ARTC

Melbourne–Brisbane
Inland Rail Alignment Study

Working Paper No. 11
Stage 2 Capital Works Costings

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a result, the assessment reported in this working paper of the section of route between Narromine and Narrabri will be superseded by further work which will assess a more direct route between these two centres involving substantial new construction.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 termed 'banks' in railway parlance
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
BCCBA	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 that is 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 Trunk 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 (ie 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; comprises maintenance, inspections and unplanned minor maintenance that is carried out annually or at more frequent cycles
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 Assessment 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 ACILTasman 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.

Melbourne-Brisbane Inland Rail Alignment Study

Existing railways and study corridor (stage 2) — **Overview plan**

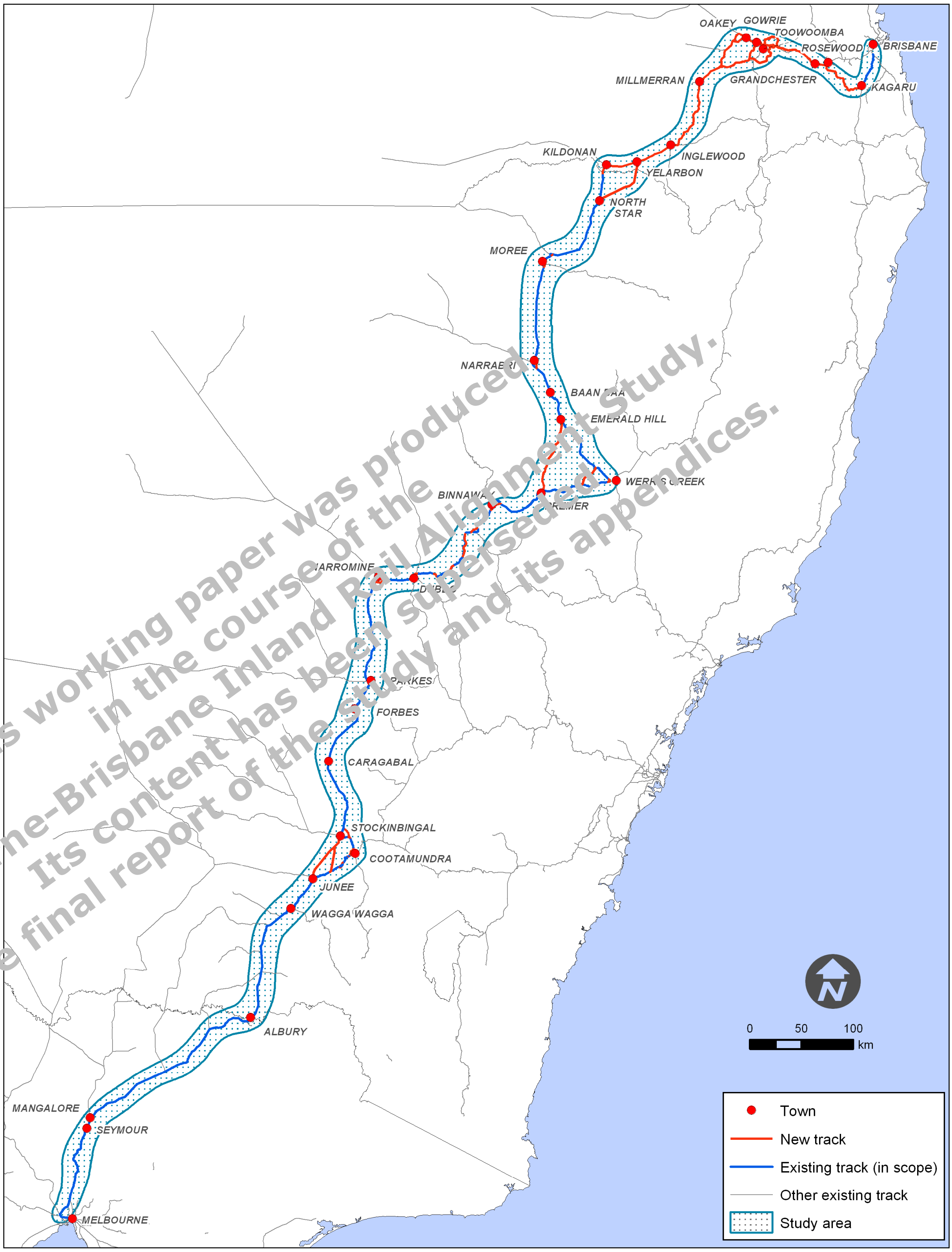

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Figure 1-1 Melbourne Brisbane inland rail corridor (Stage 2)

1.6 Objectives of Working Paper No. 11

Stage 1 used benchmarking cost data to conduct a comparative cost analysis of the route alternatives. The objective of the Stage 2 Capital Works Costings working paper is to refine the cost model and develop capital cost estimates for each of the individual sections. These costs are used as one of the criteria in Working Paper No. 10 to compare the possible deviations and determine the route for further analysis.

2. Cost model development

2.1 Introduction

2.1.1 Purpose of the cost model

A cost model has been developed to calculate the construction cost for each route section under review in Stage 2 of the study. In Working Paper No. 10 the estimated construction costs, the modelled journey times and environmental assessments are used to identify the route for further assessment.

To compare the deviations in Working Paper No. 10, the costs calculated in this paper comprise only the contractor's costs for the route alignments. Other project costs such as client costs, design, project management and client's contingency are covered at a project level in the analysis contained in Working Paper No. 12.

The cost model has been split into two categories: direct costs and indirect costs. The direct costs have been developed primarily using first principles based estimating. These costs have then been expressed as unit rates so that they can be applied to the quantities calculated for each cost element for the various sections under review.

The direct cost schedule of rates comprises the following elements:

- Earthworks;
- Track and formation;
- Turnouts/crossovers;
- Level crossings;
- Bridges and structures;
- Reinforced concrete box culverts;
- Tunnels;
- Miscellaneous structures;
- Existing services;
- Uplifting for shorter lengths.

The basis of the direct cost schedule of rates is detailed in section 2.2 of this paper.

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

- On-site overheads and preliminaries;
- Off-site overheads and margins.

The basis of the indirect percentages is detailed in section 2.4 of this paper.

The same direct cost rates and indirect percentages have been applied across all sections, with no consideration being given to the location of each individual section. This will be addressed in Stage 3 of this study.

The costs are not from end to end, as they do not include for any loops, intersections with existing track, operating requirements such as re-fuelling depot and any works required to be carried out at the route ends.

The costs have been calculated based on each section being a stand-alone project. The rationale behind this approach is that until a through alignment has been selected, the full end-to-end cost of Inland Rail cannot be calculated with sufficient cost certainty. This end-to-end cost is the output of Stage 3 of this study.

2.2 Direct Job Costs

2.2.1 Earthworks

The earthworks model has been refined in Stage 2 through the development of the horizontal and vertical designs from the alignment model. This generated the quantities of excavation, fill and geotechnical treatments for each of the sections. The costs developed are detailed in Table 2-1 below.

Table 2-1 Earthworks cost model rates

Item	Unit	Rate ($)
Excavation to fill via crusher (hard rock)	m^3	30.30
Excavation to fill via crusher (soft rock)	m^3	20.00
Excavation to fill (soil)	m^3	7.68
Haulage of material to embankment (over 1.5km from source)	m^3	6.37
Excavation to disposal on site (hard rock)	m^3	19.70
Excavation to dispose on site (soft rock)	m^3	12.90
Excavation to dispose on site (soil)	m^3	9.65
Formation of embankments	m^3	5.46
Supply of imported material from borrow pits	m^3	38.90
Strip and re-use topsoil	m^3	9.12
Clearing of bushes and trees	m^2	1.50
Hard rock surface treatment in fill and cut areas	m^2	7.33
Soft rock surface treatment in fill and cut areas	m^2	4.63
Alluvium surface treatment in fill and cut areas	m^2	10.31
Gilgai surface treatment in fill and cut areas	m^2	12.47
Capping layer	m^2	12.25
Structural layer	m^2	16.34
Batter treatment in rock	m^2	25.00

The rates detailed above are based on the following parameters.

Plant used:

The following items of plant have been allowed at this time in the preparation of the earthworks estimate (all references relate to Caterpillar equipment unless noted otherwise):

Ripping	D9 Track-type tractor
Excavating/loading	345BL-VG Hydraulic excavator
Pushing up	D8 Track-type tractor
Loading	980G Wheel loader
Moving (within 1.5 km)	D400E Articulated truck

Moving (over 1.5 km)	33T Truck & Dog
Crusher	Nordberg 400T/hr
Grader	14H Motor grader
Soil compaction	825 Landfill Compactor

Productivity rates:

The productivity rates used for the various items of plant deemed appropriate for carrying out the works were generally derived from Caterpillar Performance Handbook Edition 30.

The following general productivities have been adopted for excavations:

Ripping hard rock	100 Bm^3 / hour per machine
Excavating soft rock	150 Bm^3 / hour per machine
Excavating all soils	200 Bm^3 / hour per machine

Rate build-ups:

At this stage we have based the estimate on bulk earthwork volumes and geotechnical treatment areas provided from the Stage 2 designs, and unit rates built-up by ourselves.

In deriving these rates the following information has been used:

- Hourly plant hire rates generally taken from published rates received from industry suppliers;
- Productivity rates generally sourced from Caterpillar Performance Handbook Edition 30, modified to suit this project;
- Geotechnical treatments specified in Working Paper No. 6: Design Standards;
- Typical cutting/embankment cross sections provided in Working Paper No. 6: Design Standards.

General Assumptions:

The following assumptions have been made in determining quantities and rates used in this estimate:

- All debris from site clearance operations will either be disposed of or burned adjacent to clearance areas. i.e. no material removed to tips.
- All topsoil will be stored adjacent to strip areas and fully re-used on site.
- All excavations less than 3 m deep are assumed to be other than rock.
- Excavations over 3 m deep are split into hard and soft rock on a pro-rata basis derived from the areas of geotechnical treatments for hard and soft rock.
- All surplus excavated materials will be disposed of within 1.5 km of excavation areas. i.e. no material removed to tips.
- All excavated rock which is to be used for filling will be crushed using mobile crushing equipment before transporting to filling areas.
- Excavated materials are only used as filling within the sector in which they originate. No excavated material has been assumed to be available for use in other sectors because at this stage there are still route options an available material cannot be determined.
- 85% of any sector's excavated materials is suitable for re-use as filling.
- All imported filling is assumed to be sourced from borrow pits located no more than 25 km from any filling area.

- Additional excavation has been allowed for the 450 mm deep structural layer under the capping layer in the bottom of cuttings.
- That a 250 mm deep structural layer will be required in the bottom of cuttings.
- Structural layers have not been allowed in embankments.
- 150 mm deep capping layer allowed throughout.
- Rock bolting has been allowed in cuttings with an allowance of 1 bolt per 9 m^2. This allowance applied to 10% of hard rock and 20% of soft rock faces.
- All structural and capping layers are fully imported (from a source within 150 km).

The earthworks model allowed for the additional works involved in crossing floodplains. To improve the Stage 3 earthworks estimate additional geotechnical and hydrology information will be sought.

2.2.2 Track and formation

The track and formation cost model has been refined in Stage 2 using information from ARTC regarding the cost of materials from key suppliers. The costs developed are detailed in Table 2-2 below.

Table 2-2 Permanent way cost model rates

Item	Unit	Rate ($)
New track in greenfield location	km	700,000
Upgrade of existing Class 2 track to Class 1 track	km	660,000
Upgrade of existing Class 3 and above track to Class 1 track	km	810,000
Tangential turnouts	each	420,000
Diamond crossing	each	100,000

The rates detailed above are based on the following parameters.

