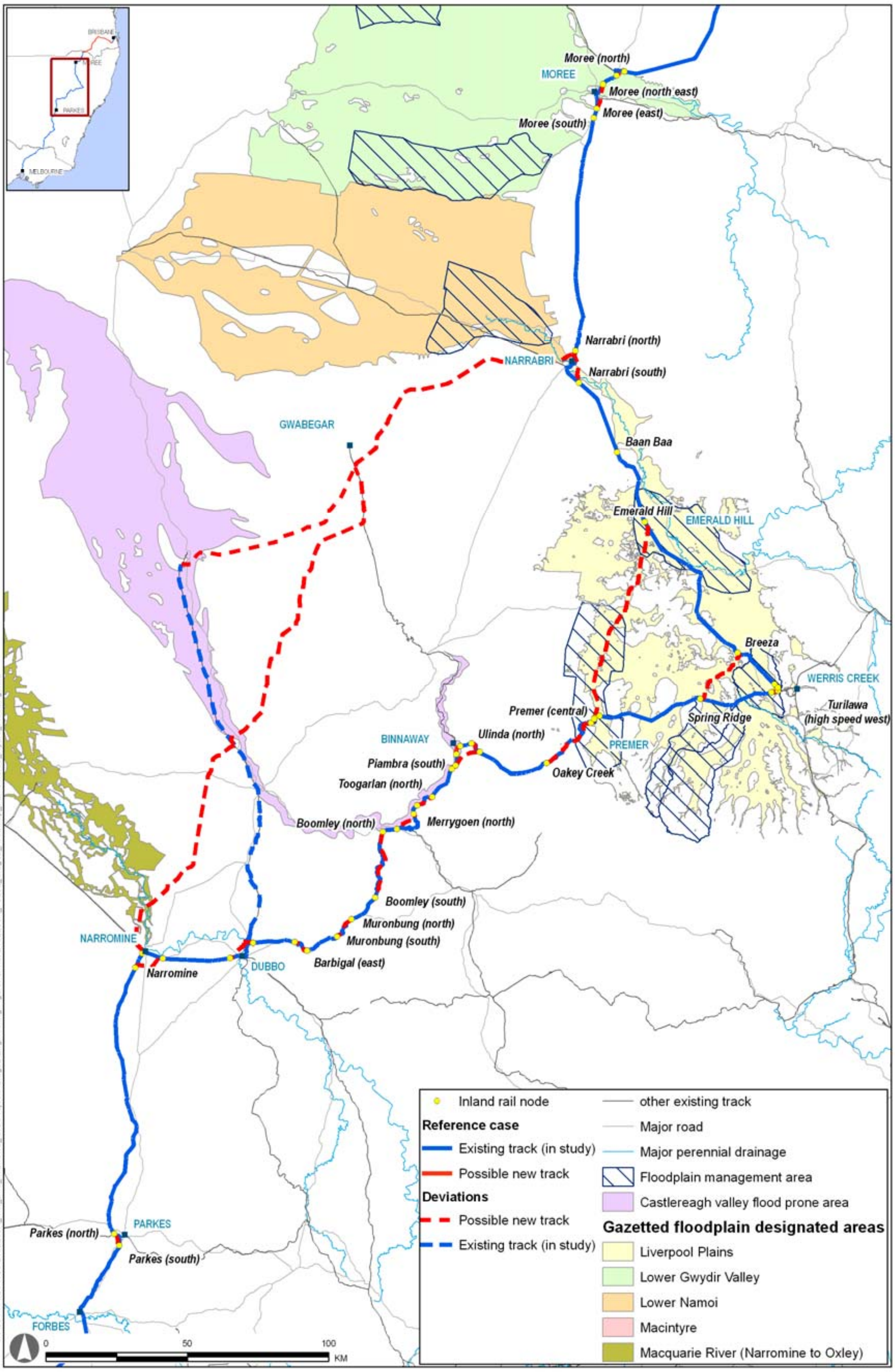

Figure 3-5 Parkes to Moree hydrology and flooding

Moree to Brisbane

The reference case route, assuming use of existing track/corridor where possible from Moree to Brisbane comprises a mixture of greenfield routes, upgraded railway within the QR narrow gauge corridor and upgrades to existing standard gauge tracks.

The Moree to Boggabilla section would involve upgrading the existing (Class 3) standard gauge Moree to North Star line and rebuilding the existing derelict standard gauge North Star to Boggabilla line.

The Boggabilla to Inglewood section would involve a greenfield section between Boggabilla and the Kildonan border crossing and the existing narrow gauge corridor of the Warwick to Dirranbandi line.

The Inglewood to Oakey section would involve a greenfield section between Inglewood and Millmerran; a new track within the existing narrow gauge alignment between Millmerran to Cecilvale; a greenfield section between Cecilvale and Yargullen; a combination of greenfield and a standard gauge rebuild of the QR Cecil Plains line between Cecilvale and Yargullen; and a section within the existing narrow gauge Dalby to Toowoomba corridor to Oakey.

The Oakey to Brisbane section would use the existing narrow gauge Toowoomba to Dalby corridor; a greenfield alignment down the range from Gowrie to Gatton; the existing narrow gauge Toowoomba to Rosewood corridor between Gatton and Grandchester; a greenfield section between Grandchester (west of Rosewood) and Kagaru; and the existing standard gauge Class 1 coastal route from Kagaru to Acacia Ridge.

Maps of the area showing an overview of the route and the terrain of the area are shown below.

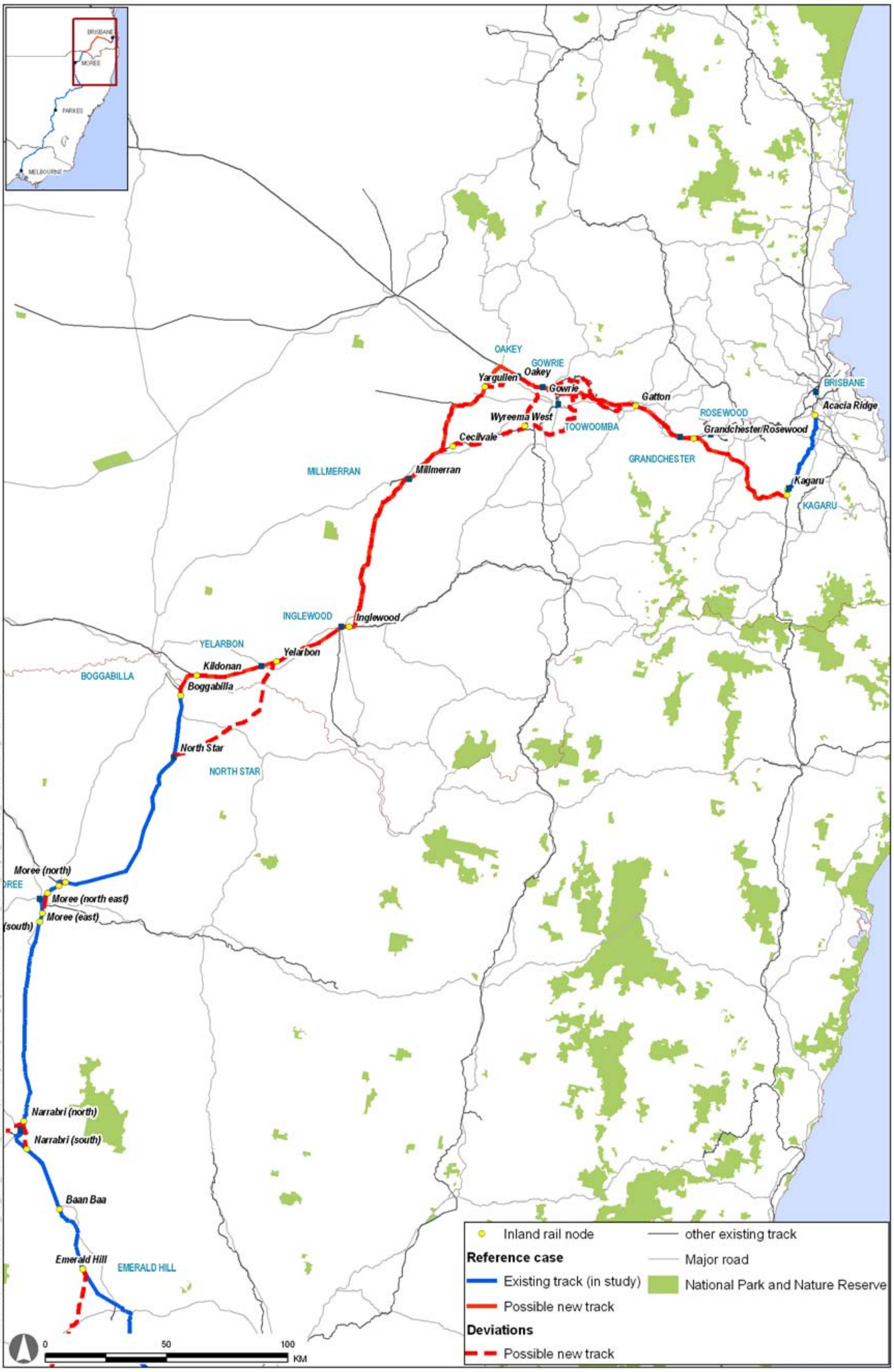

Figure 3-6 Moree to Brisbane overview

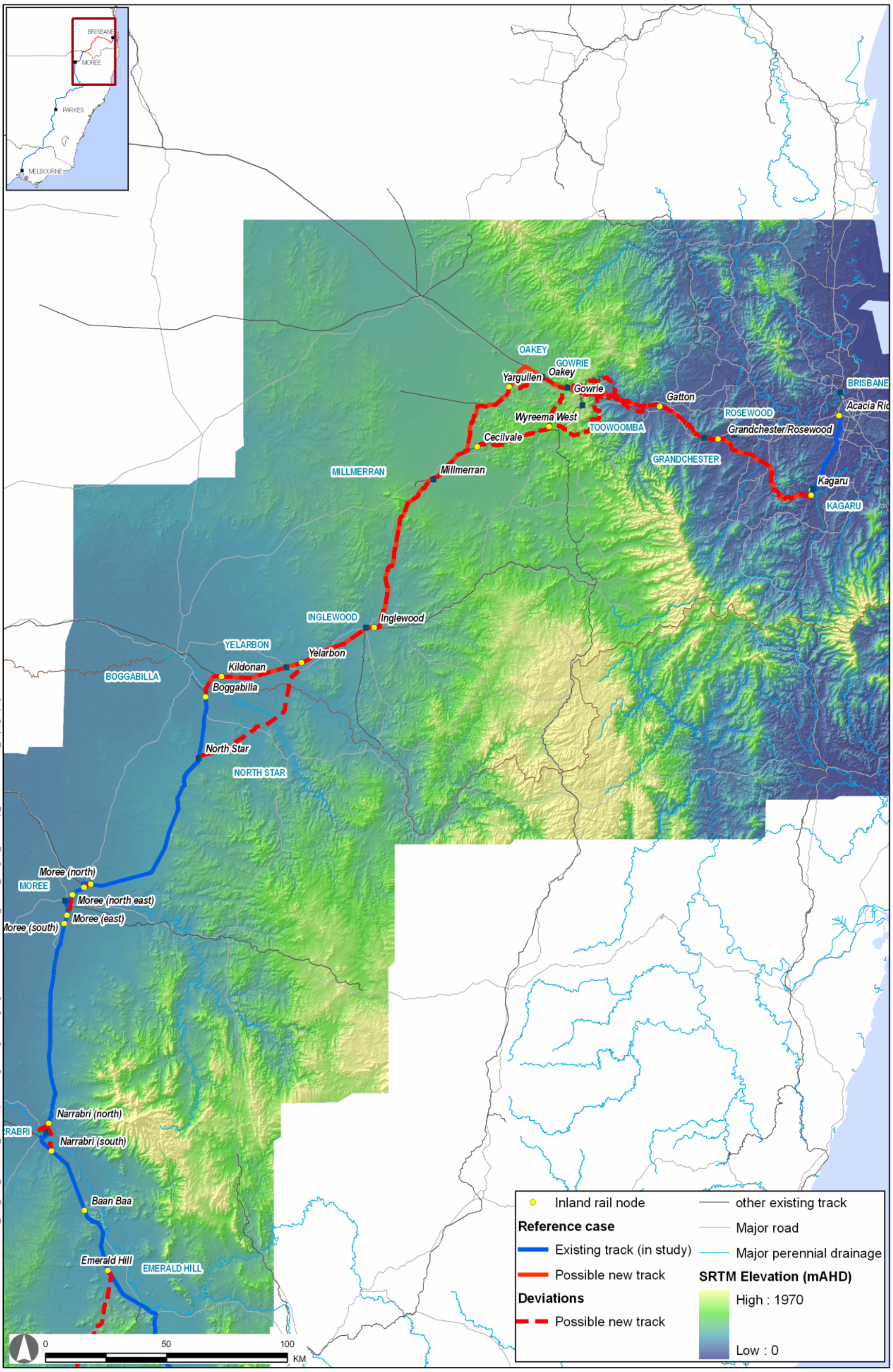

Figure 3-7 Moree to Brisbane topography

3.3.2 Deviations and upgrades

The existing railways were designed to connect freight sources with their closest capital city and were not designed for Inland Rail superfreighters. Opportunities therefore exist to improve the alignment. A deviation can improve journey time for a given capital cost, and track upgrades (from Class 2 to Class 1) can be considered in the same way. There are two areas where possible upgrades are applicable: Parkes to Werris Creek and Narrabri to Moree.

Melbourne to Parkes deviations from the reference case

The potential deviations from the reference case for the Melbourne to Parkes area are all between Junee and Parkes, with none required between Melbourne and Junee as the existing Class 1, Main South line is considered adequate.

Figure 3-8 below shows the possible deviations to replace sections of the reference case between Melbourne and Parkes. Figure 3-9 shows the area between Junee and Maleeja which contains the majority of the deviations for this area.

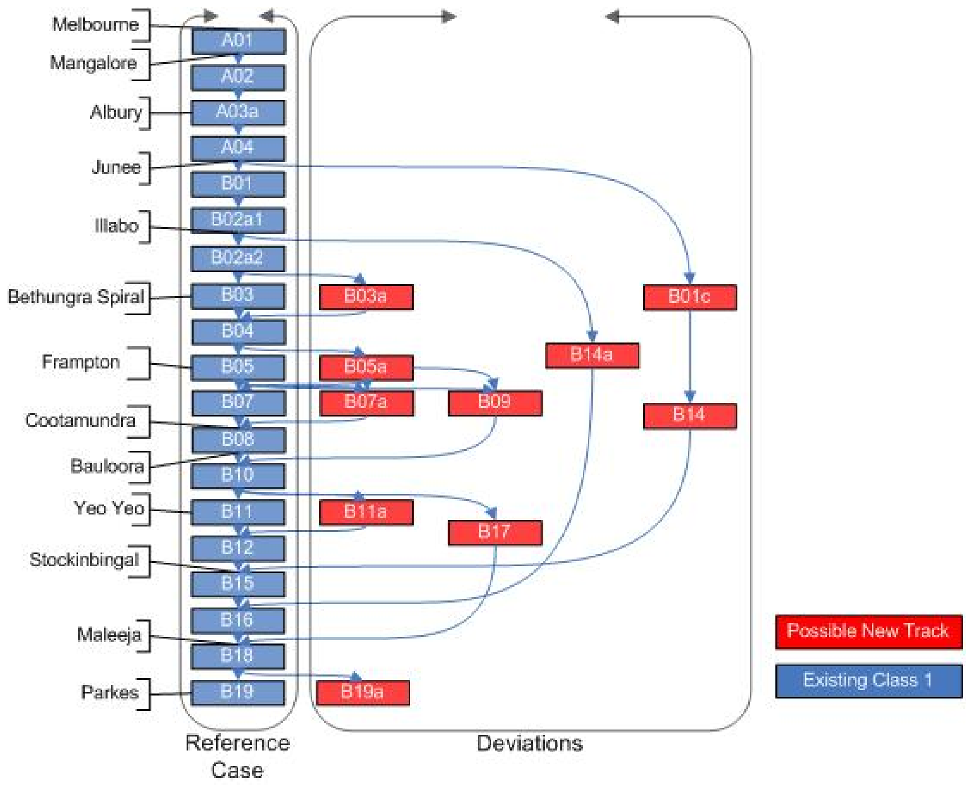

Figure 3-8 Melbourne to Parkes reference case and deviations

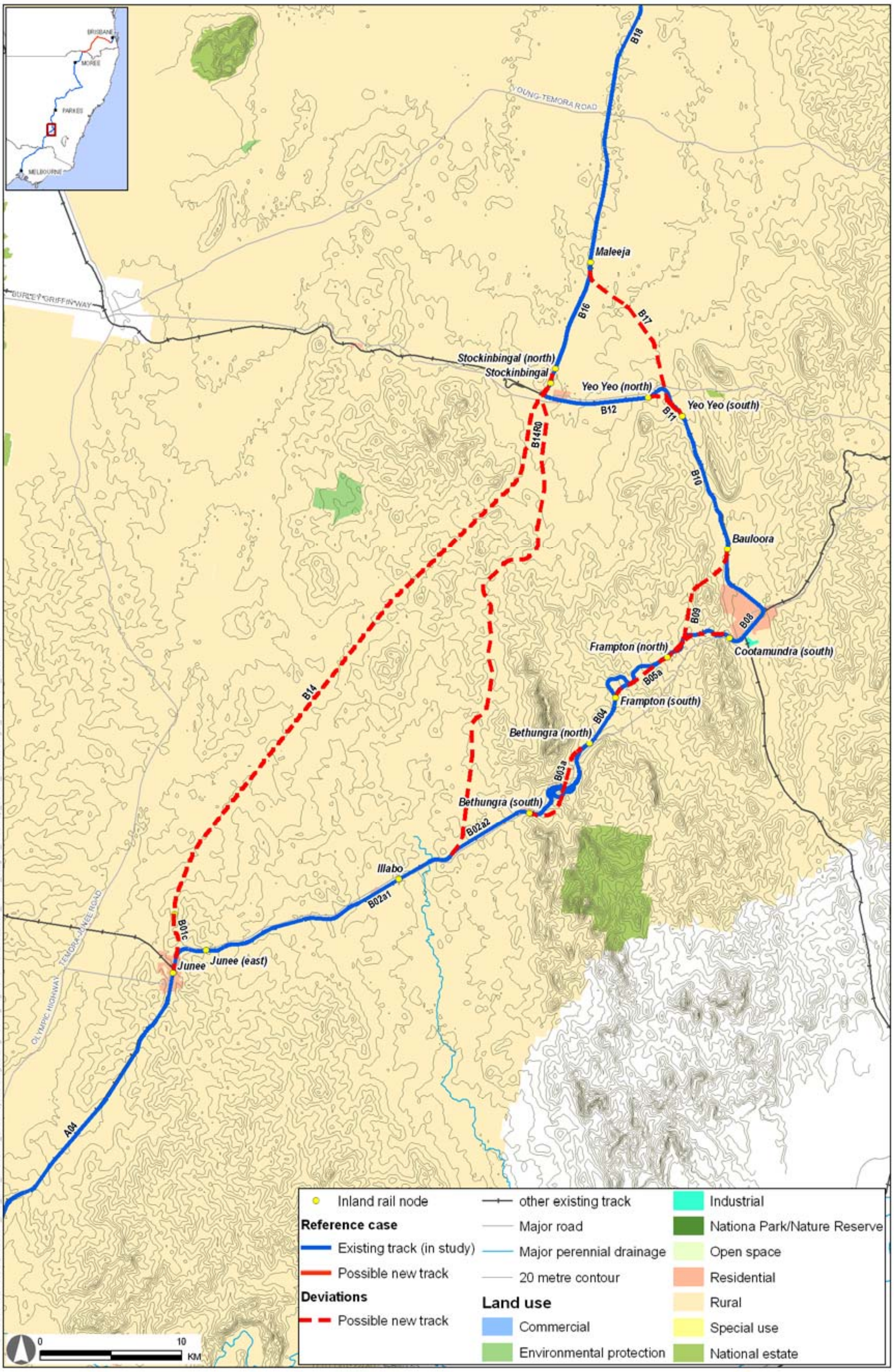

Figure 3-9 Junee to Stockinbingal

Junee to Stockinbingal (B1c & B14) – major greenfield

Between Junee and Stockinbingal, a greenfield section has been considered. The option provides a direct route from Junee on the Main South line to Stockinbingal on the Stockinbingal to Parkes line. This option would bypass low speed curves and steep grades at the Bethungra Spiral and Cootamundra, and low speed curves on the Cootamundra to Stockinbingal line. This new section would provide an alternative route to the existing Junee to Stockinbingal route. The new section would consist of approximately 51 km of Class 1 track, compared with approximately 86 km via the reference case route. The deviation would comprise generally greenfield construction, with 0.85 km of existing track retained at Junee and approximately 0.4 km of new construction through the urban area of Junee.

Illabo to Stockinbingal (B14a) – major greenfield

The Illabo to Stockinbingal section would be a greenfield section. This option provides a direct route from Illabo on the Main South line to Stockinbingal on the Stockinbingal to Parkes line. This option bypasses low speed curves and steep grades at the Bethungra spiral and Cootamundra and low speed curves on the Cootamundra to Stockinbingal line. The section would provide an alternative route to the existing Bethungra to Stockinbingal route. The section would comprise approximately 37 km of Class 1 track, compared with approximately 68 km via the reference case route.

Bethungra deviation (B03a)

The deviation would remove low speed curves at the Bethungra spiral on the Main South line. It would consist of approximately 8 km of Class 1 standard gauge track, as well as two tunnels with a total approximate length of 3.1 km. Deep cuttings along a different alignment may provide an alternative and optimised solution in this area.

Frampton deviation (B05a)

The deviation would remove low speed curves at Frampton on the Main South line. It would consist of approximately 5 km of Class 1 standard gauge track. The deviation includes a cutting up to 24 m deep.

Frampton to Cootamundra deviation (B07a)

The deviation would remove low speed curves south of Cootamundra on the Main South line. It would consist of 5 km of Class 1 standard gauge track. The new alignment would cross the existing alignment five times; construction would be difficult and would require possession of the railway whilst these crossings are built.

Cootamundra bypass (B09)

The Cootamundra deviation would be a greenfield section. The deviation would remove low speed curves at Cootamundra and bypass the town of Cootamundra. It would consist of approximately 10 km of Class 1 standard gauge track, including one tunnel approximately 2.2 km long.

Yeo Yeo deviation (B11a)

The deviation would remove low speed curves at Yeo Yeo. It would consist of approximately 3 km of Class 1 standard gauge track. It is assumed 1.7 km will be greenfield construction and 1 km will have the existing track retained.

Stockinbingal bypass (B17)

The Yeo Yeo to Maleeja section would be a greenfield section. The option would provide a direct route from Yeo Yeo on the Cootamundra to Stockinbingal line to Maleeja on the Stockinbingal to Parkes line. The option would bypass low speed curves at Yeo Yeo and the town of Stockinbingal. The section would provide an alternative route to the existing route from Yeo Yeo to Maleeja. The section would consist of 13 km of Class 1 track.

Parkes bypass (B19a)

The deviation would reduce route length by providing a connection from the Parkes to Stockinbingal line to the Parkes to Narromine line with connections to the Orange to Broken Hill line. It would consist of 5 km of Class 1 standard gauge track.

Parkes to Moree via Werris Creek route analysis

The figure below shows the possible deviations to replace sections of the reference case between Parkes and Moree.

