# ARTC

Melbourne–Brisbane
Inland Rail Alignment Study

Working Paper No. 10
Development of Route



PB

aurecon

Halcrow

# Important note

This working paper is based on the outcome of Stage 1 of the study as reported in Working Paper No. 5. This concluded that a low capital cost scenario should be adopted for development and analysis in later stages of the study. This option included the use of existing lines, with some upgrading and possible deviations on the section between Narromine, the Werris Creek area and Narrabri. Accordingly this working paper includes an assessment of this section, as part of the Melbourne-Brisbane route.

Towards the end of Stage 2 of the study, in the process of trying to identify an economically viable route, the 'high capital cost' scenario identified in Stage 1 was further assessed and optimised using additional information gained during Stage 2 activities. The outcome of the analysis was that this scenario, using a shorter route, was determined to offer a better economic result than the low capital cost option.

This further analysis is reported in Working Paper No. 12, together with the conclusion that Stage 3 of the study should focus on the shorter route, which is identified as the '1690km Inland Rail' scenario.

As a result, the assessment reported in this working paper of the section of route between Narromine and Narrabri will be superseded by further work which will assess a more direct route between these two centres involving substantial new construction.

This further assessment will be included in the final report of the study.

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# Glossary

| | |
|---|---|
| ABS | Australian Bureau of Statistics |
| AC traction | Alternating Current traction motors; used in newer diesel-electric locomotives |
| ACCC | Australian Competition and Consumer Commission |
| alignment | The exact positioning of track; may be compared with 'route', which gives only a very general indication of the location of a railway |
| ARA | Australasian Railway Association |
| area route | For the purposes of the study, a route over an entire area, i.e. areas A, B, C or D |
| ARTC | Australian Rail Track Corporation |
| articulated wagons | Wagons comprising two or more units, with adjacent ends of individual units being supported on a common bogie and permanently coupled |
| AS 4292 | Australian Standard for Railway Safety in six parts 1995-97 |
| ATC | Australian Transport Council |
| ATEC | Australian Transport and Energy Corridor Ltd |
| ATMS | Advanced Train Management System; communication-based safeworking system currently being developed by ARTC |
| ATSB | Australian Transport Safety Bureau |
| axle load | The load transmitted to the track by two wheels of one axle of a bogie |
| backhaul | Returning wagons to a point where they can be used for their next assignment; freight moving in the opposite direction to the main flow |
| BAH | Booz Allen Hamilton (now Booz & Co) |
| bank engine | Locomotive used to assist a train on part of its journey, typically to climb a steep grade; such grades are called 'banks' |
| BAU | Business As Usual |
| BCR | Benefit Cost Ratio |
| BITRE | Bureau of Infrastructure, Transport and Regional Economics (formerly BTRE and BTE) |
| bogie | two axles and a sub-frame under each end of a wagon |
| BOOT | Build, Own, Operate, Transfer |
| break of gauge | Where a line of one track gauge meets a line of a different track gauge. |
| broad gauge | Railway track gauge of 1600 mm; used in Victoria except on interstate main lines and some other lines |
| BTE | Bureau of Transport Economics; now the BITRE |
| BTRE | Bureau of Transport and Regional Economics; now the BITRE |
| cant | Difference in the height of two rails comprising the railway track; cant may also be described as superelevation. It allows a train to travel through a curve at a speed higher than otherwise. Camber on the curve of a road has a similar function. |
| capex | capital expenditure |
| BCACBA | Cost-Benefit-Cost Analysis |
| CCM | Capital cost model |
| coastal route | The existing rail route from Melbourne to Brisbane via Sydney |
| corridor | A strip of land with a width measured in kilometres suitable for a railway. Study of a corridor leads to the identification of route options. |
| CountryLink | CountryLink is part of the Rail Corporation of New South Wales (RailCorp). It operates passenger trains from Sydney to Melbourne, Sydney to Brisbane and to NSW regional centres. |
| CPI | Consumer Price Index |
| CSO | Community Service Obligation |
| DBFM | Design, Build, Finance, Maintain |

| | |
|---|---|
| DC | Direct Current; form of electric traction |
| DIRN | Defined Interstate Rail Network |
| distributed locomotives | The practice of providing additional locomotive power within or at the rear of a train as well as in front. |
| DITRDLG | Australian Government Department of Infrastructure, Transport, Regional Development and Local Government |
| DMU | Diesel multiple-unit passenger train |
| DORC | Depreciated Optimised Replacement Cost |
| double stacking | Placement of one intermodal freight container on top of another in a specially designed well-wagon |
| EBITDA | Earnings before Interest, Tax, Depreciation and Amortisation |
| EIA | United States Energy Information Administration |
| EIRR | Economic Internal Rate of Return |
| energy efficiency | Ratio of the transport task to the energy input; a measure of energy efficiency is tonne/km per megaJoule (MJ) |
| energy intensity | Ratio of energy input to transport task; the inverse of energy efficiency; a measure of energy intensity is MJ/net tonne/km |
| FEC | Financial and Economic Consultant for the Melbourne-Brisbane Inland Rail Alignment Study, i.e. PricewaterhouseCoopers with ACIL Tasman and SAHA |
| five-pack wagon | Five wagons operated as one, either through being permanently coupled or the use of articulation |
| fuel consumption | Measured in litres per gross tonne kilometre (litres/gtk) or sometimes litres per 1,000 gross tonne kilometre (litres/1,000 gtk); sometimes net tonnes are used instead of gross tonnes |
| GATR | Great Australian Tank Rail System |
| GDP | Gross Domestic Product |
| GIS | Geographic Information System |
| gross | Total mass of a wagon and its payload |
| GST | Goods and Services Tax |
| gtk | Gross tonne kilometres, a standard measure of track usage; the gross weight of a train multiplied by kilometres travelled. |
| hr | hour |
| IA | Infrastructure Australia |
| IEA | International Energy Agency |
| IGA | Intergovernmental Agreement (1997) between the Commonwealth, NSW, Victoria, Queensland, Western Australia and South Australia which led to the establishment of ARTC |
| IPART | NSW Independent Pricing and Regulatory Tribunal |
| IRR | Internal Rate of Return |
| kg | kilogram(s) |
| kg/m | kilograms per metre |
| km | kilometre(s) |
| km/h | kilometres per hour |
| kW | kilowatt, a unit of power |
| L | litre(s) |
| L/gtk*1000 | Fuel consumption expressed in litres per gross tonne kilometre x 1000 |
| land-bridging | Replacement of sea transport with land transport between two sea ports, e.g. between Brisbane and Melbourne. |
| LEP | Local Environmental Plan |
| Line sector | In the context of the study, a length of line connecting two nodal points. |
| loading gauge | The maximum permissible height and width dimensions for a rail vehicle and its load; see structure gauge |
| LTC | Lead Technical Consultant for the Melbourne-Brisbane Inland Rail Alignment Study, i.e. Parsons Brinckerhoff with Aurecon and Halcrow |

| | |
|---|---|
| mass | The mass of an object is measured in kilograms; mass and weight are used interchangeably in the study |
| M-B | Melbourne-Brisbane |
| MIMS | Maintenance Integrated Management System |
| MJ | megaJoule: a unit of both energy and work |
| mm | millimetre(s) |
| MPM | Major Periodic Maintenance; planned maintenance on infrastructure assets at intervals of more than once a year. |
| mt | million tonnes |
| mt pa | million tonnes per annum |
| narrow gauge | Railway track gauge of 1067 mm; used in Queensland except on the interstate line from Sydney to Brisbane |
| NCOP | National Code of Practice |
| node | In the context of the study, a point at which alternative routes diverge. |
| NPV | Net Present Value |
| NPVI | Ratio of Net Present Value to Investment Costs (i.e. capital costs) |
| NSRCS | North-South Rail Corridor Study completed in 2006 |
| NSW | New South Wales |
| ntk | net tonne kilometres; the payload of a train multiplied by kilometres travelled |
| opex | operating expenses |
| payload | Weight of products and containers carried on wagons |
| PB | Parsons Brinckerhoff, Lead Technical Consultant |
| PwC | PricewaterhouseCoopers, Financial and Economic Consultant |
| Qld | Queensland |
| QR | Queensland Rail, a corporation owned by the Queensland Government |
| RailCorp | RailCorp (Rail Corporation of NSW); owns rail track in the Greater Sydney region, operates passenger trains in that region, [delete comma] and (under the name Countrylink) to Melbourne and Brisbane and regional NSW |
| RAMS | Rail Access Management System; manages and records access to ARTC track; RAMS is licensed to other track owners. |
| RCRM | Routine Corrective and Reactive Maintenance; maintenance, inspections and unplanned minor maintenance carried out annually or more frequently |
| Reference train | A notional train specification used in developing the inland rail alignment |
| RIC | Rail Infrastructure Corporation, NSW, owner of NSW rail network other than metropolitan sections owned by RailCorp. Interstate track and certain other sections are leased to ARTC. |
| RL | Stands for reduced level in surveying terminology; elevation relative to a specific datum point |
| RoA | Return on Assets |
| route | In the context of the study, primary description of the path which a railway will follow. |
| RTA | Roads and Traffic Authority - various states |
| SA | South Australia |
| safeworking | Signalling system and associated rules that keep trains a safe distance apart |
| SKM | Sinclair Knight Merz |
| SNP | Short North Project; capacity increases for freight currently being planned for the railway between Strathfield and Broadmeadow; 'short north' refers to the railway between Sydney and Newcastle. |
| SPV | Special Purpose Vehicle established for the development and/or the operation of a project. |
| SSFL | Southern Sydney Freight Line; independent track for use by freight trains between Macarthur and Chullora, currently under construction |

| | |
|---|---|
| standard gauge | Railway track gauge of 1435 mm; used on the ARTC network and for the NSW railway system |
| structure gauge | Specification for the position of structures such as overhead bridges, tunnels, platform, etc, relative to a railway track, to allow adequate clearance for the passage of trains. |
| superfreighter | Term used to describe high-priority intermodal freight trains |
| tal | tonnes axle load |
| tare | Weight of an empty wagon |
| TCI | Track Condition Index; TCI is an indicator of the condition of track by compilation of a number of measures of its geometry |
| TEU | Twenty-foot Equivalent Unit, the standard unit measure of shipping container size |
| t pa | tonnes per annum |
| train kilometre | A standard measure of track usage; number of trains multiplied by the total kilometres travelled |
| TSR | Temporary Speed Restriction |
| TTM | Train Transit Manager |
| Vic | Victoria |
| VicTrack | VicTrack, owner of Victoria's rail network; interstate track and certain other lines are leased to ARTC |
| VOC | Vehicle Operating Cost |
| WA | Western Australia |
| well-wagon | A wagon where the central loading deck is lower than the bogies at either end, to allow higher loads to be carried within the loading gauge |
| WP | Working Paper |
| WTT | Working Timetable |

# 1. Introduction

## 1.1 Overview

In March 2008 the Australian Government announced that the Australian Rail Track Corporation (ARTC) had been asked to conduct the Melbourne-Brisbane Inland Rail Alignment Study.

The announcement stated that in developing a detailed route alignment, the ARTC would generally follow the far western sub-corridor identified by the previous North-South Rail Corridor Study. This study, completed in June 2006, established the broad parameters for a potential future inland rail corridor between Melbourne and Brisbane.

## 1.2 Background to Melbourne – Brisbane Inland Rail

The railways of NSW, Victoria and Queensland date from the 19th century. They were constructed using different gauges and developed for differing purposes. At present, the only north-south rail corridor in eastern Australia runs through Sydney. North of Sydney the railway runs fairly close to the coast. For that reason, the existing Melbourne–Brisbane line is referred to as the coastal route throughout this working paper.

In September 2005 the Australian Government commissioned the North–South Rail Corridor Study. The study undertook a high level analysis of various corridors and routes that had been proposed for an inland freight railway between Melbourne and Brisbane.

In its March 2008 announcement, the Government stated that the Melbourne–Brisbane Inland Rail Alignment Study would build on previous work by undertaking a more detailed engineering, land corridor and environmental assessment, to allow scoping of the project's capital cost. In the announcement, the Minister for Infrastructure, Transport, Regional Development and Local Government requested a customer focused and consultative study involving consultations with state governments, industry, local governments and major rail customers.



## 1.3 Study objectives, stages and working papers:

The objectives of the Melbourne-Brisbane Inland Rail Alignment Study (the study) are to determine:

- The optimum alignment of the inland railway, taking into account user requirements and the economic, engineering, statutory planning and environmental constraints. The alignment will be sufficiently proven up so it can be quickly taken through the statutory planning and approval process and into the detailed engineering design and construction, should a decision be taken to proceed;
- The likely order of construction costs +/-20%;
- The likely order of below-rail (infrastructure) operating and maintenance costs;
- Above-rail operational benefits;
- The level and degree of certainty of market take up of the alignment;
- A project development and delivery timetable;
- A basis for evaluating the level of private sector support for the project.

The study is being carried out in three stages, as follows:

- Stage 1 – Determination of the route for further analysis;
- Stage 2 – Engineering, environmental and land base analysis;
- Stage 3 – Development of the preferred alignment.

A series of working papers is being produced within each stage. A list of the planned working papers follows.

**Table 1-1 Working papers**

| Stage | Working paper | | Lead Responsibility |
|---|---|---|---|
| Stage 1 | WP1 | Demand and Volume Analysis | FEC |
| | WP2 | Review of Route Options | LTC |
| | WP3 | Stage 1 Capital Works Costings | LTC |
| | WP4 | Preliminary Operating and Maintenance Cost Analysis | LTC |
| | WP5 | Stage 1 Economic and Financial Analysis and Identification of the Route for Further Analysis | FEC |
| Stage 2 | WP6 | Design Standards | LTC |
| | WP7 | Preliminary Environmental Assessment | LTC |
| | WP8 | Preliminary Land Assessment | LTC |
| | WP10 | Development of Route | LTC |
| | WP11 | Stage 2 Capital Works Costings | LTC |
| | WP12 | Stage 2 Economic and Financial Analysis | FEC |
| Stage 3 | WP9 | Engineering Data Collection | LTC |
| | WP13 | Preferred Alignments Environmental Assessment | LTC |
| | WP14 | Preferred Alignments Land Assessment | LTC |
| | WP15 | Refinement of Preferred Alignments | LTC |
| | WP16 | Stage 3 Capital Works Costing | LTC |
| | WP17 | Delivery Program | LTC |
| | WP18 | Economic and Financial Assessment | FEC |
| | WP19 | Policy Issues, Options and Delivery Strategies | FEC |

Note that the list of working papers has been revised since the completion of Stage 1 of the study. Some working papers have been re-titled and/or re-scheduled. In addition, the working papers listed as outputs of Stage 3 will appear as sections or appendices within an integrated final report of the study rather than being published as standalone documents.

## 1.4 Roles of the Lead Technical Consultant (LTC) and the Financial and Economic Consultant (FEC)

The study's activities are headed by two lead consultants whose activities are coordinated by ARTC.

The Lead Technical Consultant is responsible for engineering and environmental work and associated activities, including railway operational analysis. The Financial and Economic Consultant is responsible for financial and economic analysis. The two consultants work jointly and collaboratively with each other.

The Lead Technical Consultant (LTC) is Parsons Brinckerhoff (PB) and the Financial and Economic Consultant (FEC) is PricewaterhouseCoopers (PwC). Each consultant acts independently and each has a lead responsibility for specific working papers. Whilst this occurs the other consultant plays a support role for that particular working paper.

Parsons Brinckerhoff has engaged Halcrow to support it in alignment development, operations and maintenance costing and Aurecon to support it in engineering and alignment development. Aurecon has in turn engaged Currie and Brown to assist in capital costing.

PricewaterhouseCoopers has engaged ACIL Tasman to undertake volume and demand analysis and support it in economic review, and SAHA for peer review.

## 1.5 Stage 1 analysis

Stage 1 analysed numerous routes within the study area in order to determine the route to be analysed in Stage 2 (see Working Paper No. 5 Stage 1 Economic and Financial Analysis and the Identification of the Route for Further Analysis).

The route follows existing rail lines from Melbourne via Albury to Cootamundra, Parkes, Narromine, Dubbo, Werris Creek and Moree to North Star near Goondiwindi; with new construction from North Star to Brisbane via Toowoomba. North of Parkes the railway would require parts of the existing route to be upgraded, including minor deviations to improve its alignment.

The analysis retained a number of options for further analysis in Stage 2 of the study; including possible routes between Junee and Stockinbingal, Premer and Emerald Hill avoiding Werris Creek, North Star and Yelarbon near Inglewood, and in the vicinity of Toowoomba.

The route for further analysis is shown in the map below.

Stage 2 has conducted engineering, environmental and land baseline analysis of the route sections within the area shown to identify the route for refinement in Stage 3.

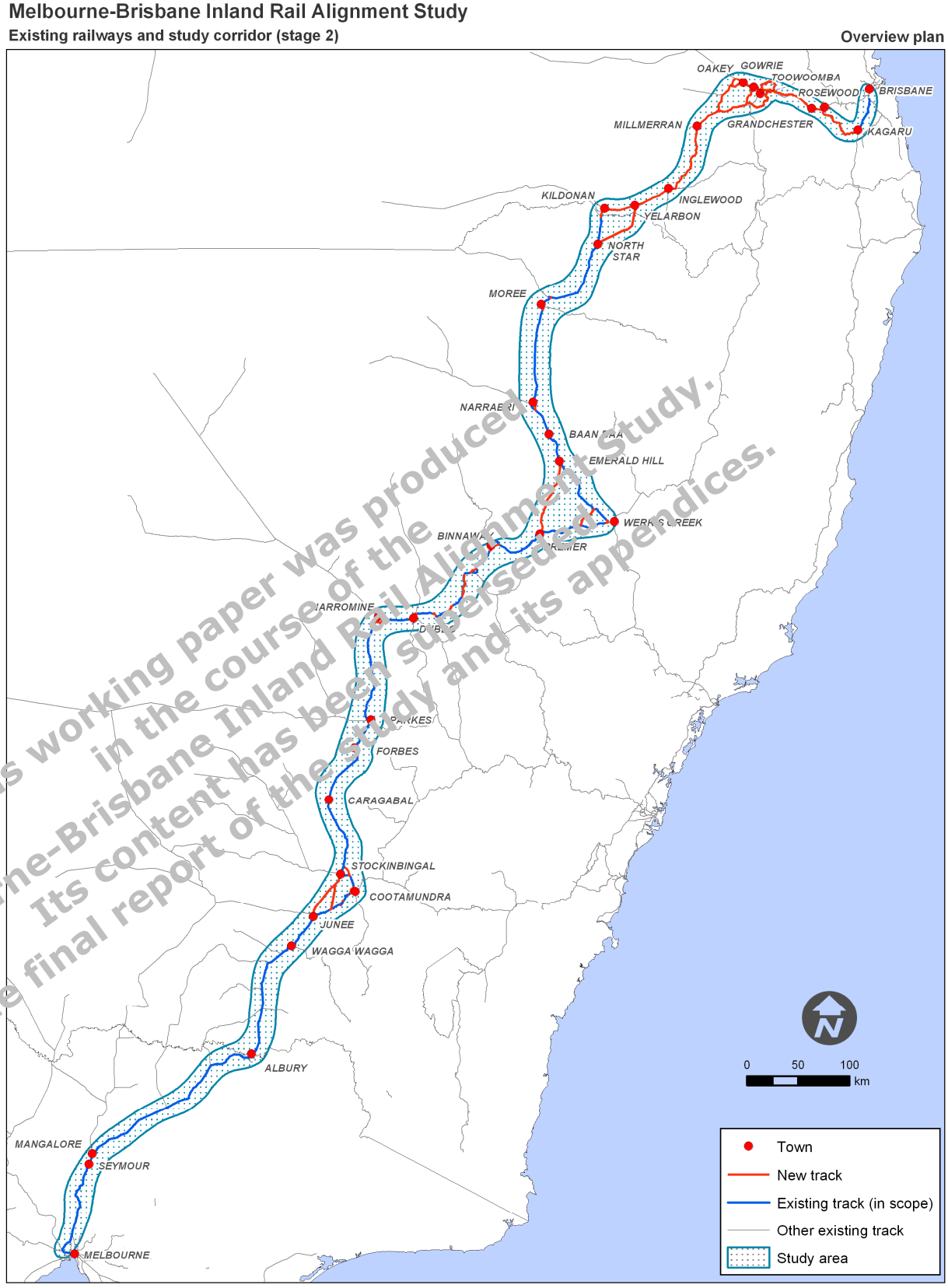


**Figure 1-1 Melbourne Brisbane inland rail corridor (Stage 2)**

## 1.6 Objectives of Working Paper No. 10

The purpose of this working paper is to document the alignment options within the Stage 2 study area, the process of their development and determine a short-list to be taken forward to Stage 3 of the study. It identifies and describes the reference case, upgrades and various deviations for the Inland Rail Alignment Study and presents the journey times for the various alignment options along the route.

The alignment options are evaluated in this working paper based on an assessment of the capital cost required to save journey time, with critical environmental aspects also being considered.

# 2. Approach to Development of Options

## 2.1 Introduction

### 2.1.1 Extent of works

The general extent of works covered by the Inland Rail Alignment Study includes the following:

- Planning and environmental;
- Permanent way;
- Tunnel structures;
- Bridges and culverts;
- Earthworks;
- Roadworks;
- Operations;
- Signalling and communications;
- Level crossings;
- Hydrology;
- Construction;
- Maintenance.

### 2.1.2 Context

Alignment options along the Stage 2 study corridor were considered in broad terms and a short-list of options was selected. The options generally comprised sections of:

- New (greenfield) track;
- New (additional) track adjacent to existing track;
- Upgrades of existing track;
- Existing track with essential work undertaken.

For the greenfield sections, high-level horizontal and vertical design was carried out and typical details were considered. From these prepared designs, earthworks quantities were calculated, which included an estimate of the number and type of structures generated.

For sections of existing track, essential works (such as replacements of speed restricted timber bridges) were identified.

Many sections of existing track have maximum speeds restricted to below 115km/h because of the quality of the infrastructure. Opportunities to upgrade the existing track were identified and the upgrade requirements and construction cost to improve train journey times on these sections was estimated.

## 2.2 Evaluation framework

This working paper provides the journey time estimates and the input data to the cost estimate.

The evaluation undertaken of the short-listed options is based on three broad criteria:

- Cost;
- Journey time saving;
- Environmental impacts.