An area for further investigation identified in Stage 1 was the supply of key materials. The supply prices received from suppliers such as Boral and ROCLA were significantly higher than the period contracts ARTC has with these suppliers.

Discussions have taken place with ARTC to investigate the possibility of basing the Capital Cost Estimates on ARTC's current contract rates for the supply of track and sleepers. The Stage 2 costs have been based on these contract rates.

Further market rates were sought from other suppliers of ballast and other materials, these rates have been used for the capital cost estimates.

Materials – rail:

Various reviews and analysis were carried out during Stage 2 to check the costings by contacting different suppliers of rail and received quotations varying from $1,850/t to $2,010/t for 110 m long rail with a rate of $1,850/t used in the cost model as per ARTC's current supply rate. An allowance of $20 per metre of rail was added for transporting to the site.

Materials – sleepers:

In an enquiry to ROCLA on costs for sleepers, they advised a cost of between $115 and $120 per sleeper ex-works as a standard rate. An additional cost of $25 per sleeper was suggested to be appropriate for delivery to site.

ARTC advised that $115 per sleeper is a budget cost, and this rate is also suggested by John Holland. Rates used must be inclusive of fastenings and this needs to be further clarified.

A rate of $145 per sleeper has been used in the cost model, although there is potential opportunity to reduce the cost which will be investigated further in the next stage.

Materials – ballast:

Different rates were developed for the varying distances that are involved in ballast delivery and they have been applied accordingly. It was decided that a distance of 100 km, based on the location of existing suitable quarries, for delivery of ballast should be used in establishing the unit rate for the ballast. The cartage distance and rate will be reviewed in Stage 3 of the project, together with the use of temporary quarries.

A ballast quotation from Wagner Quarries was significantly less than any of the quotations received from Boral in Queensland, NSW and Victoria. We used an average rate for all distances from Wagner Quarries (quote received equated to $18/tonne Ex Bin).

Plant rates

Rates for various items of plant appropriate for rail work were sought and received from Queensland, NSW and Victoria and for application to the scope of works appropriate for each state.

The plant rates will be reviewed and updated in Stage 3 based on current commercial rates.

Rate build-ups

The assumptions currently being used in developing the cost of the installation of the track, sleepers and ballast are detailed below.

Table 2-3 Track installation assumptions per 10,000 track metre

Activity	Assumptions	Productivity
Unload sleepers & stockpile	2 x front end loaders 2 x Plant operators 1 x Leading hand 3 x RW2 Rail workers	
Discharge sleepers	1 x Front end loader; 1 x Plant operator 1 x HIAB truck including driver 1 x Leading hand 2 x RW2 Rail workers	12 days
Place bottom ballast	1 x Front end loader; 1 x Excavator 2 x 10 wheel tipper; 1 x 11t Roller; Ballast box; 4 x Plant operators 1 x Leading hand 2 x RW2 Rail workers	18 days
Lay sleepers	1 x Excavator; 1 x Plant operator 1 x Leading hand; 4 x RW2 Rail workers 1 x Fitter	15 days (ARTC productivity rate)
Lay rail	1 x FBW; 1 x Atlas; 1 x Front end loader 1 x FBW Supervisor; 1 x Leading hand 2 x Plant operators 1 x Leading hand 8 x RW2 Rail workers	18 days
Fasten rail	1 x Leading hand 4 x RW2 Rail workers	16 days
Top ballast – load wagon	2 x Front end loaders; 1 x Excavator 1 x 10 wheel tipper; 4 x Plant operators	5 Days

Activity	Assumptions	Productivity
Place top ballast – Wagon	Loco & Wagon Train hire including 2 x engineers 4 x RW2 Rail workers	5 days
Tamp & profile	1 x Tamper; 1 x Regulator 2 x Tamper operators; 2 x Regulator operators 1 x Leading hand	10 days (ARTC productivity rate)
Weld & de-stress rail	1 x Leading hand 8 x RW2 Rail workers 4 x Welders	25 days-

Key:

RW2 Rail Worker Class 2

FBW Flashbutt welder

Upgrading of existing track

Part of the route selection involved the upgrade of existing sections of track which includes:

- Class 2;
- Class 3;
- Class 4;
- Class 5;
- Abandoned;
- Narrow gauge.

All upgrading of existing track has been based on the following scope of works:

- Remove existing rail (Class 1 requiring 60 kg/m rail) and remove from site (cost neutral on the basis of scrap value offsetting the cost of removal);
- Remove existing sleepers and dispose off-site (treated as waste);
- Grade and compact existing surface including existing ballast, making up levels where appropriate;
- Place and compact capping layer;
- Place bottom ballast;
- Lay sleepers;
- Lay and fasten rail;
- Place top ballast;
- Lift, line, tamp and profile;
- Weld and de-stress rail.

No allowance was made for upgrading the existing embankments to match design profile. This approach has been assumed for all grades of track requiring upgrading, with the exception of the Class 2 track that did not have a replacement capping layer installed.

No allowance has been made for upgrading the existing embankments to suit the loadings of the reference train.

We have assumed that the new standard gauge track will be constructed adjacent to the existing narrow gauge track in Queensland except where the existing track has been abandoned.

2.2.3 Turnouts and crossovers

The cost used in the Stage 2 cost model for turnouts was $420,000 each. This cost has been based on a quotation from Pacific Rail for the supply and delivery to site. The installation cost was based on first principles, similar to those used in the track installation detailed above. Rates applying to turnouts will be reviewed with ARTC during Stage 3 of this study.

During Stage 3, the strategy for integrating new rail line with existing line will be developed this may involve a number of turnouts and crossovers in addition to those already included in the cost estimates.

2.2.4 Level crossings

The costs used in Stage 2 cost model for level crossings are detailed in Table 2-4 below:

Table 2-4 Level crossings cost model rates

Item	Unit	Rate ($)
New active level crossing	each	1,199,000
New passive level crossing	each	108,000
Upgrade existing active level crossing	each	792,000
Upgrade existing passive level crossing	each	72,000

The rates detailed above in Table 3-4 are based on the following parameters.

Two level crossing types have been identified for use in this study, an active crossing and a passive crossing. Information on the class of road has been used to determine the crossing type for greenfield sections of track. No details have been provided for the upgrading of existing level crossings. We have therefore assumed that an upgrade costs approximately 66% of a new installation, after account is taken of demolition costs, non-productive working and tying into existing infrastructure. This estimate is based on experience in Victoria and Queensland.

The cost of constructing level crossings is based on required work and benchmarked against the cost of constructing similar types of crossings in Victoria and Queensland.

All level crossings are deemed to form part of an overall level crossing works package and have not been priced on an individual basis.

2.2.5 Bridges and structures

Methodology of pricing

The direct cost rate for constructing bridges and other structures were estimated using first principles. Where details were not available to allow a first principle rate to be calculated, typical rates applicable for the type of construction have been used. This applies generally for items that require further detailed design.

Bridges and viaducts have been considered as stand-alone projects that include their own overhead costs. Other assumptions depend on the configuration of a particular structure, the nature of its construction, method of erection and the condition of area being crossed, i.e. over dry ground or water, and greenfield or brownfield.

Structures having the same beam type were assigned common assumptions for piles, abutments, pile caps, columns and headstocks, where appropriate. Where appropriate the number of spans was altered to suit the structure configuration and the ground conditions.

Major issues that affect the total cost estimate are presented below.

- The overhead allowance was assessed as a generic cost based on minimum site set-up and staffing. This amount was adjusted to allow for each structure to be constructed in isolation from the overall project. The total overhead allowance is assessed as 30% of direct job costs.
- For structures constructed over water, an allowance has been made for the installation of a cofferdam and for pumping costs over a period shown in the data sheets. The estimate is expected to be refined as the designs mature.
- The basic difference between greenfield and brownfield structures is that brownfield structures are expected to be constructed in short periods during rail possessions. This was considered to result in construction up to and including headstocks adjacent to, or under the existing structure. The existing deck would be removed and beams installed from both ends of the structure during the possession period. The resulting beam installation costs are higher than transporting and lifting with smaller cranes at the span position. An allowance for dumb barges and safety boats has been made where the structures are over water.

The impact of the cost of the brownfield construction is shown in the graph detailed in Figure 2-1, which has doubled the construction cost of the bridge compared with greenfield construction. We will review this methodology in Stage 3 of this study.

Water crossings

The water crossing bridges were based on three different types:

- Type 1 – greenfield locations, based on 12 – 18 m long spans using 1,200 mm deep super T girders on 1,000 mm diameter piles/columns;
- Type 2 – greenfield locations, based on 18 – 25 m long spans using 1,515 mm deep super T girders on 1,200 mm diameter piles/columns
- Type 3 – brownfield locations, replacing existing bridges, based on 15 – 18 m long spans using 1,300 x 710 mm standard Rail Corporation planks on 1,000 mm diameter piles/columns

The Type 1 bridges were limited to a maximum length of 36 m. The Type 2 and Type 3 bridges had unlimited lengths.

The cost per metre length of bridge based on the different types developed ranged as detailed in Table 2-5 below.

Table 2-5 Bridge cost model rates

Item	Unit	Range ($)
Type 1	m	32,300 to 52,200
Type 2	m	25,100 to 54,200
Type 3	m	55,100 to 70,000

Figure 2-1 below compares the cost per metre of the three different types of bridges for the lengths identified during the study. The table shows that the cost of constructing the brownfield bridges is almost double that of the greenfield bridges based on the construction methodology used during Stage 2. This is an area for further refinement during Stage 3 to minimise the cost of the brownfield bridges.

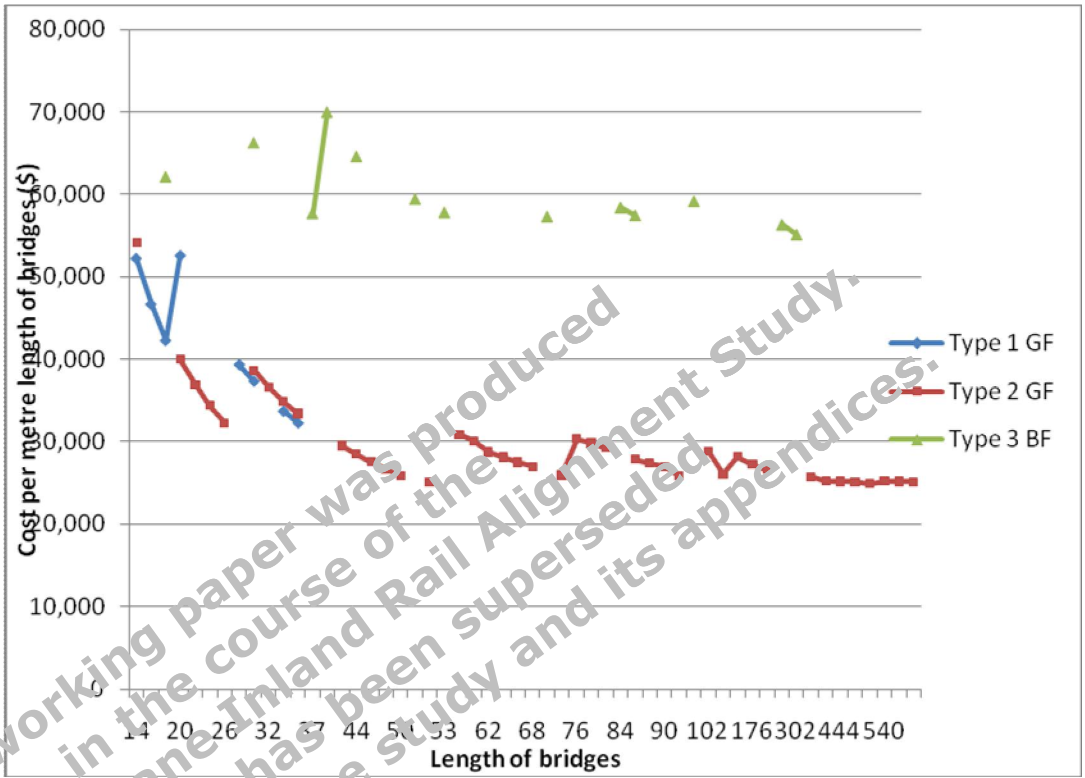

Figure 2-1 Cost per metre of bridges against length of bridges

Grade separation

Two grade separation designs have been developed based on the following criteria:

- Grade Separation – Major: based on a four lane road crossing; 27.6 m wide, a maximum of 18 m long, a minimum of 6.5 m clearance from top of rail using 6 off 750 mm diameter piles with 600 mm thick standard RTA planks.
- Grade Separation – Minor: based on a two lane road crossing; 13.4 m wide, a maximum of 18 m long, a minimum of 6.5 m clearance from top of rail using 4 off 750 mm diameter piles with 600 mm thick standard RTA planks.