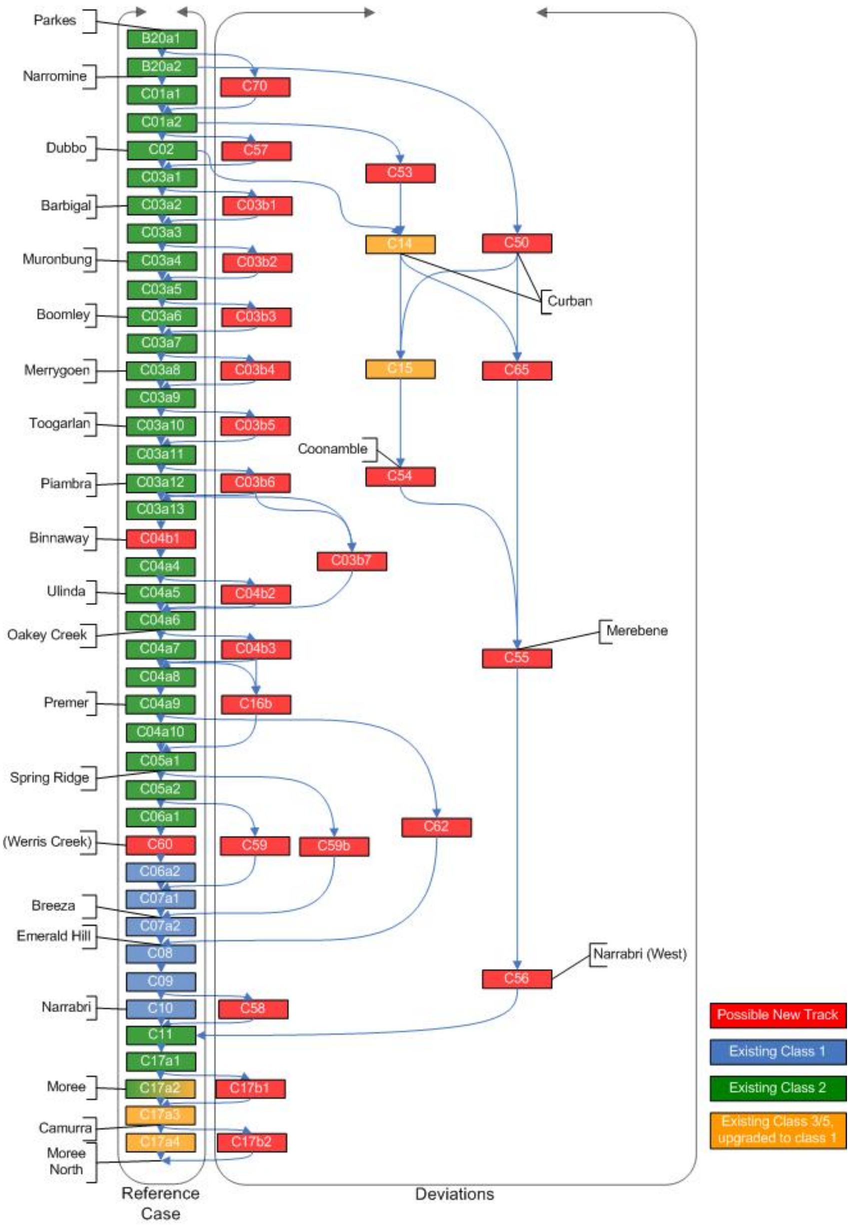

Figure 3-10 Parkes to Moree reference case and deviations

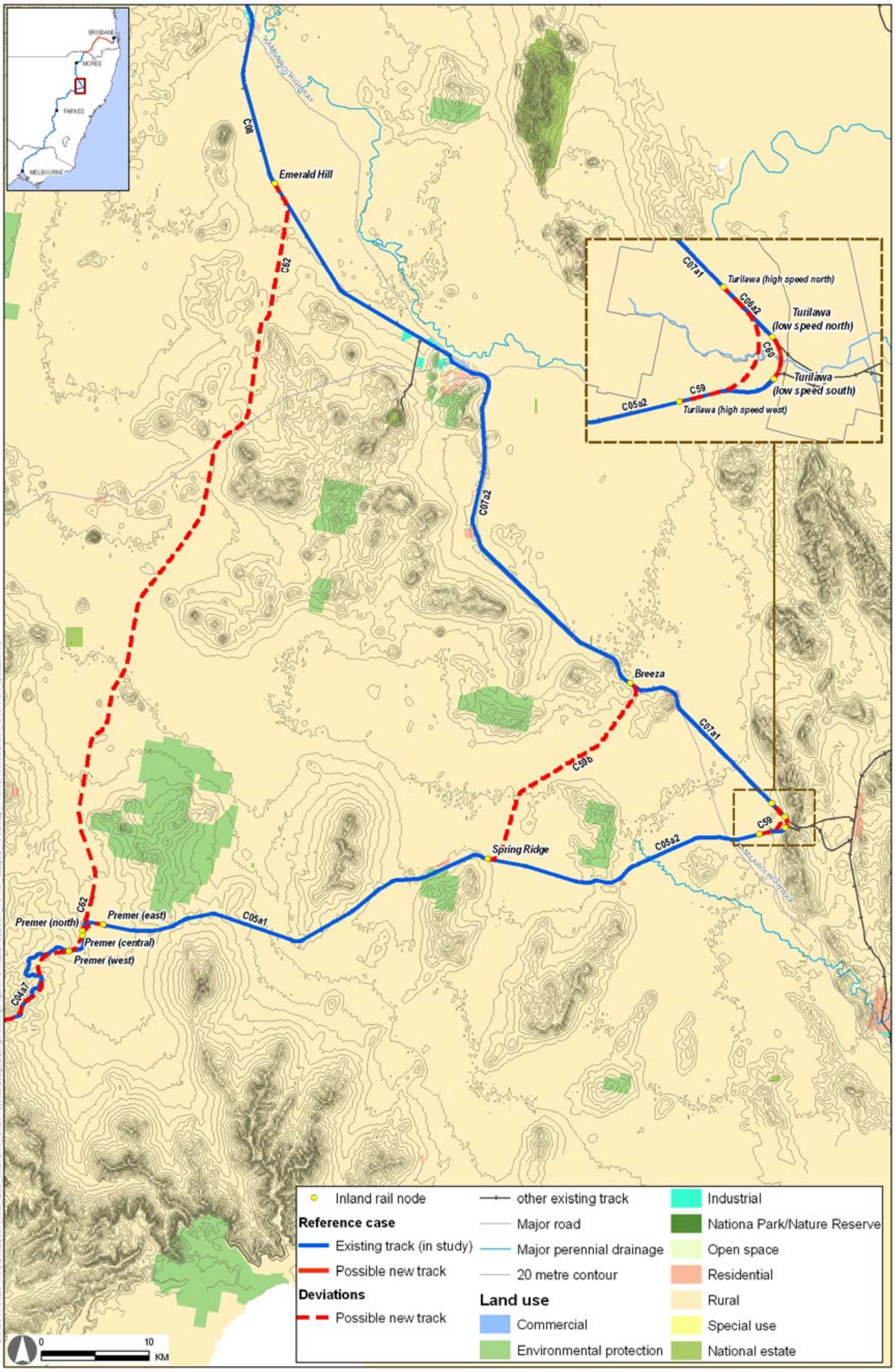

Figure 3-11 Werris Creek deviations

Narromine bypass (C70)

The Narromine deviation is a greenfield section. The deviation would remove low speed curves and bypass the town of Narromine. It would consist of approximately 12 km of Class 1 standard gauge track, compared with approximately 14 km along the reference case alignment. The deviation would also be further from the Macquarie River floodplain. There appears to be potential to further improve the deviation by moving the proposed alignment to the south.

Dubbo bypass (C57)

The Dubbo deviation is a greenfield section. It would remove low speed curves and bypass the town of Dubbo. The deviation would consist of approximately 10 km of Class 1 standard gauge track.

Barbigal deviation (C03b1)

The deviation would remove low speed curves at Barbigal. It would consist of approximately 2 km of Class 1 standard gauge track on new alignment and approximately 4 km of Class 1 standard gauge (upgraded) track on the existing alignment.

Muronbung deviation (C03b2)

The deviation would remove low speed curves at Muronbung. It would consist of approximately 4 km of Class 1 standard gauge track on new alignment and approximately 4 km of Class 1 standard gauge (upgraded) track on the existing alignment.

Boomley deviation (C03b3)

The deviation would remove low speed curves at Boomley. It would consist of approximately 21 km of Class 1 standard gauge track on new alignment and approximately 5 km of Class 1 standard gauge track on the existing alignment. There is an option to retain a further 5.8 km of the existing alignment (upgraded to Class 1).

Merrygoen deviation (C03b4)

The deviation would remove low speed curves and bypass the town centre of Merrygoen. It would consist of approximately 9 km of Class 1 standard gauge track. There is an option to move the alignment out of the Castlereagh River floodplain.

Toogarlan deviation (C03b5)

The deviation would remove low speed curves at Toogarlan. It would consist of approximately 5 km of Class 1 standard gauge track on new alignment and approximately 1 km of Class 1 standard gauge (upgraded) track on the existing alignment.

Piambra deviation (C03b6)

The deviation would remove low speed curves at Piambra. It would consist of approximately 2 km of Class 1 standard gauge track. The deviation is located on or close to the flood plain of the Castlereagh River.

Piambra to Ulinda deviation (C03b7)

This option is a further development of the Piambra deviation (C03b6). The deviation would remove low speed curves, bypass the town centre of Binnaway and remove the track reversal at Binnaway. It would consist of approximately 11 km of Class 1 standard gauge track.

Ulinda deviation (C04b2)

The deviation would remove low speed curves at Ulinda. It would consist of approximately 3 km of Class 1 standard gauge track on new alignment and approximately 1 km of Class 1 standard gauge (upgraded) track on the existing alignment.

Oakey Creek to Premer deviation (C04b3)

The deviation would remove low speed curves. It would consist of approximately 17 km of Class 1 standard gauge track on new alignment and approximately 6 km of Class 1 standard gauge (upgraded) track on the existing alignment.

Premer bypass (C16b)

The deviation would remove low speed curves and bypass the town centre of Premer. It would consist of 4 km of Class 1 standard gauge track.

Premer to Emerald Hill (C62) – major greenfield

The Premer (north) to Emerald Hill section would be a greenfield section. This option would provide a direct route from Premer on the Binnaway to Werris Creek line to Emerald Hill on the Werris Creek to Mungindi line. The option bypasses low speed curves and the towns of Werris Creek and Gunnedah and would significantly reduce route distance. The section would consist of approximately 75 km of Class 1 track.

Werris Creek high speed triangle (C59)

The deviation would provide a higher speed alignment for the Werris Creek bypass. It would consist of approximately 1.2 km of Class 1 standard gauge track on new alignment, approximately 1.3 km of Class 1 standard gauge (upgraded) track on the existing alignment and approximately 2.9 km of existing Class 1 track retained.

Spring Ridge to Breeza deviation (C59b) – major greenfield

This option is an enhancement of deviation C59 and would result in an increased journey time saving by providing a more direct route for the Werris Creek bypass. The deviation would consist of 23 km of Class 1 standard gauge track, almost entirely across floodplain.

Narrabri bypass (C58)

The deviation would remove low speed curves and bypass the town centre of Narrabri. The new deviation would consist of approximately 10.5 km of Class 1 standard gauge.

Moree bypass (C17b1)

The deviation would remove low speed curves and bypass the town centre of Moree. It would consist of approximately 9 km of Class 1 standard gauge track on new alignment. The alignment would cross two major power lines and about 2 km of zoned industrial land and is generally across floodplain.

Camurra deviation (C17b2)

The deviation would remove low speed curves at Camurra. It would consist of 3 km of Class 1 standard gauge track on new alignment across floodplain.

Parkes to Moree via Narromine to Narrabri sections

The sections and possible deviations for the Narromine to Narrabri section are identified in the figure below.

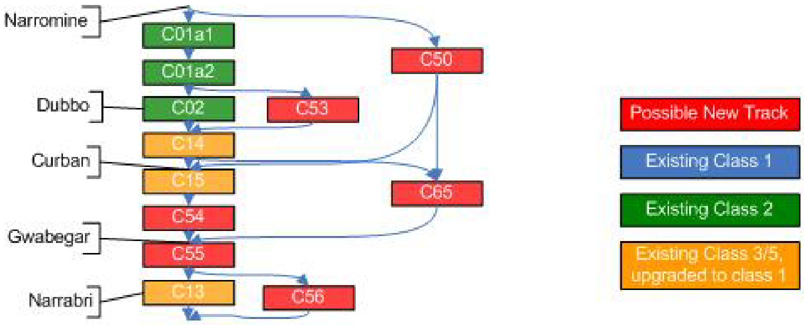

Figure 3-12 Narromine to Narrabri deviations

Dubbo (north) to Curban (C14) - upgrade

The upgrade would provide an 88 km Class 1 track link between Dubbo and Curban which would improve journey times for the section and allow the required freight traffic. It would require upgrading 63 km of Class 3 line between Dubbo and Gilgandra and approximately 25 km of Class 5 line between Gilgandra and Curban.

Curban to Coonamble (C15) - upgrade

The upgrade would provide a 57 km Class 1 track link between Curban and Coonamble which would improve journey times for the section and allow the required freight traffic. This would require upgrading the existing Class 5 line.

Coonamble to Gwabegar (C54)

This greenfield 74 km section would provide a direct link between Coonamble and Gwabegar. It would leave the Dubbo–Coonamble line about 6 km south of Coonamble.

Gwabegar to Narrabri (west) (C55)

This greenfield 83 km section would provide a direct link between Gwabegar to Kiandool starts about 6 km south of the town of Gwabegar with a turnout from the Wallerawang–Gwabegar line.

Narromine to Curban (C50)

This greenfield option would provide a direct route between Narromine and Curban instead of using the longer route via Dubbo, thereby shortening the overall distance by 40 km.

Curban to Gwabegar (C65)

This greenfield option would provide a direct route between Curban and Gwabegar instead of using the longer existing route via Coonamble, thereby shortening the overall distance by 27 km.

Dubbo bypass (C53)

Bypassing the town of Dubbo to the west would avoid low speed curves and speed restrictions within the town.

Narrabri bypass (west) (C56)

Bypassing the town of Narrabri to the west would avoid the low speed curves and speed restrictions through the town. The bypass travels through a flood zone.

Moree to Brisbane route analysis

Figure 3-13 below shows the possible deviations to replace sections of the reference case between Moree and Brisbane. Figure 3-14 shows the Toowoomba area from Cecilvale and Gatton which contains the most significant deviation options.

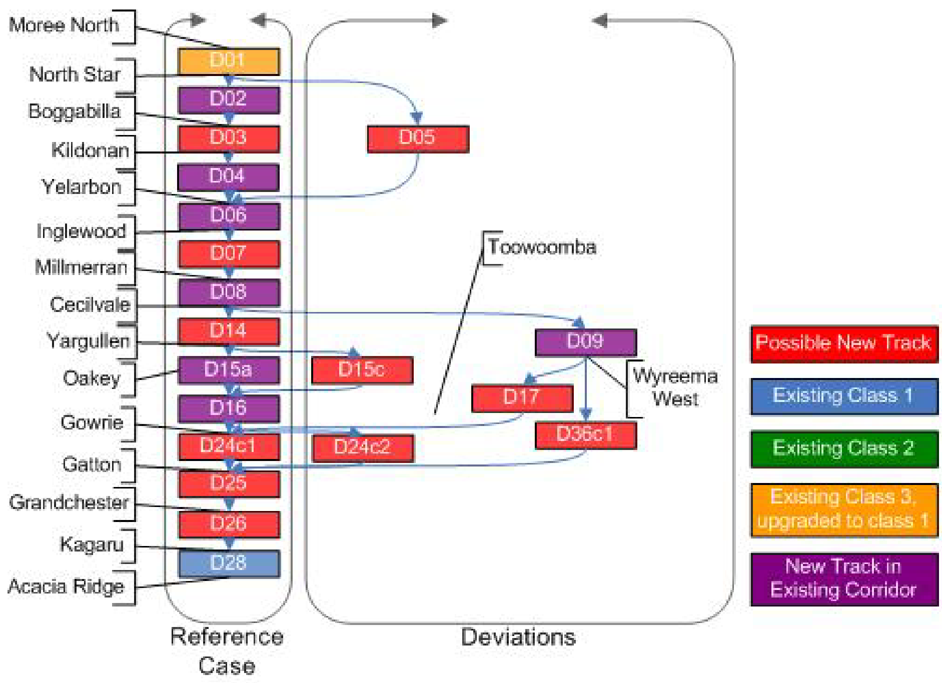

Figure 3-13 Moree to Brisbane reference case and deviations

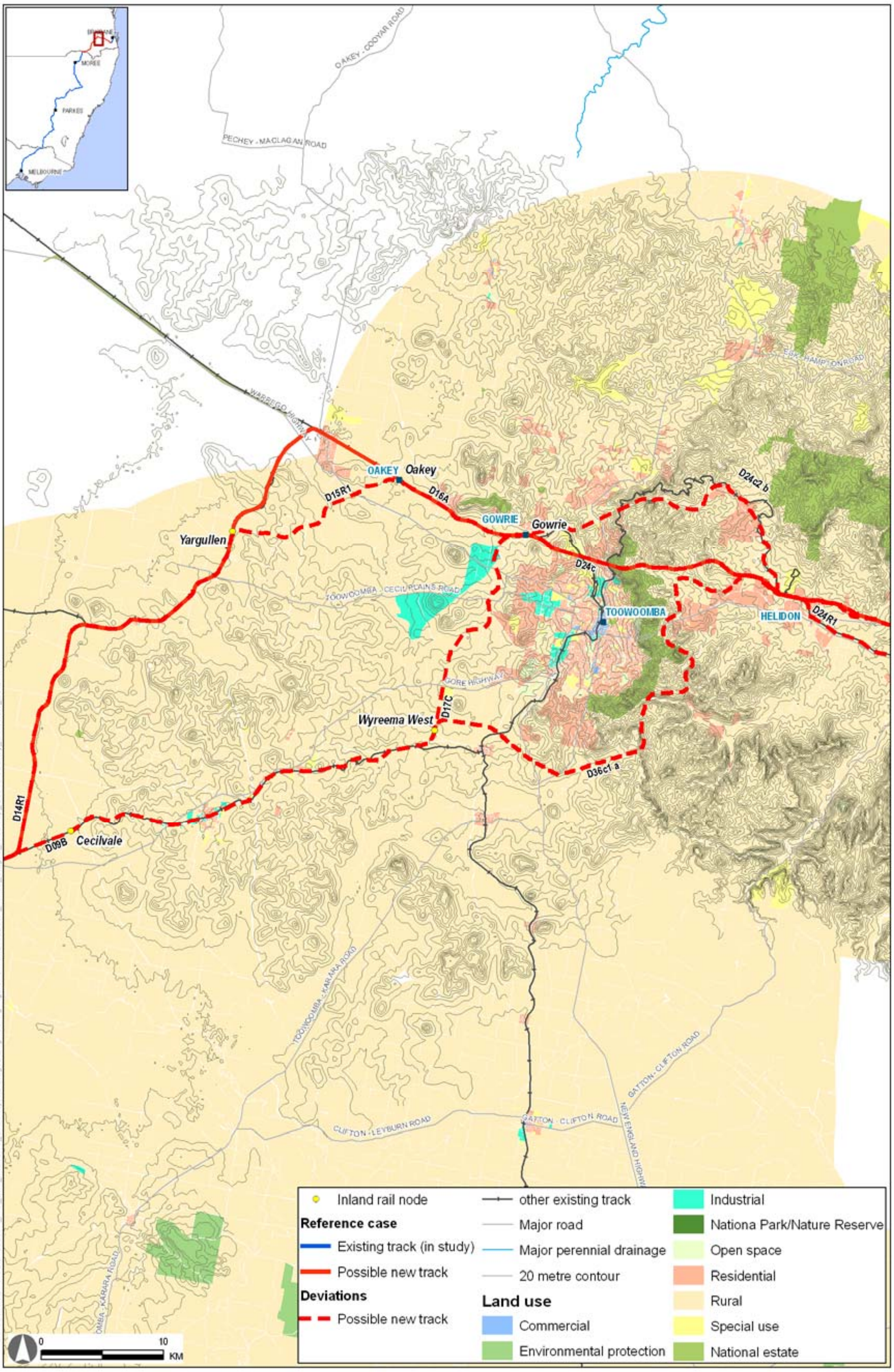

Figure 3-14 Toowoomba area

North Star to Yelarbon (D05c) – major greenfield

The North Star to Yelarbon section is a greenfield section. The option would provide a more direct route from North Star to Yelarbon whilst trying to avoid a floodplain area to the west. The option bypasses the towns of Boggabilla and Kildonan. The new route section would consist of approximately 59 km of Class 1 standard gauge track.

Oakey bypass (D15c)

The Yargullen to Oakey section would be a greenfield section. The option would provide a more direct route. This option would bypass low speed curves and the town of Oakey. The new section would consist of approximately 16 km of Class 1 standard gauge track.

Cecilvale to Gowrie via Wyreema West (D09b & D17c)

The Cecilvale to Wyreema West section is mostly within the existing narrow gauge Millmerran to Wyreema corridor, some slight deviations outside of the QR corridor are required. The new route section would consist of approximately 33 km of Class 1 standard gauge track.

The Wyreema West to Gowrie section would be a greenfield section. The new section would consist of approximately 20 km of Class 1 standard gauge track.

The purpose of the option is to provide an alternative to the route via Oakey.

Cecilvale to Gatton south of Toowoomba (D09b & D36c1)

This is an alternative range crossing which traverses the range to the south of Toowoomba, and provides an alternative to the Wyreema West to Gatton option (D17c and D24C). It is 94 km in length of Class 1 standard gauge track. It is a combination of greenfield construction and existing QR corridor between Cecilvale and Wyreema West.

By passing to the south of Toowoomba, this alignment would cross the range in a different location than the existing alignment and would therefore not be able to capture the existing western line traffic. Crossing to the south of Toowoomba is also a higher location to cross than the existing alignment location to the north of Toowoomba.

Gowrie to Gatton low speed (D24c2)

An alternative to the major tunnelled D24c option, this alignment attempts to follow the existing curvy and steep QR narrow gauge track between Gowrie and Lockyer. It is approximately 57 km in length and a combination of greenfield and new Class 1 standard gauge track within to the existing QR corridor.

3.4 Environmental and land use review

3.4.1 Land use and environmental assessment methodology

Overview

Environmental assessment has been undertaken through identification of environmental constraints and opportunities along the reference case routes and deviations using a Geographic Information System (GIS).

The key activities that were undertaken included:

1. Collection and collation of land use, zoning and environmental data and other information
2. Incorporation of this information into the GIS to generate constraints maps
3. Review of the route using the GIS to identify environmental limitations along the alignments
4. Allocation of a limitation category to the identified constraints
5. Consideration of any opportunities to minimise impacts to the identified constraints.

Constraint mapping

Constraint mapping was created using available land use, zoning, environmental data and infrastructure (e.g. roads, rail) and geographical information (topography, drainage) incorporated into the study GIS database. Aerial photography was also used to identify features.

Route section desktop assessment

Land use / tenure

Assessment of land use focused on those forms of use where acquisition costs are likely to be high. Using information including production of agricultural commodities and the identification of irrigation areas, as well as reviewing aerial photographs and man-made drainage, the following land use types were considered (hierarchically) as a constraint where the route crossed or passed in close proximity:

- Urban and residential areas
- Irrigation improved cultivation
- Orchards or infrastructure dependent cultivation (e.g. grapes, nuts or citrus)
- Dryland or surface catchment irrigation
- Grazing lands.

Zoning

The land zoning data was reviewed to identify areas of land where new alignments were within types of zonings with a high level of constraint as indicated in Table 3-1 below.

Table 3-1 Land zoning

Types of Zoning	Objectives	Comment	Level of Constraint
Rural	Provide for a range of general and intensive agricultural and primary industry	Depending on land use, fewer constraints through rural zones than through other land zones	Low
Residential	Provide for residential development, facilities or services for the community	Alignment through residential zones would generally involve significant social / community impacts	High
Commercial	Encourage development of a compatible variety of retail, business centre, commercial, bulky goods retailing and manufacturing industry uses	Alignment through commercial zones may involve economic and community impacts	Medium
Industrial	Encourage development of a mix of warehouse uses and light, medium and heavy industry land uses sufficiently distanced from sensitive uses	Alignment through industrial zones may involve economic and community impacts	Medium
Special uses	Recognise public lands for roads, railways, public utilities, community infrastructure, etc. or land uses not provided for in other identified zones.	Depending on existing and designated land use, fewer constraints through this zone than through other land zones	Medium
Open spaces	Recognise areas for public recreation and open space	Depending on existing and designated land use, fewer constraints through this zone than through other land zones	Low
Environment protection	Protect and conserve the natural environment and processes for reasons of historic, scientific, landscape, habitat or cultural value. Provide resource based uses such as mining or forestry	Alignment through these zones would require additional environmental approvals and/or excessive acquisition costs	High
National parks and Nature Reserve	Protect areas of significant vegetation, maintain and enhance habitat and habitat corridors for indigenous fauna and maintain or regenerate native vegetation	Alignment through these zones would require approvals and may involve significant community backlash	High
Rail corridor	Specify land for the current or future railway development	Alignment through rail corridor zones should result in minimal impact	Low

Limitation categories

Individual limitations were then categorised according to the following:

- The relative importance or sensitivity of the identified environmental constraint
- The level of potential impact on the environment from development of the railway
- Potential implications of the environmental constraint for the study.

The categories are discussed below, along with the level of limitation associated with each category.

Major Environmental Limitations

Major Environmental Limitations are those that would have a major impact on the project either in the planning, design, construction or operational phases. This could result from:

- Potential high level of environmental impact to listed protected areas, state or Commonwealth heritage areas or threatened species
- High cost and/or program implications associated with realignment or re-engineering solutions or associated with extensive impact mitigation
- High number of communities or stakeholders affected, i.e. towns and urban areas, with potential for high number of objections or
- Major delays associated with obtaining permits and approvals.

Major Environmental Limitations would be likely to cause extensive time delays and could have significant cost implications. In extreme circumstances, they could stop the project.

Significant Environmental Limitations

Significant Environmental Limitations are those that would have an impact on the project. Whilst it is preferable to avoid these limitations, they are not considered insurmountable and could be mitigated through engineering design, changes to construction methodologies, and/or environmental compensation.

The environmental and/or social impacts of Significant Environmental Limitations would need to be considered during detailed environmental assessment, including consideration of engineering solutions, alignment adjustment, and community and stakeholder engagement. Costs and time delays associated with these identified limitations would still be significant, although these may not be as significant as the Major Environmental Limitations.

Cumulative impacts

As well as the individual limitations, there is the potential for two or more environmental constraints along a route option to contribute to cumulative environmental impacts during construction and/or operational phases.

Assessment of key issues

A qualitative assessment of whether these issues represent ‘major’ and ‘significant’ environmental constraints or limitations for inland rail is presented in the table below.

