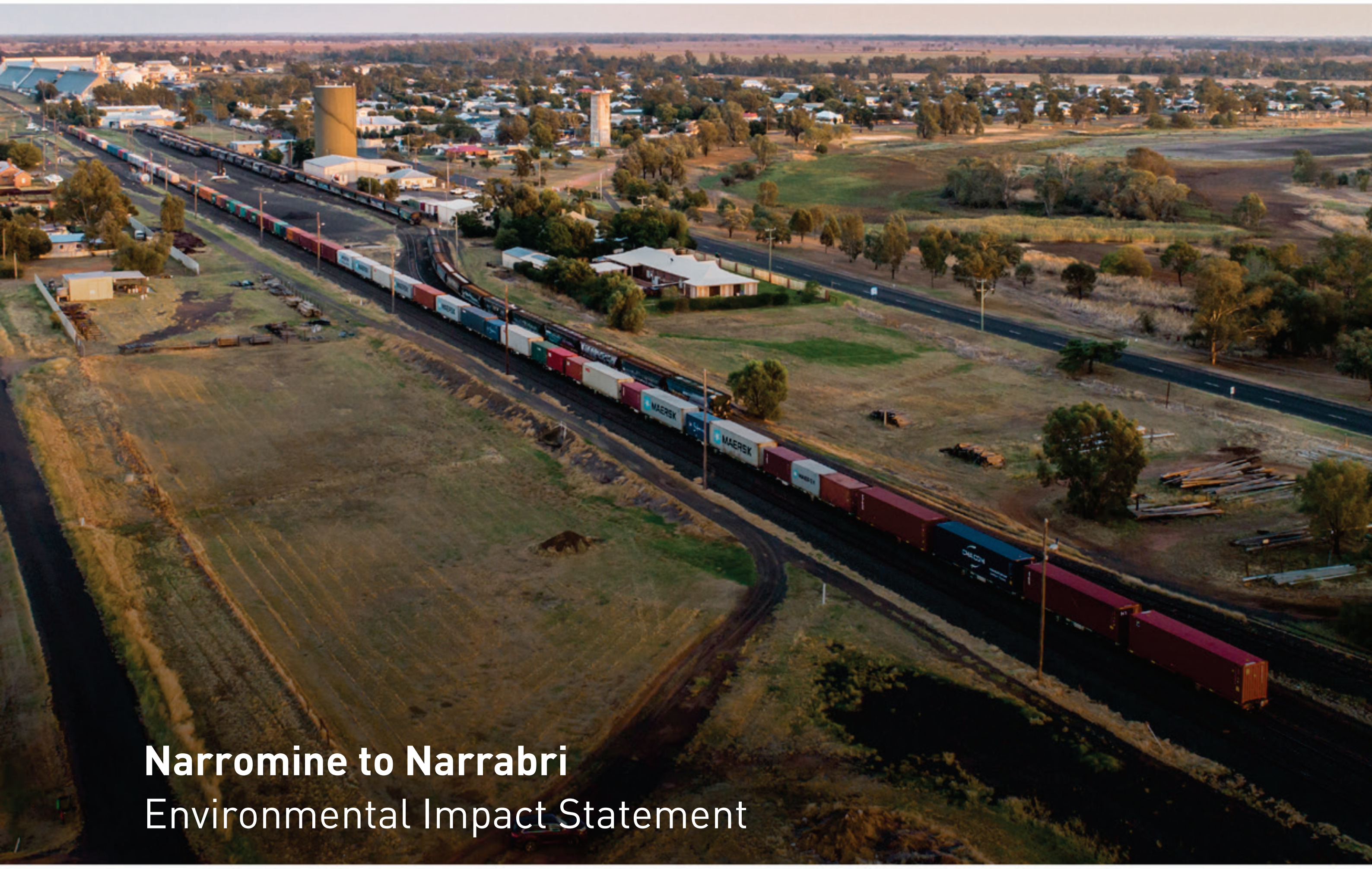
PART A

Introduction, project background and description

CHAPTER A6

Alternatives and options



Narromine to Narrabri

Environmental Impact Statement

The Australian Government is delivering Inland Rail through the Australian Rail Track Corporation (ARTC), in partnership with the private sector.

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A6. Alternatives and options

This chapter provides a summary of the alternatives that have been considered as part of the development of Inland Rail. These included the strategic alternatives to Inland Rail as a whole (including road upgrades, upgrading the east coast railway, greater use of maritime and air freight) and alternative route locations. The chapter also includes a summary of the main design and location options that were considered during the concept design process for the Narromine to Narrabri project (the proposal). Information on how the options were developed and assessed is provided.