This evaluation is included in section 5 of this working paper.

# 3. Description of Alignment Options

## 3.1 Introduction

Stage 1 established a refined study corridor to be taken forward to Stage 2. The route generally comprises 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 there are opportunities to improve the journey time by upgrading existing track, bypassing towns and building deviations.

A reference case has been defined to allow potential journey time savings of upgrades and deviations to be compared. The reference case is the alignment with the minimum capital expenditure required to operate Melbourne to Brisbane Inland Rail effectively.

The deviations provide opportunities for journey time savings and will be selected on the basis of a cost per minute saved criteria, with cognisance of total journey time and other key issues such as the environment. The deviations will replace sections of the reference case where the existing alignment is a restriction to a lower journey time.

Journey time savings can also be achieved by upgrading track on existing alignments. The cost and journey time saving of track upgrades were also considered and will be selected on the basis of cost per minute saved.

## 3.2 Reference case

### 3.2.1 Introduction

The reference case is established using the following assumptions:

- existing Class 1 and Class 2 track will be used where available;
- existing Class 3 or lower track will be upgraded to Class 1 track;
- train reversals will be eliminated by constructing triangles where required;
- bridges constraining operation (with severe speed restrictions) will be replaced or upgraded;
- standard gauge track will be built within the existing corridor, adjacent to existing narrow gauge track where appropriate;
- greenfield track will be built where no existing corridor exists.

### 3.2.2 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. It is understood that ARTC will upgrade the Cootamundra to Parkes (via Stockinbingal) route to Class 1 capable of 21 tonne axle loads at 115 km/h.

The reference case for Melbourne to Parkes is made up of the sections listed in the Table below. Maps of the area showing an overview of the route and the terrain follow the table. More detailed route maps are contained in Appendix E.

**Table 3-1 Melbourne to Parkes section list**

| Section | Description | Line Treatment |
|---|---|---|
| A01 | Melbourne to Mangalore | Existing, Class 1 |
| A02 | Mangalore to Wodonga (south) | Existing, Class 1 |
| A03a | Wodonga deviation | Class 1 under construction |
| A04 | Wodonga (north) to Junee | Existing, Class 1 |
| B01 | Junee to Junee (east) | Existing, Class 1 |
| B02a1 | Junee (east) to Illabo | Existing, Class 1 |
| B02a2 | Illabo to Bethungra (south) | Existing, Class 1 |
| B03 | Bethungra (south) to Bethungra (north) | Existing, Class 1 |
| B04 | Bethungra (north) to Frampton (south) | Existing, Class 1 |
| B05 | Frampton (south) to Frampton (north) | Existing, Class 1 |
| B07 | Frampton (north) to Cootamundra (south) | Existing, Class 1 |
| B08 | Cootamundra (south) to Bauloora | Planned Class 1 upgrade |
| B10 | Bauloora to Yeo Yeo (south) | Planned Class 1 upgrade |
| B11 | Yeo Yeo (south) to Yeo Yeo (north) | Planned Class 1 upgrade |
| B12 | Yeo Yeo (north) to Stockinbingal | Planned Class 1 upgrade |
| B15 | Stockinbingal to Stockinbingal (north) | Planned Class 1 upgrade |
| B16 | Stockinbingal (north) to Maleeja | Planned Class 1 upgrade |
| B18 | Maleeja to Parkes (south) | Planned Class 1 upgrade |
| B19 | Parkes (south) to Parkes (north) | Planned Class 1 upgrade |

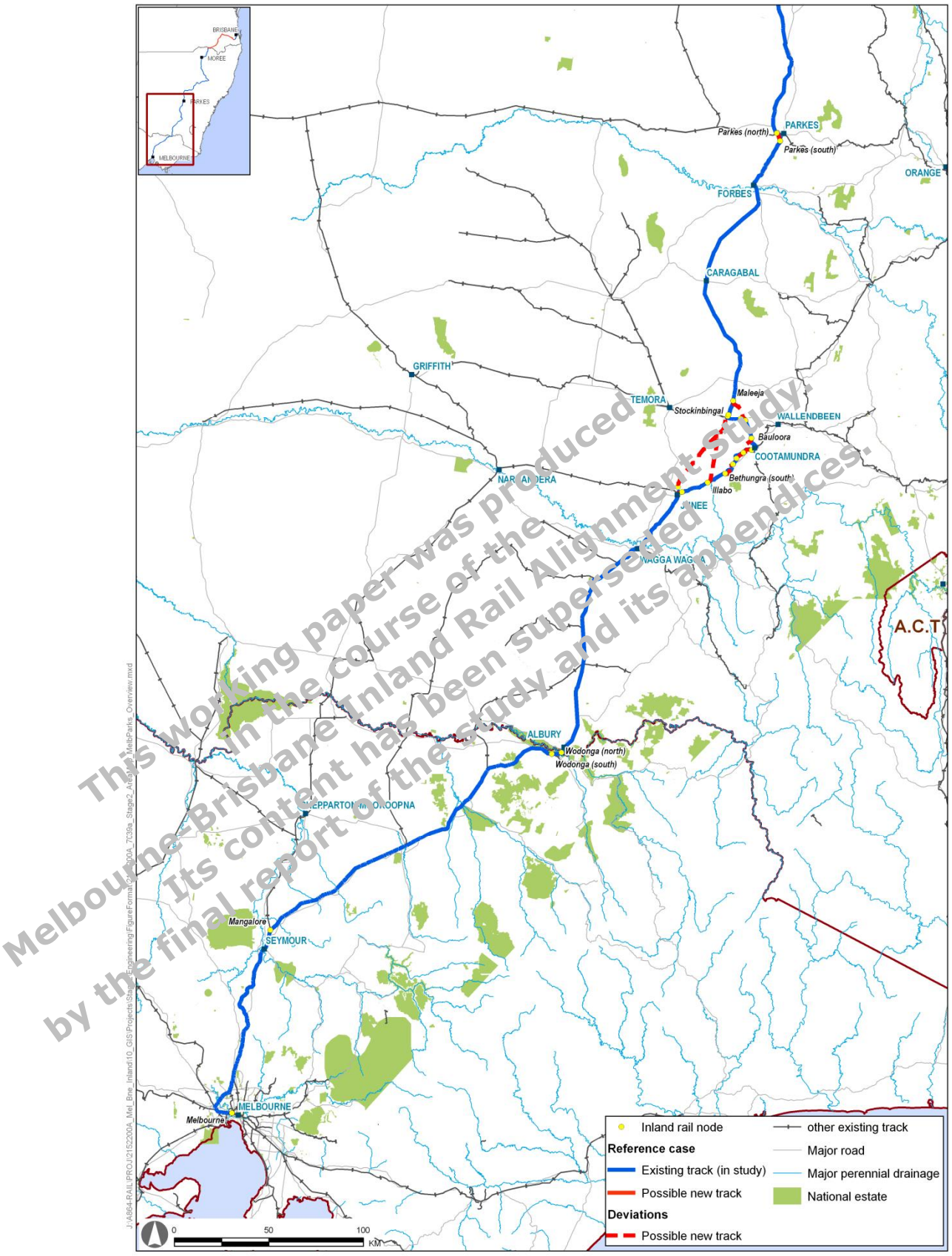


**Figure 3-1 Melbourne to Parkes overview**

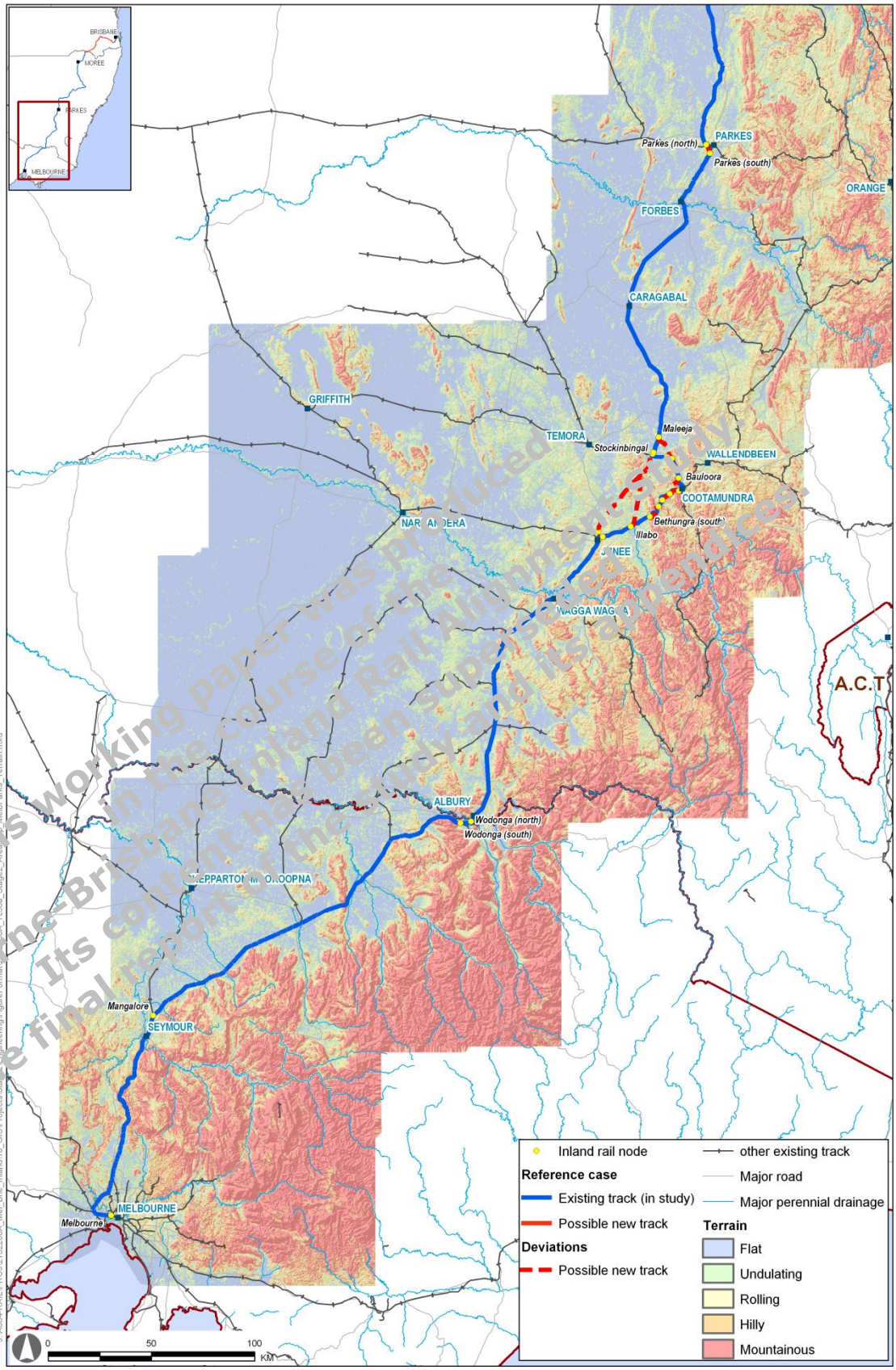


**Figure 3-2 Melbourne to Parkes terrain**

### 3.2.3 Parkes to Moree

The reference case route from Parkes to Moree comprises 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 uses 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 Wallerwang to Gwabegar line are used, with a greenfield section to remove the reversal at Binnaway.

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

The reference case for Parkes to Moree is made up of the sections listed in Table 3-2 below. Maps of the area showing an overview of the route and the terrain follow the table. A hydrology map of the area has also been included due to the flooding issues in the area. More detailed route maps are contained in Appendix F.

**Table 3-2 Parkes to Moree section list**

| Section | Description | Line Treatment |
|---|---|---|
| B20a1 | Parkes (north) to Narromine (south) | Existing, Class 2 |
| B20a2 | Narromine (south) to Narromine | Existing, Class 2 |
| C01a1 | Narromine to Narromine (east) | Existing, Class 2 |
| C01a2 | Narromine (east) to Dubbo (west) | Existing, Class 2 |
| C02 | Dubbo (west) to Dubbo (north east) | Existing, Class 2 |
| C03a1 | Dubbo (north east) to Barbigal (west) | Existing, Class 2 |
| C03a2 | Barbigal (west) to Barbigal (east) | Existing, Class 2 |
| C03a3 | Barbigal (east) to Muronbung (south) | Existing, Class 2 |
| C03a4 | Muronbung (south) to Muronbung (north) | Existing, Class 2 |
| C03a5 | Muronbung (north) to Boomley (south) | Existing, Class 2 |
| C03a6 | Boomley (south) to Boomley (north) | Existing, Class 2 |
| C03a7 | Boomley (north) to Merrygoen (south) | Existing, Class 2 |
| C03a8 | Merrygoen (south) to Merrygoen (north) | Existing, Class 2 |
| C03a9 | Merrygoen (north) to Toogarlan (south) | Existing, Class 2 |
| C03a10 | Toogarlan (south) to Toogarlan (north) | Existing, Class 2 |
| C03a11 | Toogarlan (north) to Piambra (south) | Existing, Class 2 |
| C03a12 | Piambra (south) to Piambra (north) | Existing, Class 2 |
| C03a13 | Piambra (north) to Binnaway | Existing, Class 2 |
| C04b1 | Binnaway to Binnaway (east) | New, Class 1 |
| C04a4 | Binnaway (east) to Ulinda (north) | Existing, Class 2 |
| C04a5 | Ulinda (north) to Ulinda (south) | Existing, Class 2 |
| C04a6 | Ulinda (south) to Oakey Creek | Existing, Class 2 |
| C04a7 | Oakey Creek to Premer (west) | Existing, Class 2 |

| Section | Description | Line Treatment |
|---|---|---|
| C04a8 | Premer (west) to Premer (central) | Existing, Class 2 |
| C04a9 | Premer (central) to Premer (north) | Existing, Class 2 |
| C04a10 | Premer (north) to Premer (east) | Existing, Class 2 |
| C05a1 | Premer (east) to Spring Ridge | Existing, Class 2 |
| C05a2 | Spring Ridge to Turilawa (high speed west) | Existing, Class 2 |
| C06a1 | Turilawa (high speed west) to Turilawa (low speed south) | Existing, Class 2 |
| C60 | Turilawa (low speed south) to Turilawa (low speed north) | New, Class 1 |
| C06a2 | Turilawa (low speed north) to Turilawa (high speed north) | Existing, Class 1 |
| C07a1 | Turilawa (high speed north) to Breeza | Existing, Class 1 |
| C07a2 | Breeza to Emerald Hill | Existing, Class 1 |
| C08 | Emerald Hill to Baan Baa | Existing, Class 1 |
| C09 | Baan Baa to Narrabri (south) | Existing, Class 1 |
| C10 | Narrabri (south) to Narrabri (north) | Existing, Class 1 |
| C11 | Narrabri (north) to Moree (south) | Existing, Class 2 |
| C17a1 | Moree (south) to Moree (east) | Existing, Class 2 |
| C17a2 | Moree (east) to Moree (north-east) | Upgrade, Class 3 to Class 1 |
| C17a3 | Moree (north east) to Camurra (south) | Upgrade, Class 3 to Class 1 |
| C17a4 | Camurra (south) to Moree (north) | Upgrade, Class 3 to Class 1 |