An allowance was made for the approaches to the grade separations, based on using suitable imported fill material for the length of approximately 300 m long. During Stage 3, the approaches will be refined to reflect the site specific locations and applicable road standards.

Table 2-6 below details the cost used for the grade separations

Table 2-6 Grade separation cost model rates

Item	Unit	Cost ($)
Grade Separation - Major	each	$5,626,000
Grade Separation - Minor	each	$4,722,000

Rail viaducts: box girder section

The cost model for the viaducts structures is based on the parameters detailed in Table 2-7 below. These viaducts were maximum 60 m high, for a range of lengths. We have averaged the cost on a metre length basis for the purposes of this exercise. However, through the development of the deviations, a small number of viaducts were identified being approximately 100 m high, which have been included below.

Table 2-7 Viaduct cost model rates

Item	Unit	Range of Cost per metre ($)
Viaduct, 60 m high (maximum)	m	84,000 – 90,000
Viaduct, 100 m high (maximum)	m	95,000 – 100,000

The viaduct concept is an incrementally launched (from one end) 3 m deep continuous post tensioned box girder. The structures are based on a maximum 45 m span and a maximum pier height of 60 m. The abutments are assumed to be at ground level, and the first pier sets to be 30 m high. The structures were assumed to be new and in a greenfield situation.

The cost estimate allows for a concrete casting area and access to the initial launching area, together with the subsequent removal.

The costs of designing the equipment required for launching the box girders has been spread over the whole of the project, and is based on an assumption of the project comprising 4 eight-span structures and 7 eleven-span structures, that is, the design costs are spread over 109 box girder spans.

However, it is considered that to allow for the geographic and program considerations, 5 sets of launching equipment will be required for the project as a whole, and that the manufacture and fabrication costs for 5 sets of equipment would be spread over the 109 box girders spans.

In the absence of information relating to the method constructing the continuous box girder, and for the purposes of the estimate, the viaducts have been treated as being constructed with precast box girders.

2.2.6 Reinforced concrete box culverts

Two types of box culverts have been used in the designs: one comprises a single cell 2.40 m x 2.40 m box culvert for use in floodplains; the second is a 5.05 m x 4.20 m box culvert for use where drainage lines are present; multiple cells can be combined into cells depending on the size of the drainage line.

The cost of the upgraded culverts have been based on the cost of the new culvert with an uplift of 30% to cover the cost of removing the existing culvert, installing the new culvert and making good the embankments etc. afterwards.

During Stage 3, these upgrade costs will be refined through discussions with industry and the development of a construction methodology.

Unit rates were estimated from first principles for reinforced concrete box culverts.

The estimates include for excavation to commence 1m above reinforced concrete box culvert obvert, construction of the base slab, supply and installation of the units including any required in-situ work, construction of apron slabs and wing-walls, and backfill including geo-textiles.

The cost model developed these rates for the full range of culverts incurred on the project. Table 2-8 below details the costs used in this stage of the study.

Table 2-8 Culvert cost model rates

Item	Unit	Rate - New ($)	Rate - Upgrade ($)
Floodplain culverts (2.4 m x 2.4 m)	per kilometre	1,728,000	2,247,000
Single cell culvert (5.05 m x 4.2 m)	each	177,000	230,000
2 cell culvert	each	224,000	291,000
3 cell culvert	each	271,000	352,000
4 cell culvert	each	318,000	413,000
5 cell culvert	each	365,000	475,000
6 cell culvert	each	412,000	536,000
7 cell culvert	each	459,000	597,000
8 cell culvert	each	506,000	658,000
9 cell culvert	each	553,000	719,000
10 cell culvert	each	600,000	780,000
11 cell culvert	each	647,000	841,000
12 cell culvert	each	694,000	902,000
13 cell culvert	each	741,000	963,000

2.2.7 Tunnels

Tunnel design is at a very early stage. Because the proposed construction method has not been decided at this stage, the cost has been based on use of a road header. Geotechnical data for the location of the tunnels is very limited with geotechnical investigations carried out to date.

The cost used for the Stage 2 cost model are detailed in Table 2-9 below.

Table 2-9 Tunnel cost model rates (full cost)

Item	Unit	Cost per km ($)
Tunnels without ventilation (short length less than 1km long)	km	75,400,000
Tunnels with ventilation (exceeding 1km long)	km	62,600,000

The costs have been developed using a basic tunnelling cost model using the following assumptions:

- Cross sectional area of 68 m^2;
- Road header tunnelling machine;
- Five rock bolts every metre length of tunnel;
- Steel sets for 10% of the tunnel length;
- Shot-creting for the entire length of the tunnel;
- In-situ concrete base to the invert of the tunnel for the entire length of the tunnel;
- Ventilation for tunnels in excess of 1,000 m long;
- No allowance has been made for ventilation stacks for the 6.5 km long tunnel.

- The following allowances have been made for the Contractor’s preliminaries, site establishment etc which amounts to 56% of the direct cost of the tunnelling works;
  - Preliminaries - 28% of direct costs;
  - Site establishment - 5% of direct costs;
  - Insurance - 3% of direct costs;
  - Contractor’s risk - 5% of direct costs;
  - Offsite overheads and profit - 15% of direct cost.

We have assumed that tunnelling works would form a separate contract from other works to ensure preliminaries, overheads and profit are not counted twice.

Table 2-10 Tunnel cost model rates (reduced cost)

Item	Unit	Cost per km ($)
Tunnels without ventilation (short length less than 1 km long)	km	55,100,000
Tunnels with ventilation (exceeding 1 km long)	km	45,700,000

The major issues relating to the tunnel design are the ventilation, fire and safety aspects. The assumptions detailed above are general in character, Stage 3 will address the implications of providing ventilation, fire protection and other safety issues as they are essential to increase cost certainty.

During Stage 3, a desktop geotechnical study will be undertaken to assess the rock structures being excavated through and assess the most appropriate tunnelling machine based on the physical parameters and proposed method of construction.

2.2.8 Miscellaneous structures

An allowance of $150,000 per road alignment has been made to cover changes in road alignments.

2.2.9 Existing services

In assessing service crossings, a cost of $1 million per crossing has been allowed for crossing major oil and gas pipelines on the assumption that the track would pass across the tops of the pipes using a piled structure. No allowance has been made so far for the impact of high voltage cables in the vicinity of the rail alignment. This issue will be investigated further during Stage 3 of this study, to minimise any impact of known existing services on the proposed alignment.

2.2.10 Possessions and staging

On existing Class 1 sections of track, construction of turnouts onto new greenfield sections of track will require limited possession of track which could be incorporated into ARTC’s existing possession regime.

On less trafficked route sections, the possession regime will have minimal effect, e.g. Narrabri to Moree where only one passenger train uses the line. The train could be replaced with a bus service for the time needed to upgrade the existing line. While there are implications for grain and other freight, these could be managed through the development of an access regime with the operators. Stage 3 will develop a proposed possession regime to enable the cost to be determined.

On rail routes that are shared with metropolitan passenger services and significant freight services e.g. coal, the possession regimes will have an impact on the cost of upgrading works.

Where new sections follow existing alignments, specifically in Queensland, there is minimal impact on the existing lines. However train operations on an adjacent track would affect construction, and would require provision of protective fencing and the induction of personnel.

Upgrade works associated with the reference case primarily involve the construction of new bridges to remove speed restrictions on existing lines. It is envisaged that, in the case of multi-span structures, these works would be carried out in a similar way to the replacement of the bridge over the Murrumbidgee River at Wagga Wagga, which used a planned closure of the line for the final deck replacement works. As stated previously, the bridge upgrade will be reviewed in Stage 3 of this study. The Class 2 track replacement will be based on the current possession regime being used by ARTC in upgrading its current network.

The sections that require track upgrading are limited to Class 3 or abandoned sections of track which currently carry little, if any, traffic. These upgrade works will not incur possession costs as the track can be closed for the duration of the works.

Once the route for further assessment has been developed for Stage 3, a detailed assessment of the possession requirements will be made.

2.2.11 Input from industry

An initial review by John Holland Rail of productivity rates for greenfield and upgraded sections of track found that the rates used in the cost model are consistent with industry productivity. Further reviews will be conducted in Stage 3 of the study.

Discussions have also been held with other contractors and suppliers during Stage 2 of the study to gather information on industry standards achieved, methods used for freight rail projects, impact of rail operations on construction works, and so on.

One of the industry specialist contacted was Arenco, a firm contracted by ARTC to replace the railway viaduct at Wagga Wagga on a design and construct basis. Arenco provided details of the construction method used to replace the old bridge whilst maintaining full rail operations with only a four day possession period for the demolition and installation of the new deck, track and formation. The decision to replace the main spans on the existing centreline was made because the approaches were in good condition and replacing them would have been expensive, complicated and unnecessary. The solution used was the lowest cost in that particular situation. If the approaches had needed replacing, it would have been cheaper to construct a new bridge, approaches and main spans alongside the existing structure.

Arenco considered that possession planning and management processes have a significant bearing on indirect costs. It noted that the cost of full-time rail safety and environmental supervisors were costs not incurred on non-railway civil works.

The current cost model has costed the replacement of the existing bridges based on the construction method used in the replacement of Wagga Wagga bridge. This assumption will be investigated during Stage 3 of this study.

2.2.12 Uplifting for shorter sections

It was decided to use standard rates for the estimate with uplifts for the shorter sections. These uplifts would multiply the total cost of a section by different factors depending on the length of greenfield installation/upgrade:

- A factor of 2 if the length is below 2 km long;
- A factor of 1.6, if the length is between 2 km and 4 km long;
- A factor of 1.35, if the length is between 4 km and 6 km long;
- A factor of 1.15, if the length is between 6 km and 8 km long;
- A factor of 1.08, if the length is between 8 km and 10 km long.

These factors are based on recent experience in Queensland on multiple projects for a single client.

2.3 Basis of quantities

2.3.1 Earthworks, track and formation

In Stage 2, preliminary alignment designs were prepared for each of the greenfield sections. These designs considered the constraints of the site specific characteristics of each of the sections. From these alignment models, quantities of excavation, fill and geotechnical treatments for each of the sections were generated. This enabled more accurate costing of the different sections.

The alignment models also calculated the lengths of the tunnels and viaducts based on the vertical alignments.