A6.1 Inland Rail alternatives

A6.1.1 Strategic alternatives—alternative freight transport solutions

Alternative freight transport solutions with the potential to address Australia's current and future freight challenges were considered as part of a strategic options assessment set out in the *Inland Rail Programme Business Case* (ARTC, 2015), and examined in the *Melbourne–Brisbane Inland Rail Report* (Inland Rail Implementation Group, 2015).

Strategic options assessment

Three options were assessed by the *Inland Rail Programme Business Case* (ARTC, 2015):

- Progressive road upgrades
- Upgrading the existing east coast railway
- An inland railway.

These options were subjected to a rigorous assessment consistent with Infrastructure Australia's *Reform and Investment Framework* (Infrastructure Australia, 2014). The options were assessed against seven equally weighted criteria:

- Capacity to serve east coast future inter-capital regional/bulk freight market needs
- Foster economic growth through improved freight productivity and service quality (including improved reliability and resilience)
- Optimise environmental outcomes
- Alleviate urban constraints
- Enable regional development
- Ease of implementation
- Cost-effectiveness.

Overall, constructing an inland railway ranked highest, with an average high likelihood of improving outcomes across all criteria. Progressive road upgrades and upgrading the existing east coast railway both had an average medium overall ranking across all criteria. In relation to individual criteria, progressive road upgrades outranked an inland railway, only in relation to ease of implementation, and ranked equally with an inland railway in relation to enabling regional development outcomes. An inland railway was found to be the best option across all other criteria.

Review of alternatives

The following alternatives were reviewed by the Inland Rail Implementation Group:

- Maritime freight
- Air freight
- Road freight
- Rail solutions.

The results of the review of alternatives undertaken by the Inland Rail Implementation Group are summarised below.

Maritime freight

Maritime freight was examined as a potential alternative to Inland Rail based on two types of services:

- A dedicated service between Melbourne and Brisbane (coastal shipping)
- Using spare capacity on vessels calling at Melbourne and Brisbane as part of an international voyage.

The *Inland Rail Implementation Group Report* (ARTC, 2015) concluded that:

- Shipping is unlikely to be a strong alternative to Inland Rail, as it does not provide the level of service (transit time and service availability) required by the majority of the Melbourne to Brisbane interstate market
- Shipping still has a role to play, especially due to its strengths in transporting high-volume and long-distance cargo around the coast. Shipping must be used in conjunction with other modes, such as Inland Rail, to meet Australia's future transport needs.

Air freight

Domestic air freight accounts for less than 0.01 per cent of total domestic freight movements in Australia by weight. The majority of these movements are comprised of newspapers and parcels between major cities, on either dedicated freight flights or on existing passenger flights. Air freight is highly specialised due to the inherent constraints on aircraft size and the nature of the goods that can be carried. The report (ARTC, 2015) concluded that:

- Air freight has a limited role in the transport of bulky or heavy goods on the Melbourne to Brisbane corridor but will continue to play a crucial role for small, high-value and time-dependant goods
- Air freight is not a viable alternative for addressing Australia's freight requirements on the Melbourne to Brisbane corridor into the future.

Road freight

The role of road transport was considered as a potential alternative to Inland Rail. While rail carries a larger volume of freight overall, road transport is the main mode of transport for the majority of commodities produced or consumed in Australia. Along the north–south corridor, the main routes for road freight are on the Hume Highway (between Sydney and Melbourne), the Pacific Highway (for coastal transport between Sydney and Brisbane), and the Newell Highway (between Melbourne and Brisbane).

The identified issues and considerations relevant to road freight on these corridors include:

- The north–south road corridor will face significant local and regional capacity constraints for road freight in the medium to longer term
- The mix of local traffic, private vehicles and freight vehicles on road transport corridors reduces reliability, as a result of the different average travel speeds between cars and heavy vehicles, and increases accident rates
- Conflicts between local traffic, private vehicles and freight vehicles on these corridors will increase in line with significant forecast growth in population, employment, and demands for freight transport
- Compared with rail, road freight results in additional environmental costs, including from air pollution, greenhouse gas emissions, and water pollution
- The cost to freight operators of congestion in urban areas as a result of reduced travel speeds and reliability for freight transport is estimated to be around $60 million per year for Melbourne to Brisbane inter-capital freight alone
- Australian and State governments are investing in road infrastructure along the north–south corridor; however, this investment will be insufficient to remove all the existing and predicted future issues along the full length of the corridor, leaving trucking productivity exposed to the cumulative effects of the remaining deficiencies.

The report concluded that:

- While road transport will continue to contribute to Australia's freight task, unless substantial additional investment is made, it will be unlikely to meet the longer-term needs for Australia's freight task alone
- Should the Australian Government decide not to proceed with a rail solution, further investigation of road transport is required to determine its capacity to manage the future north–south freight task.