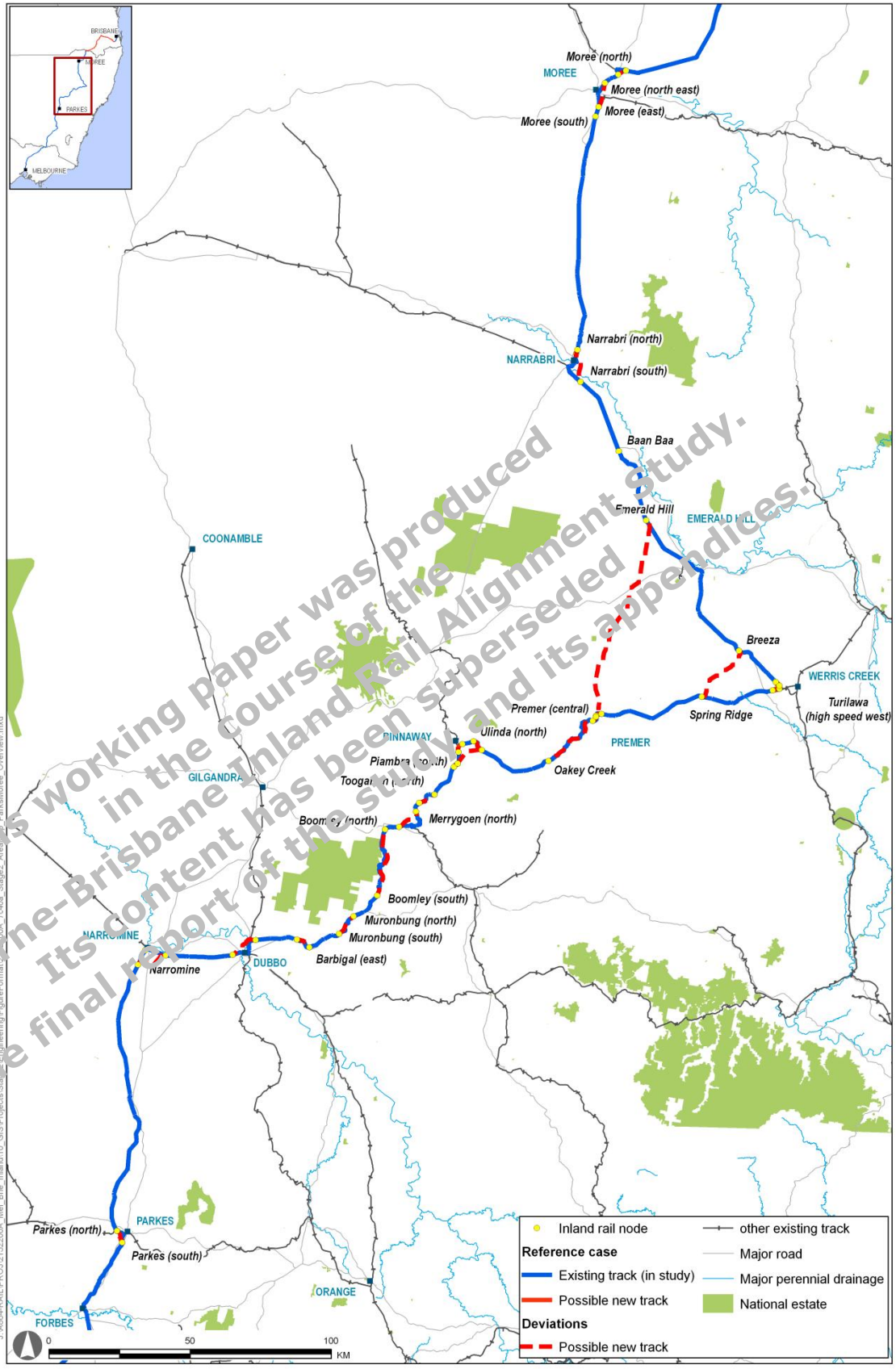


**Figure 3-3 Parkes to Moree overview**

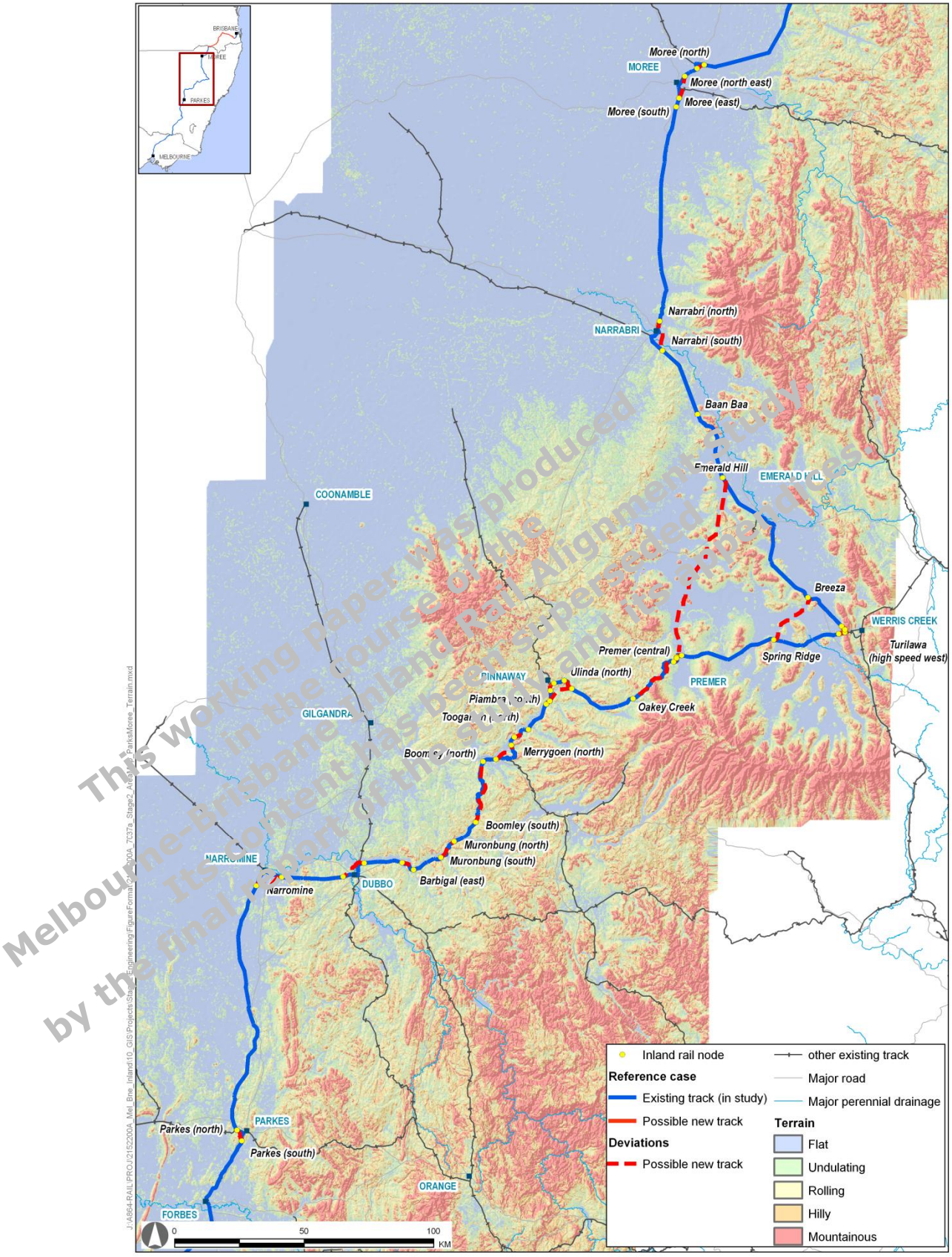




**Figure 3-4 Parkes to Moree terrain**

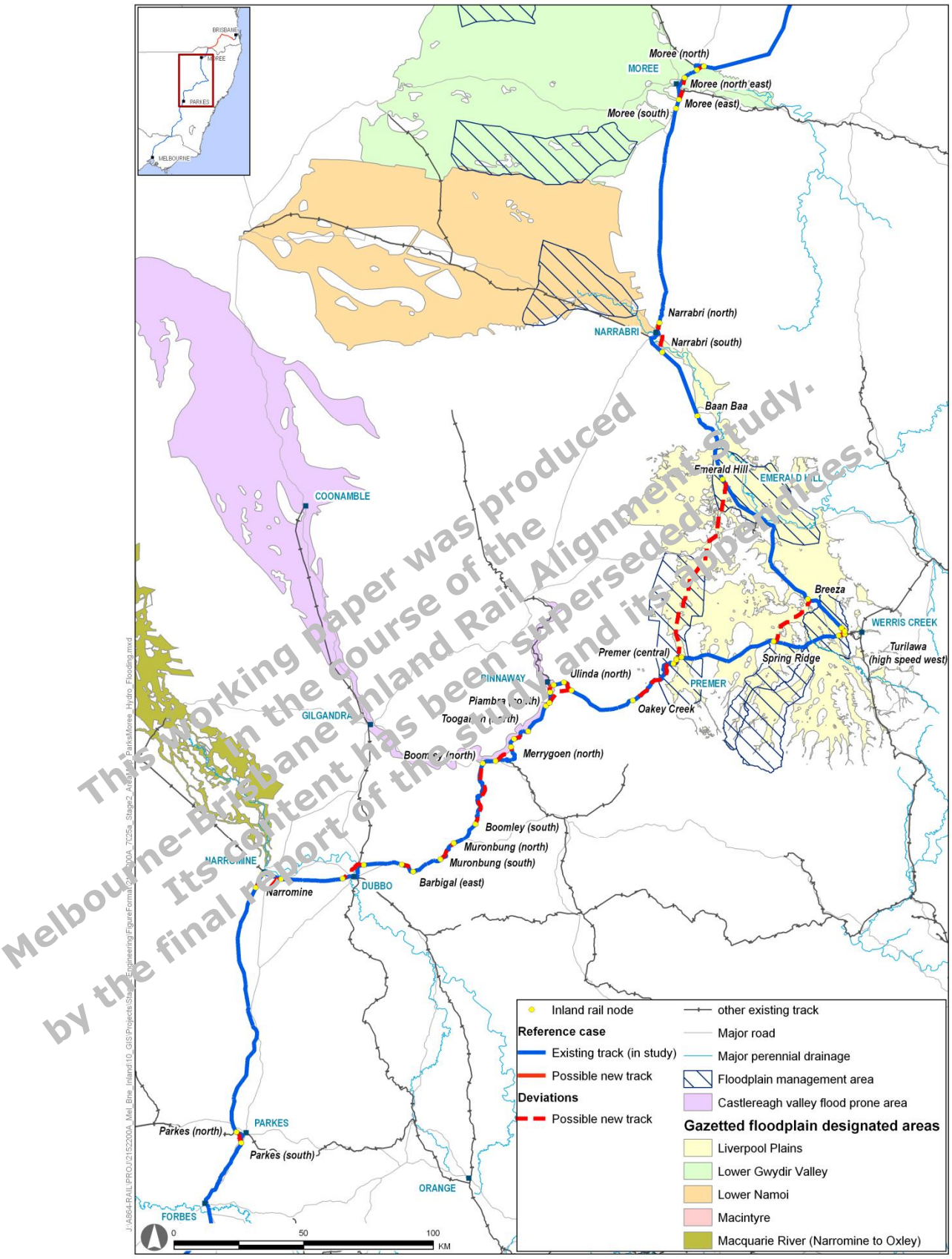




**Figure 3-5 Parkes to Moree hydrology and flooding**

There are many areas along the existing lines where speed restrictions occur. These are due to a number of factors including bridge condition, level crossings and proximity to towns. If the speed restrictions were removed there would be significant journey time savings. The speed restrictions from bridges are predominately due to ageing timber or steel structures that require speed restrictions to carry various axle loads. A number of the bridges along the reference case route were considered unsuitable for servicing the inland railway. The bridge replacements in Table 3-3 below have been assumed in the reference case:

**Table 3-3 Reference case bridge replacements**

| Section | Description | Location (km) | Existing Speed Restriction | Assumed Speed Restriction |
|---|---|---|---|---|
| C02 | Macquarie River Bridge | 462.988 | 15 | 80 |
| C03a1 | Beni Creek Bridge | 480.507 | 30 | 80 |
| C03a4 | Baragonumble Creek Bridge | 509.099 | 40 | 80 |
| C03a5 | Elong Elong Bridge | 515.710 | 30 | 80 |
| C03a6 | Boomley Creek Bridge | 524.987 | 40 | 80 |
| C03a11 | Butheroo Creek Bridge | 436.373 | 40 | 80 |
| C03a12 | Piambra Bridge | 449.631 | 20 | 80 |
| C04a6 | Weetaliba Bridge | 485.331 | 40 | 80 |
| C05a1 | Premer Bridge | 529.730 | 40 | 80 |
| C05a1 | Coxs Creek Bridge | 535.017 | 40 | 80 |
| C10 | Namoi River Bridge | 565.755 | 20 | 80 |
| C10 | Narrabri Bridge | 569.930 | 30 | 80 |

The existing railway between Moree and North Star is Class 3 and upgrade to Class 1 has been included in the reference case. A list of the bridges which are assumed to be upgraded as part of the reference case works is in Table A2 in Appendix A.



### 3.2.4 Moree to Brisbane

The reference case route from Moree to Brisbane comprises a mixture of greenfield routes, new railway adjacent to existing QR narrow-gauge tracks and upgrades to existing standard gauge tracks.

The Moree to Boggabilla section proposes an upgrade of the existing (Class 3) standard gauge Moree to North Star line and a rebuilt section of the existing derelict standard gauge North Star to Boggabilla line.

The Boggabilla to Inglewood section proposes a greenfield section between Boggabilla and the Kildonan border crossing and a new track constructed adjacent to the existing narrow gauge alignment of the Warwick to Dirranbandi line.

The Inglewood to Oakey section proposes a greenfield section between Inglewood and Millmerran, a new track constructed adjacent to the existing narrow gauge alignment between Millmerran to Cecilvale, a greenfield section between Cecilvale and Yargullen, a combination of greenfield and rebuild of the QR Cecil Plains line between Cecilvale and Yargullen and a greenfield section adjacent to the existing narrow gauge Dalby to Toowoomba line to Oakey.

The Oakey to Brisbane section uses a greenfield section adjacent to the existing narrow gauge Toowoomba to Dalby line, a greenfield alignment down the range from Gowrie to Gatton, new track adjacent to the existing narrow gauge Toowoomba to Rosewood line between Gatton and Grandchester, a greenfield section between Grandchester (west of

Rosewood) and Kagaru, and the existing standard gauge Class 1 coastal route from the NSW border to Acacia Ridge.

The reference case for Moree to Brisbane is made up of the sections listed in Table 3-4 below. Maps of the area showing an overview of the route and the terrain of the area follow the table. More detailed route maps are contained in Appendix E.

**Table 3-4 Moree to Brisbane section list**

| Section | Description | Line Treatment |
|---|---|---|
| D01a | Moree (north) to North Star | Upgrade, Class 3 to Class 1 |
| D02a | North Star to Boggabilla | New, Class 1 within corridor |
| D03c | Boggabilla to Kildonan | New, Class 1 |
| D04a | Kildonan to Yelarbon | New, Class 1 within corridor |
| D06a | Yelarbon to Inglewood | New, Class 1 within corridor |
| D07c | Inglewood to Millmerran | New, Class 1 |
| D08a | Millmerran to Cecilvale | New, Class 1 within corridor |
| D14c | Cecilvale to Yargullen | New, Class 1 |
| D15a | Yargullen to Oakey | New, Class 1 |
| D16a | Oakey to Gowrie | New, Class 1 within corridor |
| D24c | Gowrie to Gatton (QT option) | New, Class 1 |
| D25c | Gatton to Grandchester / Rosewood (QT option) | New, Class 1 |
| D26c | Grandchester / Rosewood to Kagaru (QT option) | New, Class 1 |
| D28a | Kagaru to Acacia Ridge | Existing, Class 1 |

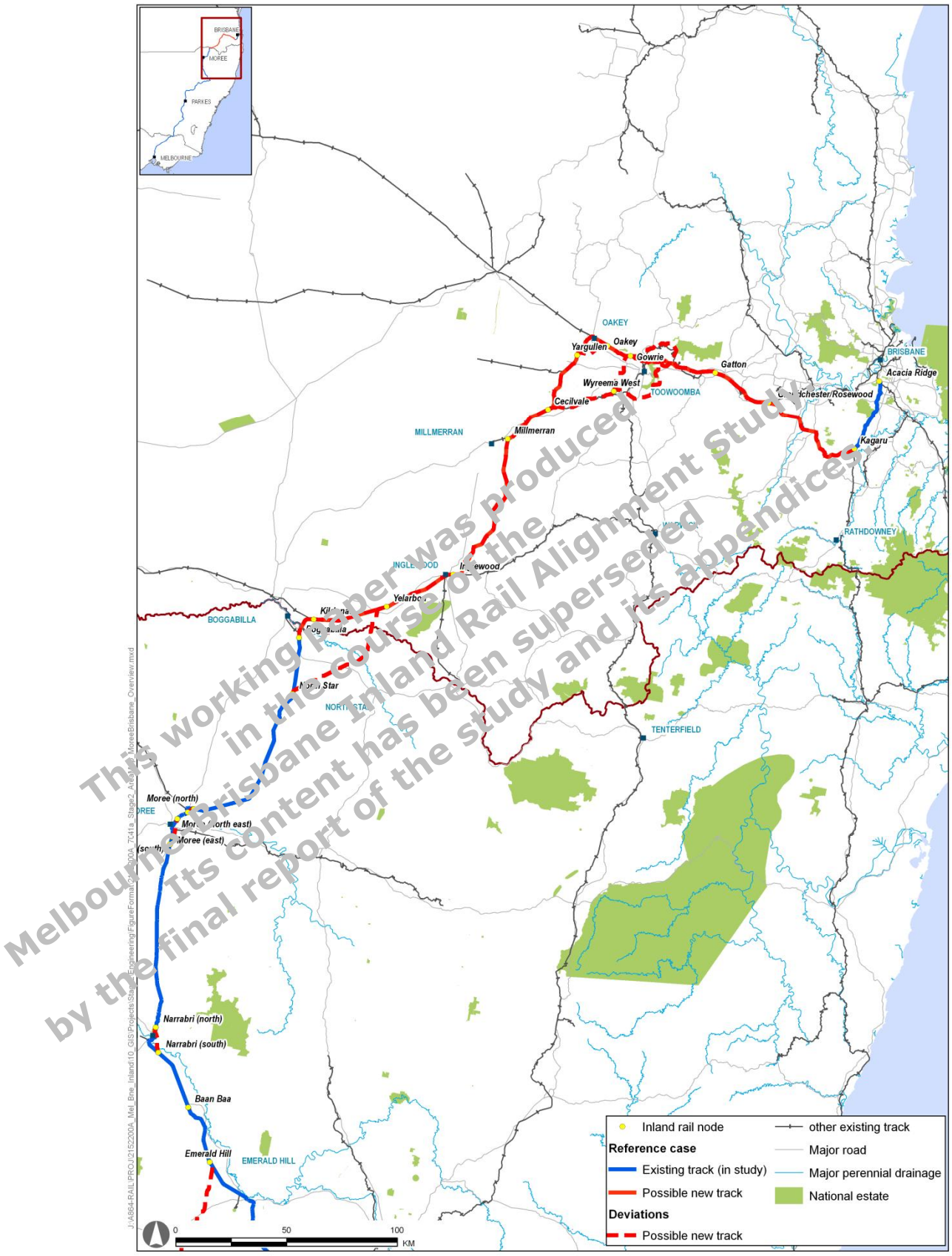


**Figure 3-6 Moree to Brisbane overview**

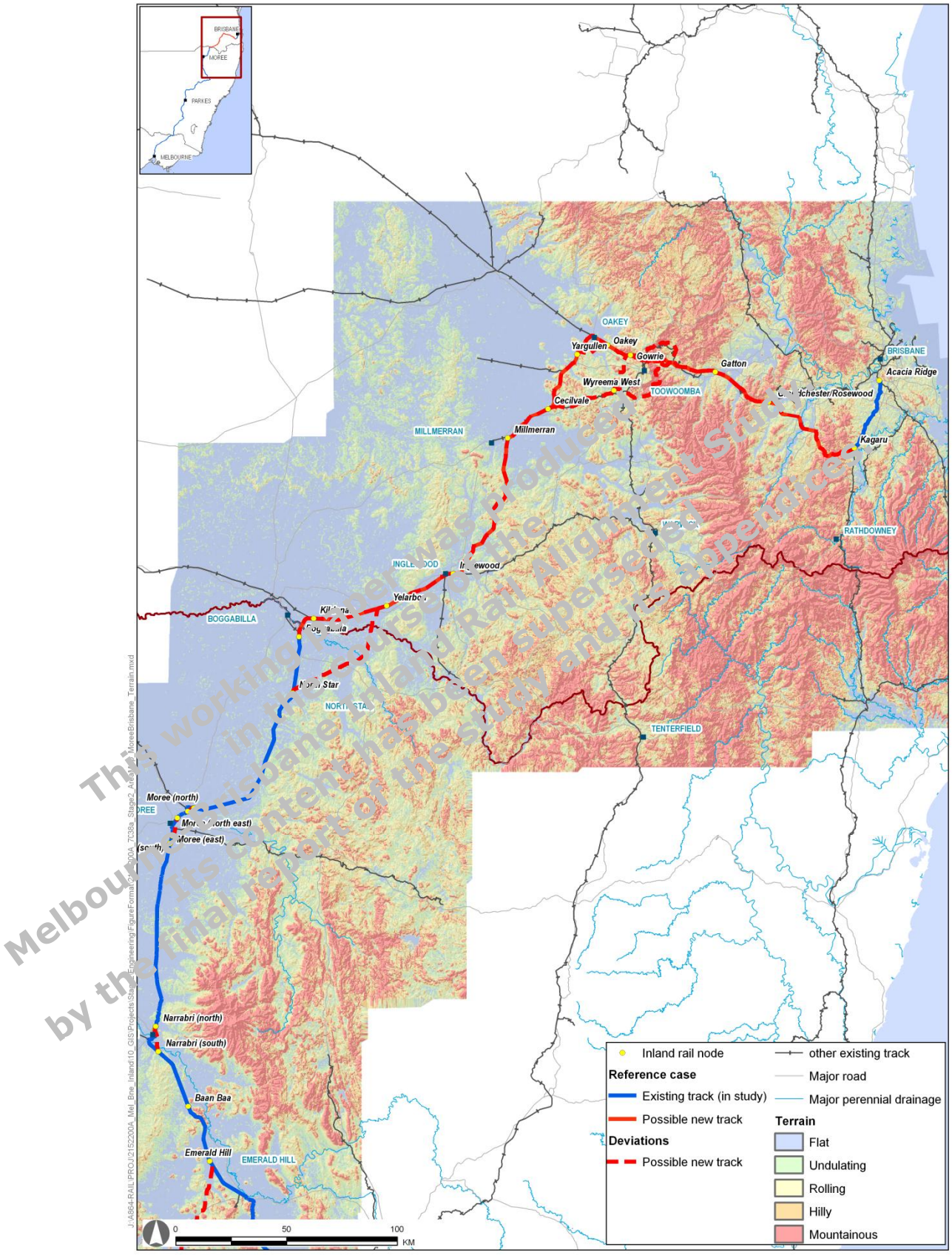


**Figure 3-7 Moree to Brisbane terrain**

## 3.3 Deviations

### 3.3.1 Introduction

The Melbourne to Brisbane inland railway will run on existing sections of track that were designed to connect freight sources with their closest capital city, not for a Melbourne-Brisbane route. Also, most existing lines were not designed for the superfreighters proposed for use on Inland Rail. For these reasons there are a number of opportunities to improve the alignment along parts of the reference case.

The deviations are all between Junee and Brisbane, with none required between Melbourne and Junee as the existing Class 1 Main South line is considered adequate.

The main purpose of the deviations is to improve the journey time for Inland Rail, usually by providing a shorter and faster alignment. Some of the main features of the deviations are summarised in the following sections. A comparison of both the lengths and journey times of the deviations, upgraded alignments and the reference case alignments are provided in section 4 of this working paper.

The environmental impacts, incremental cost and journey time savings of potential journey time improvements is considered in section 5 of the working paper. A short-list of options to be taken to Stage 3 for further analysis has been selected.

In the case of some deviations the existing track could remain and serve as a crossing loop or passing lane. This will be investigated in Stage 3.

### 3.3.2 Melbourne to Parkes

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.

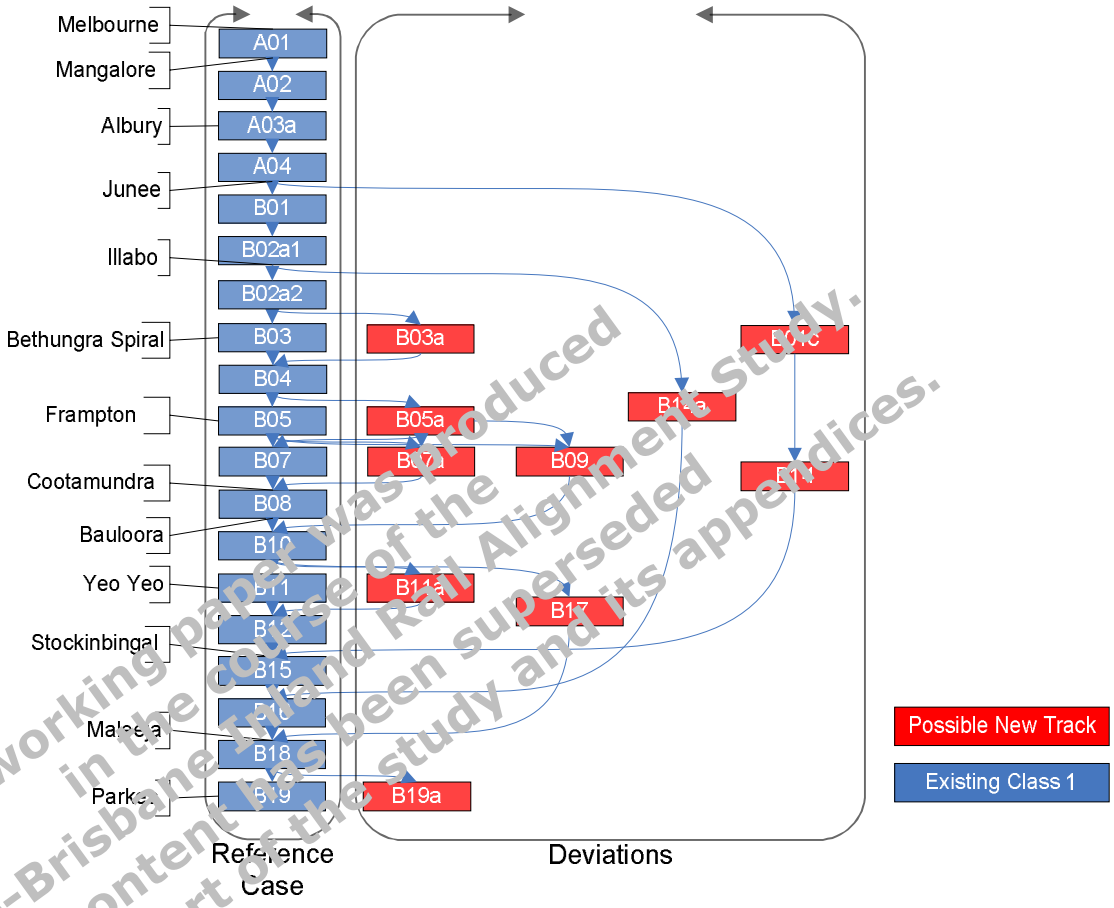


**Figure 3-8 Melbourne to Parkes reference case and deviations**



#### Junee to Stockinbingal (B1c & B14) – major greenfield

Between Junee to 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 bypasses 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 comprises generally greenfield construction, with approximately 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 Bethungra to Stockinbingal section is a greenfield section. The option provides a direct route from Bethungra 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 39 km of Class 1 track, compared to approximately 68 km via the reference case route.

### Bethungra deviation (B03a)

The purpose of the deviation is to remove low speed curves at the Bethungra spiral on the Main South line. The deviation 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 purpose of the deviation is to remove low speed curves at Frampton on the Main South line. The deviation 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 purpose of the deviation is to remove low speed curves south of Cootamundra on the Main South line. The new deviation would consist of approximately 5 km of Class 1 standard gauge track. It is noted that the new alignment crosses 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 is a greenfield section. The purpose of the deviation is to remove low speed curves at Cootamundra and bypass the town of Cootamundra. The deviation 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 purpose of the deviation is to remove low speed curves at Yeo Yeo. The deviation 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 is a greenfield section. The purpose of the option is to provide a direct route from Yeo Yeo on the Cootamundra to Stockinbingal line to Maleeja on the Stockinbingal to Parkes line. The option bypasses 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 approximately 13 km of Class 1 track.

### Parkes bypass (B19a)

The Parkes deviation bypasses the town centre, which is located on the Orange to Broken Hill line. The purpose of the deviation is to provide a connection from the Parkes to Stockinbingal line to the Parkes to Narromine line with connections to the Orange to Broken Hill line. The new deviation would consist of approximately 5 km of Class 1 standard gauge track.