Table 3-2 Guidelines for environmental assessment of key issues

Key Issue	Major Environmental Limitation	Significant Environmental Limitation
Protection areas	• Potential impact to World Heritage Areas, Register of the National Estate, national parks, natural and conservation reserves or state forests	• World Heritage Areas, Register of the National Estate, national parks, natural and conservation reserves or state forests within close proximity to the alignment
Matters protected by the EPBC Act	• Potential impact to World Heritage properties, National Heritage places and Ramsar wetlands	• World Heritage properties, National Heritage places, Ramsar wetlands within close proximity of the alignment • Close proximity of threatened species
Flora and fauna	• New alignments • Direct impacts to clusters or large numbers of threatened species indicated by listings, fauna habitat or vegetation communities. Often associated with a protection / conservation area	• New alignments • Nearby clusters or large numbers of threatened species • Severance or fragmentation of sensitive vegetation communities or wildlife corridors
Non-indigenous Heritage	• Potential impacts to items of Commonwealth heritage	• New alignments • Direct impacts to items listed as state heritage • Items of Commonwealth heritage in close proximity • Existing alignments • Railway heritage items present on track section to be upgraded (bridges, stations, etc)
Indigenous Heritage	• Direct impacts to cultural and spiritual places	• New alignments • Direct impacts to identified Aboriginal items and cultural heritage places • Existing alignments to be upgraded • Direct impacts to identified Aboriginal items and cultural heritage places
Water	• Potential impacts to drinking water catchments	• New alignments and existing alignments to be upgraded • Large number of waterway crossings, or crossings of major waterways • Route traverses large areas of flood-prone land
Noise and vibration	• Route travels through urban areas, or in close proximity of sensitive receiver where costs of mitigation extreme	• Route travels through rural areas with large number of residential dwellings or through urban areas / near sensitive receivers where noise disturbance expected • Cost of noise mitigation high
Soils and contamination	• Direct impact to hazardous facility	• Direct or potential impact to registered contaminated sites or landfill sites • Route traverses large areas of dryland salinity, black or dispersive soils (high cost to manage)

Key Issue	Major Environmental Limitation	Significant Environmental Limitation
Social issues	• Direct impacts to community facilities (e.g. showground, parks, reserves, etc)	• Route passes within close proximity of community facility • High potential for impacts to visual amenity

3.4.2 Environment and land use assessment

The environmental and land use assessments found that, whilst some of the deviations were considered preferable to the reference case (predominantly town bypasses), there were no constraints on the reference case that could not be addressed through further route refinement, mitigation, or management during construction. Therefore no deviations were progressed for further analysis on environmental grounds alone.

Most of the deviations involved construction of a new railway through greenfield areas, with potential impacts on identified environmental and land use constraints. For several deviations significant constraints were identified. These would result in difficulties in obtaining planning approval, particularly considering there are better alternatives available, namely, the reference case. It was therefore decided that the following deviations should be excluded from the analysis due to environmental constraints:

- Frampton to Cootamundra South deviation (B07a) - the deviation would cause loss and fragmentation of endangered ecological species and threatened species
- Muronbung deviation (C03b2) – the deviation would cause endangered ecological species to be fragmented
- Boomley deviation (C03b3) – the deviation would be adjacent to the Goonoo State Forest and would affect endangered ecological communities and threatened species
- Cecilvale to Gowrie via Wyreema West (D09b & D17c) – this section would pass through populated areas to the west of Toowoomba
- Cecilvale to Gatton south of Toowoomba (D09C & D36c1) – this section would affect populated areas east of Toowoomba; would involve extensive vegetation clearing through important ecological areas; and would involve construction in steep, vegetated and inaccessible terrain
- Gowrie to Gatton low speed (D24c2) – this section would affect populated areas; would involve extensive vegetation clearing, including through the White Mountain Forest Reserve; and could affect identified heritage items. It would also require construction in steep, vegetated and inaccessible terrain.

3.5 Capital cost and journey time results

3.5.1 Cost model development

A cost model was developed to compare the cost effectiveness of the different deviation options. The model calculated the construction cost, split into direct and indirect costs. Other project costs such as client costs, design, project management and client's contingency were excluded but covered at a project level.

The direct costs were developed primarily using first principles based estimating. These costs were then expressed as unit rates so that they can be applied to the quantities calculated for each cost element for the various sections under review.

Indirect costs were based on percentage additions obtained from benchmark data and current industry experience. The indirect costs were then added to the direct costs for each of the sections. The indirect costs comprise the following elements:

- On-site overheads and preliminary expenses
- Off-site overheads and margins.

3.5.2 Operational modelling of journey times

Journey time estimates were made using the Railsys computer simulation package (the model). This model uses data for locomotives, wagons, gradients, speed restrictions and timetabling principles to simulate train operations with a high level of sophistication. Journey time assumptions were made in building the model of the infrastructure. Existing speed restrictions, detailed in the ARTC train operating conditions manual for an existing train with characteristics similar to the reference train, were retained with some exceptions for planned rail upgrade works.

3.5.3 Reference case capital cost and journey time results

An estimate of the cost and journey times of the reference case sections are detailed in the table below. The results presented in this section are preliminary results, for the purpose of route comparison only. The study proposed alignment was examined in further detail. The final results are contained in the final report and the appropriate appendix, for example capital costs can be found in Appendix J and journey times in Appendix G.

Table 3-3 Reference case construction costs and journey times

Name	Section Code	Length (km)	Cost ($'000s)	Journey Time Estimate (mins)
Melbourne - Mangalore	A01	116.7	0	88
Mangalore – Wodonga (south)	A02	188.3	0	106
Wodonga deviation	A03a	5.4	0	4
Wodonga (north) – Junee	A04	163.2	0	106
Junee – Junee (east)	B01	3.6	0	3.5
Junee (east) – Illabo	B02a1	14.9	0	8.25
Illabo – Bethungra (south)	B02a2	10.6	0	8
Bethungra (south) - Bethungra (north)	B03	7.9	0	9.25
Bethungra (north) – Frampton (south)	B04	3.8	0	2.5
Frampton (south) - Frampton (north)	B05	8.0	0	6.5
Frampton (north) – Cootamundra (south)	B07	5.6	0	4
Cootamundra (south) - Bauloora	B08	9.0	0	12.5
Bauloora – Yeo Yeo (south)	B10	10.1	0	8
Yeo Yeo (south) - Yeo Yeo (north)	B11	3.7	0	2.75
Yeo Yeo (north) - Stockinbingal	B12	8.3	0	6.75

Name	Section Code	Length (km)	Cost ($'000s)	Journey Time Estimate (mins)
Stockinbingal – Stockinbingal (north)	B15	1.1	0	1
Stockinbingal (north) - Maleeja	B16	8.0	0	5.5
Maleeja – Parkes (south)	B18	159.3	0	96.75
Parkes (south) – Parkes (north)	B19	5.7	0	7.25
Parkes (north) - Narromine (south)	B20a1	100.2	0	84
Narromine (south) – Narromine	B20a2	5.8	0	5.5
Narromine - Narromine (east)	C01a1	8.4	0	10
Narromine (east) – Dubbo (west)	C01a2	23.8	0	16.5
Dubbo (west) – Dubbo (north east)	C02	12.3	23,340	13
Dubbo (north east) – Barbigal (west)	C03a1	14.9	3,031	12
Barbigal (west) - Barbigal (east)	C03a2	6.0	0	5
Barbigal (east) – Muronbung (south)	C03a3	12.1	0	10.75
Muronbung (south) - Muronbung (north)	C03a4	9.2	4,301	8
Muronbung (north) – Boomley (south)	C03a5	11.9	4,033	9.5
Boomley (south) - Boomley (north)	C03a6	27.3	3,031	26.25
Boomley (north) – Merrygoen (south)	C03a7	5.3	0	3.75
Merrygoen (south) - Merrygoen (north)	C03a8	13.4	0	13
Merrygoen (north) – Toogarlan (south)	C03a9	3.8	0	3.25
Toogarlan (south) - Toogarlan (north)	C03a10	7.2	0	6.5
Toogarlan (north) – Piambra (south)	C03a11	12.6	3,872	10
Piambra (south) - Piambra (north)	C03a12	1.9	2,821	1.5
Piambra (north) – Binnaway	C03a13	4.2	0	3.5
Binnaway – Binnaway (east)	C04b1	3.6	16,294	3.25
Binnaway (east) – Ulinda (north)	C04a4	4.1	0	3.75
Ulinda (north) - Ulinda (south)	C04a5	4.8	0	3.75
Ulinda (south) – Oakey Creek	C04a6	27.2	4,033	22

Name	Section Code	Length (km)	Cost ($'000s)	Journey Time Estimate (mins)
Oakey Creek – Premer (west)	C04a7	26.6	0	24.5
Premer (west) - Premer (central)	C04a8	2.4	0	2.25
Premer (central) - Premer (north)	C04a9	0.4	0	0.5
Premer (north) - Premer (east)	C04a10	2.4	0	2
Premer (east) – Spring Ridge	C05a1	36.0	16,683	28.25
Spring Ridge – Turilawa (high speed west)	C05a2	26.6	0	21.75
Turilawa (high speed west) - Turilawa (low speed south)	C06a1	2.5	0	2
Turilawa (low speed south) - Turilawa (low speed north)	C60	0.9	10,465	0.75
Turilawa (low speed north) - Turilawa (high speed north)	C06a2	2.2	0	1.75
Turilawa (high speed north) – Breeza	C07a1	18.7	0	10.75
Breeza – Emerald Hill	C07a2	62.6	0	38
Emerald Hill – Baan Baa	C08	28.8	0	18
Baan Baa – Narrabri (south)	C09	28.7	0	16.5
Narrabri (south) - Narrabri (north)	C10	15.4	27,977	18.5
Narrabri (north) – Moree (south)	C11	84.8	0	88.5
Moree (south) – Moree (east)	C17a1	3.5	0	3.75
Moree (east) - Moree (north east)	C17a2	9.5	17,103	9.25
Moree (north east) – Camurra (south)	C17a3	5.8	26,035	4.25
Camurra (south) – Moree (north)	C17a4	5.3	21,778	5.5
Moree (north) – North Star	D01A	78.3	137,467	48.75
North Star - Boggabilla	D02A	25.7	55,598	15
Boggabilla – Kildonan	D03C	12.6	76,008	7
Kildonan - Yelarbon	D04A	33.9	66,810	21
Yelarbon - Inglewood	D06A	33.8	88,416	24
Inglewood - Millmerran	D07C-001	73.8	230,922	47
Millmerran - Cecilvale	D08A	23.4	89,904	20
Cecilvale - Yargullen	D14C	31.3	104,337	19
Yargullen – Oakey	D15A	18.5	153,702	12
Oakey – Gowrie	D16A	11.6	55,291	14
Gowrie – Gatton	D24C	40.5	912,975	25

Name	Section Code	Length (km)	Cost ($'000s)	Journey Time Estimate (mins)
Gatton – Grandchester / Rosewood	D25C	28.8	223,976	14
Grandchester / Rosewood – Kagaru	D26C	56.2	351,005	35
Kagaru – Acacia Ridge	D28A	34.3	0	18

* Preliminary results only, for the purpose of route comparison.

3.5.4 Deviations and upgrades capital cost and journey time results

The capital costs and journey times for the deviations and upgrades to the reference case are summarised in Table 3-4 below. The results presented in this section are preliminary results, for the purpose of route comparison only. The study proposed alignment was examined in further detail. The final results are contained in the final report and the appropriate appendix, for example capital costs can be found in Appendix J and journey times in Appendix G.

Table 3-4 Deviations and upgrades construction costs and journey times

Name	Section code	Length (km)	Cost ($k)	Journey time estimate (mins)	Reference case alternative
Junee to Stockinbingal	B01c & B14	51	150,422	32.75	B01+ B02a1+ B02a2+ B03+ B04+ B05+ B07+ B08+ B10+ B11+ B12
Bethungra deviation	B03a	8	351,592	9	B03
Frampton deviation	B05a	5	33,905	6	B05
Frampton to Cootamundra deviation	B07a	5	46,498	3	B07
Cootamundra bypass	B09	10	206,886	5.5	B07+ B08
Yeo Yeo deviation	B11a	3	13,937	1.5	B11
Illabo to Stockinbingal	B14a	39	139,685	26.75	B02a2+ B03+ B04+ B05+ B07+ B08+ B10+ B11+ B12
Stockinbingal bypass	B17	13	31,297	7	B11+ B12+ B15+ B16
Parkes bypass	B19a	5	18,467	4.5	B19
Parkes (north) to Narromine (south)	Upgrade	84	149,794	64.75	B20a1
Narromine (south) to Narromine	Upgrade	6	9,152	5	B20a2
Narromine to Narromine (east)	Upgrade	8	14,567	10	C01a1
Narromine (east) to Dubbo (west)	Upgrade	24	38,533	16.5	C01a2
Dubbo (west) to Dubbo (north east)	Upgrade	12	44,915	12.5	C02
Dubbo (north east) to Barbigal (west)	Upgrade	15	22,019	9.5	C03a1
Toogarlan (south) to	Upgrade	7	23,045	6	C03a10

Name	Section code	Length (km)	Cost ($k)	Journey time estimate (mins)	Reference case alternative
Toogarlan (north)					
Toogarlan (north) to Piambra (south)	Upgrade	13	45,614	8.25	C03a11
Piambra (south) to Piambra (north)	Upgrade	2	10,865	1.25	C03a12
Piambra (north) to Binnaway	Upgrade	4	20,304	3.5	C03a13
Barbigal (west) to Barbigal (east)	Upgrade	6	10,260	4.5	C03a2
Barbigal (east) to Muronbung (south)	Upgrade	12	25,701	9.75	C03a3
Muronbung (south) to Muronbung (north)	Upgrade	9	18,942	7.75	C03a4
Muronbung (north) to Boomley (south)	Upgrade	12	24,144	8.25	C03a5
Boomley (south) to Boomley (north)	Upgrade	27	37,771	25	C03a6
Boomley (north) to Merrygoen (south)	Upgrade	5	25,848	3.5	C03a7
Merrygoen (south) to Merrygoen (north)	Upgrade	13	23,691	12.5	C03a8
Merrygoen (north) to Toogarlan (south)	Upgrade	4	8,946	3	C03a9
Barbigal deviation	C03b1	6	34,205	3.25	C03a2
Muronbung deviation	C03b2	8	45,942	5	C03a4
Boomley deviation	C03b3	26	63,068	19.5	C03a6
Merrygoen deviation	C03b4	9	34,347	5	C03a8
Toogarlan deviation	C03b5	6	32,186	2.5	C03a10
Piambra deviation	C03b6	2	12,852	1	C03a12
Piambra to Ulinda deviation	C03b7	11	38,699	8.5	C03a13+ C04b1+ C04a4+ C04a5
Premer (north) to Premer (east)	Upgrade	2	10,121	1.75	C04a10
Binnaway (east) to Ulinda (north)	Upgrade	4	3,824	3.75	C04a4
Ulinda (north) to Ulinda (south)	Upgrade	5	10,919	3.5	C04a5
Ulinda (south) to Oakey Creek	Upgrade	27	43,344	19.25	C04a6
Oakey Creek to Premer (west)	Upgrade	27	27,393	23.75	C04a7
Premer (west) to Premer (central)	Upgrade	2	2,2456	2	C04a8
Premer (central) to Premer (north)	Upgrade	1	2,630	0.5	C04a9
Ulinda deviation	C04b2	4	21,800	2.75	C04a5

Name	Section code	Length (km)	Cost ($k)	Journey time estimate (mins)	Reference case alternative
Oakey Creek to Premer deviation	C04b3	23	77,318	15.75	C04a7
Premer (east) to Spring Ridge	Upgrade	36	132,313	21.25	C05a1
Spring Ridge to Turilawa (high speed west)	Upgrade	27	121,149	17	C05a2
Turilawa (high speed west) to Turilawa (low speed south)	Upgrade	3	9,397	1.5	C06a1
Narrabri (north) to Moree (south)	Upgrade	85	112,049	52	C11
Premer bypass	C16b	4	24,974	2.5	C04a8+ C04a9+ C04a10
Moree (south) to Moree (east)	Upgrade	4	5,563	2.25	C17a1
Moree (east) to Moree (north-east)	Upgrade	9	56,379	7	C17a2
Moree bypass	C17b1	9	80,396	4.75	C17a2
Camurra deviation	C17b2	3	41,159	1.75	C17a4
Dubbo bypass	C57	10	55,566	5.5	C02
Narrabri bypass	C58	11	54,840	5.75	C10
Werris Creek high speed triangle	C59	5	28,365	4	C06a1+ C60+ C06a2
Spring Ridge to Breeza	C59b	23	102,665	12.5	C05a2+ C06a1+ C60+ C06a2+ C07a1
Premer to Emerald Hill	C62	75	401,424	42.25	C04a10+ C05a1+ C05a2 + C06a1+ C60+ C06a2+ C07a1+ C07a2
Narromine bypass	C70	12	24,007	6.5	B20a2+ C01a1
North Star to Yelarbon	D05C	59	180,094	33.25	D02+ D03+ D04
Cecilvale to Gowrie via Wyreema West	D09B & D17C	53	245,227	39.25	D14C+ D15C+ D16A
Cecilvale to Gatton south of Toowoomba	D09B & D36C1	94	1,282,611	66.75	D14C+ D15C+ D16A+ D24C
Oakey bypass	D15C	16	63,861	9.25	D15A
Gowrie to Gatton low speed	D24C2	57	1,883,775	38.75	D24C

* Preliminary results only, for the purpose of route comparison.

The capital costs and journey times for sections for the Narromine to Narrabri area are summarised in the following table.

Table 3-5 Narromine to Narrabri construction costs and journey times

Name	Section code	Length (km)	Cost ($k)	Journey time estimate (mins)	Alternative
Narrabri (west) to Narrabri (north)	C13	17	45,600	17	
Dubbo (north) to Curban	C14	88	158,400	49.5	
Curban to Coonamble	C15	57	125,400	32	
Coonamble to Gwabegar	C54	74	155,400	41.75	
Gwabegar to Narrabri (west)	C55	83	174,300	46.75	
Dubbo bypass (north)	C53	10	55,600	5.5	C02
Narromine to Curban	C50	91	273,000	51.25	C01+C02+C14
Curban to Gwabegar	C65	104	218,400	58.5	C15+C54
Narrabri bypass (west)	C56	8	41,600	4.5	C13

* Preliminary results only, for the purpose of route comparison.

The routes and the identified deviations are depicted graphically below.

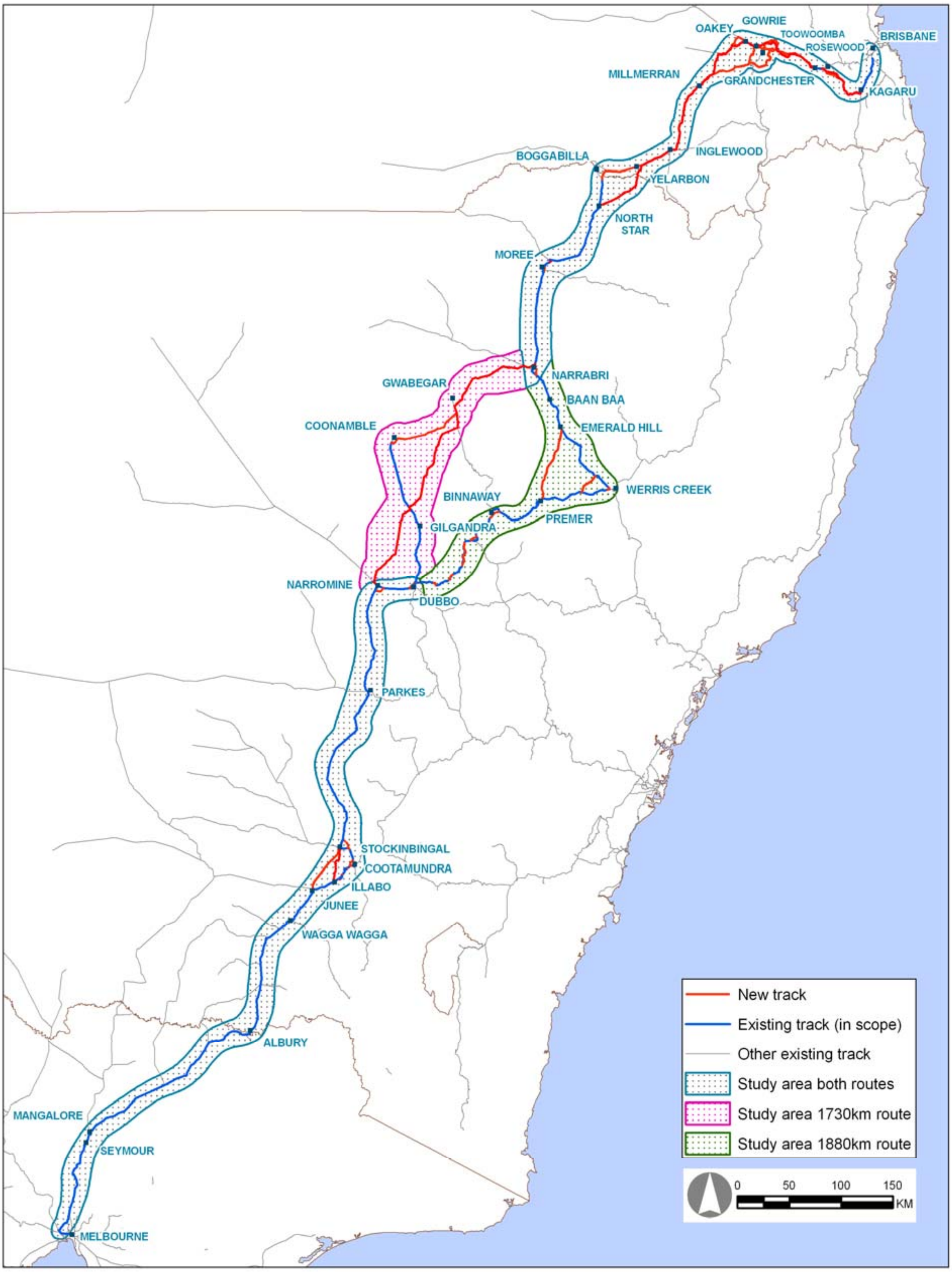

Figure 3-15 Inland rail routes for analysis

3.6 Evaluation of options

Following the technical, financial and economic analysis completed in section 2 of this appendix the evaluation of Inland Rail route options has been refined to two scenarios:

- Via existing railway lines and the route towards Werris Creek
- Via a greenfield route between Narromine and Narrabri.

3.6.1 Alignment options for the Werris Creek route

The route would generally use existing track from Melbourne to Parkes via Junee, and then to Narromine, Werris Creek, Moree and North Star, greenfield railway to Inglewood, Millmerran, Gowrie, Grandchester/Rosewood and Kagaru, and then existing track to Acacia Ridge. Within the study area opportunities exist to improve the journey time by upgrading existing track, bypassing towns and building deviations.

This route was subject to more detailed analysis of possible alignments and deviations along sub-sections of the route. The chief purpose of this was to understand which deviations may achieve the target transit time of around 27 hours. To do this, a set of alignment options was identified based on capital cost, journey time saved, and critical environmental aspects.

Approach to analyse alignment options

Modelling of the reference case alignment, prior to incorporation of possible deviations, has estimated the total journey time between Melbourne and Brisbane to be 29 hours and 2 minutes (23 hours and 2 minutes journey time with added time for crossing trains and other operational requirements, totalling 6 hours).

Having excluded deviations with potential negative environmental impacts and land use constraints, the options were differentiated based on capital cost and journey time. Comparison of the reference case with possible deviations and upgrades was done by estimating the incremental cost relative to the reference case for each minute of journey time saved, as presented in the table below. The options with the lowest capital cost per minute saved were considered the most economic options.

Table 3-6 Cost per minute saved relative to the reference case – via Werris Creek

Deviation/upgrade section that achieves a journey time improvement	Journey time saving (minutes)	Incremental cost[1] ($ millions)	Cost per minute saved ($ millions)	Shortlisted section
Oakey bypass	2.75	(89.80)	(32.70)	✓
North Star to Yelarbon	9.75	(18.30)	(1.90)	✓
Narrabri bypass	12.75	26.90	2.10	✓
Narromine bypass	9.25	24.00	2.60	✓
Narrabri (north) to Moree (south)	36.50	112.00	3.10	✓
Stockinbingal bypass	9.00	31.30	3.50	×[2]
Moree (south) to Moree (east)	1.50	5.60	3.70	✓
Spring Ridge to Breeza	24.50	92.20	3.80	✓
Junee to Stockinbingal	39.25	150.40	3.80	×[2]
Piambra to Ulinda deviation	5.75	22.40	3.90	✓
Illabo to Stockinbingal	33.5	139.70	4.20	✓
Merrygoen deviation	8.00	34.30	4.30	✓
Dubbo bypass	7.50	32.20	4.30	✓
Camurra deviation	3.75	19.40	5.20	✓
Premer to Emerald Hill	62.25	374.30	6.00	×
Parkes bypass	2.75	18.50	6.7	×[3]
Cecilvale to Gowrie via Wyreema West	3.00	21.70	7.20	×
Dubbo (north east) to Barbigal deviation (west)	2.50	19.00	7.60	×
Parkes deviation (north) to Narromine (south)	19.25	149.80	7.80	✓
Oakey Creek to Premer deviation	8.75	77.30	8.80	×
Boomley deviation	6.75	60.00	8.90	×
Premer (west) to Premer (central)	0.25	2.50	9.80	×
Narromine (east) to Dubbo (west)	3.75	38.50	10.30	×

1 incremental cost is used in the analysis: capital cost of the deviation/upgrade, minus cost of the reference case). Figures in brackets are negative; sections that are highlighted green have been excluded for environmental reasons
2 These deviations are not shortlisted as they are conflicting with deviation B14a, which offers a better journey time saving than B17 and was assessed to provide a better environmental/social outcome than B14.
3 This deviation was not considered further due to the resultant operational difficulties at Goobang Junction

The options highlighted yellow in the table above reduce the total journey time below the 27 hours specified in the performance specification. The negative incremental costs for Oakey bypass and North Star to Yelarbon indicate that the capital cost of the deviation is estimated to be less than the cost of the reference case. This analysis showed many of the options to be less favourable because:

- Capital expenditure would be significant
- Insufficient journey time improvements would arise from track upgrading due to curves and grades constraining the speed of trains or
- Options to remove speed constraints would be costly for little time saving.