Rail solutions

The two main rail solutions considered were enhancing the existing east coast railway and constructing a new inland railway.

The report noted that there are a number of capacity, reliability and performance issues associated with the existing east coast railway, mainly relating to constraints associated with moving freight trains through the Sydney metropolitan rail network.

As a sub-option of enhancing the existing east coast railway, the report noted that the proposed new Outer Sydney Orbital corridor would provide opportunities for a rail route that could ease freight congestion on Sydney freight networks; however, the main role of this corridor is to address freight capacity constraints on other routes, such as those for intrastate and export freight. In addition, this option would not provide significant transit time savings for Melbourne to Brisbane freight, as the missing link between northwest NSW and southern Queensland would still be required, or the existing coastal line would need to be upgraded. The report concluded that use of the Outer Sydney Orbital corridor would complement, but not replace, Inland Rail.

The report concluded that:

- For Melbourne to Brisbane freight, the existing east coast railway would not be competitive with road in terms of cost or time, even with significant further investment, and it is not a viable alternative to Inland Rail
- Inland Rail would meet Australia's future freight challenge and bring significant and positive national benefits by boosting national productivity and economic growth, while promoting better safety and environmental outcomes.

Summary of findings

Overall, in relation to the various alternatives to Inland Rail, the Implementation Group concluded that (ARTC, 2015):

- While shipping and air will continue to play a role in the interstate freight market, they are not viable alternatives to rail
- Without Inland Rail, road is the only mode capable of addressing the majority of the future freight task, with associated direct and indirect costs.

A6.1.2 The 'do nothing' alternative

Not developing Inland Rail would result in continued growth in the use of road for freight transport between Melbourne and Brisbane, particularly along the Newell Highway. The issues associated with using road transport alone to address Australia's freight needs into the future are considered in section A6.1.1. In addition, road transport will be unlikely to meet the longer-term needs of Australia's freight task alone unless substantial additional investment is made (ARTC, 2015).

A6.1.3 Alternative locations/route options for Inland Rail

Alternative routes for Inland Rail as a whole were considered by the following two studies:

- *North–South Rail Corridor Study* (Department of Transport and Regional Services, 2006)
- *Melbourne–Brisbane Inland Rail Alignment Study* (ARTC, 2010).

The results of the studies are summarised below.

North–South Rail Corridor Study

The *North–South Rail Corridor Study Executive Report* ('the corridor study') considered potential corridors for the rail line to determine which route would deliver the best economic and financial outcome.

Options identified

Potential options were identified within a 'north–south rail corridor', which comprises an elliptically shaped area defined by the standard-gauge rail line along the NSW coast, and a broad arc west of Shepparton, Jerilderie, Coonamble, Burren Junction, Goondiwindi and Toowoomba. This area covers all sections of the existing rail network in Victoria, NSW, and Queensland that currently form, or could potentially form, part of a freight route between Melbourne and Brisbane.

Within this corridor, four sub-corridors were identified for comparative analysis, each of which could be combined with alternative routes between Melbourne and Junee, via Shepparton or via Albury. The four sub-corridors comprised:

- Far-western sub-corridor—linking Junee to Brisbane via Parkes, Dubbo and/or Narromine, Coonamble, Burren Junction, Narrabri and/or Moree, North Star, Goondiwindi, Warwick and/or Toowoomba
- Central inland sub-corridor—linking Junee to Brisbane via any inland route that includes the Werris Creek to Armidale to Tenterfield rail links
- Coastal sub-corridor—following the existing coastal route between Junee and Brisbane (via Goulburn), through Sydney
- Hybrid sub-corridor—combining elements of an inland and coastal route, linking Junee to Brisbane via Muswellbrook and Maitland.

Within each of these sub-corridors, the feasibility of 136 possible route options was investigated. These options involved different amounts of new track and/or upgrading existing sections of track.

Analysis of options

The route options were compared using an optimisation model specifically developed for the corridor study, based on the following criteria:

- Operating efficiency
- Infrastructure requirements
- Market demand
- Environmental constraints
- Financial and economic viability.

The study identified potential demand, financial issues, environmental issues, and infrastructure costs relevant to the four sub-corridors. The analysis undertaken for the corridor study concluded that the far-western sub-corridor (as shown in Figure A6.1) was markedly superior to the other alternatives.

FIGURE A6.1 **FAR-WESTERN SUB-CORRIDOR**

Melbourne–Brisbane Inland Rail Alignment Study

The purpose of the *Melbourne–Brisbane Inland Rail Alignment Study* ('the alignment study') (ARTC, 2010) was to determine the optimum alignment, economic benefits and likely commercial success of a new standard-gauge inland railway between Melbourne and Brisbane. The terms of reference for the study required it to develop a detailed route alignment, generally following the far western sub-corridor identified by the corridor study.