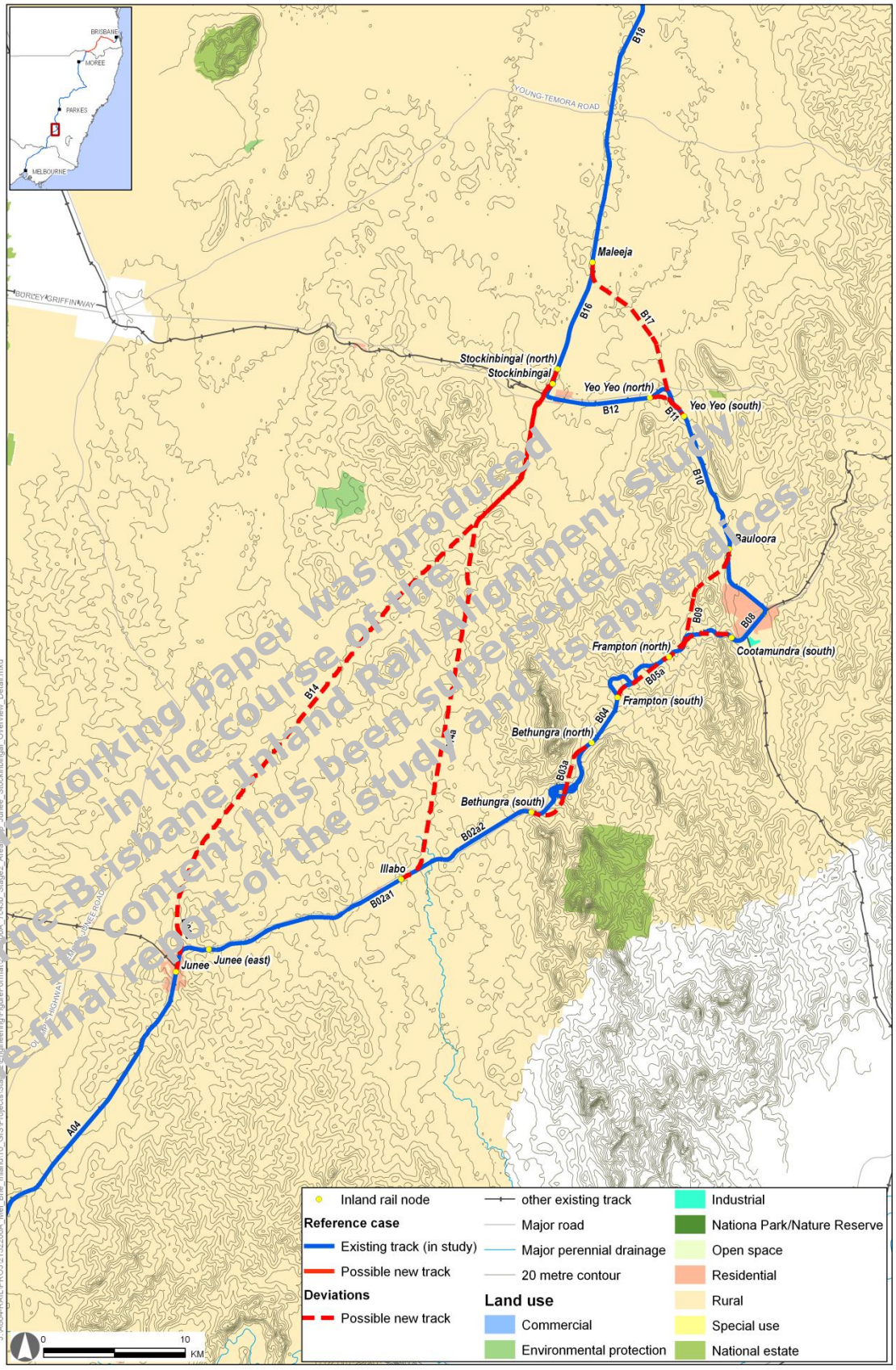




**Figure 3-9 Junee to Stockinbingal**

### 3.3.3 Parkes to Moree

Figure 3-10 below shows the possible deviations to replace sections of the reference case between Parkes and Moree. Figure 3-11 shows the area between Premer, Werris Creek and Emerald Hill which contains the longest deviations for this area.

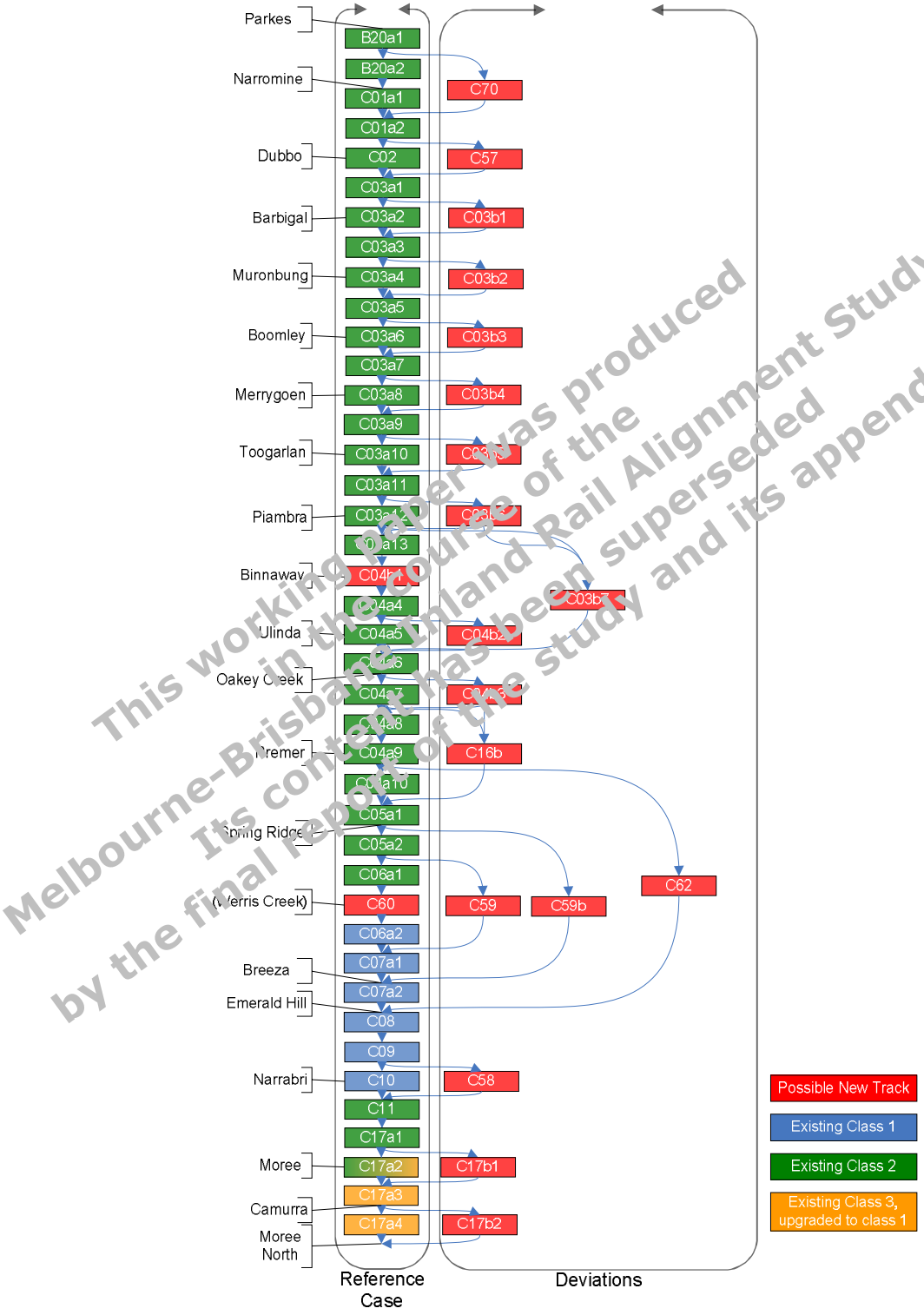




**Figure 3-10 Parkes to Moree reference case and deviations**

### Narromine bypass (C70)

The Narromine deviation is a greenfield section. The purpose of the deviation is to remove low speed curves and bypass the town of Narromine. The deviation would consist of approximately 12 km of Class 1 standard gauge track, compared with approximately 14 km along the reference case alignment. The deviation is also 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. The purpose of the deviation is to remove low speed curves and bypass the town of Dubbo. The new deviation would consist of approximately 10 km of Class 1 standard gauge track.

### Barbigal deviation (C03b1)

The purpose of the deviation is to remove low speed curves at Barbigal. The deviation 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 purpose of the deviation is to remove low speed curves at Muronbung. The deviation 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 purpose of the deviation is to remove low speed curves at Boomley. The deviation 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 opportunity to optimise the deviation during Stage 3 of the study and retain a further 5.8 km of the existing alignment (upgraded to Class 1).

### Merrygoon deviation (C03b4)

The purpose of the deviation is to remove low speed curves and bypass the town centre of Merrygoon. The deviation would consist of approximately 9 km of Class 1 standard gauge track. There is an opportunity to optimise the deviation during Stage 3 of the study by moving the alignment out of the floodplain of the Castlereagh River.

### Toogarlan deviation (C03b5)

The purpose of the deviation is to remove low speed curves at Toogarlan. The deviation 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 purpose of the deviation is to remove low speed curves at Piambra. The deviation 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 an enhancement of deviations C03b6 and C04b2. The purpose of the deviation is to remove low speed curves, bypass the town centre of Binnaway and remove the track reversal at Binnaway. The deviation would consist of approximately 11 km of Class 1 standard gauge track

### Ulinda deviation (C04b2)

The purpose of the deviation is to remove low speed curves at Ulinda. The deviation 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 purpose of the deviation is to remove low speed curves. The new deviation 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. There are opportunities to optimise the alignment in later stages of the study.

### Premer bypass (C16b)

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

### Premer to Emerald Hill (C62) – major greenfield

The Premer (north) to Emerald Hill section is a greenfield section. The purpose of the option is to provide a direct route from Premer on the Binnaway to Werris Creek line to Emerald Hill on the Werris Creek to Mungindi line. This option bypasses low speed curves and the towns of Werris Creek and Gunnedah. The section would consist of approximately 75 km of Class 1 track. There are opportunities to optimise the alignment in later stages of the study.

### Werris Creek high speed triangle (C59)

The purpose of the deviation is to provide a higher speed alignment for the Werris Creek bypass. The deviation 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 to provide 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 purpose of the deviation is to remove low speed curves and bypass the town centre of Narrabri. The deviation would consist of 10.5 km of Class 1 standard gauge.

### Moree bypass (C17b1)

The purpose of the deviation is to remove low speed curves and bypass the town centre of Moree. The deviation would consist of approximately 9 km of Class 1 standard gauge track on new alignment. The alignment crosses two major power lines and about 2 km of zoned industrial land and is generally across floodplain. There are opportunities to optimise the alignment in later stages of the study.

### Camurra deviation (C17b2)

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

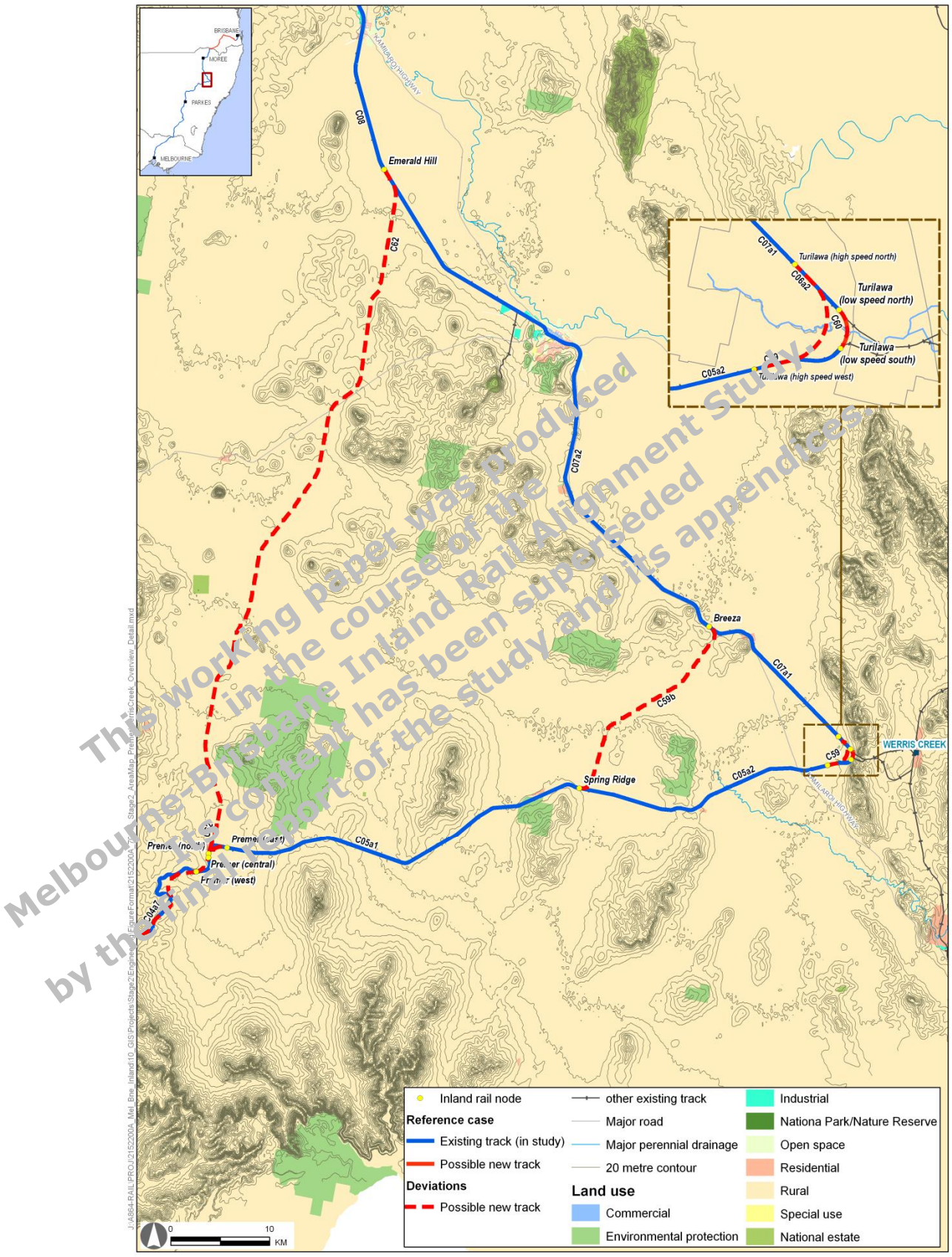




**Figure 3-11 Premer to Emerald Hill**

### 3.3.4 Moree to Brisbane

Figure 3-12 below shows the possible deviations to replace sections of the reference case between Moree and Brisbane. Figure 3-13 shows the Toowoomba area from Cecilvale and Gatton which contains the most significant deviation options for this area.

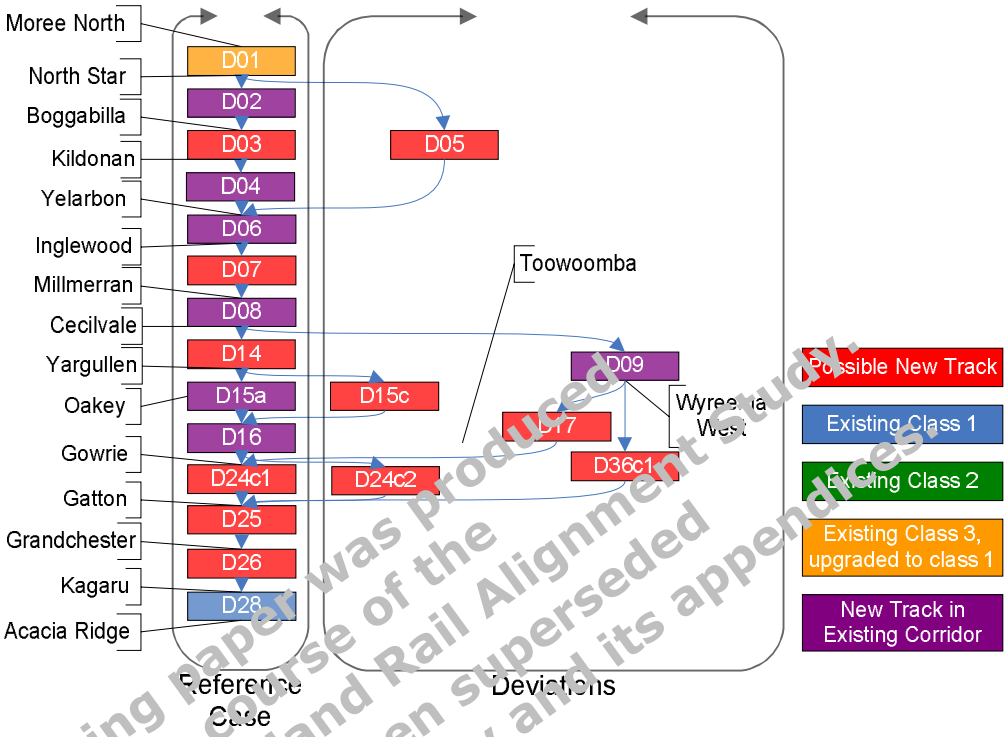


**Figure 3-12 Moree to Brisbane reference case and deviations**



#### North Star to Yelarbon (D05c) – major greenfield

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

#### Oakey bypass (D15c)

The Yargullen to Oakey section is a greenfield section. The purpose of the option is to provide a more direct route from Yargullen and Oakey. This option bypasses 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 a new standard gauge section constructed adjacent to the existing narrow gauge Millmerran to Wyreema line, which will require some slight deviations outside of the QR corridor. The new route section would consist of approximately 33 km of Class 1 standard gauge track.

The Wyreema West to Gowrie section is 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 remove low speed curves and gradients and to provide a direct route from Wyreema West to Gowrie. D09b also is required to combine with D36c1.

### 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 new track adjacent to the existing QR line between Cecilvale and Wyreema West.

By travelling 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 adjacent to the existing QR Rosewood to Toowoomba line.

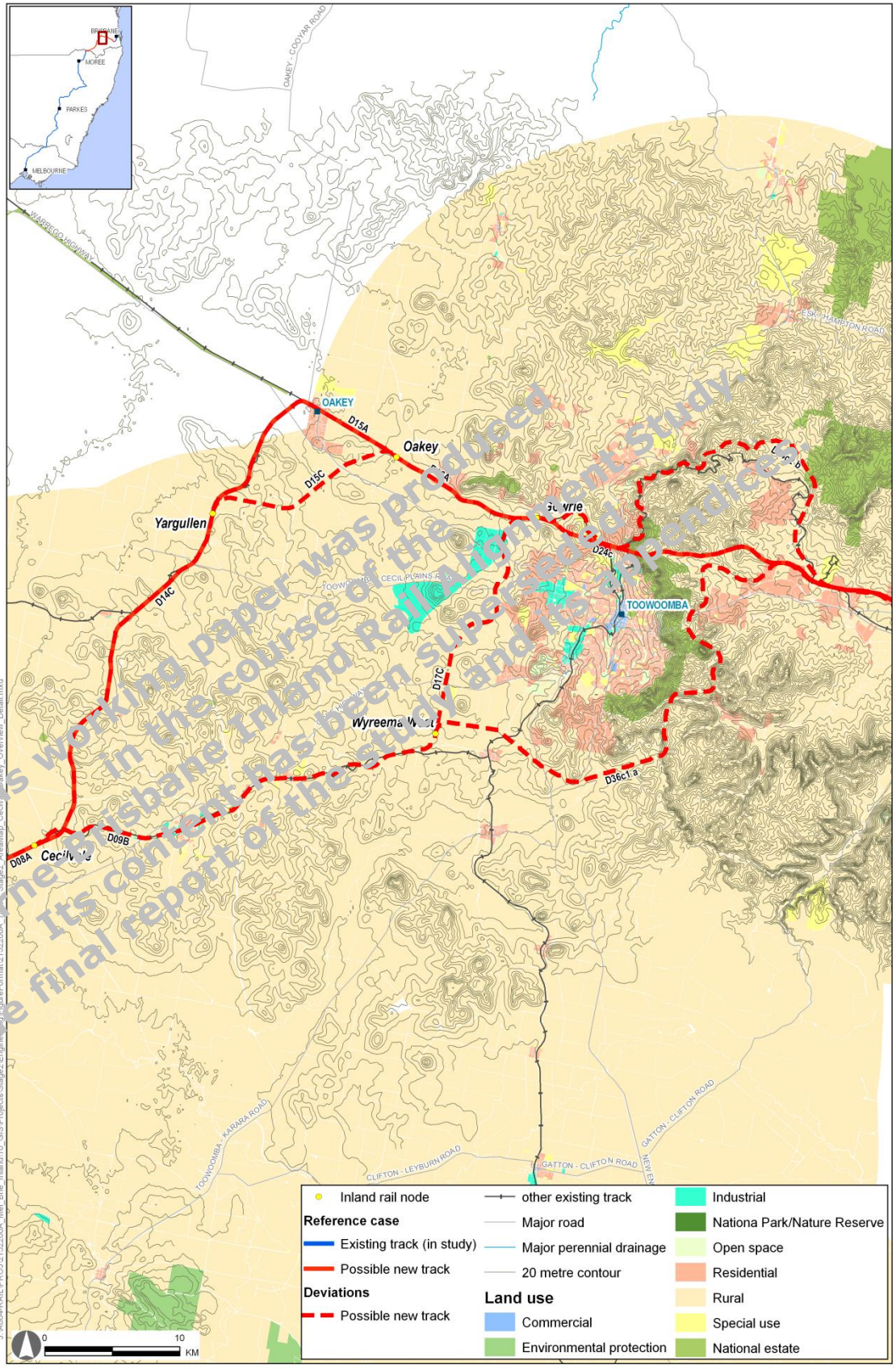




**Figure 3-13 Toowoomba area**

## 3.4 Upgrade improvements

In addition to identifying the improvements required for the reference train and expected freight traffic to use the inland railway, other improvements to existing alignments (such as track structure upgrade and bridge replacements) are possible. The upgrade from Class 2 to Class 1 can be compared in the same way as the deviations discussed in section 5 of this report. The bridge replacements that would be included in that upgrade are identified in Appendix A. It should be noted that not all bridge upgrades have been included in the journey time assessment at this stage. A review will be carried out during Stage 3.