The designs have been limited by the level of accuracy of the data sourced to date. This is based on 5 metre contours, high level geotechnical and hydrology information. To achieve the most cost effective alignments, further information is required. During Stage 3, detailed survey data will be used for further refinement of the vertical and horizontal alignments, based on 1 metre contour mapping and imagery which will enable a great accuracy of costs.

2.3.2 Bridges and structures

The bridges and structures have developed from Stage 1 through further refinement of the hydrology model in GIS. The hydrology model has predicted the length of bridges and number of culverts based on the upstream watercourse length.

During Stage 2, bridge lengths were reviewed. We received ARTC's existing bridge and culvert register which was used for the upgrade lengths and quantities. Where existing structures were located close to new greenfield bridges, the existing bridge length was used instead of the hydrology model length if there was a large difference. This is an area that requires further analysis during Stage 3 as it does not take into account any changes in hydrology requirements and standards since the existing bridges and culverts were constructed.

2.3.3 Review of the sections of route/line/track

As part of the review process carried out in Stage 2, various sections were analysed in terms of design, operations and cost, to assess whether further refinement would benefit the study.

During the review it was decided that, in some cases, the route could be improved by aligning it through more advantageous terrain minimising the cut/fill requirements.

This review process indicated that the initial vertical alignments also had the potential for significant refinement and these opportunities were taken up in the cost. This reduced the earthworks quantities by between 25% and 35% for particular alignments. These reductions were verified when the alignment earthworks model was re-run for a number of the alignments.

The number and location of grade separations and level crossings were reviewed, with road re-alignments being used to rationalise the number of crossings.

2.4 Indirect construction costs

The indirect construction costs have been applied against the total direct construction cost for each section on a percentage basis. The indirect construction costs comprise on-site overheads and preliminaries as well as off-site overheads and margins. These percentages have not changed from Stage 1. Once a route alignment has been selected, we will prepare a first principles based estimate for the indirect costs, with consultation with the industry, to ensure that the cost reflect the project.

2.4.1 On-site overheads and preliminaries

A percentage has been applied against each section to cover the contractor's on-site overheads and preliminary costs. The percentage has been applied on the basis that works will be performed concurrently to a whole route rather than each section being constructed on an individual basis. A range of costs have been considered and the 'most likely' percentages were selected based on the nature of the project and location of the sites.

A breakdown of the percentage is detailed below:

- Contractor's supervision including indirect labour – 9%;
- Contractor's site establishment, maintenance & demobilisation – 5%;
- Insurances and securities – 1.5%;
- Contractor's design – 5%;
- Wet weather and delay allowances – 1%;
- Contractor's contingency – 5%;
- **Total: 26.5%.**

These percentages have been derived from rail and large infrastructure projects. The percentage for the site establishment is based upon allowing a maximum of 10 work camps being used along the length of the route, including mobilising and demobilising the camps as required. This quantity was based on experience from other projects such as a 200 km length of track in Queensland.

During Stage 3 of this study, these percentages will be subject to a first principles based assessment once the route alignment has been selected.

2.4.2 Off-site overheads and margin

A percentage of 13% will be included against each section for the contractor's off-site overheads and margin.

This allowance includes for:

- Off-site management costs;
- Head office contributions;
- Legal costs;
- Off-site overheads;
- Profit.

The percentage is based on the current market experienced for large scale rail projects. Despite the current downturn in economic conditions, the rail market is still buoyant and no drops have been seen in the levels being applied by the companies with the capacity and capability to carry out these works, which we have assumed to be major national infrastructure companies. However, the market is very fluid and this will be addressed in Stage 3 of this study

2.4.3 Total indirect construction costs

The overall percentage addition for the indirect construction costs is 42.9%. This is based on:

- Direct construction cost x 126.5% (on-site overheads and preliminaries) = On-site costs;
- On-site costs x 113% = Construction cost.

2.5 Pricing assumptions and exclusions

2.5.1 Pricing assumptions

The following assumptions have been made in developing the cost models:

- The construction contract is let on a design and construct basis;
- That free and unobstructed access will be available to the sites at all times;
- That normal working hours only are included;
- That sufficient compound area will be available for storage containers, sheds, delivery vehicles/cranes;
- That there will be no impact on normal construction activities as a result of maintenance of pedestrian or vehicular access.

2.5.2 Pricing exclusions

During Stage 3 detailed studies will be undertaken to identify any potential issues affecting the preferred alignment and these will be factored into the CAPEX costs during these stages. At this stage, the following factors have been excluded in the calculation of the cost model:

- Owner's costs;
- Power supplies;
- Overhead wiring;
- Land acquisition including severance and compensation;
- Specific location factors;
- Modifications to existing rail infrastructure including turnouts and crossovers;
- Contaminated materials incurred during the works;
- Native Title;
- Aboriginal and heritage artefacts;
- Authority fees and charges;
- Active security to the construction zones (chain wire fence only);
- Compliance with any planning conditions;
- Relocating existing services;
- Possession costs;

- Financing;
- Legal costs;
- Escalation;
- Compensation;
- GST.

3. Cost estimates

3.1 Stage 2 cost estimates

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

The costs have been reported in three categories:

- Reference case;
- Upgrades;
- Deviations.

The capital cost estimates that follow are used in Working Paper No. 10 with the environmental assessment and the journey time estimates to produce a shortlist of options for further analysis in Stage 3 of the study.

3.2 Reference case costs

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.

The cost of the reference case is detailed in Table 3-1 below.

It is understood that ARTC will be upgrading the following sections of track:

- Cootamundra to Parkes (upgrading to interstate standard in 2009);
- Werris Creek to Narrabri (upgrading to allow coal freight before 2014).

The basis of the cost for the reference case and Upgrade Case is that the above sections of work will be completed prior to Melbourne-Brisbane Inland Rail works commencing. We have also assumed that ARTC will remove any speed restrictions within these sections as part of the upgrade works so that the Reference Train speed of 115km/h will be achieved.

The reference case route was analysed and sections of the track had maximum speed restricted to below 115km/h due to the quality of the infrastructure. The addition of the replacement of 13 existing bridges due to the significant speed restrictions on the existing infrastructure was included in the reference case and described in Working Paper No. 10.

The reference case characteristics are detailed in Appendix A of this paper.

Table 3-1 Reference case construction cost

Section No	Name	Length (km)	Cost ($'000s)	Rate per km ($'000s/km)
A01	Melbourne - Mangalore	116.7	0	0
A02	Mangalore – Wodonga (south)	188.3	0	0
A03a	Wodonga deviation	5.4	0	0
A04	Wodonga (north) – Junee	163.2	0	0
B01	Junee – Junee (east)	3.6	0	0
B02a1	Junee (east) – Illabo	14.9	0	0
B02a2	Illabo – Bethungra (south)	10.6	0	0
B03	Bethungra (south) - Bethungra (north)	7.9	0	0
B04	Bethungra (north) – Frampton (south)	3.8	0	0
B05	Frampton (south) - Frampton (north)	8.0	0	0
B07	Frampton (north) – Cootamundra (south)	5.6	0	0
B08	Cootamundra (south) - Bauloora	9.6	0	0
B10	Bauloora – Yeo Yeo (south)	10.1	0	0
B11	Yeo Yeo (south) - Yeo Yeo (north)	3.7	0	0
B12	Yeo Yeo (north) - Stockinbingal	8.3	0	0
B15	Stockinbingal – Stockinbingal (north)	1.1	0	0
B16	Stockinbingal (north) - Maleeja	8.0	0	0
B18	Maleeja – Parkes (south)	159.3	0	0
B19	Parkes (south) – Parkes (north)	5.7	0	0
B20a1	Parkes (north) - Narromine (south)	100.2	0	0
B20a2	Narromine (south) – Narromine	5.8	0	0
C01a1	Narromine - Narromine (east)	8.4	0	0
C01a2	Narromine (east) – Dubbo (west)	23.8	0	0
C02	Dubbo (west) – Dubbo (north east)	12.3	23,340	1,905
C03a1	Dubbo (north east) – Barbigal (west)	14.9	3,031	204
C03a2	Barbigal (west) - Barbigal (east)	6.0	0	0
C03a3	Barbigal (east) – Muronbung (south)	12.1	0	0
C03a4	Muronbung (south) - Muronbung (north)	9.2	4,301	466
C03a5	Muronbung (north) – Boomley (south)	11.9	4,033	339
C03a6	Boomley (south) - Boomley	27.3	3,031	111

Section No	Name	Length (km)	Cost ($'000s)	Rate per km ($'000s/km)
	(north)			
C03a7	Boomley (north) – Merrygoen (south)	5.3	0	0
C03a8	Merrygoen (south) - Merrygoen (north)	13.4	0	0
C03a9	Merrygoen (north) – Toogarlan (south)	3.8	0	0
C03a10	Toogarlan (south) - Toogarlan (north)	7.2	0	0
C03a11	Toogarlan (north) – Piambra (south)	12.6	3,872	308
C03a12	Piambra (south) - Piambra (north)	1.9	2,821	1,508
C03a13	Piambra (north) – Binnaway	4.2	0	0
C04b1	Binnaway – Binnaway (east)	3.6	16,294	4,471
C04a4	Binnaway (east) – Ulinda (north)	4.1	0	0
C04a5	Ulinda (north) - Ulinda (south)	4.3	0	0
C04a6	Ulinda (south) – Oakey Creek	27.2	4,033	148
C04a7	Oakey Creek – Premer (west)	26.6	0	0
C04a8	Premer (west) - Premer (central)	2.4	0	0
C04a9	Premer (central) - Premer (north)	0.4	0	0
C04a10	Premer (north) - Premer (east)	2.4	0	0
C05a1	Premer (east) – Spring Ridge	36.0	16,683	433
C05a2	Spring Ridge - Turilawa (high speed west)	26.6	0	0
C06a1	Turilawa (high speed west) - Turilawa (low speed south)	2.5	0	0
C60	Turilawa (low speed south) - Turilawa (low speed north)	0.9	10,465	11,240
C06a2	Turilawa (low speed north) - Turilawa (high speed north)	2.2	0	0
C07a1	Turilawa (high speed north) – Breeza	18.7	0	0
C07a2	Breeza – Emerald Hill	62.6	0	0
C08	Emerald Hill – Baan Baa	28.8	0	0
C09	Baan Baa – Narrabri (south)	28.7	0	0
C10	Narrabri (south) - Narrabri (north)	15.4	27,977	1,819
C11	Narrabri (north) – Moree (south)	84.8	0	0
C17a1	Moree (south) – Moree (east)	3.5	0	0
C17a2	Moree (east) - Moree (north east)	9.5	17,103	1.809
C17a3	Moree (north east) – Camurra (south)	5.8	26,035	4,516
C17a4	Camurra (south) – Moree (north)	5.3	21,778	4,072
D01A	Moree (north) – North Star	78.3	137,467	1,755
D02A	North Star - Boggabilla	25.7	55,598	2,164

Section No	Name	Length (km)	Cost ($'000s)	Rate per km ($'000s/km)
D03C	Boggabilla – Kildonan	12.6	76,008	6,047
D04A	Kildonan - Yelarbon	33.9	66,810	1,971
D06A	Yelarbon - Inglewood	33.8	88,416	2,618
D07C-001	Inglewood - Millmerran	73.8	230,922	3,130
D08A	Millmerran - Cecilvale	23.4	89,904	3,847
D14C	Cecilvale - Yargullen	31.3	104,337	2,785
D15A	Yargullen – Oakey	18.5	153,702	8,315
D16A	Oakey – Gowrie	11.6	55,291	4,759
D24C	Gowrie – Gatton	40.5	912,975	22,535
D25C	Gatton – Grandchester / Rosewood	28.8	223,976	7,771
D26C	Grandchester / Rosewood – Kagaru	56.2	351,005	6,249
D28A	Kagaru – Acacia Ridge	34.3	0	

3.3 Upgrade costs

As part of Stage 2, it was decided to assess the operational implications of upgrading the Class 2 sections of the reference case to Class 1.