Options identified

The alignment study shortlisted and analysed a number of route options. The stages of route analysis involved:

- Identification of the route—evaluation of the route options and preliminary analysis for the three main areas: Melbourne to Parkes, Parkes to Moree, and Moree to Brisbane
- Analysis of the route—the route was analysed in terms of capital cost, environmental impacts and journey time, as well as its preliminary economic and financial viability
- Development of the preferred alignment—the alignment was developed considering environmental and engineering factors.

The alignment study noted that, with the combination of numerous route options and sections, there were over 50,000 possible options for the route between Melbourne and Brisbane. As it was not feasible to analyse each option, two key criteria (capital cost and journey time) were used to establish a shortlist of route options in each of the three main areas (as shown in Figure A6.2). The shortlist included:

- Melbourne to Parkes—two main options:
  - Via Albury, using existing track from Melbourne to Parkes (with a possible new direct line from Junee or Illabo to Stockinbingal, bypassing Cootamundra)
  - Via Shepparton, using the existing broad-gauge Mangalore–Tocumwal line via Shepparton, the disused standard-gauge line to Narrandera, and a new direct connection through to near Caragabal, before re-joining the existing line to Parkes.
- Parkes to Moree—four main options:
  - Parkes to Moree via Werris Creek, using existing track (with a new section of track at Binnaway and Werris Creek to avoid reversals)
  - Parkes to Moree via Binnaway and Narrabri, using existing track to Binnaway, and then a new section connecting to the existing track near Emerald Hill or Baan Baa
  - Parkes to Moree via Curban, Gwabegar and Narrabri, using existing track to Narromine, predominately new track between Narromine and Narrabri, and existing track from Narrabri to Moree
  - Parkes to Moree via Burren Junction, using existing track to Narromine, and predominately new track via Coonamble and Burren Junction to Moree.
- Moree to Brisbane—two main options:
  - The Warwick route; a new 'greenfield' route via Warwick to the existing standard-gauge Sydney–Brisbane line
  - The Toowoomba route; a new corridor direct from Inglewood to Millmerran and Oakey, near Toowoomba, and then a new alignment down the Toowoomba range, and use of the proposed Southern Freight Rail Corridor from Rosewood to Kagaru.