There are two areas where the possible upgrades are applicable: Parkes to Werris Creek and Narrabri to Moree. A full list of the sections is contained in Appendix A.

# 4. Journey times

## 4.1 Introduction

The alignment options being considered during Stage 2 of the study were modelled using RailSys computer software to provide an estimate of journey times. Models were developed for:

- the reference case (comprising generally existing track from Melbourne to North Star and new alignments from North Star to Acacia Ridge);
- upgraded track structure (along the existing alignments);
- deviations (comprising new alignments along greenfield routes).

In locations where the existing railway is derelict or does not exist, greenfield alignments were considered as part of the reference case.

The journey time estimates for the reference case, upgrades and minor deviations are given in Table 4.1. Estimates for major deviations are given in Table 4.2. Minor deviations are new sections of track which potentially replace between one and three reference case sections. Major deviations replace a large number of reference case sections and also present alternatives to minor deviations.

The journey times in Tables 4.1 and 4.2 are for the reference train travelling in a northbound direction. Preliminary modelling of trains travelling in the southbound direction was also undertaken in Stage 2. Only the northbound journey times have been listed in this section as the total differences between northbound and southbound are considered (with one exception) to be minimal. The most significant differences are listed in Appendix B of this report.



**Table 4-1 Journey time estimates for reference case, upgrades and deviations**

| Reference case section | Section name | Length (km) | Journey Time Estimate - Reference case (mins) | Journey Time Estimate - Upgraded Track (mins) | Deviation Section | Length (km) | Deviation Journey time Estimate (mins) |
|---|---|---|---|---|---|---|---|
| A01 | Melbourne to Mangalore | 117 | 88 | N/A | N/A | | |
| A02 | Mangalore to Wodonga (south) | 188 | 106 | N/A | N/A | | |
| A03a | Wodonga deviation | 5 | 4 | N/A | N/A | | |
| A04 | Wodonga (north) to Junee | 163 | 106 | N/A | N/A | | |
| B01 | Junee to Junee (east) | 4 | 3.5 | N/A | N/A | | |
| B02a1 | Junee (east) to Illabo | 15 | 8.25 | N/A | N/A | | |
| B02a2 | Illabo to Bethungra (south) | 11 | 8 | N/A | N/A | | |
| B03 | Bethungra (south) to Bethungra (north) | 8 | 9.25 | N/A | B03a | 8 | 9 |
| B04 | Bethungra (north) to Frampton (south) | 4 | 2.5 | N/A | N/A | | |

| Reference case section | Section name | Length (km) | Journey Time Estimate - Reference case (mins) | Journey Time Estimate - Upgraded Track (mins) | Deviation Section | Length (km) | Deviation Journey time Estimate (mins) |
|---|---|---|---|---|---|---|---|
| B05 | Frampton (south) to Frampton (north) | 8 | 6.5 | N/A | B05a | 5 | 6 |
| B07 | Frampton (north) to Cootamundra (south) | 6 | 4 | N/A | B07a | 5 | 3 |
| B08 | Cootamundra (south) to Bauloora | 9 | 12.5 | N/A | N/A | | |
| B10 | Bauloora to Yeo Yeo (south) | 10 | 8 | N/A | N/A | | |
| B11 | Yeo Yeo (south) to Yeo Yeo (north) | 4 | 2.75 | N/A | B11a | 3 | 1.5 |
| B12 | Yeo Yeo (north) to Stockinbingal | 8 | 6.75 | N/A | N/A | | |
| B15 | Stockinbingal to Stockinbingal (north) | 1 | 1 | N/A | N/A | | |
| B16 | Stockinbingal (north) to Maleeja | 8 | 5.5 | N/A | N/A | | |
| B18 | Maleeja to Parkes (south) | 99 | 96.75 | N/A | N/A | | |
| B19 | Parkes (south) to Parkes (north) | 6 | 7.25 | N/A | B19a | 5 | 4.5 |
| B20a1 | Parkes (north) to Narromine (south) | 100 | 84 | 81.75 | N/A | | |
| B20a2 | Narromine (south) to Narromine | 6 | 5.5 | 5 | C70 | 12 | 6.5 |
| C01a1 | Narromine to Narromine (east) | 8 | 10.25 | 10 | | | |
| C01a2 | Narromine (east) to Dubbo (west) | 24 | 20.25 | 16.5 | N/A | | |
| C02 | Dubbo (west) to Dubbo (north east) | 12 | 13 | 12.5 | C57 | 10 | 5.5 |
| C03a1 | Dubbo (north east) to Barbigal (west) | 15 | 12 | 9.5 | N/A | | |
| C03a2 | Barbigal (west) to Barbigal (east) | 6 | 5 | 4.5 | C03b1 | 6 | 3.25 |
| C03a3 | Barbigal (east) to Muronbung (south) | 12 | 10.75 | 9.75 | N/A | | |
| C03a4 | Muronbung (south) to Muronbung (north) | 9 | 8 | 7.75 | C03b2 | 8 | 5 |
| C03a5 | Muronbung (north) to Boomley (south) | 12 | 9.5 | 8.25 | N/A | | |
| C03a6 | Boomley (south) to Boomley (north) | 27 | 26.25 | 25 | C03b3 | 26 | 19.5 |
| C03a7 | Boomley (north) to Merrygoen (south) | 5 | 3.75 | 3.75 | N/A | | |
| C03a8 | Merrygoen (south) to Merrygoen (north) | 13 | 13 | 12.5 | C03b4 | 9 | 5 |
| C03a9 | Merrygoen (north) to Toogarlan (south) | 4 | 3.25 | 3 | N/A | | |
| C03a10 | Toogarlan (south) to Toogarlan (north) | 7 | 6.5 | 6 | C03b5 | 6 | 4 |

| Reference case section | Section name | Length (km) | Journey Time Estimate - Reference case (mins) | Journey Time Estimate - Upgraded Track (mins) | Deviation Section | Length (km) | Deviation Journey time Estimate (mins) |
|---|---|---|---|---|---|---|---|
| C03a11 | Toogarlan (north) to Piambra (south) | 13 | 10 | 8.25 | N/A | | |
| C03a12 | Piambra (south) to Piambra (north) | 2 | 1.5 | 1.25 | C03b6 | 2 | 1 |
| C03a13 | Piambra (north) to Binnaway | 4 | 3.5 | 3.5 | N/A | | |
| C04b1 | Binnaway to Binnaway (east) | 4 | 3.25 | 3.25 | N/A | | |
| C04a4 | Binnaway (east) to Ulinda deviation (north) | 4 | 3.75 | 3.75 | N/A | | |
| C04a5 | Ulinda (north) to Ulinda (south) | 5 | 3.75 | 3.5 | C04b2 | 4 | 2.75 |
| C04a6 | Ulinda (south) to Oakey Creek | 27 | 22 | 19.25 | N/A | | |
| C04a7 | Oakey Creek to Premer (west) | 27 | 24.5 | 23.75 | C04b3 | 23 | 15.75 |
| C04a8 | Premer (west) to Premer (central) | 2 | 2.25 | | | | |
| C04a9 | Premer (central) to Premer (north) | 1 | 0.5 | 0.5 | C16b | 4 | 2.5 |
| C04a10 | Premer (north) to Premer (east) | 2 | 2 | 1.75 | | | |
| C05a1 | Premer (east) to Spring Ridge | 36 | 23.25 | 21.25 | N/A | | |
| C05a2 | Spring Ridge to Turilawa (high speed west) | 27 | 21.75 | 17 | N/A | | |
| C06a1 | Turilawa (high speed west) to Turilawa (low speed south) | 3 | 2 | 1.5 | | | |
| C60 | Turilawa (low speed south) to Turilawa (low speed north) | 1 | 0.75 | 0.75 | C59 | 5 | 4 |
| C06a2 | Turilawa (low speed north) to Turilawa (high speed north) | 2 | 1.75 | N/A | | | |
| C07a1 | Turilawa (high speed north) to Breeza | 19 | 10.75 | N/A | N/A | | |
| C07a2 | Breeza to Emerald Hill | 63 | 38 | N/A | N/A | | |
| C08 | Emerald Hill to Baan Baa | 29 | 18 | N/A | N/A | | |
| C09 | Baan Baa to Narrabri (south) | 29 | 16.5 | N/A | N/A | | |
| C10 | Narrabri (south) to Narrabri (north) | 15 | 18.5 | 18.5 | C58 | 11 | 5.75 |
| C11 | Narrabri (north) to Moree (south) | 85 | 88.5 | 52 | N/A | | |
| C17a1 | Moree (south) to Moree (east) | 4 | 3.75 | 2.25 | N/A | | |
| C17a2 | Moree (east) to Moree (north-east) | 9 | 9.25 | 7 | C17b1 | 9 | 4.75 |
| C17a3 | Moree (north-east) to Camurra (south) | 6 | 4.25 | N/A | N/A | | |
| C17a4 | Camurra (south) to Moree (north) | 5 | 5.5 | N/A | C17b2 | 3 | 1.75 |
| D01a | Moree (north) to North Star | 78 | 48.75 | N/A | N/A | | |
| D02a | North Star to Boggabilla | 26 | 15 | N/A | | | |
| D03c | Boggabilla to Kildonan | 13 | 7 | N/A | D05C | 59 | 33.25 |
| D04a | Kildonan to Yelarbon | 34 | 21 | N/A | | | |
| D06a | Yelarbon to Inglewood | 34 | 24 | N/A | N/A | | |

| Reference case section | Section name | Length (km) | Journey Time Estimate - Reference case (mins) | Journey Time Estimate - Upgraded Track (mins) | Deviation Section | Length (km) | Deviation Journey time Estimate (mins) |
|---|---|---|---|---|---|---|---|
| D07c | Inglewood to Millmerran | 74 | 47 | N/A | N/A | | |
| D08a | Millmerran to Cecilvale | 23 | 20 | N/A | N/A | | |
| D14c | Cecilvale to Yargullen | 31 | 19 | N/A | N/A | | |
| D15a | Yargullen to Oakey | 18 | 12 | N/A | D15C | 16 | 9.25 |
| D16a | Oakey to Gowrie | 12 | 14 | N/A | N/A | | |
| D24c | Gowrie to Gatton | 41 | 25 | N/A | D24c2 | 57 | 38.75 |
| D25c | Gatton to Grandchester / Rosewood | 29 | 14 | N/A | N/A | | |
| D26c | Grandchester / Rosewood to Kagaru | 56 | 35 | N/A | N/A | | |
| D28a | Kagaru to Acacia Ridge | 34 | 18 | N/A | N/A | | |

**Table 4-2 Journey time estimates for deviations bypassing multiple reference case sections**

| Deviation name | Reference case Sections | Length (km) | Journey Time Estimate Reference case (mins) | Journey Time Estimate Upgraded Track (mins) | Deviation Section | Length (km) | Deviation Journey Time Estimate( mins) |
|---|---|---|---|---|---|---|---|
| Junee to Stockinbingal | B01+ B02a1+ B02a2+ B03+ B04+ B05+ B07+ B08+ B10+ B11+ B12 | 86 | 72 | 72 | B01c & B14 | 51 | 32.75 |
| Illabo to Stockinbingal | B02a2+ B03+ B04+ B05+ B07+ B08+ B10+ B11+ B12 | 68 | 60.25 | 60.25 | B14a | 39 | 26.75 |
| Cootamundra bypass | B07+ B08 | 15 | 11.5 | 11.5 | C09 | 10 | 5.5 |
| Stockinbingal bypass | B11+ B12+ B15+ B16 | 21 | 16 | 16 | B17 | 13 | 7 |
| Piambra to Ulinda deviation | C03a13+ C04b1+ C04a4+ C04a5 | 16 | 14.25 | 14 | C03b7 | 11 | 8.5 |
| Premer to Emerald Hill | C04a10+ C05a1+ C05a2 + C06a1+ C60+ C06a2+ C07a1+ C07a2+ | 134 | 104.5 | 92 | C62 | 75 | 42.25 |
| Spring Ridge to Breeza deviation | C05a2+ C06a1+ C60+ C06a2+ C07a1 | 50 | 42.75 | 35.25 | C59b | 23 | 12.5 |
| Cecilvale to Gowrie via Wyreema West | D14C+ D15A+ D16A | 61 | 45 | 45 | D09B & D17C | 53 | 39.25 |
| Cecilvale to Gatton south of Toowoomba | D14C+ D15A+ D16A+ D24C | 101.9 | 70 | 70 | D09B & D36c1 | 94 | |



## 4.2 Operational modelling assumptions

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.

For this study, the reference train data was input using published power and resistance data for three 3,200kW AC drive diesel locomotives and a typical 40% double stacked container train, with a total length of 1,800 m. This combination was chosen using the TOC Manual power to weight requirements for a superfreighter train required over the hilly Sydney to Junee route, and resulted in the reference train achieving the same or slightly better performance than allowed for in the existing timetable for a superfreighter train on the Coastal Route, which was considered to be realistic.

The model was set to run the train 5% slower than the fastest possible performance for each section, to allow comparison with typical timetable times. An allowance of 5% is typically made for the variations in running times caused by such things as minor temporary speed restrictions and variations in driving styles, rollingstock maintenance standards, and weather conditions.

No allowance for crossing moves was made in the model in Stage 2.

Gradient and speed restriction data was obtained from various ARTC sources.

Where line speed was modelled above present maximum speeds, the curve diagrams and TOC Manual were used to identify curves and an estimate was made of the maximum achievable speed (using Table 4-3). It was assumed it would be possible to construct adequate cant transitions on the existing formation, and that a maximum cant deficiency of 80 mm is permitted.

**Table 4-3 Maximum Speeds at Curves**

| Maximum Speed Band of Curves in 100 m Increments | | | |
|---|---|---|---|
| **Speed – 70km/h** | | | |
| Radius (m) | Cant, E (mm) | Deficiency, D (mm) | Total E+D (mm) |
| 300 | 118 | 75 | 193 |
| **Speed – 80km/h** | | | |
| Radius (m) | Cant, E (mm) | Deficiency, D (mm) | Total E+D (mm) |
| 400 | 115 | 74 | 189 |
| **Speed – 90 km/h** | | | |
| Radius (m) | Cant, E (mm) | Deficiency, D (mm) | Total E+D (mm) |
| 500 | 116 | 75 | 191 |
| **Speed – 100km/h** | | | |
| Radius (m) | Cant, E (mm) | Deficiency, D (mm) | Total E+D (mm) |
| 600 | 120 | 77 | 197 |
| **Speed – 110km/h** | | | |
| Radius (m) | Cant, E (mm) | Deficiency, D (mm) | Total E+D (mm) |
| 700 | 125 | 80 | 204 |
| **Speed – 115km/h** | | | |
| Radius (m) | Cant, E (mm) | Deficiency, D (mm) | Total E+D (mm) |
| 800 | 119 | 76 | 195 |
| **Speed – 125km/h** | | | |
| Radius (m) | Cant, E (mm) | Deficiency, D (mm) | Total E+D (mm) |
| 900 | 125 | 80 | 205 |
| **Speed – 130km/h** | | | |
| Radius (m) | Cant, E (mm) | Deficiency, D (mm) | Total E+D (mm) |
| 900 | 125 | 80 | 205 |



In general, using data from the above table resulted in only small or no increases in speed at most curves when compared with existing restrictions.

During Stage 2 of the study, as lines were developed, they were modelled in isolation from each other. The accuracy of the modelling will be further improved in Stage 3 of the study when the models will be joined to create a single model for the inland rail alignment.

### 4.2.1 Reference case assumptions

For the reference case journey times, assumptions were made in building the model of the infrastructure. Existing speed restrictions, detailed in the ARTC TOC Manual for an existing train with characteristics similar to the reference train, were retained with the following six exceptions.

#### Melbourne to Cootamundra

As suggested by ARTC's *2008 – 2024 Interstate and Hunter Valley Rail Infrastructure Strategy* (2024 Strategy), it was assumed that the line will be capable of conveying the reference train at 115 km/h. It was assumed that the Bethungra Spiral will be modified by ARTC to enable double stacking. Changes to the alignment at Bethungra were modelled.

#### Cootamundra to Parkes

In line with the 2024 Strategy it was assumed that the upgrade of the line to Class 1 standards will result in a railway capable of conveying the reference train at 115 km/h.

The Lachlan River bridge near Forbes is a through-truss girder bridge with a speed restriction. It was assumed that ARTC will have replaced it with a bridge capable of carrying double stack container trains at 115 km/h. The adjacent 20 km/h level crossing speed restriction was retained as it was assumed that sighting distances were not adequate to remove the speed restriction.

#### Parkes to Turilawa

These Class 2 lines were assumed to be upgraded to convey the reference train by replacement of selected bridges (detailed in Table 3.3), which could then be used by the reference train at existing line speeds. Speed restrictions at curves were eased in line with the table above. All other speed restrictions were retained.

Using the ARTC TOC Manual for guidance, the reference train was assumed to be able to travel at a maximum speed of 80 km/h over this line.

The Macquarie River bridge at Dubbo is a through-truss girder bridge with a speed restriction. It was assumed to have been replaced by a bridge capable of carrying double stack containers. The adjacent lines through Dubbo were assumed to have been retained their 30 km/h speed restriction.

It was assumed that short bypasses are constructed at Binnaway and Werris Creek, enabling trains to travel on the inland rail route without the need to reverse.

#### Turilawa to Narrabri

In accordance with the 2024 Strategy, it was assumed that upgrading of this Class 1 line to allow the reference train to travel at 115 km/h would have taken place by the time Inland Rail is operating.

#### Narrabri to Moree

Using the ARTC TOC Manual for guidance, it was assumed that this Class 2 line will be able to convey the reference train at 80 km/h. It was assumed that the Namoi River Bridge at Narrabri, which currently has a speed restriction over it, is replaced by a bridge capable of carrying the reference train.

#### Moree to Boggabilla

It was assumed that these Class 3 and derelict lines would be upgraded and renewed to Class 1 standards, capable of carrying the reference train at 115 km/h, if the inland railway was constructed along the alignment. Speed restrictions around curves were estimated.

### 4.2.2 Upgrade case assumptions

Additions to the reference case model were made for the upgrade case journey times. The ARTC curve and gradient book was studied to identify curves and speeds allocated in Table 4-3 above. This resulted in some curves, which are unrestricted where the current maximum speed is 80km/h or 100 km/h, having speed restrictions below the new maximum of 115 km/h.

In this review eight speed restrictions were found which did not appear to be applied solely due to curves (see Table 4.4 below). Where there were curves within the existing restriction, these were used to assume a speed increase. Otherwise, these restrictions were retained. Further investigation is required to confirm the potential maximum speed and length of these restrictions.

All other areas had the speed increased from the current maximum for the reference train of 60km/h, 80km/h or 100 km/h, to 115 km/h. This assumption therefore implies that all structures are either capable of carrying the reference train at 115 km/h now, or are upgraded to allow this.

**Table 4-4 Non Curve Related Speed Restrictions**

| Approximate location | Section | Chainage | Track Length (m) | Existing Speed (km/h) | Assumed Upgrade Speed |
|---|---|---|---|---|---|
| Between Dubbo and Narromine | C01a2 | 471.800 to 471.200 | 680 | 80 | 95 |
| Boomley | C03a6 | 524.430 to 529.590 | 5,160 | 70, 65, 70 | 80, 70, 80 |
| Piambra | C03a13 | 449.440 to 449.610 | 170 | 80 | 80 |
| Premer | C04a7 | 524.385 to 525.881 | 1,469 | 80 | 90 |
| Caroona | C05 | 581.402 to 583.196 | 1,794 | 80 | 85 |
| Emerald Hill | C07 | 493.025 to 494.638 | 1,613 | 80 | 80 |
| Narrabri South Junction | C10 | 564.600 to 564.680 | 80 | 80 | 80 |
| Narrabri | C10 | 568.713 to 568.860 | 147 | 50 | 50 |



#### Parkes to Turilawa

These Class 2 lines were assumed to be upgraded to convey the reference train by replacement of the same selected bridges upgraded in the reference case, which could then be used by the reference train at 115 km/h. Speed restrictions around curves were estimated.

#### Narrabri to Moree

It was assumed that this Class 2 line would be upgraded to Class 1 standards, capable of carrying the reference train at 115 km/h, if the inland railway was constructed along the alignment.

## 4.3 Summary

The modelling during Stage 2 has estimated the total journey time between Melbourne and Brisbane for the reference train to travel along the reference case alignment to be:

- 23 hours, 2 minutes; to which would be added time for crossing trains and other operational requirements, totalling between 4 and 6 hours

This reference case assumes essential infrastructure is constructed to remove the need for reversals at Binnaway and Werris Creek, to upgrade bridges which currently impose significant speed restrictions on the existing railway, and to provide new alignments in Queensland via Boggabilla, Kildonan, Yelarbon, Inglewood, Millmerran, Cecilvale, Yargullen, Oakey, Gowrie, Gatton, Grandchester/Rosewood and Kagaru.

Modelling has also estimated the journey times for the reference case alignment with the track upgraded at various locations to Class 1 standard:

- 21 hours, 31 minutes; to which would be added time for crossing trains and other operational requirements, totalling between 4 and 6 hours

It is important to note that the modeling work undertaken in Stage 2 is an improvement in accuracy from Stage 1 and further study of train movements and timetables is required in Stage 3 to improve the confidence of the total journey times, especially the additional time for crossing delays and other operational requirements.

To put the assessment of options into perspective, the estimated total journey time savings for the quickest alignment using the sections presented in this working paper is:

- 1 hour, 11 minutes saving by upgrading the existing alignments to a Class 1 standard on sections between Parkes and Bremer (B20a1, C01a2, C03a1, C03a3, C03a5, C03a9, C03a11, C04a6), Narrabri and Moree (C11, C17a1 andC17a3);
- 3 hours, 15 minutes saving from the deviations along the route (B01c, B14, B19a, C70, C57, C03b1, C03b2, C03b3, C03b4, C03b5, C03b6, C03b7, C04b3, C62, C58, C17b1, C17b2, D05C, D09B and D17C);

The modelling has therefore estimated the total journey time between Melbourne and Brisbane for this fastest Stage 2 option[1] to be:

- 18 hours, 36 minutes in the northbound direction; to which would be added time for crossing trains and other operational requirements, totalling between 4 and 6 hours.