The assessment was carried out to see whether the additional cost of upgrading parts of the reference case offered value for money against the time gained compared to constructing deviations. The cost to upgrade the Class 2 sections of the reference case to Class 1 are detailed in Table 3-2 of this paper.

The alignment characteristics for the upgrades are detailed in Appendix B of this paper.

Table 3-2 Upgrade costs

Section No	Name	Length (km)	Cost ($'000s)	Rate per km ($'000s/km)
B20a1	Parkes (north) - Narromine (south)	100.2	149,794	1,4950
B20a2	Narromine (south) – Narromine	5.8	9,152	1,5840
C01a1	Narromine - Narromine (east)	8.4	14,567	1,739
C01a2	Narromine (east) – Dubbo (west)	23.8	38,533	1,617
C02	Dubbo (west) – Dubbo (north east)	12.3	44,915	3,666
C03a1	Dubbo (north east) – Barbigal (west)	14.9	22,019	1,483
C03a2	Barbigal (west) - Barbigal (east)	6.0	10,260	1,723
C03a3	Barbigal (east) – Muronbung (south)	12.1	25,701	2,118
C03a4	Muronbung (south) - Muronbung (north)	9.2	18,942	2,052
C03a5	Muronbung (north) – Boomley (south)	11.9	24,144	2,029
C03a6	Boomley (south) - Boomley	27.3	37,771	1,385

Section No	Name	Length (km)	Cost ($'000s)	Rate per km ($'000s/km)
	(north)			
C03a7	Boomley (north) – Merrygoen (south)	5.3	25,848	4,918
C03a8	Merrygoen (south) - Merrygoen (north)	13.4	23,691	1,769
C03a9	Merrygoen (north) – Toogarlan (south)	3.8	8,946	2,376
C03a10	Toogarlan (south) - Toogarlan (north)	7.2	23,045	3,212
C03a11	Toogarlan (north) – Piambra (south)	12.6	45,614	3,631
C03a12	Piambra (south) - Piambra (north)	1.9	10,865	5,810
C03a13	Piambra (north) – Binnaway	4.2	20,804	4,893
C04b1	Binnaway – Binnaway (east)	3.6	18,091	4,965
C04a4	Binnaway (east) – Ulinda (north)	4.1	3,824	936
C04a5	Ulinda (north) - Ulinda (south)	4.8	10,919	2,281
C04a6	Ulinda (south) – Oakey Creek	27.2	43,344	1,593
C04a7	Oakey Creek – Premer (west)	26.6	27,393	1,029
C04a8	Premer (west) - Premer (central)	2.4	2,456	1,005
C04a9	Premer (central) - Premer (north)	0.4	2,630	6,415
C04a10	Premer (north) - Premer (east)	2.4	10,121	4,413
C05a1	Premer (east) – Spring Ridge	36.0	132,313	3,431
C05a2	Spring Ridge - Turilawa (high speed west)	26.6	121,149	4,547
C06a1	Turilawa (high speed west) - Turilawa (low speed south)	2.5	9,397	3,707
C10	Narrabri (south) - Narrabri (north)	15.4	38,097	2,47
C11	Narrabri (north) – Moree (south)	84.8	112,049	1,322
C17a1	Moree (south) – Moree (east)	3.5	5,563	1,570
C17a2	Moree (east) - Moree (north east)	9.5	56,379	5,962

3.4 Deviations costs

A number of deviations to the reference case were proposed to improve the journey time for the inland rail route. These deviations include the options for major greenfield alignments, minor deviations and deviations around towns.

These deviations were developed on the same basis as the reference case, using alignment modelling on 5 metre contours. The characteristics of the deviations are detailed in Appendix C of this paper.

These deviations have been costed as detailed in Table 3-3 below.

Table 3-3 Deviation route costs

Section No	Name	Length (km)	Cost ($'000s)	Rate per km ($'000s/km)
B01c & B14	Junee – Stockinbingal	51.2	150,422	2,938
B03a	Bethungra deviation	7.5	351,592	46,754
B05a	Frampton deviation	4.7	33,905	7,164
B07a	Frampton – Cootamundra deviation	5.1	46,498	9,068
B09	Cootamundra bypass	9.8	206,886	21,111
B11a	Yeo Yeo deviation	3.0	13,937	4,685
B14a	Illabo – Stockinbingal	38.9	139,685	3,582
B17	Stockinbingal bypass	13.2	31,297	2,362
B19a	Parkes bypass	4.6	18,467	4,015
C03b1	Barbigal deviation	5.7	34,205	5,956
C03b2	Muronbung deviation	8.3	45,942	5,539
C03b3	Boomley deviation	25.6	63,068	2,466
C03b4	Merrygoen deviation	8.8	34,347	3,912
C03b5	Toogarlan deviation	6.2	32,186	5,193
C03b6	Piambra deviation	1.8	12,852	7,286
C03b7	Piambra – Ulinda deviation	10.7	38,699	3,633
C04b2	Ulinda deviation	4.1	21,800	5,317
C04b3	Oakey Creek – Premer deviation(west)	23.1	77,318	3,341
C16b	Premer bypass	4.0	24,974	3,915
C17b1	Moree bypass	8.8	80,396	9,142
C17b2	Camurra deviation	3.2	41,159	13,066
C57	Dubbo bypass	10.5	55,566	5,309
C58	Narrabri bypass	10.5	54,840	5,206
C59	Werris Creek high speed triangle	5.4	28,365	5,253
C59b	Spring Ridge – Breeza deviation	22.9	102,665	4,481
C62	Premer – Emerald Hill	75.0	401,424	5,355
C70	Narromine bypass	11.7	24,007	2,047
D05C	North Star – Yelarbon	59.1	180,094	3,045
D15C	Yargullen - Oakey	16.5	63,861	3,874
D24C2	Gowrie – Gatton low speed	57.2	1,883,775	32,930
D09B & D17C	Cecilvale to Gowrie via Wyreema (west)	53.1	245,227	4,618
D09B & D36C1	Cecilvale to Gatton south of Toowoomba	94.3	1,282,611	13,601

4. Stage 3 activities

The following activities will be carried out during Stage 3:

- At the beginning of Stage 3, the cost estimate for the selected route will be run through a risk model, using Monte Carlo analysis, to identify the key areas of cost risk which will direct the engineering focus in Stage 3.
- Development of the design criteria for the project including the following items:
  - Tunnel design and construction methodology, especially in regard to the fire, safety and ventilation issues;
  - Horizontal and vertical alignments;
  - Floodplain treatment;
  - Viaducts;
  - Upgrading of existing structures including number and construction methodology;
  - Hydrology analysis.
- Review of construction costs with contractors.
- Further discussions with contractors and suppliers to validate the construction methodology and costs developed.
- Development of a risk register for the project, to capture risks allowing for elimination or mitigation during Stage 3.
- Development of the preferred procurement route to allow for inclusion in the cost model.
- Development of an overall cost estimate for the whole of the project, including:
  - Client costs;
  - Project management and controls;
  - Design costs including geotechnical investigations;
  - Contractor's direct costs, based on first principles estimating;
  - Contractor's indirect costs based on first principles estimating;
  - Land acquisition costs;
  - Risk and opportunity allowance.

Appendix A

Summary of reference case section characteristics

A01 Melbourne - Mangalore

This section of track is an existing Class 1 track and therefore no upgrading is required.

- Length 116.7 km

A02 Mangalore - Wodonga (south)

This section of track is an existing Class 1 track and therefore no upgrading is required.

- Track length 188.3 km

A03a Wodonga deviation

This section of track is currently being constructed by ARTC and therefore no upgrading has been allowed for within this study.

- Track length 5.4 km

A04 Wodonga (north) - Junee

This section of track is an existing Class 1 track and therefore no upgrading is required.

- Track length 163.2 km

B01 Junee - Junee (east)

This section of track is an existing Class 1 track and therefore no upgrading is required.

- Track length 3.6 km

B02a1 Junee (east) - Illabo

This section of track is an existing Class 1 track and therefore no upgrading is required.

- Track length 14.9 km

B02a2 Illabo - Bethungra (south)

This section of track is an existing Class 1 track and therefore no upgrading is required.

- Track length 10.6km

B03 Bethungra (south) - Bethungra (north)

This section of track is an existing Class 1 track and therefore no upgrading is required.

- Track length 7.9 km

B04 Bethungra (north) - Frampton (south)

This section of track is an existing Class 1 track and therefore no upgrading is required.

- Track length 3.8 km

B05 Frampton (south) - Frampton (north)

This section of track is an existing Class 1 track and therefore no upgrading is required.

- Track length 8.0 km

B07 Frampton (north) - Cootamundra (south)

This section of track is an existing Class 1 track and therefore no upgrading is required.

- Track length 5.6 km

B08 Cootamundra (south) - Bauloora

This section of track is a mixture of existing Class 1 and Class 2 track and therefore no upgrading is required.

- Track length 9.0 km

B10 Bauloora - Yeo Yeo (south)

This section of track is an existing Class 2 track and therefore no upgrading is required.

- Track length 10.1 km

B11 Yeo Yeo (south) – Yeo Yeo (north)

This section of track is an existing Class 2 track and therefore no upgrading is required.

- Track length 3.7 km

B12 Yeo Yeo (north) - Stockinbingal

This section of track is an existing Class 2 track and therefore no upgrading is required.

- Track length 8.3 km

B15 Stockinbingal - Stockinbingal (north)

This section of track is an existing Class 2 track and therefore no upgrading is required.

- Track length 1.1 km

B16 Stockinbingal (north) - Maleeja

This section of track is an existing Class 2 track and therefore no upgrading is required.

- Track length 8.0 km

B18 Maleeja - Parkes (south)

This section of track is an existing Class 2 track and therefore no upgrading is required.

- Track length 159.3 km

B19 Parkes (south) - Parkes (north)

This section of track is an existing Class 2 track and therefore no upgrading is required.

- Track length 5.7 km

B20a1 Parkes (north) – Narromine (south)

This section of track is an existing Class 2 track and therefore no upgrading is required.

- Track length 100.2 km

B20a2 Narromine (south) - Narromine

This section of track is an existing Class 2 track and therefore no upgrading is required.

- Track length 5.8 km

C01a1 Narromine – Narromine (east)

This section of track is an existing Class 2 track and therefore no upgrading is required.

- Track length 8.4 km

C01a2 Narromine (east) - Dubbo (west)

This section of track is an existing Class 2 track and therefore no upgrading is required.

- Track length 23.8 km

C02 Dubbo (west) - Dubbo (north east)

This section of track is an existing Class 2 track and therefore no upgrading of the track is required. However, there is a significant speed restriction which will need eliminating.

- Track length 12.3 km
- Replacement of Macquarie River Bridge (292 m long)

C03a1 Dubbo (north east) – Barbigal (west)

This section of track is an existing Class 2 track and therefore no upgrading is required. However, there is a significant speed restriction which will need eliminating.

- Track length 14.9 km
- Replacement of Beni Beni Creek Bridge (37 m long)

C03a2 Barbigal (west) – Barbigal (east)

This section of track is an existing Class 2 track and therefore no upgrading is required.