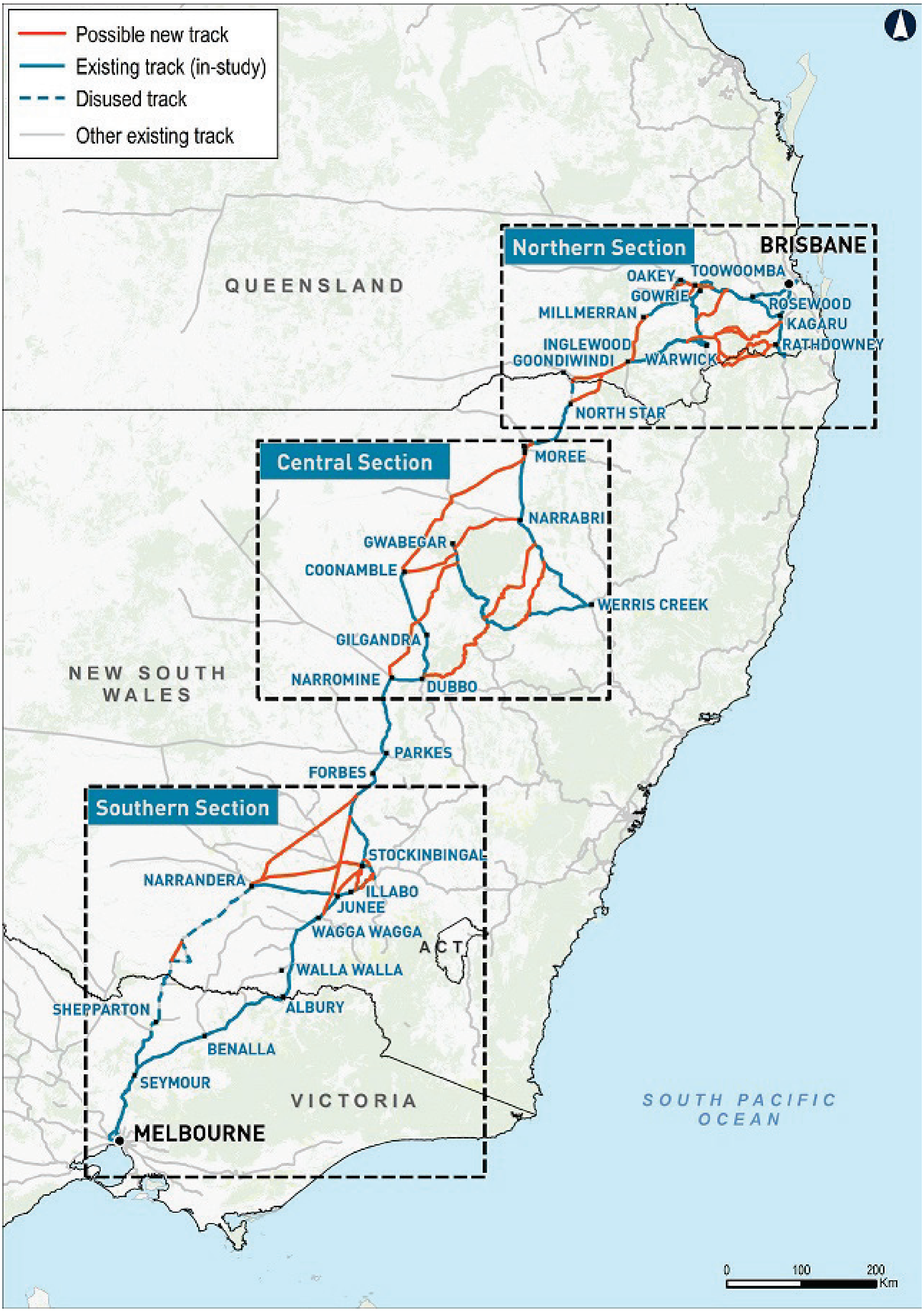

FIGURE A6.2 MELBOURNE-BRISBANE INLAND RAIL ALIGNMENT STUDY—SHORTLISTED OPTIONS

Analysis of options

The shortlist of route options was subjected to more detailed technical, financial and economic assessment. The option involving use of existing track towards Werris Creek had the lowest capital expenditure while still meeting the performance specification. This option had a length of about 1,880 kilometres (km). The option involving the more direct route between Narromine and Narrabri (via Curban) had the fastest transit time for a reasonable capital expenditure. This option, which had a length of about 1,731 km, became the focus for more detailed route, demand, economic and financial analysis.

Refining the proposed alignment involved an iterative process, with evaluation of the following:

- Environmental and land issues
- Railway operations considerations
- Engineering assessments
- Capital cost estimates.

The final preferred alignment, between South Dynon in Melbourne and Acacia Ridge in Brisbane, incorporated:

- Melbourne to Parkes—670 km of existing track and 37 km of new track on a greenfield alignment from Illabo to Stockinbingal, bypassing Cootamundra and the Bethungra spiral
- Parkes to North Star—307 km of upgraded track, and 291 km of new track on a greenfield alignment from Narromine to Narrabri
- North Star to Acacia Ridge—271 km of new track on a greenfield alignment, 119 km of existing track upgraded from narrow gauge to dual gauge, and 36 km of the existing coastal route.

A6.2 Alternative routes for the Narromine to Narrabri section

The Narromine to Narrabri section is one of the three 'missing link' projects in NSW. The original study area between Narromine and Narrabri was identified in the alignment study (as described in section A6.1.3), which informed the development of the *Inland Rail Programme Business Case* (ARTC, 2015).

A6.2.1 Initial alternatives considered

The key choice between Narromine and Narrabri (considered by the alignment study) was between an alignment via Werris Creek, largely or wholly using existing rail lines, or a more direct alignment involving a large proportion of new greenfield track (as shown in Figure A6.3).

The study identified that the more direct route:

- Was much shorter (about 150 km)
- Had higher capital costs but a faster transit time and higher potential demand.

The outcome of the alignment study was selection of the direct route between Narromine and Narrabri via Curban.