[1] Stage 1 considered faster options that were not progressed to Stage 2 due to high capital cost; refer to Working Paper No.5 for the detailed analysis.

# 5. Evaluation of options

## 5.1 Introduction

The purpose of this section is to evaluate the options for journey time improvements presented in section 3. The criteria used for the analysis are environmental factors, capital cost and journey time saving. Other factors such as additional benefits to other railway corridors was considered but not analysed in detail.

This analysis will be used to determine the route to be taken forward for further examination in Stage 3 of this study based upon a journey time requirement of 27 hours. Further economic and financial analysis will be undertaken in Working Paper No. 12 (Stage 2 Economic and Financial Analysis) and in Stage 3 of this study to determine the final alignment and operating delays for the railway.



## 5.2 Environment and land use

In Stage 2 of the study preliminary environmental assessment was conducted for the route options. This assessment in presented in Working Paper No. 7. A preliminary land assessment was also conducted and is presented in Working Paper No. 8. A summary of the results from these working papers is contained in Appendix D.

The assessments found that, whilst some of the deviations are considered preferable to the reference case (predominantly town bypasses), there are 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;
- Muronbong deviation (C03b2) – the deviation would cause endangered ecological species to be fragmented;
- Boomley deviation (C03b3) – the deviation is adjacent to the Goonoo Stage forest and would impact upon endangered ecological communities and threatened species;
- Cecilvale to Gowrie via Wyreema West (D09b & D17c) – this section passes 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.

## 5.3 Capital works costings

Capital works cost estimates were prepared for each reference case, upgrade and deviation option. The details of these estimates can be found in Working Paper No. 11 (Stage 2 Capital Works Costings). Costs were estimated using the following:

- reference case definition in section 3.2,
- upgrade criteria in section 3.4,
- greenfield track using preliminary designs and Working Paper No.6 – Design Standards.

The costs have been used in the analysis below and are contained in Appendix C.

## 5.4 Journey time

A total journey time requirement of 27 hours has been specified for Inland Rail. This journey time comprises running time and delays for crossing and refueling. During Stage 2 of this study, it has been assumed that the delays will be 6 hours[2], further modelling and timetable planning in Stage 3 will consider this delay and determine the cost effectiveness of adding additional loops to reduce journey time in place of building deviations.

When selecting the deviations and upgrades for further analysis in Stage 3, an extra 45 minute contingency was included to allow for the estimating inaccuracy.

Hence, reducing the total journey time of 27 hours by the six hours and 45 minutes gives an in-motion travel time requirement of 20 hours and 15 minutes. The reference case travel time in section 4.3 is 23 hours and 2 minutes, therefore a short-list of options saving 2 hours and 47 minutes of travel time was selected to investigate further in Stage 3.



## 5.5 Analysis

Capital cost and journey time are used in the analysis to differentiate the options. Incremental cost is used in the analysis, that is, the capital cost of the deviation (or upgrade) minus the cost of the reference case alternative.

The following table ranks the deviations and upgrades in order of incremental cost for each minute of journey time saved. The options with the lowest capital cost per minute saved were considered the most economic options. Sections that are highlighted green have been excluded for the environmental reasons described above. The negative incremental cost for D05C and D15C indicate that the capital cost of the deviation is estimated to be less than the cost of the reference case. As there is no existing route in this area the reference case was assumed to be the route within the existing corridor wherever possible.

The table below contains only the more economic options, the complete table is contained in Appendix C along with the complete analysis of journey times, lengths and capital costs.

[2] Refer to Working Paper No. 2, Review of Route Options, for the derivation of this figure.

**Table 5-1 Cost per minute saved**

| Journey time improvement | Section Name | Reference case alternative | Journey time saving (minutes) | Cost ($), (deviation/ upgrade - reference case) | Cost per minute saved |
|---|---|---|---|---|---|
| D15C | Oakey bypass | D15A | 2.75 | -$89,840,400 | -$32,669,236 |
| D05C | North Star to Yelarbon | D02+ D03+ D04 | 9.75 | -$18,322,100 | -$1,879,190 |
| C58 | Narrabri bypass | C10 | 12.75 | $26,862,400 | $2,106,855 |
| C70 | Narromine bypass | B20a2+ C01a1 | 9.25 | $24,006,700 | $2,595,319 |
| Upgrade | Narrabri (north) to Moree (south) | C11 | 36.5 | $112,048,900 | $3,069,833 |
| B17 | Stockinbingal bypass | B11+ B12+ B15+ B16 | 9 | $31,296,800 | $3,477,422 |
| Upgrade | Moree (south) to Moree (east) | C17a1 | 1.5 | $5,563,400 | $3,708,933 |
| C59b | Spring Ridge to Breeza | C05a2+ C06a1+ C60+ C06a2+ C07a1 | 24.5 | $92,200,200 | $3,763,273 |
| B01c & B14 | Junee to Stockinbingal | B01+ B02a1+ B02a2+ B03+ B04+ B05+ B07+ B08+ B10+ B11+ B12 | 39.25 | $150,421,800 | $3,832,403 |
| C03b7 | Piambra to Ulinda deviation | C03a13+ C04b1+ C04a4+ C04a5 | 5.75 | $22,405,300 | $3,896,574 |
| B14a | Illabo to Stockinbingal | B02a2+ B03+ B04+ B05+ B07+ B09+ B10+ B11+ B12 | 33.5 | $139,835,100 | $4,169,704 |
| C03b4 | Merrygoen deviation | C03a8 | 8 | $34,346,500 | $4,293,313 |
| C57 | Dubbo bypass | C02 | 7.5 | $32,226,400 | $4,296,853 |
| C17b2 | Camurra deviation | C17a4 | 3.75 | $19,380,500 | $5,168,133 |
| C62 | Premer to Emerald Hill | C04a10+ C05a2+ C05a3+ C06a1+ C09+ C06a2+ C07a1+ C07a2 | 62.25 | $374,276,800 | $6,012,479 |
| B19a | Parkes bypass | B19 | 2.75 | $18,467,100 | $6,715,309 |
| D09B & D17C | Coolvale to Gowrie via Wyreema West | D14C+ D15C[3]+ D16A | 3 | $21,737,300 | $7,245,767 |
| Upgrade | Dubbo (north east) to Baribgal (west) | C03a1 | 2.5 | $18,988,000 | $7,595,200 |
| Upgrade | Parkes (north) to Narromine (south) | B20a1 | 19.25 | $149,794,300 | $7,781,522 |
| C04b3 | Oakey Creek to Premer deviation | C04a7 | 8.75 | $77,318,400 | $8,836,389 |
| C03b3 | Boomley deviation | C03a6 | 6.75 | $60,037,900 | $8,894,504 |
| Upgrade | Premer (west) to Premer (central) | C04a8 | 0.25 | $2,455,900 | $9,823,600 |
| Upgrade | Narromine (east) to Dubbo (west) | C01a2 | 3.75 | $38,533,200 | $10,275,520 |



## 5.6 Explanation of results

The options highlighted yellow above give a journey time reduction of 2 hours and 57.5 minutes, which reduce the total journey time to the specified 27 hours.

The short-listed options were found to be cost effective for the following reasons.

### 5.6.1 Reduction in distance

Deviations that are considerably shorter than the reference case significantly reduce the journey time. Deviations that achieve this are:

- Illabo to Stockinbingal (B14a);

[3] For the purposes of this comparative analysis, D15A has been replaced in the reference case by D15C as D15C was found to be less expensive and quicker than D15A and thus gives a more accurate comparison.

- Parkes bypass (B19a);
- Merrygoen deviation (C03b4);
- Narromine bypass (C70);
- Spring Ridge to Breeza (C59b); and
- Camurra deviation (C17b2).

### 5.6.2 Avoiding reference case costs

By avoiding a high cost on the reference case a deviation has an improved incremental cost. Deviations which avoid a high cost on the reference case alignment are:

- Dubbo bypass (C57) as the reference case assumes significant cost to replace the Macquarie River Bridge;
- Piambra to Ulinda deviation (C03b7) as the reference case includes new track to eliminate the reversal at Binnaway (C04b1). This option also reduces the length of the reference alignment by about 5 km;
- Narrabri bypass (C58) as the reference case (C10) assumes the Namoi River Bridge and the Narrabri Bridge will be upgraded;
- North Star to Yelarbon (D03C) as the reference case requires rebuilding of the derelict North Star to Boggabilla (D02a) section, a new section with a large bridge crossing the border (D03c) and a new standard gauge section within the existing narrow gauge corridor between Kildonan and Yelarbon (D04a);
- Oakey bypass (D15C) which is cheaper than the reference case (D15A).

### 5.6.3 Upgrades

Upgrading from Class 2 to Class 1 will increase the line speed for the reference train and therefore reduce the journey time.

Options where the upgrade was found to be cost effective are:

- between Parkes (north) and Narromine (south) (B20a1) – where the existing track is straight and flat so the reference train can realize the benefits of the increased line speed;
- between Narrabri (north) and Moree (south) (C11) and Moree (south) to Moree (east) (C17a1) – where the existing is relatively straight and flat and the reference train has a current speed restriction of 60 km/h.

### 5.6.4 Options not selected

#### Junee to Stockinbingal versus Illabo to Stockinbingal (B01c + B14 vs B14a)

These two greenfield alignments achieve the same purpose; providing a more direct route, bypassing the tight curves and steep grades in the Bethungra area. The journey time and capital expenditure estimates for the two alignments are proportional. Environment and land factors were used to differentiate between the two options, Illabo to Stockinbingal (B14a) aligns more closely with the property boundaries and uses more of the existing corridor, it is considered to provide fewer land impacts and lower acquisition costs. Therefore Illabo to Stockinbingal was chosen in preference to Junee to Stockinbingal (B01c + B14).

### Parallel options

Some options were cost effective when considered in isolation, but are located in parallel to other more favourable options. Therefore Junee to Stockinbingal (B01C+B14), Stockinbingal bypass (B17) and Premer to Emerald Hill (C62) will not be considered in Stage 3.

### High construction costs

The analysis showed many of the options to be less favourable due to significant capital expenditure being required for tunnels, deep cuttings, large embankments (in hilly terrain) and significant structures.

### Upgrades and curve easing

On sections where the existing track is undulating and winding between Narromine and Werris Creek upgrading the track to increase the line speed of the reference train from 80 km/h to 115 km/h does not give a significant reduction in journey time as the curves and grades still constrain the speed of the train. A number of deviations were considered in Stage 2 to eliminate the low speed curves. However due to the minimal journey time improvement and relatively high construction costs they did not prove to be cost effective solutions.

# Appendix A

# Bridge works for Class 2 and Class 3 track upgrades

It has been assumed at this stage that all bridges will be replaced as part of the track upgrades. Once bridge capacity information is provided we will review this assumption during Stage 3 and some existing bridges may be adequate and can remain.

The sections that could be upgraded from Class 2 to Class 1 are listed in Table A-1. The bridges on those sections that may require upgrading are included in Table A-2. The bridges on the existing Class 3 track which are likely to require upgrading are contained in Table A-3.

**Table A-1 Possible sections for Upgrade from Class 2 to Class 1**

| Section | Description |
|---|---|
| B20a1 | Parkes (north) to Narromine (south) |
| B20a2 | Narromine (south) to Narromine |
| C01a1 | Narromine to Narromine (east) |
| C01a2 | Narromine (east) to Dubbo (west) |
| C02 | Dubbo (west) to Dubbo (north east) |
| C03a1 | Dubbo (north east) to Barbigal (west) |
| C03a2 | Barbigal (west) to Barbigal (east) |
| C03a3 | Barbigal (east) to Muronbung (south) |
| C03a4 | Muronbung (south) to Muronbung (north) |
| C03a5 | Muronbung (north) to Boomley (south) |
| C03a6 | Boomley (south) to Boomley (north) |
| C03a7 | Boomley (north) to Merrygoen (south) |
| C03a8 | Merrygoen (south) to Merrygoen (north) |
| C03a9 | Merrygoen (north) to Toogarlan (south) |
| C03a10 | Toogarlan (south) to Toogarlan (north) |
| C03a11 | Toogarlan (north) to Piambra (south) |
| C03a12 | Piambra (south) to Piambra (north) |
| C03a13 | Piambra (north) to Binnaway |
| C04a4 | Binnaway (east) to Ulinda (north) |
| C04a5 | Ulinda (north) to Ulinda (south) |
| C04a6 | Ulinda (south) to Oakey Creek |
| C04a7 | Oakey Creek to Premer (west) |
| C04a8 | Premer (west) to Premer (central) |
| C04a9 | Premer (central) to Premer (north) |
| C04a10 | Premer (north) to Premer (east) |
| C05a1 | Premer (east) to Spring Ridge |
| C05a2 | Spring Ridge to Turilawa (high speed west) |
| C06a1 | Turilawa (high speed west) to Turilawa (low speed south) |
| C11 | Narrabri (north) to Moree (south) |
| C17a1 | Moree (south) to Moree (east) |

**Table A-2 Possible Bridge Upgrade works – Existing Class 2 track**

| Section | Location | Structures Upgrade Summary | Proposed Bridge Type (refer to WP No. 11) |
|---|---|---|---|
| B20a1 | 453.403 | Goobang Jct Underbridge | Type 6 Culvert |
| B20a1 | 454.844 | Goobang Jct Underbridge | Type 3 |
| B20a1 | 455.228 | Goobang Jct Underbridge | Type 3 |
| B20a1 | 460.698 | Goonumbla Underbridge | Type 6 Culvert |
| B20a1 | 461.157 | Goonumbla Underbridge | Type 3 |
| B20a1 | 468.176 | Goonumbla Underbridge | Type 6 Culvert |
| B20a1 | 468.565 | Goonumbla Underbridge | Type 3 |
| B20a1 | 478.262 | Mickibri Underbridge | Type 3 |
| B20a1 | 484.829 | Mickibri Underbridge | Type 6 Culvert |
| B20a1 | 498.870 | Peak Hill Underbridge | Type 6 Culvert |
| B20a1 | 503.599 | Peak Hill Underbridge | Type 3 |
| B20a1 | 505.502 | Peak Hill Underbridge | Type 3 |
| B20a1 | 507.025 | Peak Hill Underbridge | Type 6 Culvert |
| B20a1 | 509.640 | Peak Hill Underbridge | Type 6 Culvert |
| B20a1 | 513.624 | Tomingley West Underbridge | Type 6 Culvert |
| B20a1 | 515.011 | Tomingley West Underbridge | Type 3 |
| B20a1 | 516.601 | Tomingley West Underbridge | Type 6 Culvert |
| B20a1 | 519.224 | Tomingley West Underbridge | Type 3 |
| B20a1 | 523.540 | Wyanga Underbridge | Type 6 Culvert |
| B20a1 | 528.608 | Wyanga Underbridge | Type 6 Culvert |
| B20a1 | 529.274 | Wyanga Underbridge | Type 6 Culvert |
| B20a1 | 529.768 | Wyanga Underbridge | Type 3 |
| B20a1 | 546.542 | Narwonah Underbridge | Type 3 |
| B20a1 | 547.559 | Narwonah Underbridge | Type 6 Culvert |
| B20a1 | 547.739 | Narwonah Underbridge | Type 6 Culvert |
| B20a1 | 547.841 | Narwonah Underbridge | Type 6 Culvert |
| B20a1 | 548.064 | Narwonah Underbridge | Type 6 Culvert |
| B20a2 | 552.631 | Narromine Cowl Underbridge | Type 3 |
| B20a2 | 556.478 | Narromine Silo Rd Underbridge | Type 6 Culvert |
| C01a1 | 469.936 | Minore Underbridge | Type 6 Culvert |
| C01a1 | 471.417 | Whylandra Ck (No.2) & Delroy St(No.3 Spa | Type 3 |
| C01a2 | 483.770 | Brummagen Ck | Type 3 |
| C01a2 | 485.278 | Minore Creek Underbridge | Type 3 |
| C01a2 | 462.988 | Macquarie River & Viaducts | Type 3 |
| C01a2 | 468.319 | Sandy Creek | Type 3 |
| C03a1 | 469.465 | Troy Jct Underbridge | Type 6 Culvert |
| C03a1 | 471.848 | Troy Jct Underbridge | Type 3 |

| Section | Location | Structures Upgrade Summary | Proposed Bridge Type (refer to WP No. 11) |
|---|---|---|---|
| C03a1 | 480.507 | Beni Beni Creek Underbridge | Type 3 |
| C03a2 | 485.336 | Beni Plain Creek Underbridge | Type 3 |
| C03a3 | 491.216 | Ballimore Mitchell Creek Underbridge | Type 3 |
| C03a3 | 493.198 | Ballimore Underbridge | Type 3 |
| C03a3 | 496.813 | Ballimore Creek Underbridge | Type 3 |
| C03a3 | 502.374 | Muronbung Underbridge | Type 6 Culvert |
| C03a4 | 504.174 | Spicers Creek Underbridge | Type 3 |
| C03a4 | 509.099 | Baragonumble Creek Underbridge | Type 3 |
| C03a5 | 515.710 | Elong Elong Underbridge | Type 3 |
| C03a5 | 517.974 | Talbragar River Underbridge | Type 3 |
| C03a6 | 523.915 | Elong Elong Underbridge | Type 3 |
| C03a6 | 524.087 | Elong Elong Underbridge | Type 3 |
| C03a6 | 525.186 | Elong Elong Underbridge | Type 3 |
| C03a6 | 526.975 | Elong Elong Underbridge | Type 3 |
| C03a6 | 549.077 | Elong Elong Underbridge | Type 3 |
| C03a7 | 553.414 | Mendooran Merrygoen Creek Underbridge | Type 3 |
| C03a8 | 418.900 | Merrygoen Underbridge | Type 6 Culvert |
| C03a8 | 424.112 | Merrygoen Underbridge | Type 3 |
| C03a10 | 430.476 | Toogalan Creek Underbridge | Type 3 |
| C03a11 | 436.573 | Neilrex Underbridge | Type 3 |
| C03a11 | 440.617 | Neilrex Underbridge | Type 6 Culvert |
| C03a11 | 443.293 | Piambra Underbridge | Type 6 Culvert |
| C03a12 | 449.431 | Piambra Underbridge | Type 3 |
| C03a13 | 453.505 | Ulindah Creek Underbridge | Type 3 |
| C04a1 | 456.012 | Binnaway Creek Underbridge | Type 3 |
| C04a3 | 462.039 | Binnaway Underbridge | Type 3 |
| C04a5 | 470.218 | Ulindah Creek Underbridge | Type 3 |
| C04a6 | 482.351 | Weetaliba Underbridge | Type 3 |
| C04a6 | 483.277 | Weetaliba Underbridge | Type 3 |
| C04a6 | 484.060 | Weetaliba Underbridge | Type 3 |
| C04a6 | 485.331 | Weetaliba Underbridge | Type 3 |
| C04a6 | 496.033 | Oakey Creek Underbridge | Type 3 |
| C05a1 | 529.736 | Premer Underbridge | Type 3 |
| C05a1 | 529.917 | Cox's Creek Underbridge | Type 3 |
| C05a1 | 530.997 | Premer Underbridge | Type 3 |
| C05a1 | 531.466 | Premer Underbridge | Type 3 |
| C05a1 | 531.888 | Premer Underbridge | Type 3 |
| C05a1 | 532.250 | Premer Underbridge | Type 3 |
| C05a1 | 533.739 | Premer Underbridge | Type 6 Culvert |

| Section | Location | Structures Upgrade Summary | Proposed Bridge Type (refer to WP No. 11) |
|---|---|---|---|
| C05a1 | 535.811 | Yannergee Underbridge | Type 6 Culvert |
| C05a1 | 538.547 | Yannergee Underbridge | Type 3 |
| C05a1 | 539.734 | Underbridge | Type 6 Culvert |
| C05a1 | 565.023 | Underbridge | Type 6 Culvert |
| C05a1 | 529.736 | Premer - underbridge | Type 3 |
| C05a2 | 583.146 | Caroona - underbridge | Type 3 |
| C05a2 | 584.856 | Underbridge | Type 3 |
| C10 | 569.930 | Narrabri - underbridge | Type 3 |
| C10 | 571.605 | Narrabri – Mulgate Creek - underbridge | Type 3 |
| C11 | 581.180 | Narrabri - underbridge | Type 6 Culvert |
| C11 | 582.605 | Edgeroi – Spring Creek - underbridge | Type 3 |
| C11 | 586.200 | Edgeroi - Bobbiwaa Creek - underbridge | Type 3 |
| C11 | 589.300 | Edgeroi Underbridge - underbridge | Type 6 Culvert |
| C11 | 599.445 | Edgeroi Underbridge - underbridge | Type 6 Culvert |
| C11 | 600.500 | Edgeroi – Ten Mile Creek - underbridge | Type 3 |
| C11 | 620.610 | Berata - Jockey Creek - underbridge | Type 6 Culvert |
| C11 | 631.085 | Gurley Underbridge - underbridge | Type 6 Culvert |
| C11 | 641.540 | Gurley - Courallie Creek - underbridge | Type 3 |
| C11 | 647.095 | Gurley Underbridge - underbridge | Type 6 Culvert |
| C11 | 648.320 | Gurley - underbridge | Type 6 Culvert |
| C11 | 649.520 | Gurley - underbridge | Type 6 Culvert |
| C11 | 653.620 | Moree - underbridge | Type 6 Culvert |