3.6.2 Alignment options for the Narromine to Narrabri route

A similar approach was adopted for the analysis of the Narromine to Narrabri route option. In this instance, the analysis only applied to the section between Narromine and Narrabri as the sections of route to the south and north of this area are common to both routes under consideration.

A base case was adopted, following the existing corridors, with the necessary upgrading works. As with the above, alternatives to the base case were differentiated based on capital cost and journey time. The options with the lowest capital cost per minute saved were considered the most economic options, and are presented in Table 3-7.

Table 3-7 Cost per minute saved – Narromine to Narrabri route

Deviation/upgrade section that achieves a journey time improvement	Journey time saving (minutes)	Incremental cost[1] ($ millions)	Cost per minute saved ($ millions)	Shortlisted section
Curban/Gilgandra to Gwabegar	15.25	-62.40	-4.10	✓
Narrabri bypass	12.50	-4.00	-0.32	✓
Narromine to Curban/Gilgandra	41.75	91.30	2.20	✓
Dubbo bypass	7.50	32.20	4.30	×

1 incremental cost is used in the analysis: capital cost of the deviation/upgrade, minus cost of the reference case). Figures in brackets are negative; sections that are highlighted green have been excluded for environmental reasons

Approach to analyse alignment options

Modelling of the base case alignment and alternatives between Narromine and Narrabri estimated the total journey time between Melbourne and Brisbane to be 24 hours 21 minutes (20 hours 21 minutes journey time with added time for crossing trains and other operational requirements, totalling 4 hours). A lower crossing delay was assumed in this analysis due to the reduced number of crosses for the lower journey time.

Options highlighted in the Table 3-7, together with those south of Narromine or north of Narrabri in Table 3-6, reduce the journey time to below 22 hours for the direct route from Narromine to Narrabri.

3.6.3 Identifying options for alignment development

Based on the analysis presented above, the following options were identified for journey time improvement to reach the journey times specified and to be taken into alignment development.

The purpose of the deviations and upgrades for each of the routes are described below:

- Illabo to Stockinbingal – as it shortens the route
- Upgrade from Class 2 to Class 1 from Parkes to Narromine and Narrabri to Moree – as it reduces transit time by increasing maximum speed
- Camurra deviation – as it shortens the route
- North Star to Yelarbon – as there is a higher cost associated with the alternative via Kildonan
- Oakey bypass – because it requires less capital expenditure than upgrading the track through Oakey.

Towards Werris Creek

- Narromine bypass – as it shortens the route
- Dubbo bypass – as it avoids the replacement of the existing Macquarie River bridge
- Merrygoen deviation – as it shortens the route
- Piambra to Ulinda deviation – as it shortens the route

- Spring Ridge to Breeza – as it shortens the route
- Narrabri bypass (east) – as it avoids bridge replacement on the existing railway.

Via Narromine to Narrabri

- Narromine to Curban – as it is more cost effective than an upgraded route via Dubbo
- Curban to Gwabegar – as it requires less capital expenditure than the upgrade from Curban to Coonamble and new track from Coonamble to Gwabegar
- Narrabri bypass (west) – due to the significant speed constraints in Narrabri and the cost of upgrading the existing bridge and track.

3.7 Capital cost, operational cost and journey time estimates

Having confirmed the options to be included, a set of preliminary capital cost, operational cost and transit time estimates for the inland railway were developed to compare the two routes. They have been used as inputs to the preliminary economic and financial analysis.

Capital cost and journey time

Table 3-8 Melbourne to Brisbane inland railway routes analysed

Corridor	Preliminary route distance (km)	Preliminary transit time (terminal-terminal)	Preliminary capital cost ($ billion)
Route from Melbourne to Brisbane via Junee, Narromine, Premer, Emerald Hill, Moree, Gowrie and Kagaru	1,880	27.5	2.82
Route from Melbourne to Brisbane via Junee, Narromine to Narrabri, Moree, Gowrie and Kagaru	1,730	22	3.75

Note: Capex and journey time figures are preliminary for the purpose of route comparison only. Capex figures are base estimate costs only and do not include any risk and opportunity allowance.

3.7.1 Above rail costs (train operating costs)

Above rail operating costs consist mainly of rollingstock maintenance, crewing, fuel and access charges. Rollingstock maintenance and crewing costs are derived from information about existing practice.

Fuel costs are highly dependent on the alignment of each section, and vary according to terrain. Fuel costs are also highly dependent on the price of oil which is expected to be volatile and may not follow previous trends. Fuel consumption was estimated for each section in litres and the FEC has incorporated a fuel price assumption based on Austroads' published resource prices for diesel (excluding GST and excise).[5]

Preliminary analysis of above rail operating costs relating to train operation on the inland railway compared with the inland railway resulted in the following findings:

- 1,880 km Inland Rail scenario – as the route kilometres and transit time are lower than the coastal railway, it is expected that this option would have lower train operating costs. This is because the faster transit time and shorter route distance are expected to result in lower crew, wagon and locomotive maintenance costs as well as lower fuel consumption per kilometre

[5] Austroads 2008, *Guide to Project Evaluation, Part 4: Project Evaluation Data*, Table 2.4, p 6

- 1,730 km Inland Rail scenario – as the route kilometres and transit time for this scenario are lower than for the 1,880 km scenario, it is expected that this inland railway option has even lower train operating costs
- Coastal railway – considering the slower transit time and longer route distance, it is expected that train operating costs on the coastal railway would be higher on a net tonne kilometre (ntk) basis.

3.7.2 Below rail costs (train operating costs)

Below rail costs consist mainly of track maintenance. There are also infrastructure operating costs to be considered. Costs in these areas were derived from information about existing practices. On existing alignments track maintenance costs vary according to the treatment of the existing track structure and the age of assets. Where new track is provided, costs vary as the assets age.

Below rail maintenance costs

Maintenance costs vary according to track category (e.g. whether it is existing, upgraded or new track) and is dependent on the proportion of track that has frequent structures or difficult operational terrain, such as steep grades and tight curves. Maintenance costs per kilometre also increase over time. The table below provides an indicative split of track category for each scenario.

Considering the track categories for each scenario, preliminary analysis of below rail maintenance costs indicated the following for the 1,880 km and 1,730 km scenarios:

- Because the 1,880 km Inland Rail scenario has a higher portion of existing track (which is generally more costly to maintain than new or upgraded track), it is estimated that this scenario would have higher rail maintenance costs per average kilometre. As the route is longer the annual maintenance costs are also expected to be higher
- Because the 1,730 km Inland Rail scenario has a higher proportion of new track and a shorter route distance, it is expected that this scenario would result in lower below rail maintenance costs compared with the longer route.

Below rail operating costs

The indicative costs included infrastructure operators' costs (on a standalone basis) that would be incurred while planning, controlling and managing trains (but exclude track maintenance activities). These costs cover such activities as train planning, train control, incident response, administration and safety inspections.

The costs are not assumed to vary between the 1,880 km and 1,730 km scenarios. It was also noted that if Inland Rail were to be operated by ARTC, then a lower incremental operating cost is possible through leveraging existing staff and equipment.

3.8 Market take up/demand

The results presented in this section are preliminary results, for the purpose of route comparison only. The study proposed alignment was examined in further detail. The final market demand analysis is contained in the final report and Appendix B.

To estimate market take up for the inland railway, ACIL Tasman initially estimated total road and rail freight in the Melbourne Brisbane corridor. Based on these estimates of the total freight market, the demand analysis assessed whether freight will remain on road or existing railways (including the coastal railway), or whether it would switch to the inland railway if it is constructed.

To investigate this, ACIL Tasman undertook a survey, based on a questionnaire and interviews with key freight companies and customers, to understand how modal choices are made. Then, incorporating assumptions for expected future journey time reliability and capacity of the current rail route and potential inland railway route, a logit model was developed to estimate future mode shares and future rail tonnages with and without Inland Rail. Additional analysis was undertaken of coal, grain and other regional freight.

The following assumptions were included in the logit model related to forecasts of relative price, reliability, availability and transit time that reflect the capital costs assumed for the coastal and inland railways. These are summarised in Table 3-9.

Table 3-9 Summary of preliminary assumptions for specific scenarios

Assumption	Mode/route	Base Case (no Inland Rail)	1,880 km scenario	1,730 km scenario
Indicative capital costs (preliminary estimates, millions incl. 20% contingency, undiscounted)	Inland railway	n/a	$2,815m	$3,750m
	Other rail in corridor	$2,701m	$2,101m	$2,101m
	Road in corridor	Assumed as equal under the three scenarios		
Distance (M-B terminal-terminal), km	Inland railway	n/a	1,881	1,730
	Coastal railway	1,904	1,904	1,904
	Road	1,650 (door-to-door)	1,650 (door-to-door)	1,650 (door-to-door)
Transit time (M-B terminal-terminal), hours	Inland railway	n/a	27.5 hrs	22 hrs
	Coastal railway	28 hrs	28 hrs	28 hrs
	Road	n/a	n/a	n/a
Transit time (M-B door-door), hours	Inland railway	n/a	32.5 hrs	27 hrs
	Coastal railway	33 hrs	33 hrs	33 hrs
	Road	23.5 hrs	23.5 hrs	23.5 hrs
Reliability (M-B)	Inland railway	n/a	85%	87.5%
	Coastal railway	70% in 2010	70% in 2010	70% in 2010
	Road	98%	98%	98%
Availability (M-B)	Inland railway	n/a	95%	95%
	Coastal railway	93%	93%	93%
	Road	98% (declining to 95%)	98% (declining to 95%)	98% (declining to 95%)
Door to door price (M-B, relative to road)	Inland railway	n/a	61.6% (declining to 57.2%)	58.6% (declining to 54.6%)
	Coastal railway	61.9% (declining to 57.6%)	61.9% (declining to 57.6%)	61.9% (declining to 57.6%)
	Road	100%	100%	100%

* Preliminary results only, for the purpose of route comparison.

The amount of tonnes expected to be carried by the inland railway under the two scenarios are shown in Table 3-10 below.

Table 3-10 Preliminary forecast tonnes and net tonne kilometres carried on Inland Rail (assuming commencement in 2020, '000 tonnes)

1,880 km scenario	2020	2030	2040	2050	2060	2070	2080
Intercapital	721	4,095	5,868	8,429	12,113	17,374	24,802
Induced	10,000	10,250	9,500	9,500	9,500	9,500	9,500
Diverted from road	1,720	2,369	2,701	3,115	3,629	4,268	5,063
Diverted from rail (e.g. Branch line, not coastal)	38,142	81,226	81,354	81,513	81,711	81,957	82,263
Outside	1,066	1,630	2,184	2,943	3,984	5,415	7,439
Regional	228	284	353	439	546	678	843
Total	**51,878**	**99,854**	**101,960**	**105,939**	**111,483**	**119,192**	**129,910**
1,730 km scenario	2020	2030	2040	2050	2060	2070	2080
Intercapital	888	5,054	7,206	10,299	14,725	21,003	29,807
Induced	10,000	10,250	9,500	9,500	9,500	9,500	9,500
Diverted from road	1,720	2,369	2,701	3,115	3,629	4,268	5,063
Diverted from rail (e.g. Branch line, not coastal)	5,542	6,026	6,154	6,313	6,511	6,757	7,063
Outside	1,076	1,689	2,270	3,068	4,167	5,680	7,803
Regional	228	284	353	439	546	678	843
Total	**19,455**	**25,671**	**28,184**	**32,735**	**39,077**	**47,887**	**60,078**

* Preliminary results only, for the purpose of route comparison.

Key findings of the preliminary demand analysis undertaken of the 1,880 km and 1,730 km options were as follows:

- The 1,730 km scenario was estimated to result in higher demand levels for Melbourne-Brisbane intercapital freight, which comprises freight transported along the entire length of the corridor. However, total tonnage was lower compared to the 1,880 km scenario as the longer Inland Rail scenario captures revenue from the transport of coal from the Gunnedah Basin whereas the 1,730 km option bypasses this section of track and foregoes the additional revenue. This freight travels relatively short distances on the entire route, so does not have a significant impact on financial viability
- Rail mode share is expected to increase as a result of Inland Rail. Rail market share (combined for the inland railway, coastal railway and other existing rail lines in the corridor) is also expected to increase. As a proportion of total Melbourne-Brisbane road and rail freight in the corridor, the rail share is expected to increase from the current 29% (by tonnes), to 45% once the inland railway commences operations in 2020, rising slowly to 57% by 2050 for the 1,880 km inland rail scenario and 60% for the 1,730 km scenario. In contrast, if there is no inland railway, the rail mode share of intercapital freight is projected to be 44% in 2020 and 54% in 2050
- Inland Rail's market share is relatively stable (but with demand/freight volumes growing by 3-4% per annum). Inland Rail's share of total road and rail intercapital

freight is estimated at 49% by 2050 (for the 1,880 km scenario, by tonnes) and 59% (for the 1,730 km scenario). This does not vary significantly if commencement of Inland Rail operations is delayed

- Inland Rail was found to induce substantial quantities of coal freight over short distances, and divert grain from other rail routes and road onto parts of the inland railway. Inland Rail would also attract regional freight and freight from outside the corridor.

3.9 Access revenue

The access revenues (to be included in the financial appraisal and affecting mode choice decisions in the demand analysis) were based on an assumption that access charges for Inland Rail would be set at broadly the same reference tariff levels that ARTC applies for the existing main south and coastal railway and that QR applies for coal. For simplicity, ARTC prices have been applied to the full Melbourne-Brisbane journey (with the exception of QR prices for coal freight). The ARTC charge levels for superfreighters are set to be road competitive which results in revenues generally being well below the potential ceiling or maximum charge levels for specific corridors.

The table below summarises the Inland Rail access revenue assumptions incorporated into the financial appraisal.

Table 3-11 Preliminary Inland Rail access revenue assumptions

Revenue item	Inland rail revenue		Unit and basis assumptions
	1,880 km scenario	1,730 km scenario	
General freight			
Access rates (applied to all general freight excluding Melbourne-Junee)	$2,880 per million gtk	$3,194 per million gtk	Based on current coastal rail approximation of $2,845 per million gtk, reduced by factor of (1,904/1,881) and (1,904/1,730) based on an assumption Inland Rail will be competitive with coastal railway per Melbourne-Brisbane trip, regardless of trip kilometres.
Fixed charge per train km ('flagfall') (applied to all general freight excluding Melbourne-Junee)	$0.59 per train kilometre	$0.65 per train kilometre	Based on current coastal rail approximation of $0.58 per train km, reduced by factor of (1,904/1,881) and (1,904/1,730) based on an assumption Inland Rail will be competitive with coastal railway per Melbourne-Brisbane trip, regardless of trip kilometres.
Coal			
Fixed charge per net tonne ('flagfall')	*$1/tonne* – Moree-Narrabri, NSW/Qld border-Narrabri and Werris Creek-Narrabri *$2/tonne* – Toowoomba-Brisbane, southeast Queensland-Brisbane and Toowoomba-Ipswich	*$1/tonne* – Moree-Narrabri, NSW/Qld border-Narrabri *$2/tonne* – Toowoomba-Brisbane, southeast Queensland-Brisbane and Toowoomba-Ipswich	In addition a revenue cap of $40 million per annum is assumed for Narrabri-Werris Creek coal revenue, reflecting an approximation of the impact of regulated maximum prices on revenues generated on this part of the corridor. Coal volumes on other lines are not expected to be significant enough to require a cap. No Werris Creek – Narrabri coal would be carried on the 1,730 km scenario.

Source: based on average of current ARTC North-South access charges, *ARTC 2008 Pricing Schedule*

Because the 1,880 km route uses existing rail lines in central NSW with proximity to coal mines, the scenario was assumed to capture some coal access revenue between Werris Creek and Narrabri. Total access revenue from this traffic was estimated to be slightly higher for the 1,880 km scenario compared with the 1,730 km scenario. However, considering intercapital freight only, the 1,730 km scenario was found to result in higher intercapital revenue.

3.10 Preliminary financial and economic analysis comparing the 1,880 km and 1,730 km scenarios

To compare the 1,880 km and 1,730 km inland railway scenarios, the economic and financial appraisals considered the following scenarios:

- *Base Case scenario* – assumed there is no Inland Rail and freight travels by road or existing rail lines; it also assumes currently planned upgrades to the existing coastal railway proceed that will achieve a terminal-to-terminal transit time of 28 hours[6]
- *1,880 km Inland Rail project scenario* – assumed development of Inland Rail based on a target 27.5 hour transit time that would require low-level capital costs, and upgrades to the coastal railway in line with the Base Case
- *1,730 km Inland Rail project scenario* – assumed development of Inland Rail based on a target 22 hour transit time that would require high-level capital costs and upgrades to the coastal railway in line with the Base Case.

The Base Case or 'without project' case assumed that no inland railway project proceeds. Investment in the coastal railway, which forms the Base Case, is also assumed under the Inland Rail scenario. Table 3-12 summarises the route distances, capital costs and other assumptions of the Inland Rail scenario compared to the Base Case.

3.10.1 Financial appraisal methodology

The overall objective of the financial analysis was to evaluate the feasibility of the identified scenarios for the procurement of Inland Rail in terms of the net present value of project cashflows. At the core of the analysis was the development of a financial model which was used to translate raw cost and revenue data into estimates of the net present value.

The financial analysis was undertaken on a forecast cash flow basis, using annual periods and nominal dollar forecasts. The general analytical framework adopted focused on the Inland Rail project cash flows. A before tax and financing net cash flow profile was estimated for each of the options. This net cash flow profile was then for three Inland Rail commencement years: 2020, 2030 and 2040.

3.10.2 Economic appraisal methodology

The appraisal used a rail freight CBA framework. This framework assessed the potential change in economic welfare with the scenario by considering the following parameters:

- project and Base Case capital costs
- project and Base Case recurrent costs
- rail operating costs
- freight value of travel time
- road and rail crash costs
- external costs (such as air pollution, noise, and greenhouse gases).

[6] ACIL Tasman suggests that the 28 hour transit time may be difficult to achieve as this would require three locomotives, which operators may not otherwise choose for haulage of a 1500m train. As such, this may be a conservative estimate for Inland Rail viability.

3.10.3 Preliminary financial and economic results

The section below presents the results of the financial and economic analysis. These results are preliminary results to compare the two route options and will differ from the results of the final assessment when transit time, demand, capital cost and train and track operating and maintenance costs were refined.

Financial results

The table below presents the financial assessment results. The results present an estimate of financial viability from the perspective of the Inland Rail track operator. The preliminary analysis focused on the Inland Rail project cash flows, and excludes financing cash flows as they were more relevant for analysis of specific private/public sector financing structures.

Analysis indicated that financial viability of the project worsened under the 1,730 km scenario, as despite an increase in demand resulting in an increase in intercapital freight access revenue for the track operator, this would not be sufficient to fund the higher capital costs and subsequent borrowing costs.

An important assumption that affects comparability of the two transit time scenarios was the question of Narrabri-Werris Creek coal revenue. This coal revenue was included in the 1,880 km scenario (despite these mines being very likely to use existing rail lines if there were no inland railway) but not the 1,730 km scenario. When the revenue was removed from the 1,880 km scenario financial results, the 1,730 km scenario resulted in higher access revenue over the appraisal period.

Table 3-12 Preliminary financial analysis – project NPV (pre tax) nominal cash flows ($ million, discounted, excluding financing costs)[7]

Government D&C Operations commence:	1,880 km scenario			1,730 km scenario		
	2020	2030	2040	2020	2030	2040
Indicative capital cost	-2,006	-1,177	-693	-2,673	-1,568	-923
Below rail operating revenue	1,830	1,257	832	1,504	1,095	758
Below rail operating cost	-585	-339	-192	-504	-292	-165
Project NPV – operating cashflows only (excluding capital costs)	1,245	918	640	1,000	803	594
Project NPV – total project cashflows	-761	-259	-53	-1,672	-765	-329

Notes: excludes financing cost (debt and equity). Figures in this table may not total due to rounding
Capital cost figures that form the basis for the financial appraisal are indicative and subject to change
As described further below, Narrabri-Werris Creek revenue affects comparability of 'operating revenue' as it is included in the 1,880 km scenario only. Removing this revenue stream results in the 1,730 km scenario generating higher total revenues.

Economic results

The economic assessment was undertaken from a national perspective that included costs and benefits accruing to likely users and non-users of the inland railway. Benefits included freight time savings to end customers, train operator and road freight cost savings, producer surplus from induced freight, road maintenance savings and environmental externality cost savings resulting from the inland railway. The economic assessment covered the Inland Rail scenario with three different operating commencement years, assessed incrementally to the Base Case to represent the net economic benefits to community that would be expected to result from the proposed railway. The Inland Rail scenario assumed that upgrades to the coastal railway will take place regardless of whether the inland railway is built.

[7] Note: coal revenue assumptions for this preliminary analysis are based on a simplified assumption of $2/tonne for Toowoomba-Brisbane coal, and $1/tonne for Narrabri coal. In addition, Werris Creek–Narrabri revenues for the 1,800 km scenario are capped at $40m, reflecting an approximation of the impact of regulated maximum prices on revenues generated on this part of the corridor.

As indicated in the table below, economic viability improved under a 1,730 km scenario. However the economic NPV remained negative. As with the financial appraisal, these results are preliminary and compare the two route options. They are different from the results of the final assessment when transit time, demand, capital cost and train and track operating/maintenance costs have been refined.

Table 3-13 Preliminary economic appraisal results for Inland Rail (incremental to the Base Case, $ million, discounted, 2010 dollars)

Economic indicators	Inland Rail ($2.81b capital cost / 1,880 km scenario)			Inland Rail ($3.75b capital cost / 1,730 km scenario)		
Operations commence:	2020	2030	2040	2020	2030	2040
Economic NPV	-1,229	-554	-300	-923	-252	-71
Economic benefit cost ratio (BCR)	0.27	0.36	0.39	0.58	0.77	0.89
NPVI	-0.91	-0.80	-0.74	-0.49	-0.26	-0.13
Economic IRR	1%	1%	1%	4%	6%	6%

Note: Preliminary results only. Capital cost figures that form the basis for the economic appraisal are for the purpose of route comparison and subject to change.

3.10.4 Route identified for further analysis

A comparison of the 1,880 km scenario with the 1,730 km scenario (which has a faster transit time, shorter route distance, higher capital costs but also higher demand), indicates the latter scenario improved economic but not financial viability. More specifically, economic viability improved as a result of an increase in mode shift from road and coastal railway to the inland railway, combined with a reduction in hours travelled for freight diverting to the inland railway. However, the financial viability of the 1,730 km worsened as a result of the significant capital cost and subsequent borrowing cost increases while demand and revenues were not estimated to increase by the same scale.

The reason the 1,730 km scenario had the different impact on financial and economic viability is that whilst the increased cost of the projects is reflected in both the economic and financial appraisals, the benefits are not captured symmetrically. There are two main explanations.

First, a series of *significant economic benefits were not captured in the financial analysis*. The 1,730 km scenario caused an increase in mode shift from road and the coastal railway to the inland railway – i.e. demand would rise. The impact of increased demand would be reflected in the financial analysis in the form of additional revenues. However, two economic benefits were not captured. These were:

- *Train operating costs (incurred by train operators).* These costs, which include those relating to fuel, train crew and rollingstock maintenance were estimated to be approximately 10% lower for the 1,730 km scenario. The route is shorter and would require less transit time relative to the 1,880 km scenario. This results in greater economic benefits due to cost savings for freight diverting from both the coastal railway and from road to Inland Rail. However, the additional operating cost savings from the 1,730 km scenario were not captured in the financial analysis as it was a below rail financial appraisal. In reality, this economic benefit might be captured by increasing the rail access charges. However, it was not factored into the preliminary financial appraisal comparing the two route options as it could result in a reduction in demand if prices were significantly higher than the coastal route or road.

- *Transit time savings.* For freight currently travelling on rail and road that is expected to shift to the inland railway, as well as induced freight that is not currently carried under existing conditions, the faster transit time of the 1,730 km scenario results in significant savings. For example, the freight that is expected to be transported on the coastal railway if there is no inland railway, was assumed to have a terminal-to-terminal transit time of 28 hours. Under a 1,880 km scenario, this freight would save only 0.5 hours on a Melbourne-Brisbane trip relative to the coastal railway. However under a 1,730 km scenario, the freight would save 6 hours per trip. This represents a very significant increase in time savings.