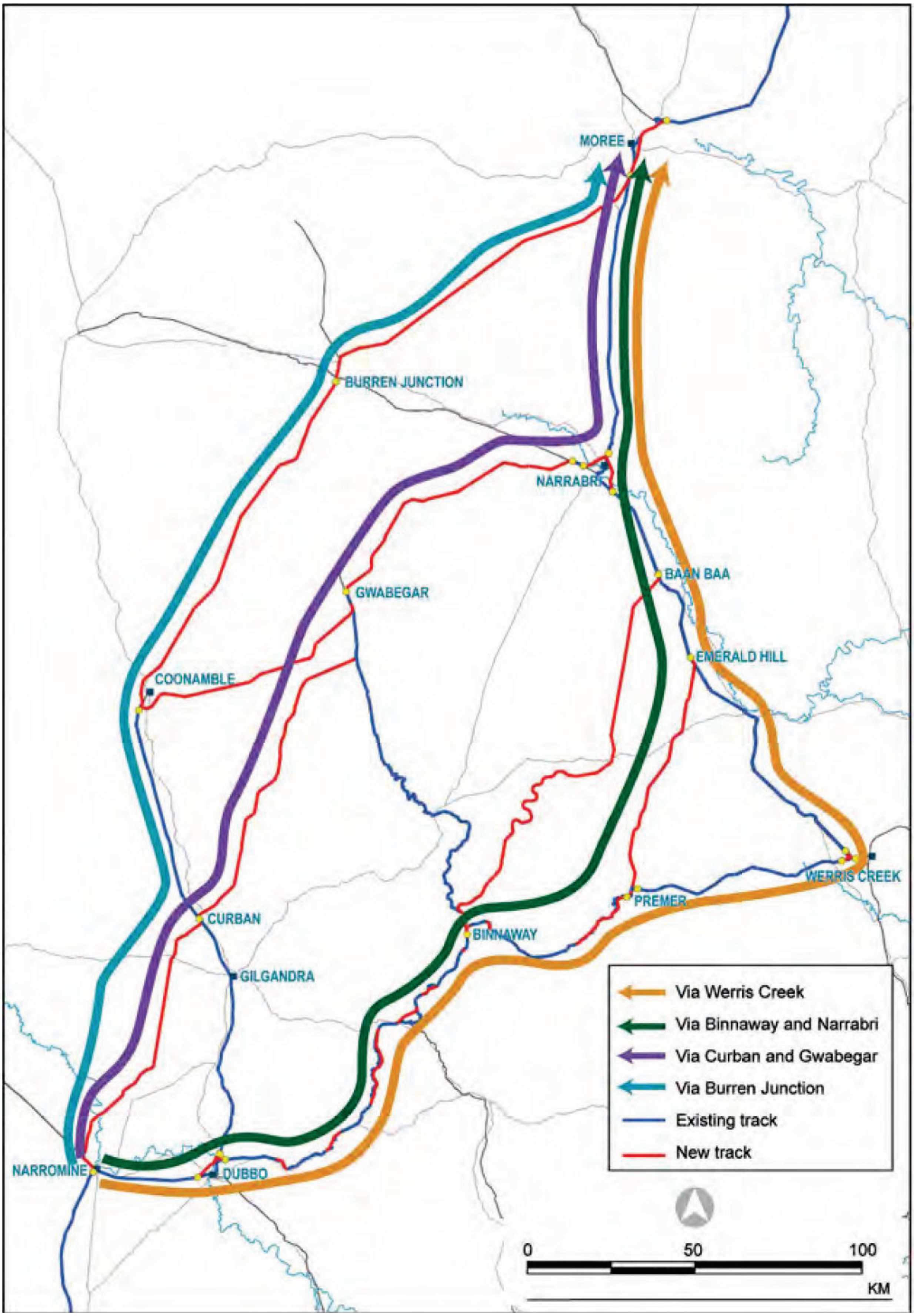

FIGURE A6.3 ROUTES BETWEEN NARROMINE AND NARRABRI CONSIDERED BY THE ALIGNMENT STUDY

A6.2.2 Refining the route

Option development has been an integral part of the overall design process for the proposal. An iterative process of option selection, design development and evaluation has been undertaken to define the proposal. Further to the strategic and initial planning studies for Inland Rail, as described above, the design process for the proposal involves the following general phases:

- Phase 1—concept design
- Phase 2—reference design
- Phase 3—detailed design.

A comprehensive review and assessment of potential options between Narromine and Narrabri has been undertaken during both phase 1 and phase 2 and is described in sections A6.2.3 and A6.2.4. The option selection and design process has also taken into account the issues raised during consultation with relevant stakeholders (see chapter A4), and the findings of environmental and engineering investigations. This process included consideration of maximising separation distances between the rail line and agricultural enterprises, and dwelling, where practicable. In addition, all options that were subject to assessment included, as relevant, an appropriate separation distance between the rail line and public roads in accordance with Transport for NSW requirements and design criteria. This separation distance enables vehicles to safely turn off the public road and have sufficient room to stop clear of the public road where there is a level crossing on the side road.

Key factors used to select the preferred option included multi-criteria assessment (MCA) workshops, consideration against the service offering and value for money considerations, as summarised in Figure A6.4.

The reference design documents the rail alignment and rail corridor, including any adjustments to roads and utilities. The proposal, as described in this EIS, is based on the outcomes of the reference design. The detailed design would take into account the outcomes of the reference design phase; the findings of this EIS, including the mitigation measures; and any conditions of approval (if the proposal is approved).

IS A ROUTE VIABLE?

MULTI-CRITERIA ANALYSIS *

TECHNICAL VIABILITY (17%)
considers the alignment, impact on public utilities, geotechnical conditions, impacts on existing road and rail networks, flood immunity and hydrology and future proofing.