**Table A-3 Possible Bridge Upgrade works – Existing Class 3 track**

| Section | Location | Structures Upgrade Summary | Proposed Bridge Type |
|---|---|---|---|
| C17a2 | 666.340 | Moree Underbridge - underbridge | Type 3 |
| C17a2 | 666.341 | Moree - underbridge | Type 3 |
| C17a2 | 666.645 | Moree - underbridge | Type 3 |
| C17a2 | 666.945 | Moree - underbridge | Type 3 |
| C17a2 | 667.210 | Moree - underbridge | Type 3 |
| C17a2 | 667.370 | Moree - underbridge | Type 3 |
| C17a2 | 667.945 | Moree - underbridge | Type 3 |
| C17a2 | 668.720 | Moree - underbridge | Type 6 Culvert |
| C17a4 | 676.220 | Camurra - Gwydir River - underbridge | Type 3 |
| C17a4 | 676.221 | Camurra Underbridge - underbridge | Type 3 |
| C17a4 | 680.615 | Camurra Underbridge | Type 3 |
| D01a4 | 690.830 | Camurra Underbridge | Type 6 Culvert |
| D01a | 691.025 | Camurra Underbridge | Type 3 |
| D01a | 696.990 | Milguy Underbridge | Type 3 |
| D01a | 706.250 | Milguy Underbridge | Type 6 Culvert |
| D01a | 708.445 | Milguy Underbridge | Type 6 Culvert |

| Section | Location | Structures Upgrade Summary | Proposed Bridge Type |
|---|---|---|---|
| D01a | 711.620 | Milguy Underbridge | Type 3 |
| D01a | 714.820 | Crooble Underbridge | Type 6 Culvert |
| D01a | 716.850 | Crooble Underbridge | Type 6 Culvert |
| D01a | 721.030 | Crooble Underbridge | Type 3 |
| D01a | 723.875 | Crooble Underbridge | Type 6 Culvert |
| D01a | 725.275 | Crooble Underbridge | Type 6 Culvert |
| D01a | 734.945 | Croppa Creek Underbridge | Type 6 Culvert |
| D01a | 735.115 | Croppa Creek Underbridge | Type 6 Culvert |
| D01a | 736.210 | Croppa Creek Underbridge | Type 3 |
| D01a | 737.555 | Croppa Creek Underbridge | Type 3 |
| D01a | 740.665 | Croppa Creek Underbridge | Type 3 |
| D01a | 741.345 | Croppa Creek Underbridge | Type 3 |
| D01a | 742.240 | Croppa Creek Underbridge | Type 3 |
| D01a | 742.690 | Croppa Creek Underbridge | Type 3 |
| D01a | 744.555 | Croppa Creek Underbridge | Type 3 |
| D01a | 750.965 | North Star Underbridge | Type 6 Culvert |

# Appendix B

# Southbound journey time details

**Table B-1 Southbound journey time estimates**

| Section Name | Reference case Section | Length (km) | Northbound Journey Time Estimate - Reference case (mins) | Southbound Journey Time Estimate - Reference case (mins) | Northbound Journey Time Estimate - Upgraded Track (mins) | Southbound Journey Time Estimate - Upgraded Track (mins) |
|---|---|---|---|---|---|---|
| Melbourne to Mangalore | A01 | 117 | 88 | 77 | 88 | 77 |
| Wodonga (north) to Junee | A04 | 163 | 106 | 97 | 106 | 97 |
| Junee (east) to Illabo | B02a1 | 15 | 8.25 | 11 | 8.25 | 11 |
| Illabo to Bethungra (south) | B02a2 | 11 | 8 | 6 | 8 | 6 |
| Bethungra (south) to Bethungra (north) | B03 | 8 | 9.25 | 6 | 9.25 | 6 |
| Cootamundra (south) to Bauloora | B08 | 9 | 12.5 | 10 | 12.5 | 10 |
| Narromine (south) to Narromine | B20a2 | 6 | 5.5 | 8.75 | 5 | 8.5 |
| Narromine to Narromine (east) | C01a1 | 8 | 10.25 | 6.75 | 10 | 5 |
| Narrabri (south) to Narrabri (north) | C10 | 15 | 18.5 | 23.75 | 18.5 | 23 |
| Moree (north) to North Star | D01A | 78 | 48.75 | 46.5 | 48.75 | 46.5 |
| Yelarbon to Inglewood | D06A | 34 | 24 | 20 | 24 | 20 |
| Oakey to Gowrie | D16A | 12 | 14 | 11 | 14 | 11 |
| Gowrie to Gatton | D24C | 41 | 25 | 47 | 25 | 47 |
| Gowrie to Gatton low speed | D24c2 | 57 | 38.75 | 57.25 | 38.75 | 57.25 |



The different journey times in the northbound and southbound directions are generally due to gradients and speed restrictions at critical locations (such as at the bottom of gradients).

There is a large difference between the northbound and southbound journey times for sections D24C and D24C2. It is assumed that this difference will be considered and managed during the timetable planning in Stage 3 of the study.

# Appendix C

# Analysis of cost per minute saved

**Table C–1 Cost per minute saved (complete)**

| Journey time improvement | Section Name | Reference case alternative | Journey time saving (minutes) | Incremental cost ($) | Cost per minute saved |
|---|---|---|---|---|---|
| D15C | Oakey bypass | D15A | 2.75 | -$89,840,400 | -$32,669,236 |
| D05C | North Star to Yelarbon | D02+ D03+ D04 | 9.75 | -$18,322,100 | -$1,879,190 |
| C58 | Narrabri bypass | C10 | 12.75 | $26,862,400 | $2,106,855 |
| C70 | Narromine bypass | B20a2+ C01a1 | 9.25 | $24,006,700 | $2,595,319 |
| Upgrade | Narrabri (north) to Moree (south) | C11 | 36.5 | $112,048,900 | $3,069,833 |
| B17 | Stockinbingal bypass | B11+ B12+ B15+ B16 | 9 | $31,296,800 | $3,477,422 |
| Upgrade | Moree (south) to Moree (east) | C17a1 | 1.5 | $5,563,400 | $3,708,933 |
| C59b | Spring Ridge to Breeza | C05a2+ C06a1+ C60+ C06a2+ C07a1 | 24.5 | $92,200,200 | $3,763,273 |
| B01c & B14 | Junee to Stockinbingal | B01+ B02a1+ B02a2+ B03+ B04+ B05+ B07+ B08+ B10+ B11+ B12 | 39.25 | $150,421,800 | $3,832,403 |
| C03b7 | Piambra to Ulinda deviation | C03a13+ C04b1+ C04a4 + C04a5 | 5.75 | $22,405,300 | $3,896,574 |
| B14a | Illabo to Stockinbingal | B02a2+ B03+ B04+ B05+ B07+ B08+ B10+ B11+ B12 | 33.5 | $139,685,100 | $4,169,704 |
| C03b4 | Merrygoen deviation | C03a8 | 8 | $34,346,500 | $4,293,313 |
| C57 | Dubbo bypass | C02 | 7.5 | $32,226,400 | $4,296,853 |
| C17b2 | Camurra deviation | C17a4 | 3.75 | $19,380,500 | $5,168,133 |
| C62 | Premer to Emerald Hill | C04a10+ C05a1+ C05a2 + C06a1+ C60+ C06a2+ C07a1+ C07a2 | 62.25 | $374,276,800 | $6,012,479 |
| B19a | Parkes bypass | B19 | 2.75 | $18,467,100 | $6,715,309 |
| D09b & D17C | Cecilvale to Gowrie via Wyreema West | D14C+ D15C+ D16A | 3 | $21,737,300 | $7,245,767 |
| Upgrade | Dubbo (north east) to Barbigal (west) | C03a1 | 2.5 | $18,988,000 | $7,595,200 |
| Upgrade | Parkes (north) to Narromine (south) | B20a1 | 19.25 | $149,794,300 | $7,781,522 |
| C04b3 | Oakey Creek to Premer deviation | C04a7 | 8.75 | $77,318,400 | $8,836,389 |
| C03b3 | Boomley deviation | C03a6 | 6.75 | $60,037,900 | $8,894,504 |
| Upgrade | Premer (west) to Premer (central) | C04a8 | 0.25 | $2,455,900 | $9,823,600 |
| Upgrade | Narromine (east) to Dubbo (west) | C01a2 | 3.75 | $38,533,200 | $10,275,520 |
| C16b | Premer bypass | C04a8+ C04a9+ C04a10 | 2.25 | $24,974,400 | $11,099,733 |
| B11a | Yeo Yeo deviation | B11 | 1.25 | $13,936,900 | $11,149,520 |

| | | | | | |
|---|---|---|---|---|---|
| C03b5 | Toogarlan deviation | C03a10 | 2.5 | $32,186,200 | $12,874,480 |
| C03b2 | Muronbung deviation | C03a4 | 3 | $41,640,300 | $13,880,100 |
| C17b1 | Moree bypass | C17a2 | 4.5 | $63,292,500 | $14,065,000 |
| Upgrade | Ulinda (south) to Oakey Creek | C04a6 | 2.75 | $39,311,200 | $14,294,982 |
| Upgrade | Muronbung (north) to Boomley (south) | C03a5 | 1.25 | $20,111,100 | $16,088,880 |
| Upgrade | Premer (east) to Spring Ridge | C05a1 | 7 | $115,630,200 | $16,518,600 |
| Upgrade | Moree (east) to Moree (north-east) | C17a2 | 2.25 | $39,276,021 | $17,456,010 |
| Upgrade | Narromine (south) to Narromine | B20a2 | 0.5 | $9,152,000 | $18,304,000 |
| Upgrade | Turilawa (high speed west) to Turilawa (low speed south) | C06a1 | 0.5 | $9,397,000 | $18,794,000 |
| B09 | Cootamundra bypass | C07+ B08 | 11 | $206,885,500 | $18,807,773 |
| C03b1 | Barbigal deviation | C03a2 | 1.75 | $34,205,200 | $19,545,829 |
| C03b6 | Piambra deviation | C03a12 | 0.5 | $10,031,500 | $20,063,000 |
| Upgrade | Barbigal (west) to Barbigal (east) | C03a1 | 0.5 | $10,260,200 | $20,520,400 |
| C04b2 | Ulinda deviation | C04a5 | 1 | $21,799,500 | $21,799,500 |
| Upgrade | Toogarlan (north) to Piambra (south) | C03a11 | 1.75 | $41,742,100 | $23,852,629 |
| Upgrade | Spring Ridge to Turilawa (high speed west) | C05a2 | 4.75 | $121,149,100 | $25,505,074 |
| Upgrade | Barbigal (east) to Muronbung (south) | C03a3 | 1 | $25,701,200 | $25,701,200 |
| Upgrade | Boomley (south) to Boomley (north) | C03a6 | 1.25 | $34,740,000 | $27,792,000 |
| Upgrade | Piambra (south) to Piambra (north) | C03a12 | 0.25 | $8,044,600 | $32,178,400 |
| Upgrade | Merrygoen (north) to Toogarlan (south) | C03a9 | 0.25 | $8,945,600 | $35,782,400 |
| C59 | Werris Creek high speed triangle | C06a1+ C60+ C06a2 | 0.5 | $17,900,900 | $35,801,800 |
| Upgrade | Oakey Creek to Premer (west) | C04a7 | 0.75 | $27,393,200 | $36,524,267 |
| Upgrade | Premer (north) to Premer (east) | C04a10 | 0.25 | $10,120,700 | $40,482,800 |
| Upgrade | Dubbo (west) to Dubbo (north east) | C02 | 0.5 | $21,575,300 | $43,150,600 |
| Upgrade | Ulinda (north) to Ulinda (south) | C04a5 | 0.25 | $10,918,900 | $43,675,600 |
| Upgrade | Toogarlan (south) to Toogarlan (north) | C03a10 | 0.5 | $23,045,300 | $46,090,600 |
| B07a | Frampton to Cootamundra deviation | B07 | 1 | $46,498,100 | $46,498,100 |
| Upgrade | Merrygoen (south) to Merrygoen (north) | C03a8 | 0.5 | $23,691,000 | $47,382,000 |
| Upgrade | Narromine to Narromine (east) | C01a1 | 0.25 | $14,567,100 | $58,268,400 |
| Upgrade | Muronbung (south) to Muronbung (north) | C03a4 | 0.25 | $14,640,800 | $58,563,200 |
| B05a | Frampton deviation | B05 | 0.5 | $33,905,300 | $67,810,600 |
| Upgrade | Boomley (north) to Merrygoen (south) | C03a7 | 0.25 | $25,848,200 | $103,392,800 |
| D09B & D36C1 | Cecilvale to Gatton south of Toowoomba | D14C+ D15C+ D16A+ D24C | 0.5 | $146,147,200 | $292,294,400 |
| B03a | Bethungra deviation | B03 | 0.25 | $351,591,800 | $1,406,367,200 |

| | | | | | |
|---|---|---|---|---|---|
| Upgrade | Piambra (north) to Binnaway | C03a13 | 0 | $20,304,200 | #DIV/0! |
| Upgrade | Binnaway (east) to Ulinda (north) | C04a4 | 0 | $3,823,500 | #DIV/0! |
| Upgrade | Premer (central) to Premer (north) | C04a9 | 0 | $2,630,100 | #DIV/0! |
| D24C2 | Gowrie to Gatton low speed | D24C | -13.75 | $970,800,900 | -$70,603,702 |

**Table C–2 Cost per minute saved estimates -Upgrades and deviations**

| Reference case Section | Length (km) | Journey Time Estimate - Reference case (mins) | Journey Time Estimate Upgraded Track (mins) | Journey time saving (Reference case to upgrade - mins) | Reference case cost ($K) | Upgrade cost ($K) | Cost (Upgrade – Reference case) | Cost per minute saved (Upgrade - $K) | Deviations Section | Length (km) | Journey time Estimate – Deviations (mins) | Journey time saving | Deviation cost ($K) | Cost (Deviation – Reference case - $K) | Deviations - Cost per minute saved ($K/min)) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A01 | 117 | 88 | N/A | 0 | 0 | 0 | 0 | N/A | N/A | | | | | | |
| A02 | 188 | 106 | N/A | 0 | 0 | 0 | 0 | N/A | N/A | | | | | | |
| A03a | 5 | 4 | N/A | 0 | 0 | 0 | 0 | N/A | N/A | | | | | | |
| A04 | 163 | 106 | N/A | 0 | 0 | 0 | 0 | N/A | N/A | | | | | | |
| B01 | 4 | 3.5 | N/A | 0 | 0 | 0 | 0 | N/A | N/A | | | | | | |
| B02a1 | 15 | 8.25 | N/A | 0 | 0 | 0 | 0 | N/A | N/A | | | | | | |
| B02a2 | 11 | 8 | N/A | 0 | 0 | 0 | 0 | N/A | N/A | | | | | | |
| B03 | 8 | 9.25 | N/A | 0 | 0 | 0 | 0 | N/A | B03a | 8 | 9 | 0.25 | 351,592 | 351,592 | 1,406,367 |
| B04 | 4 | 2.5 | N/A | 0 | 0 | 0 | 0 | N/A | N/A | | | | | | |
| B05 | 8 | 6.5 | N/A | 0 | 0 | 0 | 0 | N/A | B05a | 5 | 6 | 0.5 | 33,905 | 33,905 | 67,810 |
| B07 | 6 | 4 | N/A | 0 | 0 | 0 | 0 | N/A | B07a | 5 | 3 | 1 | 46,498 | 46,498 | 46,498 |
| B08 | 9 | 12.5 | N/A | 0 | 0 | 0 | 0 | N/A | N/A | | | | | | |
| B10 | 10 | 8 | N/A | 0 | 0 | 0 | 0 | N/A | N/A | | | | | | |
| B11 | 4 | 2.75 | N/A | 0 | 0 | 0 | 0 | N/A | B11a | 3 | 1.5 | 1.25 | 13,937 | 13,937 | 11,149 |
| B12 | 8 | 6.75 | N/A | 0 | 0 | 0 | 0 | N/A | N/A | | | | | | |
| B15 | 1 | 1 | N/A | 0 | 0 | 0 | 0 | N/A | N/A | | | | | | |
| B16 | 8 | 5.5 | N/A | 0 | 0 | 0 | 0 | N/A | N/A | | | | | | |
| B18 | 159 | 96.75 | N/A | 0 | 0 | 0 | 0 | N/A | N/A | | | | | | |
| B19 | 6 | 7.25 | N/A | 0 | 0 | 0 | 0 | N/A | B19a | 5 | 4.5 | 2.75 | 18,467 | 18,467 | 4,924 |
| B20a1 | 100 | 84 | 64.75 | 19.25 | 0 | 149,794 | 149,794 | 7,781 | N/A | | | | | | |

| Reference case Section | Length (km) | Journey Time Estimate - Reference case (mins) | Journey Time Estimate Upgraded Track (mins) | Journey time saving (Reference case to upgrade - mins) | Reference case cost ($K) | Upgrade cost ($K) | Cost (Upgrade – Reference case) | Cost per minute saved (Upgrade - $K) | Deviations Section | Length (km) | Journey time Estimate – Deviations (mins) | Journey time saving | Deviation cost ($K) | Cost (Deviation – Reference case - $K) | Deviations - Cost per minute saved ($K/min)) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| B20a2 | 6 | 5.5 | 5 | 0.5 | 0 | 9,152 | 9,152 | 18,304 | C70 | 12 | 6.5 | 9.25 | 24,007 | 20,007 | 2,585 |
| C01a1 | 8 | 10.25 | 10 | 0.25 | 0 | 14,567 | 14,567 | 58,268 | | | | | | | |
| C01a2 | 24 | 20.25 | 16.5 | 3.75 | 0 | 38,533 | 38,533 | 10,275 | N/A | | | | | | |
| C02 | 12 | 13 | 12.5 | 0.5 | 23,640 | 44,915 | 21,574 | 43,150 | C57 | 10 | 5.5 | 7.5 | 55,566 | 32,226 | 4,297 |
| C03a1 | 15 | 12 | 9.5 | 2.5 | 3,031 | 22,019 | 18,988 | 7,595 | N/A | | | | | | |
| C03a2 | 6 | 5 | 4.5 | 0.5 | 0 | 10,260 | 10,260 | 20,520 | C03b1 | 6 | 3.25 | 1.75 | 34,205 | 35,205 | 19,546 |
| C03a3 | 12 | 10.75 | 9.75 | 1 | 0 | 25,701 | 25,701 | 25,701 | N/A | | | | | | |
| C03a4 | 9 | 8 | 7.75 | 0.25 | 4,301 | 18,942 | 14,641 | 58,564 | C03b2 | 8 | 5 | 3 | 45,942 | 41,641 | 13,880 |
| C03a5 | 12 | 9.5 | 8.25 | 1.25 | 4,033 | 24,144 | 20,111 | 16,088 | N/A | | | | | | |
| C03a6 | 27 | 26.25 | 25 | 1.25 | 3,031 | 37,771 | 34,741 | 27,792 | C03b3 | 26 | 19.5 | 6.75 | 63,068 | 60,038 | 8,895 |
| C03a7 | 5 | 3.75 | 3.5 | 0 | 0 | 25,848 | 25,848 | 51,696 | N/A | | | | | | |
| C03a8 | 13 | 13 | 12.5 | 0.5 | 0 | 23,691 | 23,691 | 47,382 | C03b4 | 9 | 5 | 8 | 34,347 | 34,347 | 4,293 |
| C03a9 | 4 | 3.25 | 3 | 0.25 | 0 | 8,946 | 8,946 | 35,784 | N/A | | | | | | |
| C03a10 | 7 | 6.5 | 6 | 0.5 | 0 | 23,045 | 23,045 | 46,090 | C03b5 | 6 | 4 | 2.5 | 32,186 | 32,186 | 12,874 |
| C03a11 | 13 | 10 | 8.25 | 1.75 | 3,872 | 45,614 | 41,742 | 23,852 | N/A | | | | | | |
| C03a12 | 2 | 1.5 | 1.25 | 0.25 | 2,821 | 10,865 | 8,044 | 32,176 | C03b6 | 2 | 1 | 0.5 | 12,852 | 10,031 | 20,063 |
| C03a13 | 4 | 3.5 | 3.5 | 0 | 0 | 20,304 | 20,304 | - | N/A | | | | | | |
| C04b1 | 4 | 3.25 | 3.25 | 0 | 16,294 | 18,091 | 1,797 | - | N/A | | | | | | |
| C04a4 | 4 | 3.75 | 3.75 | 0 | 0 | 3, 824 | 3,824 | - | N/A | | | | | | |
| C04a5 | 5 | 3.75 | 3.5 | 0.25 | 0 | 10,919 | 10,919 | 43,676 | C04b2 | 4 | 2.75 | 1 | 21,800 | 21,800 | 21,800 |
| C04a6 | 27 | 22 | 19.25 | 2.75 | 4,033 | 43,344 | 39,311 | 14,294 | N/A | | | | | | |
| C04a7 | 27 | 24.5 | 23.75 | 0.75 | 0 | 27,393 | 27,393 | 36,524 | C04b3 | 23 | 15.75 | 8.75 | 77,318 | 77,318 | 8,836 |

| Reference case Section | Length (km) | Journey Time Estimate - Reference case (mins) | Journey Time Estimate Upgraded Track (mins) | Journey time saving (Reference case to upgrade - mins) | Reference case cost ($K) | Upgrade cost ($K) | Cost (Upgrade – Reference case) | Cost per minute saved (Upgrade - $K) | Deviations Section | Length (km) | Journey time Estimate – Deviations (mins) | Journey time saving | Deviation cost ($K) | Cost (Deviation – Reference case - $K) | Deviations - Cost per minute saved ($K/min)) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C04a8 | 2 | 2.25 | 2 | 0.25 | 0 | 2,456 | 2,456 | 9,824 | | | | 2.25 | 24,974 | 24,974 | 11,100 |
| C04a9 | 1 | 0.5 | 0.5 | 0 | 0 | 2,630 | 2,630 | - | C16[illegible] | 4 | 2.5 | | | | |
| C04a10 | 2 | 2 | 1.75 | 0.25 | 0 | 10,121 | 10,121 | 40,484 | | | | | | | |
| C05a1 | 36 | 28.25 | 21.25 | 7 | 16,683 | 132,313 | 115,630 | 16,518 | N/A | | | | | | |
| C05a2 | 27 | 21.75 | 17 | 4.75 | 0 | 121,149 | 121,149 | 25,505 | N/A | | | | | | |
| C06a1 | 3 | 2 | 1.5 | 0.5 | | 9,397 | 9,397 | 18,794 | | | | 0.5 | 28,365 | 17,900 | 35,801 |
| C60 | 1 | 0.75 | 0.75 | 0 | 10,465 | 10,465 | 0 | N/A | C59 | 5 | 4 | | | | |
| C06a2 | 2 | 1.75 | N/A | 0 | | 0 | 0 | N/A | | | | | | | |
| C07a1 | 19 | 10.75 | N/A | 0 | | 0 | 0 | N/A | N/A | | | | | | |
| C07a2 | 63 | 38 | N/A | 0 | | 0 | 0 | N/A | N/A | | | | | | |
| C08 | 29 | 18 | N/A | 0 | | 0 | 0 | N/A | N/A | | | | | | |
| C09 | 29 | 16.5 | N/A | 0 | | 0 | 0 | N/A | N/A | | | | | | |
| C10 | 15 | 18.5 | 18.5 | 0 | 27,977 | 38,097 | 10,120 | - | C58 | 11 | 5.75 | 12.75 | 54,840 | 26,863 | 2,107 |
| C11 | 85 | 88.5 | 52 | 36.5 | 0 | 112,049 | 112,049 | 3,069 | N/A | | | | | | |
| C17a1 | 4 | 3.75 | 2.25 | 1.5 | 0 | 5,563 | 5,563 | 3,708 | N/A | | | | | | |
| C17a2 | 9 | 9.25 | 7 | 2.25 | 17,103 | 56,379 | 39,276 | 17,456 | C17b1 | 9 | 4.75 | 4.5 | 80,396 | 63,293 | 14,065 |
| C17a3 | 6 | 4.25 | N/A | 0 | 26,035 | 26,035 | 0 | N/A | N/A | | | | | | |
| C17a4 | 5 | 5.5 | N/A | 0 | 21,778 | 21,778 | 0 | N/A | C17b2 | 3 | 1.75 | 3.75 | 41,159 | 16,381 | 5,168 |
| D01a | 78 | 48.75 | N/A | 0 | 137,467 | 137,467 | 0 | N/A | N/A | | | | | | |
| D02a | 26 | 15 | N/A | 0 | 55,598 | 55,598 | 0 | N/A | | | | 9.75 | 180,094 | -19,322 | -1,879 saving |
| D03c | 13 | 7 | N/A | 0 | 76,008 | 76,008 | 0 | N/A | D05C | 59 | 33.25 | | | | |
| D04a | 34 | 21 | N/A | 0 | 66,810 | 66,810 | 0 | N/A | | | | | | | |