  Similarly, the amount of freight expected to shift from road to the inland railway was estimated to experience a longer transit time to and from the railhead. While this would offset the economic savings from a faster rail journey, the increase in time would be reduced significantly under the 1,730 km scenario. (Instead of door-to-door transit time increasing by 10.5 hours under the 1,880 km scenario, it will only increase 5 hours for an average Melbourne-Brisbane trip under the 1,730 km scenario.) Again, these economic benefits (or reduced negative impacts) were not captured in the financial analysis. In reality, this economic benefit might be captured by increasing rail access charges, but this was not factored into the preliminary financial appraisal comparing the two route options.

Second, *financial revenue was lower due to the loss of Gunnedah coal revenue.* The 1,880 km scenario captured revenue from the transport of coal from the Gunnedah Basin. This revenue did not appear as a benefit in the economic appraisal because the revenue would be unaffected by the completion of the inland railway (as the coal currently travels on existing lines). However, it was counted in the financial appraisal because it was assumed that once the inland railway is built, the revenues would flow to the operator of the railway. For this reason, whilst the 1,730 km route from Narromine to Narrabri was assumed not to capture Gunnedah Basin coal revenues due to its different rail alignment, the loss of revenues affected the financial analysis but not the economic analysis.

3.10.5 Conclusion

Compared with the 1,880 km route, the 1,730 km route had superior economic results and a better outcome for society. Therefore the planned focus for more detailed route / demand / economic / financial analysis shifted to routes via a direct line from Narromine to Narrabri that can offer a route distance in the order of 1,730 km and a transit time in the order of 22 hours. Considering this, the route that was developed is presented in the map below.

Figure 3-16 Inland rail route identified for alignment development

4. Development of the alignment

4.1 Introduction

The objectives of this section of the appendix are to describe:

- the refinement of the proposed alignment for the inland railway
- typical engineering solutions proposed along the alignment
- the alignment options and how they were reduced to a single solution based on railway operations, engineering, environmental, land and capital cost assessments.

This section describes the approach to refining the alignment of the inland railway. It describes a range of typical engineering solutions which have been allocated along the alignment and used in the estimates of capital cost for the project.

For each section of the proposed alignment, an outline is provided of the options considered during the study. The proposed alignment is presented and the reasons for selecting the solution are discussed. The proposed alignment is illustrated in Appendix F.

4.2 Approach to refining the alignment

General approach

Whilst more than 50% of the inland railway is along existing railway corridors, the refinement of the alignment concentrated mainly on the development of the greenfield sections.

In developing the alignment, the aim was to achieve a railway which would cater for required traffic travelling at 115 km/h, over the shortest alignment, at the least capital cost and with an acceptable environmental outcome. Where significant constraints exist, an alignment was selected which balanced these aspirations.

Broad alignment options were discussed at a series of workshops. The workshops were attended by the project team which comprised the engineering, environmental, construction and cost consultants. A broad option was selected and further developed to mitigate local constraints. In deciding on the proposed alignment, qualitative or quantitative assessments were made, based on railway operations, engineering, environmental, land and capital cost issues. The connections of the greenfield sections to existing railway corridors were also considered during the process.

In some locations, such as the crossing of the Toowoomba Range, constraints and issues were potentially critical to the project outcome and more detailed investigations were made than for the less constrained areas.

Where the alignment passes along existing railway corridors the infrastructure upgrade requirements were identified.

4.2.1 Development and evaluation of options

Greenfield alignments

Broad options considered

For each greenfield section, the study team reviewed aerial photography, the project GIS database and other available desk-top information and considered the major constraints within the study area. Broad options, fitting the natural terrain and avoiding the most significant constraints were developed.

The broad alignment options were assessed at a high level based on capital cost, journey time, environmental and land issues. Initially, major cost drivers such as topography, geotechnical and flooding characteristics, alignment length and land-use were considered. Options having significantly higher capital costs than other options or critical environmental characteristics were not considered further. Where the choice between options was unclear, preliminary alignments were drawn and assessed in more detail. A multi-criteria evaluation matrix was used when the choice between options could not be decided by one or two evaluation criteria.

Workshops

A series of workshops were undertaken covering the following constraints:

- Alignment design
- Engineering
- Environment and land use
- Operational
- Construction
- Costing.

The inland railway route was divided into sections and each section was considered in detail as the design progressed. The approach was generally to:

- Identify and discuss broad options for a section and identify areas where further investigation is required
- Prepare constraints maps and analyse the broad options
- Select a preferred broad option;
- Identify outline alignment drawings to be prepared
- Consider potential impacts to identified environmental and land use constraints and opportunities to avoid these where possible
- Consider the likely engineering solutions and cost of the local options
- Agree refinements of the alignment.

Following the review of the alignment for each route section, the alignment designers and environmental team members collaborated to further develop the alignments to ensure that environmental and land use constraints were avoided as much as possible.

Once the horizontal design of the alignments was finalised, the preferred alignment for each route section was made available for preliminary environmental assessment. The preliminary environmental assessment of the preferred alignment is documented in Appendix H.

Environmental and land use assessment methodology

During the alignment development stage, greenfield alignments were reviewed for environmental and land use constraints in order to minimise impacts on constraints as much as practical. The key activities that were undertaken included:

1. Preparation of environmental constraint maps using the study GIS
2. Alignment workshops to review constraints along each route section
3. Iterative development / refinement of alignments.

The environmental issues and key constraints that were generally considered during the alignment development phase of the study are listed in Table 4-1.

Table 4-1 Environmental and land use issues and constraints

Issue	Key constraints considered
Protection areas	• World Heritage Areas, Ramsar wetlands • National parks, nature reserves, conservation areas • State forests
Flora and fauna	• Vegetation communities (regional ecosystem, endangered ecological communities • Threatened species • Habitat areas, connectivity, fragmentation, etc
Heritage	• Commonwealth heritage and Register of the National Estate • Historic heritage (state heritage, local heritage, railway heritage) • Indigenous heritage
Water	• Waterways • Flood-prone land
Noise	• Noise disturbance
Land-use / tenure	• Non-rural (residential, townships, industrial) • Conservation / recreation areas, community / public facilities • Agriculture (irrigation, cultivation, grazing, hobby farms) • Resources (state forests, mining) • Travelling stock routes, Crown land / road reserve
Zoning	• Residential / townships • Environmental protection
Property impacts	• Property access (internal and external) • Severance • General amenity (noise, visual, safety, etc)
Infrastructure	• Roads and other rail • Utilities (water/gas pipelines, transmission lines)

From a land use and property perspective, the alignments were developed to take advantage of some existing features and minimise impacts on others. The order of preference was:

1. To use ‘paper roads’ (i.e. corridors designated as roads, but not used)
2. To provide clearance to residences
3. To run parallel to existing roads where there is minimal impact on property access
4. To run alongside or parallel to a property boundary (to minimise severance) rather than through the middle of a property
5. To run across larger (by land area) properties rather than smaller properties (cost of acquisition is generally lower).

Due to the environmental analysis undertaken earlier in the study alignments generally minimise impacts on environmentally sensitive areas such as State Forest, National Parks, areas of significant vegetation and conservation areas.

Constraint mapping

Constraint maps were generated from the study GIS, displaying the indicative route section alignment as well as environmental and land use information (as listed in the table above), infrastructure (e.g. roads, rail), topography and drainage. The data layers were laid over detailed aerial photography to show further information such as vegetated areas and condition, rural homesteads and agricultural land use (e.g. grazing or cultivation).

Large scale constraint maps were printed out for each greenfield route section, and these were used in the alignment workshops.

Local options considered

After selection of a preferred broad option, the alignment was developed further. The alignment was tailored to the natural terrain, topographic features and environmental constraints. An environmental constraints map was produced to assist the process and ground level data was purchased.

In areas containing significant constraints, such as major existing infrastructure or natural features, local options were considered. Initially a high level assessment was made. Where the choice between options was unclear, preliminary alignments were drawn and assessed in more detail.

Output alignments and engineering solutions

Maps of the chosen alignment are presented in Appendix F.

Where it would be relatively inexpensive, large radii curves and flat grades have been adopted to reduce long-term maintenance costs and establish a basis for faster train running times in the future. On sections of track that could be described as ‘fast inland alignment’, the limits enable a maximum speed of 115 km/h for superfreighter traffic. Where a constraint leads to lower speeds, such as in mountainous terrain, sections of alignments have been optimised for speeds less than 115 km/h.

To allow drainage, a minimum grade through cuttings of 1 in 200 and a minimum grade through tunnels of 1 in 333 was adopted.

The vertical alignment has been developed to allow reuse of earthworks fill, gained from cuttings, in embankment sections. An assumed 10% of excavation is likely to be unusable for fill and would be disposed of. The alignment design has been developed to allow reuse of fill within 5 km of the cutting location where possible, but otherwise up to 20 km away. Balancing of cut and fill becomes more critical in environmentally sensitive areas where there is less opportunity for finding nearby sources of fill or areas for disposal. In areas identified as flood zones, embankments are provided. Alignment selection has attempted to allow the fill to be obtained from nearby cuts.

In parallel with the refinement of the alignment, a range of engineering solutions in the form of typical cross-sections were developed. The typical sections were allocated along the various alignments and provided input to the capital costs estimates.

Existing railway corridors

The inland railway will pass along several existing railway corridors. At present, the corridors have either standard or narrow railway gauges and have different standards of infrastructure (such as asset condition, track class and maximum axle load).

During the refinement of the alignment, several options were considered for providing the necessary infrastructure for the inland railway.

Existing Class 1 standard gauge railway

The existing Class 1 railway, such as between Melbourne and Junee, was reviewed for incorporation into the inland railway. Class 1 track was assumed to be capable of transporting the Reference Train without upgrading of the existing infrastructure. Some upgrade works planned by ARTC were assumed to be in operation by the time the inland railway opens.

Upgrade of existing standard gauge railway

Between Parkes and the Queensland border, the existing standard gauge railway along the inland railway route is either Class 2, Class 3 or Class 5. The infrastructure was reviewed for incorporation into the inland railway as follows:

- Class 2 railway, such as from Parkes to Narromine and from Narrabri to Moree, while suitable for the axle load requirements would be upgraded to remove speed restriction currently in force, and this would improve journey time
- Class 3 railway, such as the Moree to North Star Line, and Class 5 railway, such as on the Gwabegar Line are unsuitable for the proposed tonnages for the inland railway. Upgrading the track structure and replacement of all bridges and culverts would be required. The study team reviewed available bridge data to estimate the structures to be replaced.

Track duplication or dual gauge

Existing railways in Queensland are narrow gauge. To provide a standard gauge track for the inland railway, either a dual gauge or a railway comprising separate standard and narrow gauge tracks would be required.

The options and chosen solution(s) are described in section 4.4 of this report. Preliminary cost estimates showed that upgrading to dual gauge along existing alignments would generally be more cost effective than providing additional standard gauge tracks adjacent to the existing narrow gauge railway; and would involve less environmental/land use impacts.

Therefore, dual gauge tracks are proposed unless it could be clearly demonstrated that an alternative solution would be superior.

It has been assumed that significant possessions of the QR track would be available for construction of standard gauge track due to the improved alignment that would be available following completion of the proposed railway. Existing power stations are expected to be affected and strategies for stockpiling coal and using road haulage during railway possessions would be required.

Where a realignment is proposed within a section (deviating outside the existing narrow gauge corridor), dual gauging would continue along the realignment. Tie-ins with the existing corridor will generally be at the same grade and join the existing alignment to facilitate staged construction.

Double-track narrow-gauge corridors would be replaced by double-track dual-gauge. The figure below shows where standard gauge or dual gauge has been assumed.

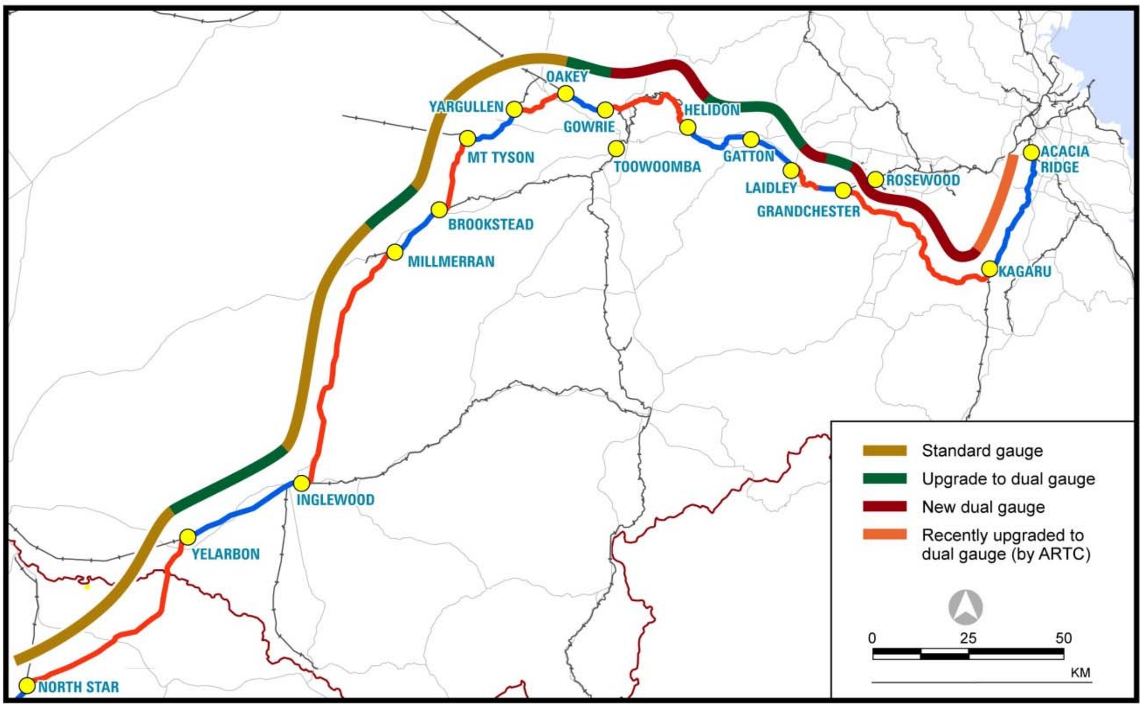

Figure 4-1 Standard and dual gauge corridors

Land use and property

In considering the upgrade of existing railways, the following order of preference was used:

1. Alignments would be wholly within an existing corridor where it is possible to achieve project design limits and maintain the desired 115 km/h design speed
2. Existing corridor would be widened to achieve project design limits where property issues are reasonable and manageable
3. Speed restrictions would be placed on trains where property issues prevent corridor widening.

Approach to double stacking

In accordance with government strategy, proposed new construction would be designed to cater for double-stacked trains. Bridges over the existing railway catering for single-stacked trains were assumed to remain and would typically be upgraded to allow double stacking at a later date.

4.2.2 Safety in design

The proposal for the inland railway included a preliminary review of design safety aspects. The safety aspects incorporated in the inland railway proposal include:

- For the Toowoomba tunnel, hazards associated with mined tunnelling techniques have been mitigated by an assumption of tunnel boring machine construction with segmental lining erected immediately behind the machine
- For the Toowoomba tunnel, hazards to train-crew from air pollution inside the tunnel generated by locomotives working hard uphill were considered in the requirements for ventilation systems.

Safety related risks identified for inclusion in future project stages include:

- Safety assurance of the Advanced Train Management System
- Specification of grade-separated and level crossings in accordance with ALCAM.

4.3 Typical engineering solutions

A range of typical engineering solutions were developed during the study and a selection is described in the following sections.

Greenfield alignments at-grade

A large proportion of the greenfield alignments for the inland railway pass across flat terrain. In these locations, earthworks would be limited to removal of topsoil, minor and local earthworks profiling and preparation of the formation. The railway would be standard gauge track comprising 60 kg/m rails, heavy duty concrete sleepers and 300 mm ballast on a 150 mm capping layer.

A local low point on both sides of the railway (the cess), would provide drainage.

Fencing on both sides of the railway has been assumed, with gates at intervals to maintain access and occasionally to provide potential for future crossings.

Upgrade of existing track

For sections requiring an upgrade of the track, it has been assumed that rails, sleepers, ballast would be removed and replaced. The railway would be standard gauge track comprising 60 kg/m rails, heavy duty concrete sleepers and 300 mm ballast on a 150 mm capping layer, constructed over the existing capping layer.

Existing bridges and culverts would be replaced unless the existing capacity has been confirmed as acceptable for 25 tal by the asset owner. The design load for replacement bridges is 325LA, that is 32.5 tal.

Overbridges

New overbridges (bridges over the railway) would be provided where the proposed inland railway crosses major highways. Cellular precast (standard RTA) planks would span up to 18 m across the new railway corridor. The planks would bear on a capping beam and a row of bored piles. Shotcrete would be sprayed between the bored piles and retain the existing ground behind. A typical arrangement for a two-lane highway is shown in Figure 4-2. Similar details would be proposed for four-lane highway overbridges which require a bridge deck approximately 24 m wide.

An alternative design is also proposed for cases in which a span of between 18 m and 34 m is required across the railway corridor. Details would be similar to the shorter spanning solution except that deeper super-T girders are required for the longer spans. Overbridges on the sections of existing railway generally provide clearance for single stacked trains and would not be upgraded to cater for double stacked train clearances under the inland railway proposal.

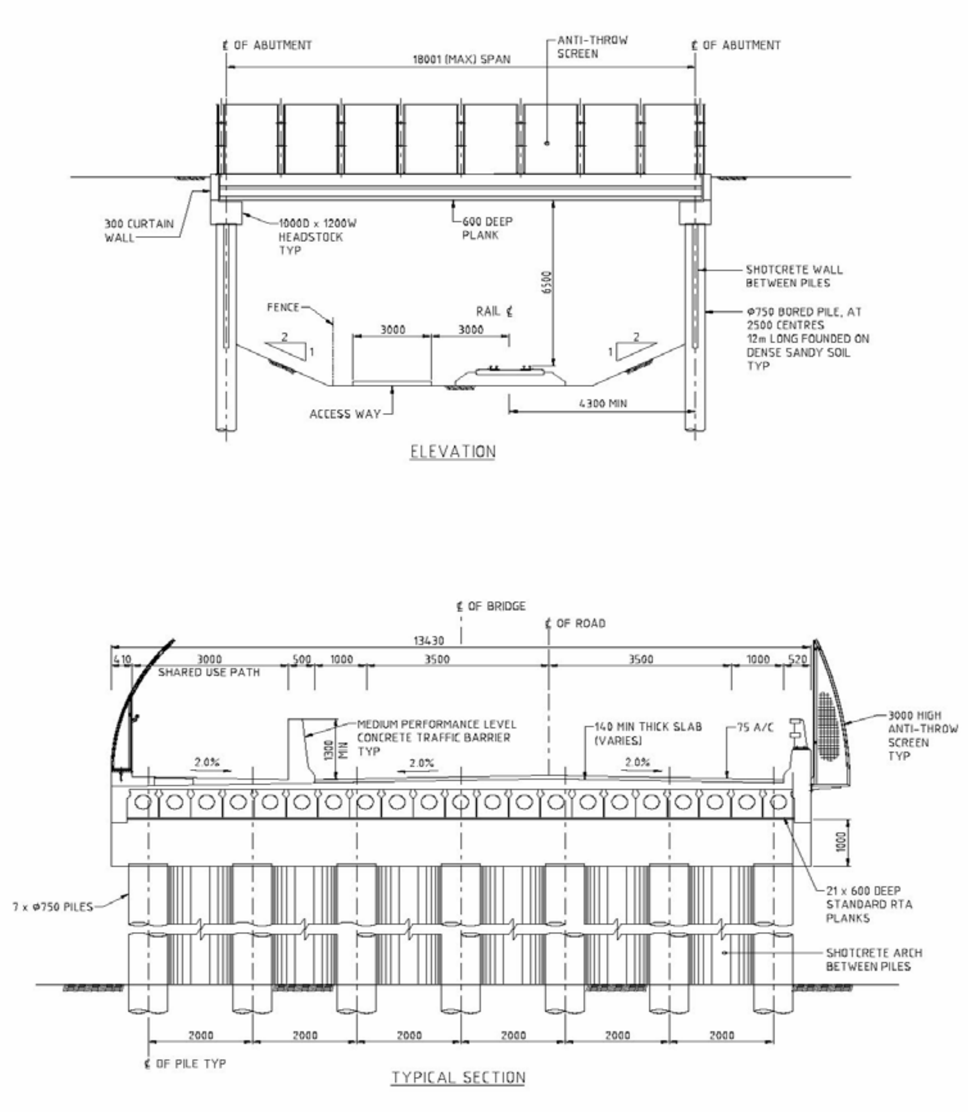

Figure 4-2 Typical highway overbridge

Underbridges

A range of underbridges would be built on new and existing alignments over water crossings and roads. A typical underbridge is shown in Figure 4-3. Two 1200 deep Super-T girders would support the railway and span between abutments and piers at 12 to 18 m centres. Whilst the foundation design would be developed significantly to suit particular conditions at each site, two bored piles at each pier and abutment have been assumed in the cost estimates of the study. The piers of the bridge are assumed to be twin cast-in-place concrete columns. Other designs were also proposed as follows:

- Details similar to Figure 4-3 but with larger structural sizes to allow spans of between 18 and 25 m

- Details similar to Figure 4-3 but with a deck comprising 1,300 mm deep cellular planks to allow spans of between 15 m and 18 m.

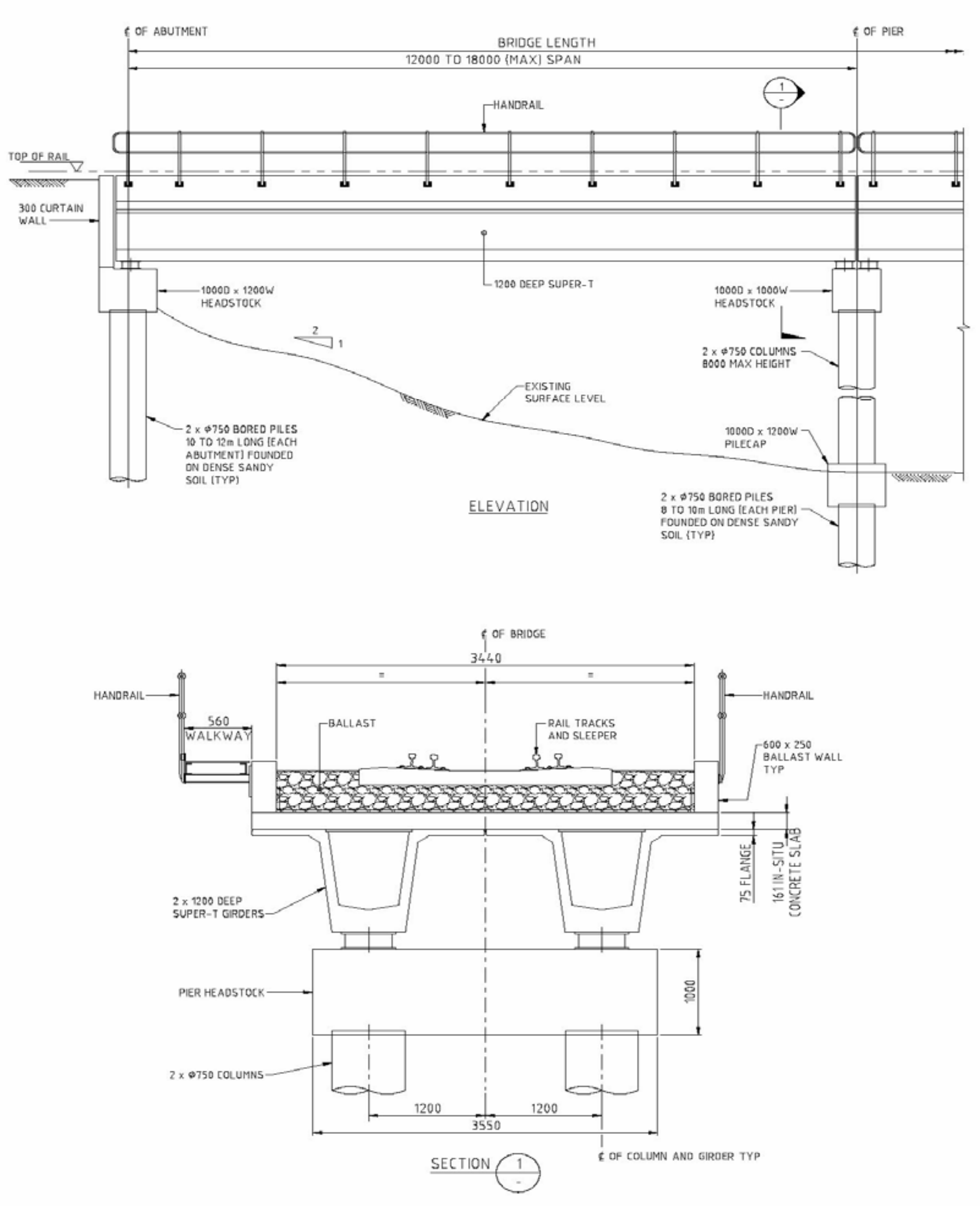

Figure 4-3 Typical Underbridge

Culverts

Box cell culverts would be constructed using reinforced concrete at points along the inland railway to provide appropriate drainage paths for surface stormwater. The number and size of cells would be designed to cater for the flows anticipated in a 1 in 100 year stormwater event, where information is available.