ENVIRONMENTAL IMPACTS (12.5%)
considers the ecological impacts (flora, fauna and habitats), visual impacts, noise and vibration impacts, flooding and waterway impacts and the effect on air quality and greenhouse gas emissions.

OPERATIONAL APPROACH (16.5%)
considers the impact on travel time, reliability and availability, and network interoperability and connectivity including interfaces with rail terminals and network.

SAFETY ASSESSMENT (16.5%)
considers construction safety, operational safety, public safety, road safety interfaces and emergency response response.

COMMUNITY AND PROPERTY IMPACTS (12.5%)
considers property impacts, Indigenous and non-Indigenous heritage, heritage, impact on community, community response and current and future land use and links to economic impacts.

APPROVALS AND STAKEHOLDER ENGAGEMENT (12.5%)
considers planning and approval requirements, State and Federal agency buy-in, Local government buy-in, other statutory and regulatory approvals and service authorities, such as utilities etc.

CONSTRUCTABILITY & SCHEDULE (12.5%)
considers construction duration, access and complexity, resources, interface with operational railway and staging opportunities.

This is a broad range of qualitative and quantitative criteria that is considered as part of the Multi-Criteria Analysis (MCA). The MCA process is recognised as an industry standard and is widely used in Australia and internationally.

DOES IT ENHANCE THE SERVICE OFFERING?

Alternatives are compared on their ability to enhance the

SERVICE OFFERING

TRANSIT TIME
< 24 HOURS
requires a transit time from Melbourne to Brisbane of less than 24 hours.

RELIABILITY
98%
requires 98% reliability to freight customers.

COMPETITIVE PRICING
requires competitive pricing for freight customers .

AVAILABILITY
requires suitable train paths at the times that suit the needs of the market.

This is the minimum level of service required by rail operators and freight customers.

* The criteria are weighted to reflect relative importance in decision making. However, different MCAs can have slightly different weightings reflecting the specifics of the options under assessment and taking into account any previous MCA results or other assessments undertaken in respect of the options being considered.

IS IT VALUE FOR MONEY?

Alternatives are compared on basis of

COSTS

CONSTRUCTION ESTIMATE

OPERATING COSTS

This is the construction estimate, and track maintenance and train operating costs for customers.

The final step in the process is that ARTC makes a recommendation to the Minister for Infrastructure and Transport through the Inland Rail Sponsors Group (Previously the Inland Rail Steering Committee).

FIGURE A6.4 FACTORS AFFECTING ROUTE SELECTION SINCE 2016

A6.2.3 Phase 1 concept design assessment

Options identification

The Phase 1 concept design process commenced in early 2016. During 2016 and 2017 ARTC carried out a detailed review of the Narromine to Narrabri section based on the route selected in the alignment study. The review included field investigations and consultation with the community and stakeholders.

This involved reviewing the 'base case' (the 2010 alignment) to investigate potential deviation options that could offer overall improvements, taking into account a range of factors, including property, environment and safety. The outcome of this assessment was development of the 2016 concept alignment. This alignment informed initial discussions with the community and stakeholders, including local councils, landholders and farmers' representatives. Feedback from these discussions highlighted the expectation that ARTC should consider alternative options.

In response to community and stakeholder feedback, about 50 alternative options were developed. These included:

- South of Curban—options including use of sections of the existing Dubbo to Narromine and Dubbo to Coonamble rail lines
- North of Curban—incorporating sections of the existing Dubbo to Coonamble line to reduce the length of greenfield corridor
- Direct routes through the Pilliga East State Forest—avoiding prime farmland along the 2016 concept alignment.

A comparison of the additional options indicated that:

- The routes through the Pilliga East State Forest would result in a favourable combination of reduced transit time and lower construction cost
- Routes via Dubbo and Coonamble would increase travel times and substantially increase construction cost.

Options assessment

The options were refined and assessed during MCA workshops held in October 2016, December 2016 and May 2017. During the initial October 2016 workshop, 28 corridor options were assessed across 5 discrete geographic sections. Options were assessed using the Inland Rail MCA criteria, in addition to the service offering and value for money, as shown in Figure A6.4.

The shortlisted options were subject to further alignment refinements and were considered by the December 2016 MCA workshop. The purpose of this workshop was to determine the options to take forward for further investigation and consultation. The shortlisted options developed as an outcome of the assessment are shown in Figure A6.5.

Further information on the options considered, and the results of the assessment, is provided in the *Melbourne to Brisbane Inland Rail Route History 2006–2019* (ARTC, 2020a).