- Track length 6.0 km

C03a3 Barbigal (east) – Muronbung (south)

This section of track is an existing Class 2 track and therefore no upgrading is required.

- Track length 12.1 km

C03a4 Muronbung (south) – Muronbung (north)

This section of track is an existing Class 2 track and therefore no upgrading is required. However, there is a significant speed restriction which will need eliminating.

- Track length 9.2 km
- Replacement of Baragonumble Creek Bridge (51m long)

C03a5 Muronbung (north) – Boomley (south)

This section of track is an existing Class 2 track and therefore no upgrading is required. However, there is a significant speed restriction which will need eliminating.

- Track length 11.9 km
- Replacement of Elong Elong Bridge (44 m long)

C03a6 Boomley (south) – Boomley (north)

This section of track is an existing Class 2 track and therefore no upgrading is required. However, there is a significant speed restriction which will need eliminating.

- Track length 27.3 km
- Replacement of Boomley Creek Bridge (37 m long)

C03a7 Boomley (north) – Merrygoen (south)

This section of track is an existing Class 2 track and therefore no upgrading is required.

- Track length 5.3 km

C03a8 Merrygoen (south) – Merrygoen (north)

This section of track is an existing Class 2 track and therefore no upgrading is required.

- Track length 13.4 km

C03a9 Merrygoen (north) – Toogarlan (south)

This section of track is an existing Class 2 track and therefore no upgrading is required.

- Track length 3.8 km

C03a10 Toogarlan (south) – Toogarlan (north)

This section of track is an existing Class 2 track and therefore no upgrading is required.

- Track length 7.2 km

C03a11 Toogarlan (north) – Piambra (south)

This section of track is an existing Class 2 track and therefore no upgrading is required. However, there is a significant speed restriction which will need eliminating.

- Track length 12.6 km
- Replacement of Butheroo Creek Bridge (39m long)

C03a12 Piambra (south) – Piambra (north)

This section of track is an existing Class 2 track and therefore no upgrading is required. However, there is a significant speed restriction which will need eliminating.

- Track length 1.9 km
- Replacement of Piambra Bridge (30 m long)

C03a13 Piambra (north) - Binnaway

This section of track is an existing Class 2 track and therefore no upgrading is required.

- Track length 4.2 km

C04b1 Binnaway – Binnaway (east)

This section of track is a mixture of 1.2 km of existing Class 2 track and 2.4 km of new track involving the following works:

- Track length 3.6 km;
- 3.1 km in floodplains;

- 8,000 m^3 of embankments;
- 1,000 m^3 of cuttings;
- 1 off creek crossing, 20 m long;
- 1 off creek crossing, 26 m long;
- 1 off grade separation;
- 60% uplift for short construction length.

C04a4 Binnaway (east) – Ulinda (north)

This section of track is an existing Class 2 track and therefore no upgrading is required.

- Track length 4.1 km

C04a5 Ulinda (north) – Ulinda (south)

This section of track is an existing Class 2 track and therefore no upgrading is required.

- Track length 4.8 km

C04a6 Ulinda (south) – Oakey Creek

This section of track is an existing Class 2 track and therefore no upgrading is required. However, there is a significant speed restriction which will need eliminating.

- Track length 27.2 km
- Replacement of Weetaliba bridge (44 m long)

C04a7 Oakey Creek – Premer (west)

This section of track is an existing Class 2 track and therefore no upgrading is required.

- Track length 26.6 km

C04a8 Premer (west) - Premer (central)

This section of track is an existing Class 2 track and therefore no upgrading is required.

- Track length 2.4 km

C04a9 Premer (central) - Premer (north)

This section of track is an existing Class 2 track and therefore no upgrading is required.

- Track length 0.4 km

C04a10 Premer (north) - Premer (east)

This section of track is an existing Class 2 track and therefore no upgrading is required.

- Track length 2.4 km

C05a1 Premer (east) – Spring Ridge

This section of track is an existing Class 2 track and therefore no upgrading is required. However, there are significant speed restrictions which will need eliminating.

- Track length 36.0 km
- Replacement of Premer Bridge (67 m long)

- Replacement of Cox's Creek Bridge (50 m long)
- Replacement of Bundall Creek Bridge (86 m long)

C05a2 Spring Ridge - Turilawa (high speed west)

This section of track is an existing Class 2 track and therefore no upgrading is required.

- Track length 26.6 km

C06a1 Turilawa (high speed west) – Turilawa (low speed south)

This section of track is an existing Class 2 track and therefore no upgrading is required.

- Track length 2.5 km

C60 Turilawa (low speed south) - Turilawa (low speed north)

This section of track is new and involves the following works:

- Track length 0.9 km
- 0.2 km of floodplains
- 19,000 m^3 of embankments
- 16,000 m^3 of cuttings
- 1 off creek crossing, 52 m long
- 1 off active level crossing
- 100% uplift for short length

C06a2 Turilawa (low speed north) – Turilawa (high speed north)

This section of track is an existing Class 1 track and therefore no upgrading is required.

- Track length 2.2 km

C07a1 Turilawa (high speed north) - Breeza

This section of track is an existing Class 1 track and therefore no upgrading is required.

- Track length 18.7 km

C07a2 Breeza - Emerald Hill

This section of track is an existing Class 1 track and therefore no upgrading is required.

- Track length 62.6 km

C08 Emerald Hill - Baan Baa

This section of track is an existing Class 1 track and therefore no upgrading is required.

- Track length 28.8 km

C09 Baan Baa - Narrabri (south)

This section of track is an existing Class 1 track and therefore no upgrading is required.

- Track length 28.7 km

C10 Narrabri (south) - Narrabri (north)

This section of track is a mixture of existing Class 1 and Class 2 track and therefore no upgrading is required. However, there are significant speed restrictions which will need eliminating.

- Track length 15.4 km
- Upgrading Namoi River Bridge (302 m long)
- Upgrading Narrabri Bridge (53 m long)

C11 Narrabri (north) - Moree (south)

This section of track is an existing Class 2 track and therefore no upgrading is required.

- Track length 84.8 km

C17a1 Moree (south) – Moree (east)

This section of track is an existing Class 2 track and therefore no upgrading is required.

- Track length 3.5 km

C17a2 Moree (east) – Moree (north east)

This section of track is a mixture of 5.6 km of existing Class 2 and upgrade 3.8 km of existing Class 3. The works include the upgrading of the following:

- Track length 9.4 km
- 2.3 km of floodplain construction
- 1 off creek crossing, 102 m long

C17a3 Moree (north east) – Camurra (south)

This section of track is an upgrade of existing Class 3 to Class 1. The works include the upgrading of the following:

- Track length 5.8 km
- 5.8 km of floodplain construction

C17a4 Camurra (south) - Moree (north)

This section of track is an upgrade of existing Class 3 to Class 1. The works include the upgrading of the following:

- Track length 5.3 km
- 1.3 km of floodplain construction
- 1 off creek crossing, 44 m long
- 1 off creek crossing, 75 m long
- 1 off culvert

D01A Moree North (Camurra) - North Star

This section of track is an upgrade of existing Class 3 to Class 1. The works include the upgrading of the following:

- Track length 78.3 km
- 3 off creek crossing, 18 m long

- 3 off creek crossing, 24 m long
- 1 off creek crossing, 39 m long
- 1 off creek crossing, 67 m long
- 13 off culverts
- 25 off level crossings

D02A North Star - Boggabilla

This section of track is an upgrade of an abandoned track to Class 1. The works include the upgrading of the following:

- Track length 25.7km
- 5.0km of floodplains
- 4 off culverts
- 6 off level crossings

D03C Boggabilla - Kildonan

This section of track is new and involves the following works:

- Track length 12.6 km
- 4.7 km of floodplains
- 51,000 m^3 of embankments
- 82,000 m^3 of cuttings
- 1 off water crossing, 568 m long
- 2 off culverts
- 1 off grade separation
- 5 off level crossings

D04A Kildonan - Yelarbon

This section of track is new (within the existing corridor) and involves the following works:

- Track length 33.9 km
- 202,000 m^3 of embankments
- 273,000 m^3 of cuttings
- 1 off grade separation
- 7 off level crossings

D06A Yelarbon - Inglewood

This section of track is new (within the existing corridor) and involves the following works:

- Track length 33.8 km
- 278,000 m^3 of embankments
- 198,000 m^3 of cuttings
- 1 off creek crossing, 14 m long
- 1 off creek crossing, 126 m long
- 1 off creek crossing, 176 m long

- 2 off grade separation
- 5 off level crossings

D07C Inglewood - Millmerran

This section of track is new and involves the following works:

- Track length 73.8 km
- 1,302,000 m^3 of embankments
- 1,995,000 m^3 of cuttings
- 1 off creek crossing, 14 m long
- 1 off creek crossing, 16 m long
- 1 off creek crossing, 18 m long
- 1 off creek crossing, 22 m long
- 1 off creek crossing, 24 m long
- 1 off creek crossing, 34 m long
- 1 off creek crossing, 36 m long
- 1 off creek crossing, 48 m long
- 1 off creek crossing, 56 m long
- 1 off creek crossing, 72 m long
- 1 off creek crossing, 80 m long
- 1 off creek crossing, 90 m long
- 13 off culverts
- 1 off grade separation
- 26 off level crossings

D08A Millmerran - Cecilvale

This section of track is new (within the existing corridor) and involves the following works:

- Track length 23.4 km
- 152,000 m^3 of embankments
- 109,000 m^3 of cuttings
- 1 off creek crossing, 14 m long
- 1 off creek crossing, 50 m long
- 1 off creek crossing, 118 m long
- 1 off creek crossing, 358 m long
- 1 off culvert
- 2 off grade separations
- 8 off level crossings

D14C Cecilvale - Yargullen

This section of track is new and involves the following works:

- Track length 31.3 km
- 2,790,000 m^3 of embankments
- 1,486,000 m^3 of cuttings

- 1 off creek crossing, 14 m long
- 1 off creek crossing, 16 m long
- 1 off creek crossing, 22 m long
- 1 off creek crossing, 24 m long
- 1 off creek crossing 30 m long
- 7 off culverts
- 8 off grade separations
- 12 off level crossings

D15A Yargullen - Oakey

This section of track is new (within the existing corridor) and involves the following works:

- Track length 18.5 km
- 1,845,000 m^3 of embankments
- 392,000 m^3 of cuttings
- 1 off creek crossing, 86 m long
- 1 off culvert
- 4 off grade separations
- 9 off level crossings

D16A Oakey - Gowrie

This section of track is new (within the existing corridor) and involves the following works:

- Track length 11.6 km
- 663,000 m^3 of embankments
- 41,000 m^3 of cuttings
- 1 off creek crossing, 50 m long
- 2 off culverts
- 1 off grade separation
- 1 off level crossing

D24C Gowrie - Gatton

This section of track is new and involves the following works:

- Track length 40.5 km
- 3,386,000 m^3 of embankments
- 3,270,000 m^3 of cuttings
- 1 off creek crossing, 14 m long
- 1 off creek crossing, 16 m long
- 1 off creek crossing, 22 m long
- 1 off creek crossing, 48 m long
- 1 off creek crossing, 102 m long
- 1 off viaduct, 500 m long
- 1 off viaduct, 550 m long
- 1 off tunnel, 800 m long

- 1 off tunnel 6.5 km long
- 12 off culverts
- 2 off grade separations
- 12 off level crossings

D25C Gatton - Grandchester

This section of track is new (17.5km of which is within the existing corridor) and involves the following works:

- Track length 28.8 km
- 1,062,000 m^3 of embankments
- 2,568,000 m^3 of cuttings
- 1 off creek crossings, 18 m long
- 1 off creek crossing, 30 m long
- 1 off creek crossing, 42 m long
- 1 off creek crossing, 44 m long
- 1 off creek crossing, 78 m long
- 1 off tunnel, 1.3 km long
- 6 off culverts
- 3 off grade separations
- 10 off level crossings

D26C Grandchester - Kagaru

This section of track is new and involves the following works:

- Track length 56.2 km
- 2,929,000 m^3 of embankments
- 2,430,000 m^3 of cuttings
- 2 off creek crossings, 14 m long
- 1 off creek crossing, 18 m long
- 2 off creek crossing, 20 m long
- 1 off creek crossing, 22 m long
- 1 off creek crossing, 26 m long
- 1 off creek crossing, 28 m long
- 2 off creek crossings, 30 m long
- 1 off creek crossing, 36 m long
- 1 off creek crossing, 44 m long
- 1 off creek crossing, 56 m long
- 1 off creek crossing, 62 m long
- 1 off creek crossing, 96 m long
- 14 off culverts
- 1 off tunnel, 350 m long
- 1 off tunnel, 1.2 km long

- 3 off grade separations
- 39 off level crossings

D28A Kagaru – Acacia Ridge

This section of track is an existing Class 1 track and therefore no upgrading is required.