The cells would be precast and lowered onto a compacted sub-base during dry periods. At least one central cell would be available for low flow conditions, with additional cells being provided where necessary for peak flows. Wing walls orientated at approximately 45 degrees (in plan) to the water course would gather the water and protect the adjacent embankments. The concrete cells would be designed to support the loading from the railway including the ballast, track structure and trains. Details of a typical culvert are provided in Figure 4-4.

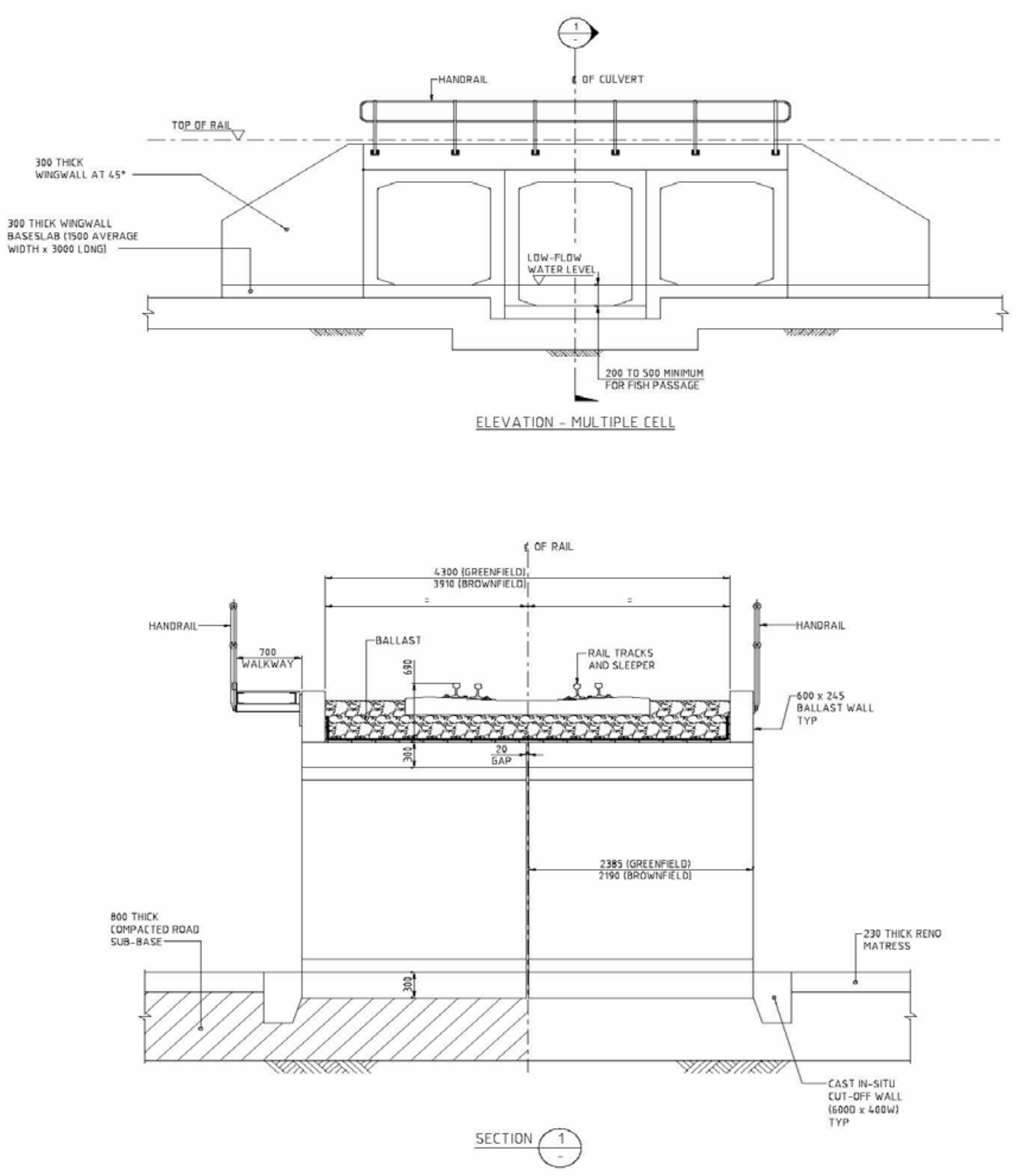

Figure 4-4 Typical culvert

Viaducts

In a number of locations, viaducts have been proposed for the inland railway. The viaducts allow the railway to overcome substantial constraints such as hilly terrain or major river floodplains. A typical viaduct is shown in Figure 4-5. A post-tensioned continuous box girder supports the railway and spans between abutments and piers at 45 m centres. Whilst the foundation design would be developed significantly to suit particular conditions at each site, bored piles founded on weak rock have been assumed in the cost estimates of the study.

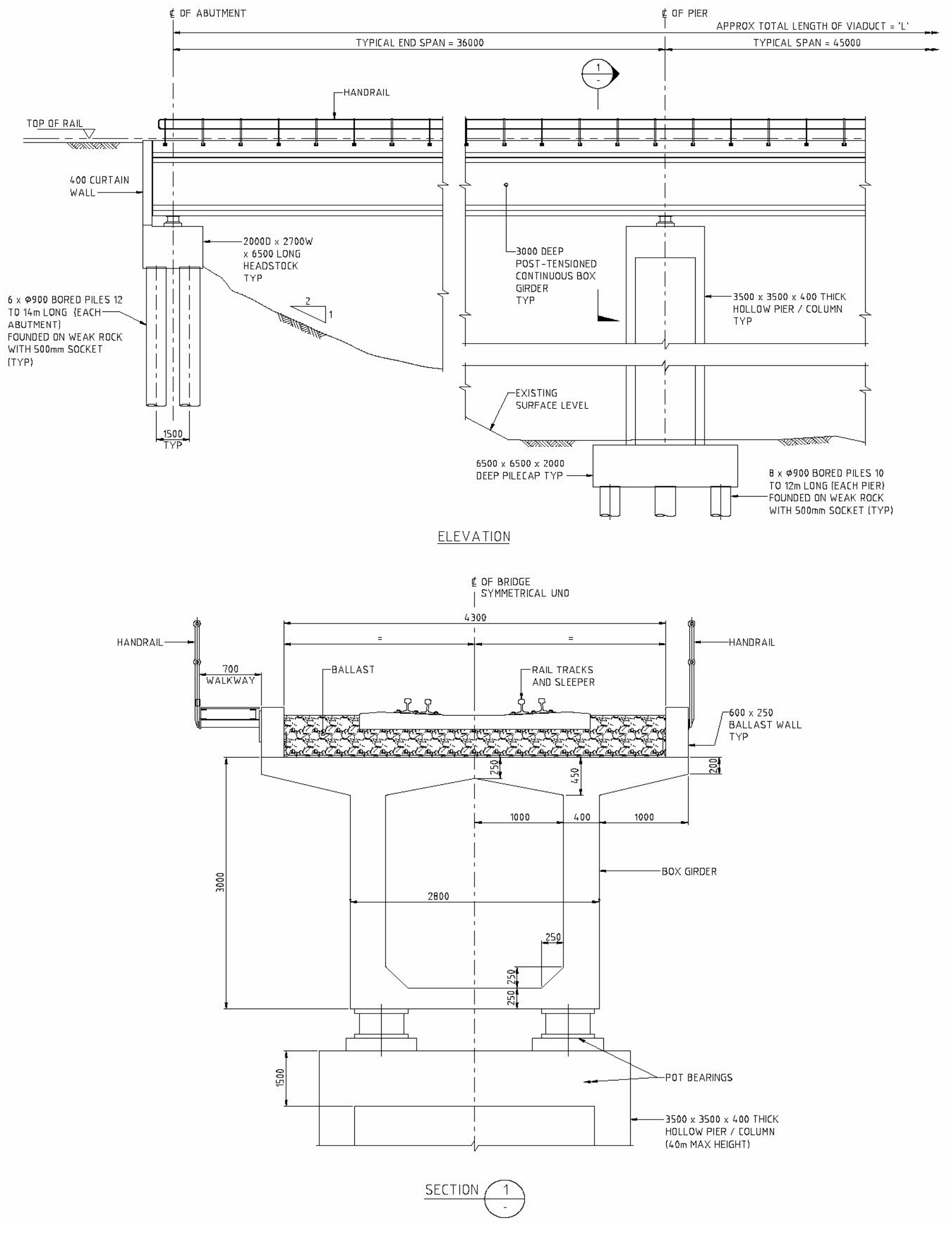

Figure 4-5 Typical viaduct

Tunnels

The most significant natural features along the alignment are between Toowoomba and Kagaru. Four tunnels are proposed:

- The Toowoomba tunnel, approximately 5,030 m long on the northern outskirts of Toowoomba
- The Laidley tunnel, approximately 500 m long to the east of Laidley
- The Flinders tunnels, approximately 1,050 m and 200 m long near Flinders Peak in the hills to the west of Kagaru.

The Laidley and Flinders tunnels are expected to be constructed by mined tunnelling techniques.

The Toowoomba tunnel would be the most significant and expensive piece of infrastructure constructed for the inland railway.

A desk top review of ground conditions suggested the Toowoomba tunnel would have at least its western half, and perhaps most of the eastern half in basalt rock with the tunnel passing into poorer ground conditions (Mesozoic strata comprising interbedded sedimentary sandstones, mudstones, claystones, shale and siltstones with possible overlying Walloon Coal Measures) for the eastern half.

It is plausible that the final one kilometre or so at the eastern end of the tunnel would pass through the upper Mesozoic strata. If this is correct then it is likely that these strata could be the Walloon Coal Measures (which are typically 20-30 m thick in this area). It is emphasised that inferring the assumed ground conditions along the tunnel alignment is very tentative and should not be relied on for accuracy. Further ground investigation is recommended in the area of the proposed tunnel and further alignment optimisation is likely to have benefits.

Several tunnel design concepts and construction methods were considered and the following options were short-listed for further study.

- Tunnel Boring Machine (TBM) option - comprising segmental tunnel lining erected behind the TBM and with egress for fire and life safety being provided by a passageway within the segmental lining
- Mined tunnelling techniques – comprising concrete lining, with egress for fire and life safety being provided by a passageway within the tunnel.

A preliminary assessment of the two options suggested that the TBM solution is likely to be the approach that would be chosen by contractors during a design and construct contract. The TBM solution is expected to have program and cost advantages, and would be potentially safer to construct. However, the mined option has some merit and should be considered during later project stages as additional information, especially ground investigation and assessment of hydro-geological aspects, becomes available.

A typical cross-section for the TBM segmental lined tunnel is shown in Figure 4-6. The lining would comprise 8 segments and a key forming a ring, 1,500 mm long. The lining would contain reinforcing bars for strength and robustness during construction and in the finished works. The concrete mix of the lining has been assumed to include polypropylene fibres which prevent spalling of the concrete in the event of a tunnel fire.

The provision of passive fire protection to railway tunnels is not usually required if the fire loads are low and safety provisions within the rollingstock and rail infrastructure are specified and maintained to a high standard. However, the existence of 'imported' fire risks such as vehicle shuttles and fuel tankers may imply significantly higher fire loads. In cases where the collapse of the tunnel would result in unacceptably high social costs, a cost/benefit analysis, informed by a quantitative risk assessment, may demonstrate a strong case for additional measures, including fire protection and/or fire suppression systems. For the fire design of the segmental lining on the inland railway, it has been assumed that the lining will need to withstand two hours of fire to the standard increased hydrocarbon fire curve. Further study of the fire load and fire design cases would be required during detailed tunnel design.

It is expected that the TBM would be driven uphill from the lower tunnel portal so that water entering the excavation would drain naturally away from the face. Space is required to erect and deploy the TBM and a mined cavern approximately 200 m long has been assumed.

Little information is available regarding the ground conditions in which the cavern would be excavated. It has been assumed that weak rock comprising interbedded sedimentary layers would surround the cavern. The cavern is expected to be constructed using roadheader machines. A heading (about 5 m high) would then be excavated in the top of the tunnel across half of the tunnel width and steel arches (followed by sprayed concrete) would be inserted to temporarily support the tunnel roof. The heading will be advanced in 1 m sections. There may be opportunities to use rock-bolts as temporary support and avoid the need of steel arches if ground conditions are found to be more favourable than those assumed. Some distance behind the heading, the rest of the tunnel cross-section would be excavated in a sequence of four benches (stages). The sides of the excavation would be supported by steel sections and sprayed concrete. When the cavern excavation has been completed and the TBM drive has started, the permanent lining for the cavern would be constructed.

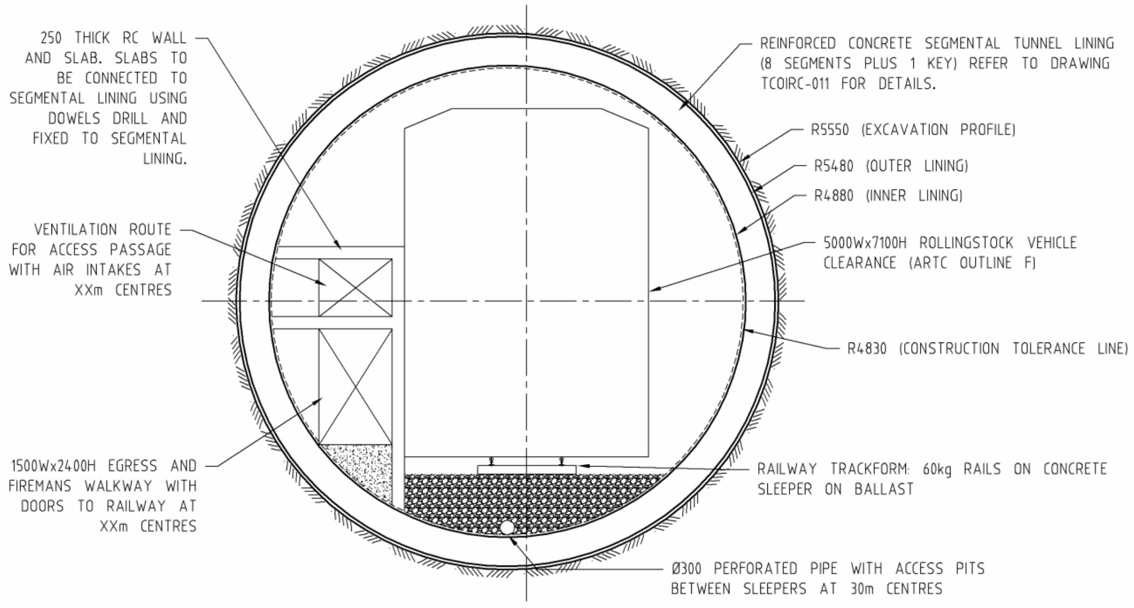

Figure 4-6 Typical segmental lined tunnel

Ventilation of tunnels

Three tunnels with lengths of approximately 1000 m or less have been proposed. These tunnels would be ventilated with jet fans.

The following options were considered as possible tunnel ventilation methods for the tunnel near Toowoomba, but for reasons stated in each of the sections, have not been pursued.

Natural ventilation

In order to control the air temperature in a tunnel and prevent the overheating of the locomotives, a minimum ventilation air flow must be maintained for trains. Natural ventilation of the tunnel, based on the level difference of the portals at either end of the tunnel or atmospheric conditions, was considered, but found to be insufficient for ventilation purposes.

Similarly, piston-generated airflows (from the movement of the trains) are often sufficient to keep the tunnel air temperature below the critical value. However, the combination of tunnel length, tunnel grade, train load and other factors resulted in a high heat release rate and therefore piston-action ventilation was considered inadequate.

Forced ventilation with central fan plant

The use of a central fan plant (without the use of a portal gate), located adjacent to the portal structure at the higher elevation portal, was considered for the ventilation of the tunnel. However, due to the high airflow rate, pressure and fan power requirements, this option was considered to be inefficient and costly.

Forced ventilation with distributed fan plant (jet fans)

Jet fans are generally a viable option for road tunnel ventilation. However they can also be used for rail tunnels. Jet fans require additional tunnel space for installation (in the form of a larger tunnel or niches), require extensive electrification and the possible construction of in-tunnel sub-stations (for long tunnels), and have a high maintenance requirement. Maintenance can be a particular issue when there is only one tunnel tube, which would need to be closed down to traffic during the maintenance activity. For these reasons, and given the length of the tunnel, the use of jet fans was seen as being costly with a negative impact on operations.

Full/semi transverse ventilation

Full or semi-transverse ventilation systems have primarily been used in road tunnels. However they have also been considered for the ventilation of this tunnel. Fully transverse ventilation systems involve the use of both supply and exhaust air ductwork along the length of the tunnel with separate fan plants. Semi-transverse ventilation systems involve the use of either a supply air or an exhaust air duct along the length of the tunnel with one fan plant.

The disadvantage with either system is the number of fan plants required, and the corresponding high power demand, as well as the need for a large tunnel diameter. Both of these options were considered to be too costly and were therefore not pursued.

Proposed ventilation of the Toowoomba tunnel

The tunnel ventilation system for a tunnel serving diesel-driven freight trains is required to provide:

- Sufficient ventilation to prevent the overheating of the locomotives
- Sufficient ventilation to purge the tunnel of diesel exhaust emissions before subsequent trains can enter the tunnel
- Smoke control during emergency operation.

The train handling capacity of a tunnel is determined by the time required for a train to transit and clear the tunnel plus the time required to purge the tunnel of diesel exhaust pollutants.

Therefore, the evaluation focused on train operations in the uphill direction, since the train speeds would be lower and the quantity of train heat generated will be higher.

Design train

The project has defined a reference train to be used as the basis for analysis. The reference train is specified as being 1,800 m long and configured to handle 40% double-stacked containers; carrying 292 TEU weighing 2,920 tonnes (including container weight) resulting in a trailing load of 4,456 tonnes. The train is hauled by three locomotives that can deliver 3,220 kW of traction power each. In addition, three other train consists were identified for evaluation. The key parameters of the reference train and the three alternatives are summarised in the table below. Note that in all cases the trains are assumed to be 1,800 m long and hauled by three locomotives.

Table 4-2 Design trains

Train type	Consist description	Trailing load (tonnes)	Total train weight (tonnes)	Train speed (km/h)
Reference train	40% double stacked	4,456	4,858	34
Alternative 1	100% double stacked	4,800	5,202	32.1
Alternative 2	NSW coastal route. Limit for 3 locomotives	5,460	5,862	28.9
Alternative 3	Limit outside NSW for 3 locomotives (ARTC code of practice)	6,272	6,674	25.8

Note: Total train weight includes weight of 3 locomotives at 134 tonnes each

Locomotive cooling

Large quantities of heat are generated in a tunnel by locomotives hauling heavily laden freight trains. The largest localised heat sources are the diesel engine exhaust stacks and the radiator cooling fan discharges. When multiple locomotives are grouped together, the accumulated heat can potentially affect the operation of the rearmost locomotive(s).

As the tunnel air temperature at the inlet to the locomotive radiator rises, locomotive performance would fall; if the temperature is sufficiently high the locomotive may overheat and shutdown. In order to control the air temperature in a tunnel, effective air flow is required. The piston-generated airflows are often sufficient to keep the tunnel air temperature below the critical value. However, there are circumstances where the combination of tunnel length, tunnel grade, train load and other factors could result in high heat release rates and piston-action ventilation may not be adequate.

If piston ventilation is not sufficient, ventilation can be supplemented by installing a portal gate. The air displaced by a train moving against a closed gate is forced to flow back over the train; thereby, producing a significant amount of ventilation. In instances where the amount of ventilation is not sufficient, supplemental ventilation could be provided by installing fans to supply outside air into the tunnel.

Air quality

The tunnel must be purged after the passage of each diesel-powered train in order to provide a safe environment for crews of subsequent trains. This will require a full air change of the volume of air in the tunnel.

Preferred option analysis

An analysis was performed for each of the design trains identified in Table 4-2 to determine whether there was potential for locomotive overheating and, if so, to propose a method for mitigating such an occurrence. The analysis required an estimate of the total heat generated by each locomotive and an estimate of the ventilation rate available.

The heat release rate was estimated using information regarding the locomotive speed and grade. The piston ventilation was estimated by performing a balance between the pressure rise caused by the moving train and the air resistance of the tunnel.

The results indicate that the critical radiator inlet air temperature would not be exceeded with the ventilation rates that could be achieved with the train moving against a closed portal gate.

Portal door with central fan plant

The installation of fans near the portal gate would be required in order to purge the tunnel after the train has passed. The ventilation capacity selected in a given application represents a trade-off between the duration of the purge cycle and the total energy required to drive the fans.

For the purpose of this study, 16-minutes was considered to be a suitable tunnel purge time.

Train headway

It was previously noted that the time between successive trains (i.e. the train headway) is determined by the time required for a train to transit and clear the tunnel plus the time required to purge the tunnel of diesel exhaust pollutants. For the purposes of this study, a 16-minute purge time was the reference, although other purge times were also assessed.

Based on a 16-minute purge time and the reference train speed from Table 1 above, the total cycle time per uphill train is estimated to be approximately 30 minutes.

Fan plant

The fan plant is envisaged to be located adjacent to the portal gate structure at the higher elevation portal. With this configuration, the purge fans would supply air to the tunnel and discharge the tunnel air at the opposite portal.

The advantage of locating the portal gate and purge fans at the higher elevation is that the purge time for trains travelling downhill can be reduced by beginning the purge operation as soon as the locomotives exit the portal. It may also be possible that the portal gate could be left open for downhill trains, since the train heat load would be significantly less and could thereby be handled by the piston-action ventilation. In this instance, the tunnel would still have to be purged. However a good portion of the tunnel would have self-purged by the outside air drawn in through the portal. The portal gate would be closed as the train begins to exit the tunnel and the purges would be activated for a shortened duration.

The total flow rate could be provided by two axial fans, each handling 50% of the capacity. It has been assumed that sound attenuators at the intake and discharge sides of the fans would be required.

Fire and Life Safety in tunnels

Fire and Life Safety is an important factor to consider in the design of freight rail tunnels.

The Fire and Life Safety (F&LS) strategy would be required to take account of an expected small number of staff and a potentially large fire (possibly greater than 200 MW). At this stage it has been assumed that the F&LS issue can be appropriately dealt with using a combination of fire safety measures and operational responses.

The following general requirements have been considered:

- Occupant egress provisions
- Emergency services access provisions
- Smoke management
- Fire detection – linear heat detection could be considered
- Structural fire resistance – requirements would be determined during design
- Fire protection – hydrant system likely requiring multiple tanks and pumps
- Emergency communications
- Lighting – emergency lighting would be required
- Fire size – potentially very large (>200 MW) given freight types (e.g. coal trains).

Preferred option – fire Isolated egress passage

- Occupant emergency egress is envisaged to be provided via the use of a pressurised egress passage along the length of the tunnel. The passage would have entry doors at regular intervals, with exit doors leading out at either end of the tunnel, beyond the portals.

Pressurisation of the passage will be provided by a dedicated system comprising fans at both portals. The pressurisation of the egress passage will minimise the entry of smoke during a fire, providing staff with a place of relative safety passage away from the fire.

The pressurised egress passage would also serve as a means of access into the tunnel for emergency services personnel.

The normal ventilation system adopted could also help remove smoke from the tunnel in the event of fire. Smoke management would be through longitudinal ventilation with discharge points at either portal depending on fire location.

The preferred option provides a system that would not be heavily reliant on operations, intervention or mechanical systems. It was also seen to be the best system to preserve life and ensure ready access.

Other options considered

Dedicated access points

Dedicated access tunnels at regular intervals along the main tunnel, each leading to the surface, have been considered as a means of escape in the case of fire, as well as providing emergency services access. A number of these access tunnels would be required, each with a dedicated pressurisation system and a service road and possible hardstand at the exit point at ground level.

However, due to the depth of the tunnel, the length of the access points from the main tunnel to surface would be significant when taking the maximum grade for egress into account. This option was seen as costly and would possibly have a significant effect on the construction program.

Dedicated egress tunnel

A secondary egress tunnel of a smaller diameter running parallel to the main tunnel could be constructed, with cross-passages (complete with fire rated doors) connecting to the main tunnel at regular intervals. Pressurisation of the egress tunnel would be provided by fan plant at either end of the tunnel. Train operators would only have to walk a short distance (up to about 244 m) during an emergency to reach a cross passage and enter the parallel egress passage, which would be a place of relative safety.

Although this option could be regarded as being robust in terms of F&LS, it is also an expensive option.

Holding areas

A number of holding areas within the mainline tunnel could be constructed for temporary train operator refuge until emergency services could intervene and evacuate people.

This option is expected to be cost effective in terms of tunnelling, when a mined tunnelling option is adopted but not when using a TBM. However it is also the least preferred in terms of F&LS due to train operators not being able to evacuate the tunnel during a fire. .

Holding areas with stairs

Holding areas with stairs leading to surface could be constructed to allow train operators to evacuate the tunnel during an emergency. Approximately four to five stairs would be required at various locations along the length of the tunnel, each with a dedicated stairway pressurisation system and a service road and hardstand at the exit point at ground level.