| Reference case Section | Length (km) | Journey Time Estimate - Reference case (mins) | Journey Time Estimate Upgraded Track (mins) | Journey time saving (Reference case to upgrade - mins) | Reference case cost ($K) | Upgrade cost ($K) | Cost (Upgrade – Reference case) | Cost per minute saved (Upgrade - $K) | Deviations Section | Length (km) | Journey time Estimate – Deviations (mins) | Journey time saving | Deviation cost ($K) | Cost (Deviation – Reference case - $K) | Deviations - Cost per minute saved ($K/min)) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| D06a | 34 | 24 | N/A | 0 | 88,416 | 88,416 | 0 | N/A | N/A | | | | | | |
| D07c | 74 | 47 | N/A | 0 | 230,922 | 230,922 | 0 | N/A | N/A | | | | | | |
| D08a | 23 | 20 | N/A | 0 | 89,904 | 89,904 | 0 | N/A | N/A | | | | | | |
| D14C | 31 | 19 | N/A | 0 | 104,337 | 104,337 | 0 | N/A | N/A | | | | | | |
| D15a | 18 | 12 | N/A | 0 | 153,702 | 153,702 | 0 | N/A | D15C | 16 | 9.25 | 2.75 | 63,861 | -89,841 | -32,669 saving |
| D16a | 12 | 14 | N/A | 0 | 55,291 | 55,291 | 0 | N/A | N/A | | | | | | |
| D24c | 41 | 25 | N/A | 0 | 912,975 | 912,975 | 0 | N/A | D24c2 | 57 | 38.75 | -13.75 (longer) | 1,883,775 | 970,800 | longer |
| D25c | 29 | 14 | N/A | 0 | 223,976 | 223,976 | 0 | N/A | N/A | | | | | | |
| D26c | 56 | 35 | N/A | 0 | 351,005 | 351,005 | 0 | N/A | N/A | | | | | | |
| D28a | 34 | 18 | N/A | 0 | 0 | 0 | | N/A | N/A | | | | | | |

**Table C–3 Cost per minute saved estimates – Major deviations**

| Reference case Sections | Length (km) | Journey Time Estimate - Reference case (mins) | Journey Time Estimate - Upgraded Track (mins) | Journey time saving | Reference case cost ($K) | Upgrade cost ($K) | Cost (upgrade – Reference case - $K) | Cost per minute saved (Upgrade - $K/min) | Major Deviations Section | Length (km) | Journey Time Estimate – Major Deviations (mins) | Journey time saving | Deviation cost ($K) | Cost (Deviation – Reference case - $K) | Deviation Cost per minute saved ($K/min) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| B01+ B02a1+ B02a2+ B03+ B04+ B05+ B07+ B08+ B10+ B11+ B12 | 86 | 72 | 72 | 0 | 0 | 0 | 0 | N/A | B01c & B14 | 51 | 32.75 | 39.25 | 150,422 | 150,422 | 3,832 |
| B02a2+ B03+ B04+ B05+ B07+ B08+ B10+ B11+ B12 | 68 | 60.25 | 60.25 | 0 | 0 | 0 | 0 | N/A | B14a | 39 | 26.75 | 33.5 | 139,685 | 139,685 | 4,170 |
| B07+ B08 | 15 | 16.5 | 16.5 | 0 | 0 | 0 | 0 | N/A | B09 | 10 | 5.5 | 11 | 206,886 | 206,886 | 18,807 |
| B11+ B12+ B15+ B16 | 21 | 16 | 16 | 0 | 0 | 0 | 0 | N/A | B17 | 13 | 7 | 9 | 31,297 | 31,297 | 3,477 |
| C03a13+ C04b1+ C04a4+ C04a5 | 16 | 14.25 | 14 | 0.25 | 9,938 | 55,153 | 45,215 | 180,860 | C03b7 | 11 | 8.5 | 5.75 | 38,699 | 16,294 | 3,897 |
| C04a10+ | 154 | 104.5 | 92 | 12.5 | 27,148 | 283,445 | 256,297 | 20,503 | C62 | 75 | 42.25 | 62.25 | 401,424 | 27,148 | 6,012 |

| Reference case Sections | Length (km) | Journey Time Estimate - Reference case (mins) | Journey Time Estimate - Upgraded Track (mins) | Journey time saving | Reference case cost ($K) | Upgrade cost ($K) | Cost (upgrade – Reference case - $K) | Cost per minute saved (Upgrade - $K/min) | Major Deviations Section | Length (km) | Journey Time Estimate – Major Deviations (mins) | Journey time saving | Deviation cost ($K) | Cost (Deviation – Reference case - $K) | Deviation Cost per minute saved ($K/min) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C05a1+ C05a2 + C06a1+ C60+ C06a2+ C07a1+ C07a2+ | | | | | | | | | | | | | | | |
| C05a2+ C06a1+ C60+ C06a2+ C07a1 | 50 | 37 | 31.75 | 5.25 | 10,464 | 141,011 | 130,547 | 24,866 | C59b | 23 | 12.5 | 24.5 | 102,665 | 92,201 | 3,762 |
| D14C+ D15C+ D16A | 61 | 45 | 45 | 0 | 313,330 | N/A | N/A | N/A | D09B & D17C | 53 | 39.25 | 3 | 245,227 | 223,489 | 7,246 |
| D14C+ D15C+ D16A+ D24C | 101.9 | 70 | 70 | 0 | 1,226,304 | N/A | N/A | N/A | D09B & D36c1 | 94 | 66.75 | 0.5 | 1,282,611 | 1,136,464 | 292,294 |

# Appendix D

# Environmental summary data

**Table D-1: Environment and land use issues matrix**

| Section | Environmental constraints | | | | | | | Land use constraints | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Flora and Fauna | Historic Heritage | Indigenous Heritage | Flooding Impacts | Protection Areas | Noise | Construction Impacts | Zoning – Residential | Zoning – Environ-ment | Residential – Rural / Urban | Mining Titles / Leases | Irrigation Areas | State Forests | Community Impacts |
| **Reference Case** | | | | | | | | | | | | | | |
| Melbourne to Wodonga | | | | | | | | | | | | | | |
| Wodonga to Parkes | | X | | | | X | | X | | X | | | | |
| Parkes to Dubbo | | X | | | | X | | X | | X | | | | |
| Dubbo (east) to Binnaway (east) | X | | | X | | X | | X | | X | | | | |
| Binnaway (east) to Emerald Hill | | | | X | | X | | X | | X | | | | |
| Emerald Hill to Moree | | X | | | | X | | X | | X | | | | |
| Moree (north) to Inglewood | X | | X | X | X | | | X | | X | | X | X | |
| Inglewood to Cecilvale | X | | X | | X | | | X | | X | X | X | | |
| Cecilvale to Gowrie | X | | | | X | X | | X | | X | | | | |
| Gowrie to Grandchester / Rosewood | X | X | X | | X | X | X | X | | X | X | | | |
| Grandchester / Rosewood to Acacia Ridge | X | X | X | | X | X | X | | | | X | | | |
| **Deviations** | | | | | | | | | | | | | | |
| Junee to Stockinbingal | X | X | | | | | | X | | X | X | | | |
| Illabo to Stockinbingal | X | | | | | | | | | X | X | | | |
| Bethungra deviation | | X | | | | | X | | | X | | | | |
| Frampton deviation | X | | | | | | | | | | | | | |
| Frampton to Cootamundra deviation (south) | X | | | | | | | | | | | | | X |
| Cootamundra bypass | X | | | | | | X | | | X | | | | |
| Yeo Yeo deviation | | | | | | | | | | X | | | | |
| Stockinbingal bypass | X | | | | | | | | | X | | | | |
| Parkes deviation | | | | | | | | | | X | X | | | X |

| Section | Environmental constraints | | | | | | | Land use constraints | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Flora and Fauna | Historic Heritage | Indigenous Heritage | Flooding Impacts | Protection Areas | Noise | Construction Impacts | Zoning – Residential | Zoning – Environ-ment | Residential – Rural / Urban | Mining Titles / Leases | Irrigation Areas | State Forests | Community Impacts |
| Narromine bypass | | | | | | | | | | X | X | X | | |
| Dubbo bypass | X | | X | | | | | | | X | | X | | |
| Baribigal deviation | | | X | | | | | | X | | | | | |
| Muronbong deviation | X | | X | | | | | | X | | X | | | |
| Boomley deviation | X | | X | | | | | | X | | X | | | |
| Merrygoen deviation | | | | | | | | | | X | X | | | |
| Toorgarlan deviation | | | | | | | | X | | X | X | | | |
| Piambra deviation | | | | | | | X | | | | X | | | |
| Piambra to Ulinda deviation | | | | | | | | | | | X | | | |
| Ulinda deviation | | | | | | | | | | | X | | | |
| Premer deviation | | | | | | | | | | | X | | | |
| Oakey Creek to Premer West deviation | X | | | | | | | | | | X | | | |
| Premer to Emerald Hill | X | | | X | X | | | | | | X | | X | |
| Spring Ridge to Breeza deviation | X | | | X | | | | | | | X | | | |
| Werris Creek high speed triangle | | | | | | | | | | | X | | | |
| Narrabri bypass | | | | | | | | | | | X | X | | |
| Canowra deviation | | | | | | | | | | | | X | | |
| Moree bypass | | | X | | | | | | | X | X | X | | X |
| North Star to Yelarbon | X | | X | X | X | | | | | | X | | | X |
| Cecilvale to Gowrie (via Wyreema West) | X | | X | | | X | | X | | X | X | | | |
| Cecilvale to Gatton south of Toowoomba | X | X | X | | | X | X | | | X | | | | X |
| Oakey bypass | X | | | | | | | | | | | | | |
| Gowrie to Gatton (low speed) | X | X | X | | X | X | X | | | X | | | X | |

**Table D-2: Environment and land use risk scoring**

| Section | Key Issues | Risk score | | | Comments / Opportunities |
|---|---|---|---|---|---|
| | | E | L | C | |
| **Reference Case** | | | | | |
| Melbourne to Wodonga | ▪ None | 0 | 0 | 0 | ▪ n/a |
| Wodonga to Parkes | ▪ Residential areas (Bethungra, Cootamundra, Stockinbingal, Parkes) | 1 | 1 | 1 | ▪ n/a |
| Parkes to Dubbo | ▪ Residential areas (Narromine, Dubbo) | 1 | 1 | 1 | ▪ n/a |
| Dubbo (east) to Binnaway (east) | ▪ Macquarie River Rail Bridge – heritage listed<br>▪ Goonoo State Forest near Boomley<br>▪ Residential areas (Merrygoen, Binnaway) | 2 | 1 | 2 | ▪ Consider Dubbo bypass<br>▪ Avoid works near Boomley<br>▪ Consider Merrygoen bypass |
| Binnaway (east) to Emerald Hill | ▪ Residential areas (Weetaliba, Premer, Spring Ridge, Wean's Creek, Breeza, Curlewis, Gunnedah) | 1 | 1 | 1 | ▪ n/a |
| Emerald Hill to Moree | ▪ Residential areas (Bogopbil, Baan Baa, Narrabri, Moree) | 1 | 1 | 1 | ▪ n/a |
| Moree (north) to Inglewood | ▪ Potential impacts during upgrade works through Whetstone State Forest<br>▪ Residential areas (North Star, Inglewood)<br>▪ Passes through floodplain | 2 | 2 | 2 | ▪ Minimise impacts in Whetstone State Forest<br>▪ Consider flooding in design. |
| Inglewood to Cecilvale (D07 & D08) | ▪ Traverses the corner of Bringalily State Forest and passes near Devine State Forest<br>▪ Mineral development lease<br>▪ Irrigation area<br>▪ Residential areas (Brookstead) | 3* | 3* | 3* | ▪ Realign around Bringalily State Forest (would reduce risk score to 2), but avoid Devine State Forest.<br>▪ Minimise land use impacts (e.g. land take and severance) through irrigation areas. |
| Cecilvale to Gowrie (D14, D15, D16) | ▪ Residential areas (Oakey, Kingsthorpe) | 1 | 2 | 2 | ▪ Consider Oakey bypass |
| Gowrie to Grandchester / Rosewood (D24c, D25c) | ▪ Noise in Gatton, Forest Hill and Lockyer Valley<br>▪ Construction and access impacts in range areas<br>▪ Mining titles | 2 | 2 | 2 | ▪ Optimise alignment near Gatton and Forest Hill to minimise noise impacts<br>▪ Avoid landfill sites and prohibited areas |

| Section | Key Issues | Risk score | | | Comments / Opportunities |
|---|---|---|---|---|---|
| | | E | L | C | |
| | ▪ Prohibited area east of Gowrie<br>▪ Landfill sites | | | | |
| Grandchester / Rosewood to Acacia Ridge (D26c, D28a) | ▪ Passes through Koala conservation area and areas of Essential Habitat and Regional Ecosystem<br>▪ Passes through a mining lease<br>▪ Construction and access impacts in hilly areas<br>▪ Indigenous and cultural heritage items and places | 3* | 2 | 3* | ▪ Realign around Koala conservation areas (would reduce risk score to 2)<br>▪ Optimise to minimise impacts heritage items and Regional Ecosystem / Essential Habitat areas<br>▪ Avoid mining lease area |
| **Deviations** | | | | | |
| Junee to Stockinbingal (B01c + B14) | ▪ Residential areas (Junee)<br>▪ Mineral titles | 1 | 1 | 1 | ▪ Benefits in bypassing Bethungra and Cootamundra.<br>▪ More impact to propertes than B14a |
| Illabo to Stockinbingal (B14a) | ▪ Mining title | 1 | 1 | 1 | ▪ Benefits in bypassing Bethungra and Cootamundra.<br>▪ Less impact to properties than B01c+B14 |
| Bethungra deviation (B05a) | ▪ Bethungra Spiral listed on Register of National Estate | 2 | 1 | 2 | ▪ Reference case preferred<br>▪ Assess impacts on heritage listed Bethungra Spiral prior to any works |
| Frampton deviation (B05a) | ▪ Potential impacts to EEC | 2 | 0 | 1 | ▪ n/a |
| Frampton to Cootamundra deviation (B07a) | ▪ Loss and fragmentation of EEC and threatened species habitat | 3 | 1 | 3 | ▪ Reference case or Cootamundra Deviation preferred |
| Cootamundra bypass (B09) | ▪ Rural residential areas | 1 | 1 | 1 | ▪ Benefits in bypassing Cootamundra. |
| Yerong deviation (B11a) | ▪ Minor | 0 | 1 | 1 | ▪ n/a |
| Stockinbingal bypass (B17) | ▪ Minor | 1 | 1 | 1 | ▪ n/a |
| Parkes bypass (B19a) | ▪ Rural residential areas<br>▪ Golf course southwest of Parkes<br>▪ Mining titles | 0 | 2 | 1 | ▪ Benefits in bypassing Parkes. |
| Narromine bypass (C70) | ▪ Irrigation areas<br>▪ Mineral mining title | 0 | 2 | 1 | ▪ Benefits in bypassing Narromine.<br>▪ Minimise land use impacts (e.g. land take and severance) |

| Section | Key Issues | Risk score | | | Comments / Opportunities |
|---|---|---|---|---|---|
| | | E | L | C | |
| | | | | | through irrigation areas. |
| Dubbo bypass (C57) | ▪ Urban fringe residential areas<br>▪ Irrigation areas | 1 | 2 | 1 | ▪ Benefits in bypassing Dubbo.<br>▪ Minimise land use impacts (e.g. land take and severance) through irrigation areas. |
| Baribigal deviation (C03b1) | ▪ Environmental Protection land | 1 | 2 | 2 | ▪ Potential zoning restrictions – base case preferred. |
| Muronbong deviation (C03b2) | ▪ EEC fragmentation impacts<br>▪ Environmental Protection land<br>▪ Mining title | 2 | 3 | 3 | ▪ Reference case preferred |
| Boomley deviation (C03b3) | ▪ EEC and threatened species habitat fragmentation impacts with Goonoo State Forest<br>▪ Mining licence | 3 | 2 | 3 | ▪ Reference case preferred |
| Merrygoen deviation (C03b4) | ▪ Mining title<br>▪ Rural residential area | 0 | 1 | 1 | ▪ Benefits in bypassing Merrygoen residential area. |
| Toorgarlan deviation (C03b5) | ▪ Residential areas (Uelirex)<br>▪ Mineral mining title<br>▪ Coal mining title | 0 | 2 | 1 | ▪ n/a |
| Piambra deviation (C03b6) | ▪ Coal mining title | 1 | 1 | 1 | ▪ n/a |
| Piambra to Ulinda deviation (C03b7) | ▪ Coal mining title | 0 | 1 | 1 | ▪ Benefits by increasing distance to Binnaway residential area.. |
| Ulinda deviation (C04b2) | ▪ Coal mining title | 0 | 1 | 1 | ▪ n/a |
| Premer deviation (C16b) | ▪ None | 0 | 0 | 0 | ▪ n/a |
| Oakey Creek to Premer deviation (C04b3) | ▪ Minor | 1 | 0 | 1 | ▪ n/a |
| Premer to Emerald Hill (C62) | ▪ EEC and threatened species (koala) habitat<br>▪ Floodplain<br>▪ Passes near Trinkey State Conservation Area | 2 | 2 | 2 | ▪ Optimise to avoid vegetated areas and koala habitat.<br>▪ Avoid Trinkey State Conservation Area.<br>▪ Consider flooding in design. |

| Section | Key Issues | Risk score | | | Comments / Opportunities |
|---|---|---|---|---|---|
| | | E | L | C | |
| | ▪ Coal mining title | | | | |
| Spring Ridge to Breeza (C59b) | ▪ EEC and threatened species (koala) habitat<br>▪ Floodplain<br>▪ Coal mining titles | 2 | 1 | 2 | ▪ Optimise to avoid vegetated areas and koala habitat.<br>▪ Consider flooding in design. |
| Werris Creek high speed triangle (C59) | ▪ Coal mining title | 0 | 1 | 1 | ▪ n/a |
| Narrabri bypass (C58) | ▪ Irrigation areas<br>▪ Mining title | 0 | 2 | 2 | ▪ Benefits in bypassing Narrabri<br>▪ Minimise land use impacts (e.g. land take and severance) through irrigation areas. |
| Camurra deviation (C17b2) | ▪ Irrigation areas | 0 | 2 | 2 | ▪ Minimise land use impacts (e.g. land take and severance) through irrigation areas. |
| Moree bypass (C17b1) | ▪ Industrial/intensive farming areas<br>▪ Rural residences<br>▪ Sports field, drive-in theatre, farm buildings | 1 | 2 | 2 | ▪ Benefits in bypassing Moree<br>▪ Minimise land use impacts (e.g. land take and severance) through irrigation areas. |
| North Star to Yelarbon (D05c) | ▪ Adjacent to floodplain<br>▪ Close proximity to Dthinna Dthinnawan Nature Reserve<br>▪ Yelarbon Desert | 2 | 2 | 2 | ▪ Avoid realigning towards Dthinna Dthinnawan Nature Reserve.<br>▪ Assess ecological impacts in Yelarbon Desert |
| Cecilvale to Oakey (via Wyreema West) (D09b & D17c) | ▪ Noise impacts in urban fringe residential areas west of Toowoomba and in Pittsworth and Southbrook.<br>▪ Essential Habitat and Regional Ecosystems areas. | 3 | 2 | 3 | ▪ Reference case preferred (including Oakey bypass). |
| Cecilvale to Gatton south of Toowoomba (D09b & D36c1) | ▪ Essential Habitat and Regional Ecosystem areas and extensive vegetation clearing and habitat loss<br>▪ Noise impacts south and east of Toowoomba and in Pittsworth, Southbrook, Withcott and Placid Hills.<br>▪ Indigenous and Cultural heritage items and places<br>▪ Construction and access impacts in range areas. | 3 | 2 | 3 | ▪ Reference case preferred (including Oakey bypass). |
| Oakey bypass (D15c) | ▪ None | 0 | 0 | 0 | ▪ Benefit in bypassing Oakey. |

| Section | Key Issues | Risk score | | | Comments / Opportunities |
|---|---|---|---|---|---|
| | | E | L | C | |
| Gowrie to Gatton low speed (D24c2) | ▪ White Mountain Forest Reserve<br>▪ Essential Habitat and Regional Ecosystem areas, extensive vegetation clearing, habitat loss<br>▪ Noise impacts in Blue Mountain Heights, Ballard and rural areas<br>▪ Indigenous and Cultural heritage items and places<br>▪ Landfill sites and sewage treatment works | 3 | 2 | 3 | ▪ Reference case preferred |

*Notes:*
*E = Environmental risk score*
*L = Land use risk score*
*C = Combined environment and land use risk score*
**Risk may be downgraded if constraints can be avoided.*

*Score key:*
*3 – major issues along alignment*
*2 – considerable issues along alignment*
*1 – some issues along alignment*
*0 – no issues*