- Track length 34.3 km

Appendix B

Summary of upgraded reference case section characteristics

B20a1 Parkes (north) – Narromine (south)

This section of track is an existing Class 2 track and therefore the following works require upgrading:

- Track length 100.2 km
- 5 off creek crossings, 18 m long
- 2 off creek crossings, 20 m long
- 2 off creek crossings, 22 m long
- 1 off creek crossing, 30 m long
- 1 off creek crossing, 53 m long
- 16 off culverts
- 32 off level crossings

B20a2 Narromine (south) - Narromine

This section of track is an existing Class 2 track and therefore the following works require upgrading:

- Track length 5.8 km
- 1 off creek crossing, 30 m long
- 1 off culvert
- 2 off level crossings

C01a1 Narromine – Narromine (east)

This section of track is an existing Class 2 track and therefore the following works require upgrading:

- Track length 8.4 km
- 1 off creek crossing, 37 m long
- 1 off culvert
- 3 off level crossings

C01a2 Narromine (east) - Dubbo (west)

This section of track is an existing Class 2 track and therefore the following works require upgrading:

- Track length 23.8 km
- 1 off creek crossing, 24 m long
- 1 off creek crossing, 37 m long
- 1 off creek crossing, 44 m long
- 7 off level crossings

C02 Dubbo (west) - Dubbo (north east)

This section of track is an existing Class 2 track and therefore the following works require upgrading:

- Track length 12.3 km
- Macquarie River Bridge (292 m long)

- 9 off level crossings

C03a1 Dubbo (north east) – Barbigal (west)

This section of track is an existing Class 2 track and therefore the following works require upgrading:

- Track length 14.9 km
- 1 off creek crossing, 18 m long
- Beni Beni Creek Bridge (37 m long)
- 1 off culvert
- 7 off level crossings

C03a2 Barbigal (west) – Barbigal (east)

This section of track is an existing Class 2 track and therefore the following works require upgrading:

- Track length 6.0 km
- 1 off creek crossing, 53 m long
- 2 off level crossings

C03a3 Barbigal (east) – Muronbung (south)

This section of track is an existing Class 2 track and therefore the following works require upgrading:

- Track length 12.1 km
- 1 off creek crossing, 30 m long
- 1 off creek crossing, 37 m long
- 1 off creek crossing, 33 m long
- 1 off culvert
- 8 off level crossings

C03a4 Muronbung (south) – Muronbung (north)

This section of track is an existing Class 2 track and therefore the following works require upgrading:

- Track length 9.2 km
- Baragonumble Creek Bridge (51 m long)
- 1 off creek crossing, 44 m long
- 6 off level crossings

C03a5 Muronbung (north) – Boomley (south)

This section of track is an existing Class 2 track and therefore the following works require upgrading:

- Track length 11.9 km
- Elong Elong Bridge (44 m long)
- 1 off creek crossing, 102 m long
- 4 off level crossings

C03a6 Boomley (south) – Boomley (north)

This section of track is an existing Class 2 track and therefore the following works require upgrading:

- Track length 27.3 km
- Boomley Creek Bridge (37 m long)
- 1 off creek crossing, 1 8m long
- 1 off creek crossing, 22 m long
- 1 off creek crossing, 24 m long
- 6 off level crossings

C03a7 Boomley (north) – Merrygoen (south)

This section of track is an existing Class 2 track and therefore the following works require upgrading:

- Track length 5.3 km
- 4.9km of floodplain construction
- 1 off creek crossing, 44 m long
- 2 off level crossings

C03a8 Merrygoen (south) – Merrygoen (north)

This section of track is an existing Class 2 track and therefore the following works require upgrading:

- Track length 13.4 km
- 0.3 km of floodplain construction
- 1 off creek crossing, 30 m long
- 1 off culvert
- 7 off level crossings

C03a9 Merrygoen (north) – Toogarlan (south)

This section of track is an existing Class 2 track and therefore the following works require upgrading:

- Track length 3.8 km
- 1.6 km of floodplain construction
- 1 off level crossing

C03a10 Toogarlan (south) – Toogarlan (north)

This section of track is an existing Class 2 track and therefore the following works require upgrading:

- Track length 7.2 km
- 4.4 km of floodplain construction
- 1 off creek crossing, 22 m long
- 1 off level crossing

C03a11 Toogarlan (north) – Piambra (south)

This section of track is an existing Class 2 track and therefore the following works require upgrading:

- Track length 12.6 km
- 8.7 km of floodplain construction
- Butheroo Creek Bridge (39 m long)
- 2 off culverts
- 8 off level crossings

C03a12 Piambra (south) – Piambra (north)

This section of track is an existing Class 2 track and therefore the following works require upgrading:

- Track length 1.9 km
- 1.9 km of floodplain construction
- Piambra Bridge (30 m long)
- 2 off level crossings

C03a13 Piambra (north) – Binnaway

This section of track is an existing Class 2 track and therefore the following works require upgrading:

- Track length 4.2 km
- 4.2 km of floodplain construction
- 1 off creek crossing, 37 m long
- 1 off level crossing

C04b1 Binnaway – Binnaway (east)

This section of track is a mixture of 1.2 km of existing Class 2 track and 2.4 km of new track involving the following works:

- Track length 3.6 km
- 3.1 km in floodplains
- 8,000 m^3 of embankments
- 1,000 m^3 of cuttings
- 1 off creek crossing, 20 m long
- 1 off creek crossing, 26 m long
- 1 off grade separation
- 60% uplift for short construction length

C04a4 Binnaway (east) – Ulinda (north)

This section of track is an existing Class 2 track and therefore the following works require upgrading:

- Track length 4.1 km

C04a5 Ulinda (north) – Ulinda (south)

This section of track is an existing Class 2 track and therefore the following works require upgrading:

- Track length 4.8 km
- 1 off creek crossing, 75 m long
- 2 off level crossings

C04a6 Ulinda (south) – Oakey Creek

This section of track is an existing Class 2 track and therefore the following works require upgrading:

- Track length 27.2 km
- Weetaliba bridge (44 m long)
- 2 off creek crossings, 18 m long
- 1 off creek crossing, 24 m long'
- 1 off creek crossing, 39 m long
- 10 off level crossings

C04a7 Oakey Creek – Premer (west)

This section of track is an existing Class 2 track and therefore the following works require upgrading:

- Track length 26.6 km
- 9 off level crossings

C04a8 Premer (west) - Premer (central)

This section of track is an existing Class 2 track and therefore the following works require upgrading:

- Track length 2.4 km
- 1 off level crossing

C04a9 Premer (central) - Premer (north)

This section of track is an existing Class 2 track and therefore the following works require upgrading:

- Track length 0.4 km
- 2 off level crossings

C04a10 Premer (north) - Premer (east)

This section of track is an existing Class 2 track and therefore the following works require upgrading:

- Track length 2.4 km
- 1.8 km of floodplain construction
- 2 off level crossings

C05a1 Premer (east) – Spring Ridge

This section of track is an existing Class 2 track and therefore the following works require upgrading:

- Track length 36.0 km
- 18.2 km of floodplain construction
- Premer Bridge (67 m long)
- Cox's Creek Bridge (50 m long)
- Bundall Creek Bridge (86 m long)
- 1 off 18 m creek crossing, 18 m long
- 1 off creek crossing, 37 m long
- 1 off creek crossing, 39 m long
- 1 off creek crossing, 44 m long
- 11 off level crossings

C05a2 Spring Ridge - Turilawa (high speed west)

This section of track is an existing Class 2 track and therefore the following works require upgrading:

- Track length 26.6 km
- 20.1 km of floodplain construction
- 1 off creek crossing, 108 m long
- 1 off creek crossing, 230 m long
- 5 off level crossings

C06a1 Turilawa (high speed west) – Turilawa (low speed south)

This section of track is an existing Class 2 track and therefore the following works require upgrading:

- Track length 2.5 km
- 2.2 km of floodplain construction
- 1 off level crossing

C10 Narrabri (south) - Narrabri (north)

This section of track is a mixture of existing Class 1 and Class 2 track and therefore the following works require upgrading:

- Class 2 track length 3.1 km
- Namoi River Bridge (302 m long)
- Narrabri Bridge (53 m long)
- 1 off creek crossing, 75 m long
- 1 off level crossing

C11 Narrabri (north) - Moree (south)

This section of track is an existing Class 2 track and therefore the following works require upgrading:

- Track length 84.8 km
- 2 off creek crossings, 37 m long
- 1 off creek crossing, 53 m long
- 1 off creek crossing, 75 m long
- 9 off culverts
- 25 off level crossings

C17a1 Moree (south) – Moree (east)

This section of track is an existing Class 2 track and therefore the following works require upgrading:

- Track length 3.5 km
- 2 off level crossings

C17a2 Moree (east) – Moree (north east)

This section of track is a mixture of 5.6 km of existing Class 2 and upgrade 3.8 km of existing Class 3. The works include the upgrading of the following:

- Track length 9.5 km
- 2.3 km of floodplain construction
- 1 off creek crossing, 53 m long
- 1 off creek crossing, 67 m long
- 1 off creek crossing, 75 m long
- 1 off creek crossing, 102 m long
- 1 off culvert

Appendix C

Summary of bypass and deviation section characteristics

B03a Bethungra deviation

This section of track is new and involves the following works:

- Track length 7.5 km
- 1,097,000 m^3 of embankments
- 250,000 m^3 of cuttings
- 1 off tunnel, 2 km long
- 1 off tunnel, 1.1 km long
- 1 off grade separation
- 4 off level crossings
- Short length uplift of 15%

B05a Frampton deviation

This section of track is new and involves the following works:

- Track length 4.7 km
- 5,000 m^3 of embankments
- 592,000 m^3 of cuttings
- 1 off culvert
- Short length uplift of 35%

B07a Frampton – Cootamundra deviation (south)

This section of track is new and involves the following works:

- Track length 5.1 km
- 219,000 m^3 of embankments
- 200,000 m^3 of cuttings
- 1 off creek crossing, 42 m long
- 1 off culvert
- 1 off grade separation
- 1 off level crossing
- Short length uplift of 35%

B09 Cootamundra bypass

This section of track is new and involves the following works:

- Track length 9.8 km
- 335,000 m^3 of embankments
- 148,000 m^3 of cuttings
- 1 off creek crossing, 14 m long
- 1 off creek crossing, 20 m long
- 1 off tunnel, 2.2 km long
- 1 off culvert