However, due to the depth of the tunnel, which exceeds 200 m in some places, this option was seen as impractical and costly to construct. It would possibly have a significant cost effect on the construction program.

Special access vehicles

The use of a special access vehicle was also considered during our assessment of the F&LS strategy, which could be used to intervene during emergencies (including fires) and also be used to evacuate staff. However, until the special access vehicle is mobilised, staff would not be able to evacuate the tunnel or reach a place of relative safety. Train operators could be required to walk the length of the tunnel (up-grade) relying on longitudinal ventilation only. This was not considered to be an acceptable F&LS solution.

Retaining walls

In locations where the inland railway would either be adjacent to private land, in areas where space is limited or at a different level to the natural ground level, retaining walls have been proposed. For a retained height of up to 1.5 m in sandy ground conditions, and up to 2.5 m in clays, steel piles with precast sleepers as infill panels have been proposed. For heights up to 3 m in sands and 6 m in clays, a contiguous piled wall with sprayed concrete infill has been proposed.

Noise walls

Noise walls have been proposed in places where the inland railway would otherwise lead to unacceptable noise for nearby residents. A typical noise wall design has been assumed and comprises steel posts at 3 m centres with Hebel or precast infill panels. The walls are typically 3 m high and are assumed to be supported on reinforced concrete retaining walls and slab footings.

Earthwork profiles

The cost estimates for inland railway have been developed using a range of earthworks profiles along the alignment. In locations where the proposed railway is elevated above the natural ground level, embankments have been generally proposed. Different site preparation has been proposed for various existing ground conditions which range from swamps and poor ground, through alluvial, aeolian and black soils to soft and hard rock. A typical cross-section of an embankment is provided in Figure 4-7. On rock and alluvium, the embankments are expected to be formed from general fill and have sides sloping at 1 vertical to 2 horizontal. On poorer ground including black soils, sides sloping at 1 vertical to 3 horizontal are proposed. A capping layer is proposed on all embankments. In areas of Gilgai (black soil) lime stabilisation is likely to occur in the top metre of the re-used clayey, reactive general fill.

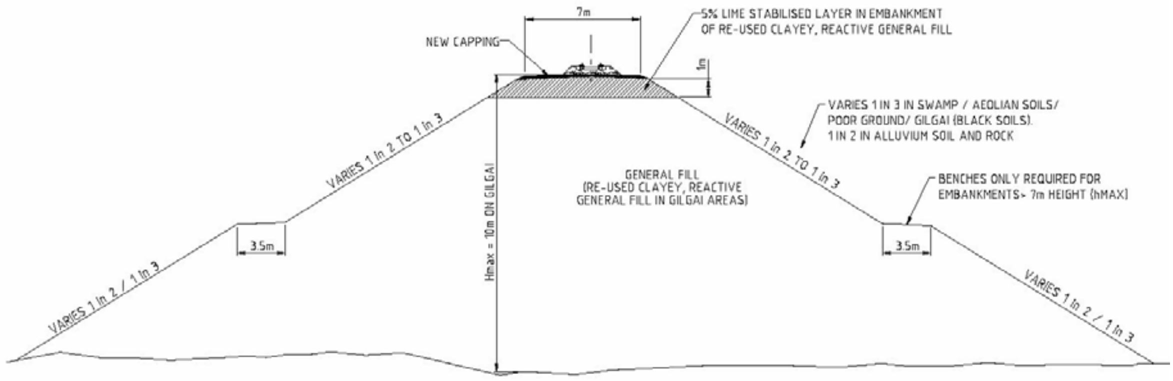

Figure 4-7 Typical embankment

Cuttings

Where the alignment for inland railway is below the natural ground level, cuttings have been proposed. The profile and side slopes of the cuttings are designed according to the existing ground conditions as summarised in Table 4-3. Typical cross sections are provided in Figure 4-8 and Figure 4-9.

Table 4-3 Summary of profiles of cuttings

Existing ground conditions	Side slope profile	Other major features
Gilgai (black soils)	1 vertical to 4 horizontal	Capping layer and lime stabilisation of top 300mm below formation
Alluvium/soils (non-dispersive)	1 vertical to 2 horizontal	Capping layer and proof roll subgrade
Alluvium/soils (dispersive)	1 vertical to 3 horizontal	Capping layer and proof roll subgrade
Aeolian	1 vertical to 3 horizontal	Capping layer and replace top 1.5 metres below formation with well graded gravel
Soft rock	4 vertical to 1 horizontal with 3.5m benches at 7m vertical intervals	Full face support in sections of poor rock and spot bolting where necessary over full slope face. Capping layer.
Very weathered soft rock	1 vertical to 1 horizontal with 3.5m benches at 7m vertical intervals	Full face support in sections of poor rock and spot bolting where necessary over full slope face. Capping layer.

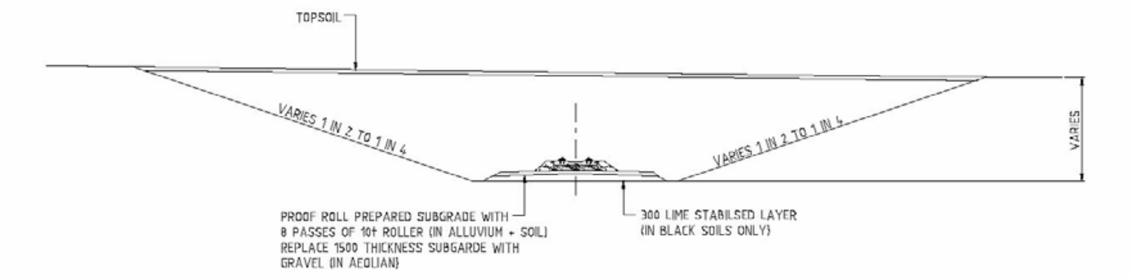

Figure 4-8 Typical cutting in soil

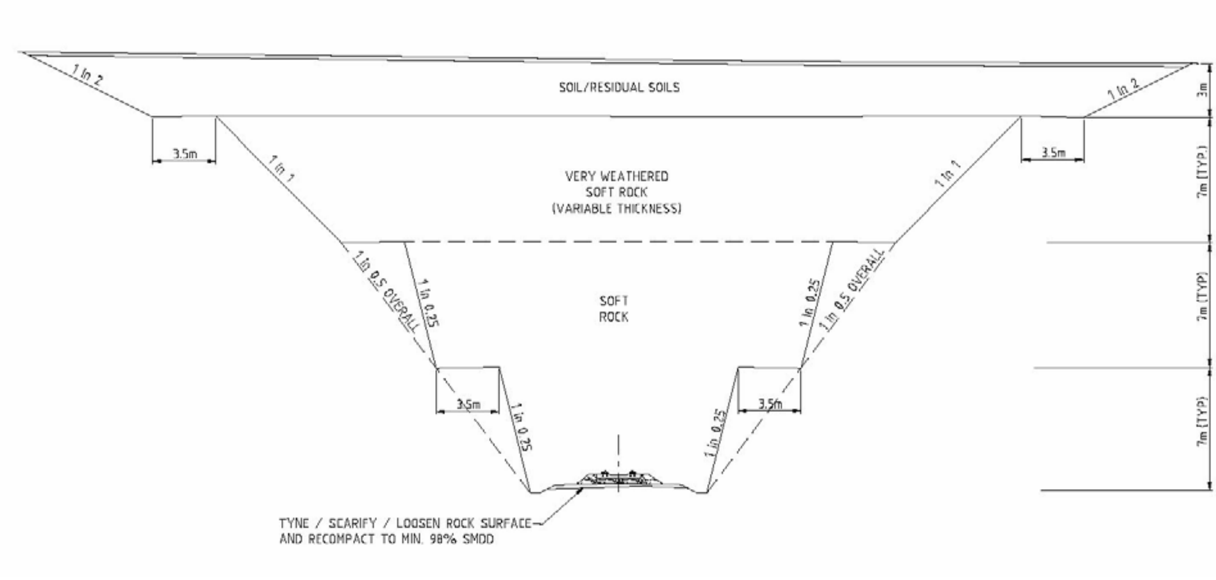

Figure 4-9 Typical cutting in rock

Roads

Designated highways and major arterial roads crossing the inland railway would be grade-separated. Generally roads over railway are of lower cost due to the steeper allowable grades on roads. However, local terrain may result in other options being favoured and advantage would be taken of existing cuttings or embankments to reduce the scale of proposed earthworks.

An attempt has been made to minimise the number of level crossings along the alignment:

- Minor roads have been realigned and combined
- Minor roads have been combined with waterway underbridges
- Minor roads would be closed where reasonable alternative access is available
- Road deviations provide alternative access to private property in cases where a private level crossing can be avoided.

Where existing highways pass over the railway, typical approach ramps to the overbridge were considered. On flat natural ground, each approach ramp will be about 370 m long if a highway design speed of 100 km/h is adopted.

Three types of pavement have been considered. On low-use rural access roads a 200 mm thick, 20 mm dense gravel base-course will be laid over a 150 mm thick, 40 mm dense gravel sub-base. For moderate-use rural roads, a two coat seal is applied on top of the same base-course and sub-base layers. The highest specification is proposed for high-use rural roads and comprises 40 mm thick wearing course on 250 mm thick, 20 mm dense gravel base-course, on 300 mm thick, 40 mm dense gravel sub-base. The pavement designs assume a sub-grade having a California Bearing Ratio (CBR) greater than 5%. Typically this equates to a good strength of sub-grade for which a capping layer is not usually needed.

Level crossings

The detailed design of the crossings of the inland railway and the road network would be in accordance with the Australian Level Crossing Assessment Model (ALCAM). Each crossing would be assessed according to its level of safety for grade-separated and level crossing options. Where the use of a level crossing can be justified on safety and economic grounds, an active or passive level crossing would be provided (again according to an ALCAM assessment). The options assessment could also be expected to consider alternative routes such as those achieved by combining crossings.

In this study, assumptions have been made for each railway crossing, with grade-separation, active or passive level crossings being assumed in the design. Passive crossings are generally non-preferred because they only provide a stop sign and a range of passive signs and road markings for road traffic. Active crossings have barrier gates, red stop lights and warning sounds in addition to warning signs and road markings. The approach assumed at each instance where the alignment intersects an existing road is shown below.

Table 4-4 Treatment of road intersections

Treatment	Suitable for
Terminate road	Minor roads and tracks where alternative route is available to another crossing
Terminate road and construct new road to alternative crossing	Minor roads and tracks where another crossing is available but there is no suitable direct route
Construct level crossing with passive controls	Minor roads and tracks with no alternative crossing and adequate lines of sight.
Construct level crossing with active controls	Major roads where traffic levels do not warrant a grade separated crossover
Grade separated crossing	Major roads such as highways and freeways

4.4 Refinement of the alignment

Introduction

From Melbourne to Parkes existing ARTC tracks are available for the inland railway, namely:

- The Class 1 Main South line from Melbourne to Illabo (North of Junee)
- A new section of track is proposed between Illabo and Stockinbingal
- The existing Stockinbingal to Parkes line from Stockinbingal to Parkes.

From Parkes to Moree, the proposed inland railway would comprise:

- The Class 1 Orange to Broken Hill line at Parkes
- The Class 2 Parkes to Narromine line (upgraded to Class 1)
- New greenfield alignment northwards from Narromine to the Dubbo to Coonamble line at Curban, north of Gilgandra
- New greenfield alignment north-eastwards from Curban to the Wallerawang to Gwabegar line south of Gwabegar
- An upgrade of a short length of the Wallerawang to Gwabegar line south of Gwabegar
- New greenfield alignment from Gwabegar to west of Narrabri, passing along the existing railway for a short distance before bypassing Narrabri to the west
- The Werris Creek to Mungindi line from Narrabri to Moree (upgraded to Class 1).

The inland railway from Moree to Brisbane would comprise a mixture of greenfield alignments, railway adjacent to, or dual gauging of, existing QR narrow-gauge tracks and upgrades to existing standard-gauge tracks. The route would comprise:

- From Moree, upgrading the existing (Class 3) standard gauge Moree to North Star line with a deviation at Camurra (approx 8 km north of Moree)
- A greenfield section from North Star to Yelarbon
- Upgrading from narrow gauge to dual gauge of the Warwick to Dirranbandi line between Yelarbon and Inglewood
- A greenfield section between the Warwick to Dirranbandi line near Inglewood and the Millmerran branch line at Millmerran

- Upgrading the Millmerran branch line from narrow gauge to dual gauge between Millmerran and Brookstead
- A greenfield section between Brookstead and the Cecil Plains line near Yargullen
- Laying a new standard gauge railway along the disused Cecil Plains line and a greenfield bypass to the south-east of Oakey
- Upgrading the railway from narrow gauge to dual gauge between Oakey and Gowrie
- A new greenfield alignment with a new tunnel from Gowrie to Helidon
- A combination of greenfield alignment and upgrading from narrow gauge to dual gauge of the Toowoomba to Rosewood line between Helidon and Grandchester/Rosewood
- A greenfield dual gauge section between Grandchester/Rosewood and Kagaru
- The existing Class 1 coastal route from the Kagaru to Acacia Ridge (recently converted to dual gauge by ARTC).

4.4.1 Melbourne to Parkes

Melbourne to Illabo

Between Melbourne and Illabo, the existing railway is Class 1 track suitable for the inland railway.

Illabo to Stockinbingal

North of Junee, the existing Main South Line would be used as far as Illabo. A turnout is proposed between Illabo and Bethungra and a greenfield section would provide a direct route from Illabo to Stockinbingal. The proposed alignment would bypass low speed curves and steep grades at the Bethungra spiral. The greenfield section would consist of approximately 37 km of Class 1 track, compared with approximately 65 km via the existing main line.

Two broad options were considered for the greenfield section: one passing from near Bethungra and along the edge of the Bethungra Ranges to Stockinbingal; the other comprising a turnout from the existing railway near Illabo and an alignment generally following cadastral boundaries. The option from near Illabo was selected for further study because of the lower property and land use impacts and less hilly terrain.

South of Stockinbingal, two saddles of hills provide opportunities for local alignment options.

Options for crossing the existing Stockinbingal to Temora railway at Stockinbingal include:

- An at-grade (diamond) crossing. This was not chosen because of concerns about maintenance and reliability. It is noted however that a grade-separated crossing would result in a need for inspections and maintenance of the bridge
- An at-grade crossing created by developing the inland railway alignment so as to join and leave the existing railway through two turnouts. The solution was found to be impractical with significant land and cost concerns.
- Grade-separation of the proposed and existing railways. The existing Burley Griffin Way could be diverted so that a single structure crosses both the road and existing railway. This option was incorporated into the proposed alignment design.

Another option considered was to divert Temora traffic south to Melbourne and provide a turnout towards Sydney via Bethungra. However, signalling was considered to be expensive and the solution was operationally unfavourable.

The proposed alignment between Illabo and Stockinbingal was preferred given the terrain and topography, particularly with regard to land use, earthworks quantities and known significant vegetation. The alignment follows cadastral and road boundaries as closely as possible. The alignment would also avoid remnant patches of native vegetation and potential habitat for the Superb Parrot.

It is necessary for the alignment to cross a number of watercourses including Iron Bong Creek. Some riparian vegetation would have to be removed at this crossing. The alignment was chosen to minimise the number of water crossings required and the amount of vegetation removal from Iron Bong Creek.

The greenfield alignment would join the existing Stockinbingal to Parkes railway to the north of Stockinbingal. A turnout is proposed at the connection so that the existing route between Parkes and Cootamundra is retained. Traffic on the Parkes-Stockinbingal route includes interstate intermodal and steel trains between Perth/Whyalla and Sydney.

Stockinbingal to Parkes

This section has recently been upgraded by ARTC and was assumed to be suitable for the inland railway.

Parkes bypass

The existing railway touches the edge of Parkes and passes through Goobang Junction where the railways from Melbourne, Sydney, Adelaide and Narromine converge. The deviation bypasses both Goobang Junction to the west and the town of Parkes.

The existing Goobang Junction includes a 1,870 m loop which is used for crossing East-West services. The junction to / from Melbourne is at the eastern end of this loop, and the junction towards Narromine is part way along it.

A deviation to bypass Goobang Junction would require an alignment to either:

- Join the Parkes line to Broken Hill line before passing over two crossovers in the middle of the Main Western line passing loop to access the line towards Narromine or
- Cross the Parkes to Broken Hill Line, potentially with a grade separated crossing, to the west of (or over) the existing loop before joining the existing line to Narromine.

Passing over the existing tracks in the middle of the loop imposes a major operational constraint for both East-West and Melbourne-Brisbane traffic, therefore this option was not further considered. The cost of a grade separation to avoid these constraints significantly adds to the capital cost of the deviation making it unfavourable.

A west-north triangle is proposed to provide a connection between the Broken Hill line and the line to Narromine for Brisbane to Perth/Adelaide traffic.

4.4.2 Parkes to Moree

Parkes to Narromine upgrade

This section of track will be upgraded to Class 1.

The existing Class 2 Parkes to Narromine line is about 106 km in length and generally allows trains to travel at 80 km/h. There is a speed restriction of 25 km/h at Goobang Junction and a further three local speed restrictions of between 60 and 75 km/h for short lengths of track between Parkes and Narromine.

The upgrades would allow trains on the inland railway to travel up to a speed of 115 km/h for about 90 km of the line and 100 km/h for another 11 km. The existing speed restrictions at Goobang Junction would be retained and it has been assumed that the three existing restrictions of between 60 and 75 km/h would also be retained. There may be opportunities to investigate improvements to these restrictions during detailed design of the upgrade.

Narromine to Curban

The inland railway between Narromine and Narrabri passes across flat terrain along the western edge of the Warrumbungles before passing between several areas of state forest and bypassing the western side of Narrabri.

Broad options for passing Narromine on either side were considered. An alignment to the west of the town was chosen because it provided a more convenient route from the existing railway and minimised the effects on existing land use.

A west-facing curve from the Parkes to Narromine line is proposed to enable the inland railway to join the Main Western line at Narromine. The inland railway would then pass along the Main Western line for about 2 km before turning northwards onto a greenfield section to Curban.

The alignment passes to the west of Narromine airfield and follows property boundaries across irrigated land for about 15 km until crossing the Macquarie River. The alignment would then cross several flood-prone areas near the Macquarie River. An option to the east was considered but found to be less favourable from a land-use and flooding perspective.

Moving away from the Macquarie River, the alignment follows an unsealed road in a north-easterly direction for about 13 km. The unsealed road would provide access across the open agricultural land for construction and maintenance of the inland railway.

Leaving the road, the alignment crosses Ewenmar Creek before turning northwards across Crown land for about 3 km. A crossing of Emogandry Creek is followed by about 35 km along the side of an existing road. This part of the alignment crosses many creeks, passes adjacent to two areas of Crown land (on the eastern side) and through about 3 km of Crown land at the northern end of the section. Options on both sides of the road were considered and the eastern side was favoured because of an abundance of trees lining the western side of the road.

At the northern end of the road, the alignment encroaches into several property boundaries before turning north-easterly and crossing open countryside for 9 km to Curban where the inland railway briefly joins the existing railway.

Key environmental and land use considerations for this section included minimising vegetation removal and maximising distance to rural residences to reduce the need for property acquisition and minimise noise and loss of amenity.

Curban to Gwabegar

At Curban, north of Gilgandra, the inland railway crosses the Dubbo to Coonamble line. Possible options included:

- A straight inland railway alignment with a diamond crossover
- An S-shaped inland railway alignment crossing the existing railway at about 45 degrees and with turnouts joining to a realignment of the existing railway
- An S-shaped inland railway alignment joining the existing railway with two turnouts.

The option providing connections to the existing railway but without changing the alignment of the existing railway was chosen. The inland railway would be the main line railway with two speed-restricting turnouts being provided on the existing railway which is little used. The proposed arrangement would retain the existing station and silo siding. The solution would avoid maintenance of a diamond crossover and would provide interconnectivity with existing lines which are expected to provide access for maintenance equipment.

After leaving the existing Dubbo to Coonamble line, the inland railway heads to the north-east and crosses the Castlereagh River. The river has a significant floodplain which is forested; some clearing of vegetation would be required. The alignment would be raised above the floodplain on embankments through this area.

After the Castlereagh River crossing, the alignment follows Warrumbungle Park Road, avoiding hills to the south-east. It crosses Tooraweenah Creek, about 5 km of flood-prone land containing creek tributaries, before reaching Gulargambone Creek and then Baronne Creek.

An alternative alignment was considered from south of Tooraweenah Creek to Baronne Creek. The option comprised a slightly shorter and straighter alignment to the west of the proposed inland railway. It follows cadastral boundaries for a large proportion of its length and reduces the number of creek crossings. However, the option was not proposed because it had inferior access for construction and maintenance. More significant effects on properties were expected because some properties would be divided. Whilst fewer creeks were crossed by the option, the alignment was still across low-lying land and flood mitigation measures for poorly defined creeks were likely.

Between Baronne Creek and Frazers Creek to the north, a 15 km length of alignment crosses a low-lying area containing a number of creeks and signs of flood impacts, although not identified as a flood zone by flood mapping. The alignment has therefore been raised above the natural ground level.

To the north of Frazers Creek, the alignment skirts the higher ground of the Warrumbungles to the east. It follows a road for a short distance before veering north-east through four areas of Crown land prior to joining the existing railway about 29 km south of Gwabegar (midway between Baradine and Kenebri).

At the connection to the existing railway, the inland railway passes between large areas of State Forest on both sides of the alignment. The alignment cuts through a small area of the Merriwindi State Forest; the planning approvals process for this area would be significant as an act of Parliament would be required. However, the area affected is significantly less than 20 hectares, the threshold for which, under section 16A of the Forestry Act 1916, a sale or other disposal of State Forest land would be required to pass through the NSW Parliament.

An alternative alignment was considered, comprising an alignment passing between and through other areas of State Forest to the north, and joining the existing railway at Kenebri. The alignment was not selected because the severance of vegetation and impact on State Forest was larger than the proposed alignment.

The existing railway to Gwabegar is a Class 5 line. The 19 km section south of Gwabegar proposed to be included in the inland railway would be upgraded to Class 1.

Key environmental and land use considerations in alignment development for this section involved minimising severance of the Merriwindi State Forest and avoiding extensive vegetation removal.

Gwabegar to Narrabri (west)

About 8 km south of Gwabegar, the inland railway turns north-east from the existing railway and passes between State Forest, National Park and State Conservation Areas on both sides of the proposed alignment. At Etoo Creek, the alignment is constrained to a point where the areas of State Forest converge and the alignment would cut through a small area of the Quegobla State Forest. However, again, the area affected is less than 20 hectares and therefore, would not have to pass through the NSW Parliament.

The alignment meets and runs along the eastern side of Cuttabri Road. About 12 km from Etoo Creek, the alignment crosses Tenegie Creek. An option to follow Cuttabri Road through the edge of Cubbo State Forest was considered but the alternative of bypassing to the west of this State Conservation area was adopted.

North of Tenegie Creek, the proposed alignment would divide numerous properties. The land generally appears not to be in use. Alternative alignments following property boundaries could be pursued but are not expected to provide significant benefit because of the existing vacant land-use for which access roads are not present.

The proposed alignment follows an existing road for about 14 km, before joining the existing railway near Kiandool, approximately 6 km to the west of Narrabri. An alternative alignment joining the existing railway further to the west and passing along the corner of an area of coal titles was considered. The alternative required about 12 km of greenfield alignment compared to 22 km for the proposed inland railway. However, the alternative option had larger land-use and severance impacts because the propose alignment follows a road for most of its length. The road would be useful for the construction and maintenance of the railway.

Key environmental and land use considerations for this section involved minimising use of land from the Quegobla State Forest and avoiding disturbance to the Pillaga State Conservation Area, as well as minimising extensive vegetation removal.

Kiandool to Narrabri upgrade

The inland railway will travel along about 5 km of the existing Narrabri to Walgett railway before turning northwards onto a greenfield bypass of Narrabri.

The existing track is Class 3 track which is flat and straight. The alignment is single track passing over Bohemia Creek and running through open country side.

The vertical alignment climbs towards Narrabri at an average gradient of around 1 in 300 with the track bed elevated slightly above the surrounding fields.

This section of the inland railway crosses farmland. There may be an effect, primarily noise, due to increased freight operations but this is not expected to be significant on this section given its rural characteristics.

Narrabri (west) to Narrabri (north)

The proposed Narrabri bypass would be located to the west of the town centre, crossing two rivers and the associated (zoned) floodplain before joining the Narrabri to Moree railway to the north of the town. After crossing the rivers, the alignment passes along the eastern side of the race track and the sewage treatment plant.

Near the proposed northern connection, the existing railway passes under a highway, a constraint to the proposed railway alignment. The proposed inland railway remains to the west of the highway, using a wide strip of open space from the Sewage Treatment Works to the connection with the existing railway.

Environmental and land use issues considered during the development of this study primarily related to the crossing of the Namoi River floodplain, so as to avoid, or minimising severance of, irrigation properties and zoned industrial land on the outskirts of Narrabri.

Narrabri to Camurra upgrade

The existing Class 2 line between Narrabri and Moree is about 92 km in length and allows trains with 19t axle loads to travel at 100km/h, and 21t axle loads at 80km/h. To the north of Moree, the line is Class 3 and not suitable for the proposed traffic. Both will be upgraded as part of the inland railway project.