- 1 off grade separation
- 2 off level crossings
- Short length uplift 8%

B11a Yeo Yeo deviation

This section of track is new and involves the following works:

- Track length 3.0 km
- 17,000 m^3 of embankments
- 208,000 m^3 of cuttings
- 1 off culvert
- 1 off level crossing
- Short length uplift 60%

B01c & B14 Junee - Stockinbingal

This section of track is new and involves the following works:

- Track length 51.1 km
- 573,000 m^3 of embankments
- 1,203,000 m^3 of cuttings
- 2 off creek crossing, 14 m long
- 16 off culverts
- 5 off grade separations
- 14 off level crossings

B14a Illabo - Stockinbingal

This section of track is new and involves the following works:

- Track length 38.9 km
- 350,000 m^3 of embankments
- 1,494,000 m^3 of cuttings
- 1 off creek crossing, 14 m long
- 2 off creek crossings, 16 m long
- 4 off creek crossings, 34 m long
- 2 off creek crossings, 48 m long
- 13 off culverts
- 2 off grade separations
- 9 off level crossings

B17 Stockinbingal bypass

This section of track is a mixture of 2 km existing Class 1 track and 11.2 km of new Class 1 track and involves the following works:

- Track length 13.2 km
- 186,000 m^3 of embankments
- 156,000 m^3 of cuttings

- 1 off creek crossing, 20 m long
- 1 off creek crossing, 34 m long
- 1 off culvert
- 1 off grade separation
- 3 off level crossings

B19a Parkes bypass

This section of track is new and involves the following works:

- Track length 4.6 km
- 700 m^3 of embankments
- 409,000 m^3 of cuttings
- 2 off grade separations
- 2 off level crossings
- Short length uplift 35%

C03b1 Barbigal deviation

This section of track is a mixture of 3.7 km of upgraded Class 1 to Class 2 track and 2 km of new Class 1 track and involves the following works:

- Track length 5.7 km
- 83,000 m^3 of embankments
- 32,000 m^3 of cuttings
- 1 off creek crossing, 44 m long
- 2 off culverts
- 1 off grade separation
- 2 off level crossings
- Short length uplift 35%

C03b2 Muronbung deviation

This section of track is a mixture of 4.3 km of upgraded Class 1 to Class 2 track and 4 km of new Class 1 track and involves the following works:

- Track length 8.3 km
- 408,000 m^3 of embankments
- 172,000 m^3 of cuttings
- 1 off creek crossing, 50 m long
- 1 off creek crossing, 76 m long
- 5 off level crossings
- Short length uplift 8%

C03b3 Boomley deviation

This section of track is a mixture of 5.8km of upgraded Class 1 to Class 2 track and 19.8 km of new Class 1 track and involves the following works:

- Track length 25.6 km

- 276,000 m^3 of embankments
- 512,000 m^3 of cuttings
- 1 off creek crossing, 18 m long
- 1 off creek crossing, 22 m long
- 1 off creek crossing, 24 m long
- 1 off creek crossing, 28 m long
- 1 off creek crossing, 3 m long
- 1 off creek crossing, 42 m long
- 1 off creek crossing, 46 m long
- 1 off creek crossing, 50 m long
- 2 off culverts
- 3 off level crossings

C03b4 Merrygoen deviation

This section of track is a mixture of 1.5 km of upgraded Class 1 to Class 2 track and 7.3 km of new Class 1 track and involves the following works:

- Track length 8.8 km
- 120,000 m^3 of embankments
- 114,000 m^3 of cuttings
- 1 off creek crossing, 18 m long
- 1 off creek crossing, 34 m long
- 4 off culverts
- 2 off level crossings
- Short length uplift 8%

C03b5 Toogarian deviation

This section of track is a mixture of 1 km of upgraded Class 1 to Class 2 track and 5.2 km of new Class 1 track and involves the following works:

- Track length 6.2 km
- 3.6 km of floodplain construction
- 109,000 m^3 of embankments
- 339,000 m^3 of cuttings
- 4 off culverts
- Short length uplift 15%

C03b6 Piambra deviation

This section of track is new and involves the following works:

- Track length 1.8 km
- 12,000 m^3 of embankments
- 6,000 m^3 of cuttings
- 1 off creek crossing, 20 m long
- 1 off grade separation

- 1 off level crossing
- Short length uplift 100%

C03b7 Piambra to Ulinda deviation

This section of track is new and involves the following works:

- Track length 10.7 km
- 2. 5km of floodplain construction
- 405,000 m^3 of embankments
- 283,000 m^3 of cuttings
- 3 off culverts
- 3 off level crossings

C04b2 Ulinda deviation

This section of track is a mixture of 1km of upgraded Class 1 to Class 2 track and 3.1 km of new Class 1 track and involves the following works:

- Track length 4.1 km
- 54,000 m^3 of embankments
- 51,000 m^3 of cuttings
- 1 off creek crossing, 16 m long
- 1 off creek crossing, 75 m long
- 2 off level crossings
- Short length uplift 85%

C04b3 Oakey Creek – Premer deviation

This section of track is a mixture of 6.4 km of upgraded Class 1 to Class 2 track and 16.7 km of new Class 1 track and involves the following works:

- Track length 23.1 km
- 619,000 m^3 of embankments
- 1,280,000 m^3 of cuttings
- 10 off culverts
- 8 off level crossings

C16b Premer bypass

This section of track is new and involves the following works:

- Track length 4.0 km
- 1.3 km of floodplain construction
- 5,000 m^3 of embankments
- 34,000 m^3 of cuttings
- 1 off creek crossing, 24 m long
- 1 off creek crossing, 78 m long
- 1 off tunnel, 1.3 km long
- 1 off culvert

- 2 off level crossings
- Short length uplift 15%

C17b1 Moree bypass

This section of track is new and involves the following works:

- Track length 8.8 km
- 5.0 km of floodplain construction
- 149,000 m^3 of embankments
- 17,000 m^3 of cuttings
- 1 off creek crossing, 96 m long
- 1 off creek crossing, 566 m long
- 1 off culvert
- 1 off grade separation
- 3 off level crossings
- Short length uplift 8%

C17b2 Camurra deviation

This section of track is new and involves the following works:

- Track length 3.2 km
- 1.5 km of floodplain construction
- 22,000 m^3 of embankments
- 9,000 m^3 of cuttings
- 1 off creek crossing, 540 m long
- 5 off level crossings
- Short length uplift 60%

C57 Dubbo bypass

This section of track is new and involves the following works:

- Track length 10.5 km
- 54,000 m^3 of embankments
- 436,000 m^3 of cuttings
- 1 off creek crossing, 494 m long
- 1 off culvert
- 2 off grade separations
- 9 off level crossings

C58 Narrabri bypass

This section of track is new and involves the following works:

- Track length 10.5 km
- 3.2 km of floodplain construction
- 138,000 m^3 of embankments
- 66,000 m^3 of cuttings

- 1 off creek crossing, 36 m long
- 1 off creek crossing, 66 m long
- 1 off creek crossing, 625 m long
- 1 off culvert
- 6 off level crossings

C59 Werris Creek high speed triangle

This section of track is a mixture of 2.9 km of existing Class 1 track, 1.3 km of upgraded Class 1 to Class 2 track and 1.2 km of new Class 1 track and involves the following works:

- Track length 5.4 km
- 0.2 km of floodplain construction
- 126,000 m^3 of embankments
- 1,000 m^3 of cuttings
- 1 off creek crossing, 52 m long
- 1 off grade separation
- Short length uplift 35%

C59b Spring Ridge – Breeza deviation

This section of track is new and involves the following works:

- Track length 22.9 km
- 20.8 km of floodplain construction
- 575,000 m^3 of embankments
- 356,000 m^3 of cuttings
- 1 off creek crossing, 86 m long
- 1 off culvert
- 10 off level crossings

C62 Premer – Emerald Hill

This section of track is a mixture of 1.8 km of existing Class 1 track, 0.7 km of upgraded Class 1 to Class 2 track and 72.5 km of new Class 1 track and involves the following works:

- Track length 75 km
- 69.1 km of floodplain construction
- 3,652,000 m^3 of embankments
- 545,000 m^3 of cuttings
- 1 off creek crossing, 20 m long
- 1 off creek crossing, 22 m long
- 2 off creek crossings, 30 m long
- 1 off creek crossing, 88 m long
- 9 off culverts
- 1 off grade separation
- 27 off level crossings

C70 Narromine bypass

This section of track is new and involves the following works:

- Track length 11.7 km
- 107,000 m^3 of embankments
- 61,000 m^3 of cuttings
- 1 off creek crossing, 48 m long
- 1 off culvert
- 10 off level crossings

D05C North Star - Yelarbon

This section of track is new and involves the following works:

- Track length 59.1 km
- 736,000 m^3 of embankments
- 720,000 m^3 of cuttings
- 1 off creek crossing, 48 m long
- 1 off creek crossing, 182 m long
- 1 off creek crossing, 442 m long
- 1 off creek crossing, 444 m long
- 1 off creek crossing, 494 m long
- 17 off culverts
- 3 off grade separations
- 10 off level crossings

D15C Yargullen - Oakey

This section of track is new and involves the following works:

- Track length 16.5 km
- 1,709,000 m^3 of embankments
- 629,000 m^3 of cuttings
- 1 off creek crossing, 68 m long
- 1 off creek crossing, 76 m long
- 1 off culvert
- 4 off grade separations
- 5 off level crossings

D09B & D17C Cecilvale - Gowrie

This section of track is new and involves the following works:

- Track length 53.1 km (33.0 km in the existing corridor)
- 1,870,000 m^3 of embankments
- 2,025,000 m^3 of cuttings
- 1 off creek crossing, 14 m long
- 1 off creek crossing, 280 m long

- 2 off creek crossings, 30 m long
- 13 off culverts
- 7 off grade separations
- 20 off level crossings

D24C2 Gowrie – Gatton low speed

This section of track is new and involves the following works:

- Track length 57.2 km
- 12,719,000 m^3 of embankments
- 4,867,000 m^3 of cuttings
- 9 off creek crossings, 30 m long
- 1 off tunnel, 400 m long
- 1 off tunnel, 500 m long
- 1 off tunnel, 550 m long
- 1 off tunnel, 1.5 km long
- 5 off viaducts 100 m long
- 1 off viaduct, 200 m long
- 1 off viaduct, 250 m long
- 2 off viaducts, 300 m long
- 1 off viaduct, 350 m long
- 1 off viaduct, 400 m long
- 1 off viaduct, 500 m long
- 1 off viaduct, 1.2 km long
- 1 off viaduct, 1.4 km long
- 14 off culverts
- 5 off grade separations
- 37 off level crossings

D09B & D36C1 Cecilvale – Gatton south of Toowoomba

This section of track is new and involves the following works:

- Track length 94.3 km (33.0km in the existing corridor)
- 8,890,000 m^3 of embankments
- 6,997,000 m^3 of cuttings
- 1 off creek crossing, 14 m long
- 6 off creek crossings, 30 m long
- 1 off creek crossing, 280 m long
- 1 off tunnel, 200 m long
- 1 off tunnel, 450 m long
- 1 off tunnel, 500 m long
- 1 off tunnel, 550 m long
- 1 off tunnel, 950 m long

- 1 off viaduct, 100 m long
- 2 off viaducts, 250 m long
- 1 off viaduct, 1.2 km long
- 1 off viaduct, 1.3 km long
- 35 off culverts
- 8 off grade separations
- 34 off level crossings