Between Narrabri and Moree, the line is generally straight (with about five curves less than 800 m radius) and has a ruling gradient of 1 in 100. The section commences to the north of Narrabri and generally follows the highway over relatively flat terrain to Moree. The route passes through Edgeroi, Bellata and Gurley where loop lines exist.

The horizontal alignment has minor constraints given the need to avoid areas of low hills north of Narrabri. The alignment generally crosses farmland.

It has been assumed that 10 culverts and 11 bridges would be replaced between Narrabri and the start of a proposed deviation at Camurra. However, it has been observed that improvements to some of the structures on this section of the railway are currently being undertaken. There is an opportunity during detailed design stages to review the improvements already undertaken and investigate whether any of the structures can be retained as part of an upgraded line.

The upgrades would allow trains using the inland railway to travel up to a speed of 115km/h except for three short curves where speeds will be limited to between 90 and 100 km/h.

Camurra Deviation (to Moree (north))

The deviation would remove low speed curves at Camurra. The existing alignment was originally built towards Weemelah to the west and appears to cross the river at a convenient point. The alignment to North Star was developed to use the existing river crossing and also pass through Camurra station which was located on the north bank of the river but has since been removed. The existing bridge and alignment to Weemelah is retained for existing traffic but would not be used for the inland railway. Depending on traffic volumes there is an opportunity to reconfigure the junction.

The deviation comprises about 3 km of Class 1 standard gauge track on a new alignment generally across floodplain.

Two local options were considered across the river and nearby properties. The benefits of the proposed option are such that it:

- Crosses the Gwydir River at a point which is closer to the existing bridge
- Allows for a more square-crossing of the river
- avoids more of the designated flood plain area
- Is located further north of the existing property and pistol club which would lessen property and noise impacts
- Requires less new build (approximately 2.6 km compared with 3 km).

The alignment has two 800 m radius reverse curves, crossing the Gwydir River at about 45 degrees and passing to the west of the pistol club before rejoining the existing railway.

The alignment avoids a significant number of houses to the east and is predominantly across an existing strip of unused land (approximately 500 m to 800 m wide in a north-south orientation).

4.4.3 Moree to Brisbane

Moree (north) to North Star upgrade

Between Moree (north) and North Star, the inland railway follows the existing railway except for the short deviation at Camurra. The existing Class 3, standard gauge track would be upgraded to a Class 1 railway. It is assumed that approximately 12 culverts and 9 bridges would be replaced.

North Star to Yelarbon

To the north of North Star, a greenfield alignment of the inland railway is proposed to Yelarbon. The new alignment bypasses the towns of Boggabilla and Kildonan and passes around the eastern edge of a gazetted designated floodplain area but it is likely that floods will occur so track alignments will incorporate embankments. The proposed alignment consists of about 64 km of Class 1 standard gauge track.

The selected route was chosen in favour of the 75 km long existing railway via Boggabilla and Kildonan as it would provide a more direct route to Yelarbon and avoided the designated flood plain area. This avoided the need for complicated flood crossings.

The broad options considered in the alignment development comprised:

- Several alignments to the south of the floodplain area (where few constraints exist)
- An alignment along the edge of the gazetted floodplain (options exist on both sides of Holdfast Road) and an alternative alignment closer to Dthinna Dthinnawan Nature Reserve to the east
- Several alignments across Yelarbon Desert including along a Travelling Stock Route, alignment further north, and different river crossing options. Aboriginal heritage sites may be relevant to the construction of the railway.

In this area, the alignment of the inland railway comprises essentially straight sections. To the north of North Star it follows (in parts) short sections of existing roads. The alignment generally follows property boundaries and has been developed (where practical) to provide 500 m clearance to existing dwellings.

The alignment passes along property boundaries east of the Holdfast Road before heading north-east, following an existing stock route and crossing the MacIntyre and Dumaresq

Rivers. Whilst the Yelarbon Desert is classified as a Regional Ecosystem, the vegetation along the Travelling Stock Route is degraded and so vegetation impacts through this area are likely to be less than other alignments and environmental effects would be small.

Yelarbon to Inglewood upgrade

Between Yelarbon and Inglewood, the inland railway generally follows the existing narrow gauge railway from Dirranbandi. Part of the section passes through State Forest and an alternative alignment to the east was considered. The existing alignment was favoured over a new greenfield section.

The inland railway proposal is therefore for an upgrade of the existing tracks to a Class 1 dual gauge railway. There are no sidings along this section and the most significant infrastructure feature is a grade separation of the Cunningham Highway over the railway which would comprise a single lane in each direction and a regraded road to provide for double-stacked trains.

The upgrade is assumed to comprise removal of the existing track, sleepers and ballast, and replacement with 60 kg/m rails, heavy duty concrete sleepers, 300 mm minimum thickness of ballast and a new capping layer. A number of bridge replacements would be required.

Inglewood to Millmerran

After passing through Inglewood, the inland railway leaves the existing railway and passes north-east to Millmerran, joining the alignment of the Millmerran branch line to the east of the town.

The route crosses gently undulating terrain, although some rolling hills are present mid-way along the route to the east of the Millmerran-Inglewood road.

The broad options considered in the study were:

- Option 1- a 74 km long alignment which would avoid areas of State Forest but cross forested areas of rolling hills mid-way along the alignment
- Option 2 - an alignment similar to option 1 with small variations
- Option 3 – a 73 km long alignment that would follow the Millmerran Inglewood road, passing through the Bringalily State Forest and close to an open-cut mine (in the northern half)
- Option 4 – a 77 km long alignment that would follow the Millmerran-Inglewood road through the State Forest before crossing north-east along property boundaries to follow the alignments of options 1 and 2.

Alignments through areas of State Forest are expected to be possible but are likely to require a long planning approvals process. Early identification and progress would therefore be desirable. The process would involve revoking the dedication of the land as a State Forest and would require an Act of the Queensland Parliament.

A preliminary environmental assessment identified some areas of endangered ecosystem within the State Forest for option 3. Endangered ecosystems which are affected by the inland railway would require careful ecological assessment at later stages and would be required to be offset by three times the affected area. Development of the alignment to avoid areas of endangered ecosystems would be necessary following detailed ecological assessment.

Areas of regional ecosystems were also identified along all alignments. Regional ecosystems must have an offset of at least the same area as that affected.

Option 1 was found to be predominantly across natural vegetation and severance (bisecting vegetated areas) and would have a greater impact than for options 3 and 4 which follow the existing road.

Capital cost estimates suggested that option 3 would be the cheapest solution, with option 4 about 5% more expensive. Options 1 and 2 would be the most expensive, being about 14% more expensive than option 4.

The proposed alignment for the inland railway follows the Millmerran-Inglewood road (option 3). Between Inglewood and the area of State Forest at the southern end, the alignment passes adjacent to an existing road about one to three kilometres to the east of Canning Creek. The alignment was favoured over an alignment between the Millmerran-Inglewood road and Canning Creek which has restricted space and environmental impacts over significant lengths. The selected local option creates a better fit to property boundaries, is further from the creek and has less of an effect on travelling stock routes.

The alignment crosses Canning Creek and follows the Millmerran-Inglewood road for about 40 km; passing through State Forest and near areas underlain by mining resources and other areas subjected to mining leases (Mineral Development Licence). The proposed alignment passes through an area of mining resources, this being the shortest alignment and one that is located at the side of a major road. As such, the alignment would have less impact on property owners. These benefits were considered sufficiently significant when compared with alternative alignments that avoided the mining resources.

The inland railway proposal would avoid the existing open cut mine in the northern part of this section. It passes to the west of the open cut where there is a better fit to property boundaries, avoids local Regional Ecosystem areas, and is located closer to the road (which makes the route more accessible for construction).

Overall, the proposed alignment has the following benefits:

- There is ready access for construction from the Millmerran-Inglewood road
- Severance of properties would be low
- There are no endangered ecosystems except in State Forest
- Vegetation impacts on sections along existing roads would be minimal and considered less than those for the other options
- There would be less land clearing of sections of Regional Ecosystems which could result in segregation of vegetation corridors
- Property acquisition would be minimal.

Millmerran to Brookstead upgrade

From Millmerran, the inland railway follows the existing narrow gauge QR track to Brookstead. The track would be upgraded to dual gauge and the track structure would be replaced. The track upgrade would include turnouts to two narrow-gauge sidings serving grain silos at Yandilla and Brookstead.

To the east of Millmerran, the existing tracks cross three significant watercourses; the existing bridges would be replaced and this would require possessions of the railway during construction. Between the rivers is flat and low-lying land which appears to have been flooded in the past. The soil has a very black appearance, particularly in the area between the rivers. However, the available mapping does not show Gilgai soil in this area. Further ground investigation would be required at detailed design. A number of bridge replacements would be required.

Brookstead to Yargullen

To the west of Brookstead, the proposed track moves away from the existing railway and crosses country to join the Cecil Plains line which was placed out of service in 1994.

Three broad options were considered. A direct alignment across hilly terrain joining the alignment of the Cecil Plains line east of Mount Tyson was more expensive and required more vegetation clearing than options passing to the west of the hills and using a longer length of the Cecil Plains line. An alignment which hugs the western edges of the hills and minimises lengths across low lying land was slightly longer but flatter and straighter than other options. Therefore an alignment passing across the flat land to the north of Brookstead, along the western edge of the hills and along the Cecil Plains line was selected for further refinement. The alignment passes to the west of Irongate Conservation Park.

Several alignments were considered across the flat land north of Brookstead. A preliminary engineering assessment determined that hydrology (flooding) issues were not expected to be significant and surface ground conditions were expected to generally comprise alluvium. The alignment was refined to generally follow an existing road whilst minimising impacts on houses and dams.

A moratorium exists because of vegetation on the central part of the alignment and the proposed alignment for the inland railway passes to the west of the affected area.

The proposed alignment has the following benefits:

- It would require minimal vegetation clearing, with no clearing of mapped Regional Ecosystems or Essential Habitats being required
- It provides a direct route in the low lying, southern part of the section
- It would require only limited earthworks (cut and fill); this would reduce scarring of the landscape and minimise loss of visual amenity
- It is adjacent to a main road in the north and uses property boundaries, thereby reducing impacts to properties and vegetation
- It would minimise impacts on residential and built up areas with impacts being confined to rural properties.

Cecil Plains line upgrade (south of Yargullen)

The inland railway joins the Cecil Plains line to the west of Mount Tyson.

The Cecil Plains line passes through the south-eastern edge of the Mount Tyson settlement. In refining the alignment the following options were considered:

- Retaining the existing railway alignment through the town centre, including 400 m and 600 m radius curves which would restrict the speed of the inland railway trains to less than 115 km/h
- Providing a deviation around the town for which land would be required

- Improving the alignment to include 800 m radius curves; land outside the railway corridor would be required and houses and a dam are located on the inside of the curves through the town
- Easing curves to 600 m and 800 m radius within the existing railway corridor; speed restrictions for the inland railway would be less severe than for the existing alignment.

Easing curves on the Cecil Plains line within the existing railway corridor was chosen for the proposed inland railway. Working within the railway corridor would be possible and would avoid environmental impacts provided clearing of significant vegetation would not be required. Where the alignment is within 100 m of residences, noise mitigation measures would warrant consideration.

Some curves of the existing alignment would be improved between Mount Tyson and Yargullen. Land acquisition would be required adjacent to the existing corridor.

Yargullen to Oakey

At Yargullen, the proposed alignment leaves the disused Cecil Plains line and crosses countryside to the south of Oakey before joining the Western line west of Kingsthorpe.

The alignment options on this section traversed undulating and vegetated areas surrounded by numerous rural properties and waterways. An alignment was chosen that avoided the environmental constraints and also minimised earthworks and land use impacts. Critical constraints were not found.

The south western part of the bypass is proposed to follow existing roads and property boundaries so that land and environmental issues are minimised.

In the vicinity of the Warrego Highway, a creek and a gas pipeline would be crossed. The proposed solution would take advantage of the natural terrain which includes higher ground to the east. Here the highway would be changed to pass over the railway which in turn would pass over the gas pipeline.

The railway would pass across the creek about 500 m to the north of the Warrego Highway. Preliminary cost estimates showed that the proposed solution would be less expensive than a combined crossing.

To the north of the pipeline, the alignment is parallel to an existing road. A minor road diversion and level crossing is proposed where the inland railway joins the existing Western line.

The proposed alignment has the following advantages:

- It avoids endangered Regional Ecosystems and Essential Habitat areas and minimises clearing of vegetation
- It minimises earthworks (cut and fill), thereby reducing scarring of the landscape and loss of visual amenity
- It generally follows property boundaries and roads thereby reducing impacts to properties (noise and access)
- It avoids most houses in the area.

Oakey to Gowrie upgrade

An upgrade from narrow gauge to dual gauge track along the existing alignment is proposed because it is the most economical solution. A minor improvement of the alignment on a curve to the east of Kingsthorpe is also proposed.

Gowrie to Helidon

The Toowoomba Range between Gowrie and Helidon poses the most significant natural constraint to the inland railway. The natural terrain rises from a level of about 520 m near Gowrie to about 680 m on the north side of Toowoomba and steeply down to about 160 m to the west of Helidon.

The terrain posed a major challenge of finding an alignment which satisfies railway design criteria and operational requirements in the most cost effective way. The existing QR railway has sharp curves and steep grades which makes it unsuitable for Inland Rail superfreighter traffic.

Five broad options were investigated, namely:

- Option 1: A 25 km long, relatively straight alignment between Gowrie and Helidon, including a 6 km long tunnel near Toowoomba and a 90 m tunnel near Postmans Ridge plus 6 lengths of viaduct ranging from 450 m to 120 m. Several alternatives of the alignment were developed to reduce the tunnels, viaducts and environmental issues. The alignment is based on previous work by Queensland Transport
- Option 2: An alignment generally following the route of the existing QR narrow gauge railway via Toowoomba, Murphy's Creek and Helidon. Approximately 41 km of generally greenfield construction close to the existing corridor was considered. The alignment requires 14 viaducts and 4 short tunnels (generally under 1 km in length)
- Option 3: A 31 km long alignment comprising a 5 km long tunnel from east of Gowrie to Spring Bluff (near the head of Murphy's Creek), and a surface railway generally following Murphy's Creek to west of the town of Murphy's Creek and then near or along the existing railway corridor to Helidon
- Option 4: An alignment similar to option 1, but with tighter curves to minimise viaducts
- Option 5: An alignments similar to option 4 but further south and with a longer tunnel and a tunnel portal at a lower level.

A broad evaluation of Options 1 to 5 concluded that Option 3 was to be refined because it:

- Would be significantly less expensive than other options due to the reduced tunnel length
- Had the most favourable environmental assessment having fewer impacts to Indigenous cultural heritage sites/items and mapped vegetation. The option also minimised the amount of earthworks required thereby reducing the visual amenity impact on the landscape. Other options passed through various Regional Ecosystems and protected areas (environmental and cultural heritage)
- Avoids the Register of National Estate 'escarpment and foothills of Great Dividing Range'
- Reduces the 'endangered', 'of concern' and 'not of concern' REs and Essential Habitat areas to be traversed and reduces clearing of vegetation required

- Avoids Lockyer National Park (Recovery), Helidonica Nature Refuge, Helidon Hills (Register of National Estate), White Mountain Forest Reserve and bioregional wildlife corridors (east of Murphy's Creek alignment)
- Generally follows property boundaries and roads thereby reducing impacts to properties
- Avoids mining lease areas (Titan Sandstone 1 and Jovebrook 1 & 2)
- Minimises interaction with infrastructure (Roma to Brisbane Gas Pipeline and high voltage powerlines)
- Generally follows more of the existing rail corridor
- Provides the shortest tunnel having significant advantages regarding ventilation and fire and life safety design
- Enables any tunnel to pass under fewer water features (creeks) than other options.

A desk top review of ground conditions revealed that option 3 may be found, by further ground investigation, to be more favourable than other tunnel options to the west. Tunnels generally along the alignment proposed by Queensland Transport are expected to have the western half of the tunnel in hard Basalt rock with the tunnel passing into poorer ground conditions (Mesozoic strata comprising interbedded sedimentary sandstones, mudstones, claystones, shale and siltstones with possible overlying Walloon Coal Measures) for the eastern half.

There is some suggestion that option 3 will have at least its western half and perhaps most of the eastern half, through the Basalt layers. It is plausible that the final one kilometre or so in the east will traverse through the upper Mesozoic strata. If this is correct then it is likely that these strata could be the Walloon Coal Measures (which are typically 20-30 m thick in this area). It is emphasised that inferring the assumed ground conditions along the tunnel alignment is very tentative and should not be relied on for accuracy. Further ground investigation is recommended in the area of the proposed tunnel and further alignment optimisation is likely to have benefits.

Option 3 was selected for further study and was developed as follows.

The proposed alignment would leave the existing railway corridor on the north western outskirts of Toowoomba. It crosses Gowrie Creek and follows along the eastern side of the Creek for about 3 km before turning north-westerly under the range.

The alignment for the tunnel section is proposed to be on straight track with a long radius curve encroaching into the tunnel at the western portal. The straight track will allow the tunnel size to be as small as possible. It could also enable use of a circular tunnel boring machine by a future tunnelling contractor.

The alignment provides a tunnel portal and construction site within a large cadastral boundary near Pengarry Junction at the western portal. The site would be adjacent to a road for convenient access and would have a gently rising natural slope, giving flexibility in the detailed design of the portal and construction site.

The eastern portal is situated in a more difficult and highly constrained area. Further design development would occur at a later stage when extra information, such as ground investigation data, becomes available. The contractors tendering for the design and construction of the tunnel may wish to investigate alternative tunnel portal sites. One option may be to have a longer tunnel which would provide better access during the construction phase. However the operational attributes of such a tunnel would also have to be considered.

The alignment crosses an existing creek near the eastern tunnel portal and design development in the future may consider options to divert either the creek or the proposed inland railway alignment. The proposed alignment passes across rugged and highly vegetated terrain on the northern side of the existing road for about 1,400 m before crossing the road. The northern side of the road has about 11 cadastral areas that would be affected by the alignment, most of which appear to be residential.

The alignment follows the southern side of Murphys Creek Road for about 5.6 km, passing through a 22 m deep cutting and using mainly viaducts across hilly terrain. The engineering solutions were chosen because preliminary cost estimates suggested that viaducts are the cost-effective solution once the alignment is more than about 10 m above the natural ground level. The terrain has areas of dense vegetation and viaducts would also minimise environmental impacts.

Passing to the north of Murphys Creek Road, the alignment crosses Murphys Creek and a number of property boundaries before joining the existing railway alignment on the western side of the township of Murphys Creek. A turnout from the inland railway to the existing track is proposed and would allow existing passenger trains to continue to serve Toowoomba.

There are heritage items in the railway corridor at Murphy's Creek as well as a passing loop and a siding.

Between Murphys Creek and Helidon, the proposed alignment passes near the existing alignment, but is at a higher level due to the grade constraints. A 3 km greenfield alignment would shorten the alignment near Lockyer. The alignment crosses land zoned residential, passing close to the eastern boundary of property lots and following to the side of a power line easement from Murphy's Creek to Upper Lockyer. From here the alignment crosses dense vegetation near Murphys Creek; environmental impacts can be expected. There are two heritage bridges between Murphy's Creek and Helidon and a passing loop near Lockyer.

The proposed alignment would be a dual gauge track between Gowrie and Helidon. A passing loop is proposed on the downhill section of track to the east of the tunnel. The loop allows trains on the long climb up the range to pass downhill trains before entering the tunnel. The location of the loop is coordinated with the requirements for train timetabling and tunnel ventilation, both of which affect railway headways achievable through the tunnel.

Helidon to Laidley upgrade

To the east of Helidon, the inland railway joins the existing double track Ipswich to Toowoomba Line and passes along the existing alignment through Helidon, Grantham and Gatton to Forest Hill.

The broad options considered during the study were:

- An alignment following the existing rail corridor with both existing tracks upgraded to dual gauge tracks. There is an opportunity to improve existing 240 m radius curves to radii of about 400 m
- An additional standard gauge track adjacent and parallel to the QR corridor. Deviations were considered to bypass towns and environmentally sensitive areas
- A greenfield alignment between Helidon and north of Grantham to provide a shorter and more direct alignment than the existing railway.

It is proposed that both existing narrow gauge tracks would be upgraded to dual gauge to cater for the inland railway. Cost comparison showed a greenfield alignment would be approximately 25% more expensive than using the existing QR alignment. Using the existing railway corridor would also have fewer impacts on vegetation and ecosystems compared with more direct greenfield routes.

A major bridge supports the Warrego Highway over the existing railway near Helidon. It is assumed that this bridge will not be replaced as part of the proposed construction of the inland railway. The existing structure provides insufficient clearance for double-stacked trains and would constrain the intermodal freight task to single stacked operations. There is an opportunity to reconstruct the existing railway at a lower level beneath the Warrego Highway to achieve clearance for double stacking. Further study including investigation of the existing bridge foundations and hydrology would be required.

A minor improvement of the existing alignment is proposed immediately west of Gatton within the railway corridor. The improvement would improve speed restrictions on the railway.

The proposed alignment of the inland railway would have the following advantages:

- It would reduce the 'not of concern' and 'of concern' Regional Ecosystems and Essential Habitat areas to be traversed and would also reduce clearing of vegetation
- It would reduce costs because fewer earthworks (cut and fill) would be required; this would reduce scarring of the landscape and loss of visual amenity
- It would involve no interaction with infrastructure (Moonie to Brisbane Oil Pipeline and high voltage powerlines).

Laidley to Grandchester / Rosewood

To the east of Forest Hill, a greenfield alignment is proposed to bypass Laidley as well as an existing tunnel and sharp reverse curves before rejoining the existing tracks west of Grandchester.

Various alignments between Forest Hill and Grandchester were considered because the existing alignment is unusable for intermodal freight trains due to steep gradients and 110 m to 120 m radius curves. The greenfield options include:

- Maintaining 800 m curves so that an alignment suitable for 115 km/h train speeds is achieved. The alignment would pass through a sub-division and have a longer tunnel than other options
- A slower speed alignment with tighter curves (down to 400 m radius) and a shorter tunnel. This alignment would avoid the sub-division and be situated beside the existing railway tunnel.

A single, dual gauge track is proposed which would replace the existing railway. An alignment with radii down to 400 m was chosen to minimise the effects of the various significant constraints in the area and make most use of the existing railway corridor. The bypassing of Laidley would not only minimise effects on the urban environment, it would also allow the proposed railway to gain height towards the higher ground, thus minimising the length of tunnelling through the range. The proposed alignment passes to the north of the sub-division and environmental constraints on the north-east of Laidley before passing through a 500 m long tunnel. However the approach proposed would involve decommissioning of the railway through Laidley and relocation of Laidley railway station.

East of the tunnel, the alignment descends and rejoins the existing corridor immediately to the west of Grandchester, with heritage constraints in the corridor at Grandchester being avoided.

The proposed alignment has the following advantages:

- It minimises the 'not of concern' and 'of concern' Regional Ecosystems and Essential Habitat areas to be traversed and would also reduce clearing of vegetation
- It involves a limited amount of earthworks (cut and fill), thereby reducing scarring of the landscape and loss of visual amenity
- It minimises the length of tunnel; this would reduce the amount of spoil for disposal or reuse as well as tunnel ventilation and fire and life safety impacts.

Grandchester / Rosewood to Kagaru

Queensland Department of Transport and Main Roads (TMR) has been conducting a separate study, somewhat in parallel with this study known as the Southern Freight Rail Corridor (SFRC) Study[8]. This route would be used by the inland railway to connect to the existing coastal route near Kagaru. TMR's study has included extensive public consultation and engagement with affected parties. The SFRC route identified by TMR has been adopted for the inland railway and included in the scope of works required.

The inland railway takes advantage of a 6 km straight section of existing railway between Grandchester and Calvert. Both the existing tracks would be upgraded to dual gauge.

East of Grandchester / Rosewood, the inland railway travels across flat to undulating land for about 30 km before passing through hilly terrain to Kagaru. Two tunnels (1050 m and 200 m tunnels are proposed (Flinders tunnels). It would be a single line, dual gauge track.

Kagaru to Acacia Ridge upgrade

Northwards from Kagaru, the inland railway uses the existing coastal route. The existing Class 1 standard gauge railway has recently been upgraded to dual gauge by ARTC as part of its Northern Improvement Alliance works. Therefore no works are required on this section of track.

4.5 Summary of proposed alignment

The proposed inland railway would comprise a 1,731 km long alignment between South Dynon in Melbourne and Acacia Ridge in Brisbane; as shown in appendix F: Maps of the proposed alignment

- Melbourne to Parkes - 670 km of existing Class 1 track and 37 km of greenfield track from Illabo to Stockinbingal, bypassing Cootamundra and the Bethungra Spiral.
- Parkes to North Star - 291 km of greenfield alignment from Narromine to Narrabri and 307 km of upgraded track
- North Star to Acacia Ridge - 271 km of greenfield construction, 119 km of existing track upgraded from narrow gauge to dual gauge and 36 km of the existing coastal railway.

[8] Queensland Transport 2008, Southern freight rail corridor study - Draft Assessment Report prepared by Maunsell, October 2008.