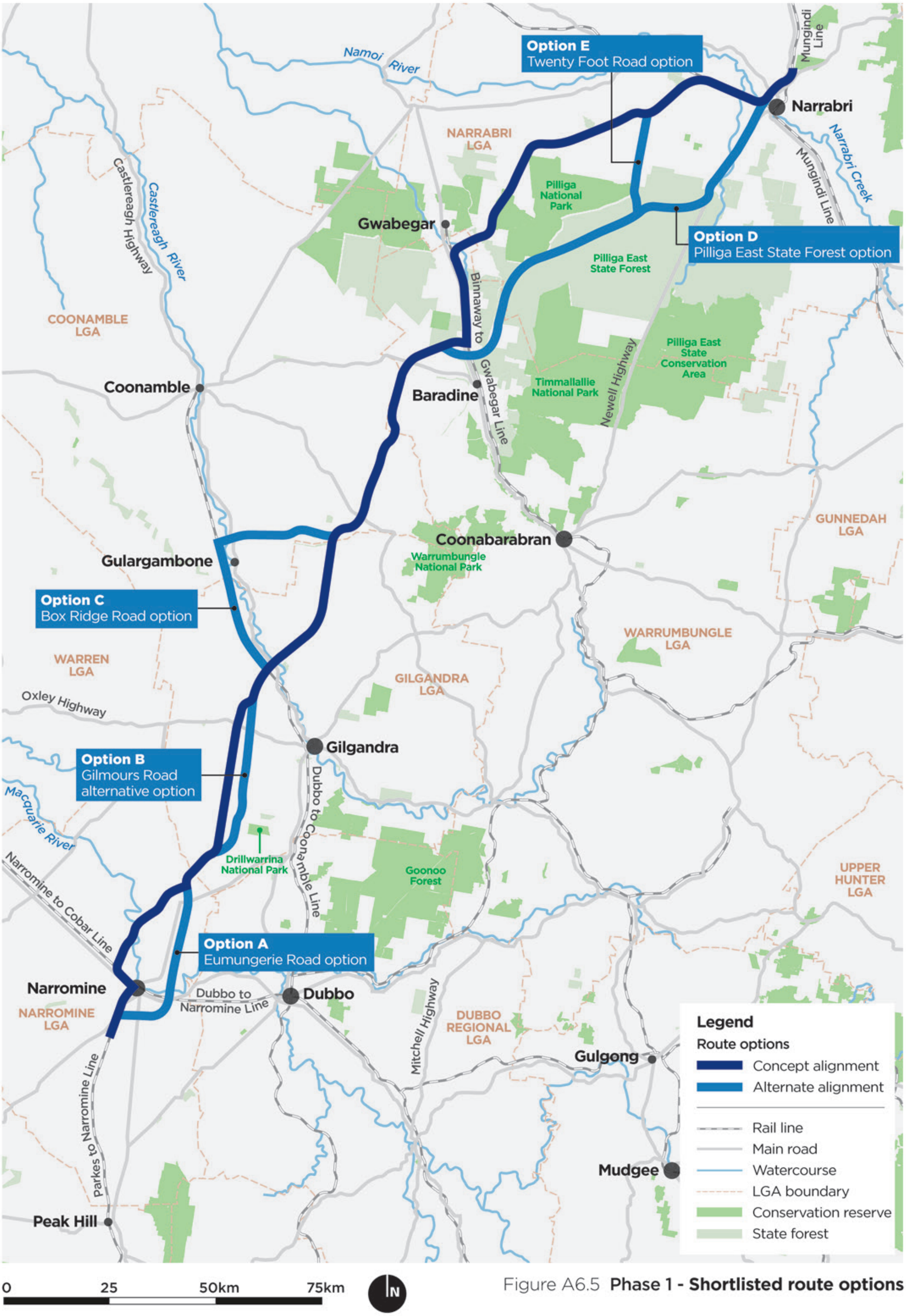

Figure A6.5 **Phase 1 - Shortlisted route options**

Following the December 2016 MCA workshop, over 400 meetings were held with landholders, local councils, government agencies and other key stakeholders. Additional field surveys were also completed. Feedback from the consultations and surveys was considered in the final MCA held in May 2017. A summary of the outcomes of the assessment, including the options considered and the preferred options identified, is provided in Table A6.1.

TABLE A6.1 PHASE 1 OPTIONS ASSESSMENT—SUMMARY OF RESULTS

Section	Options considered	Preferred option	Justification for preferred option
Narromine to Burroway	▸ 2016 concept alignment ▸ Option A—Eumungerie Road option	Option A	▸ Overall MCA scoring was positive ▸ Reduces property impacts ▸ Minimises impacts at Narromine ▸ Fewer geotechnical issues ▸ Fewer hydrology and flooding issues
Burroway to Curban	▸ 2016 concept alignment ▸ Option B—Gilmours Road alternative option	Option B	▸ Overall MCA scoring was positive ▸ Capital cost benefits ▸ Fewer geotechnical issues ▸ Fewer hydrology and flooding issues
Curban to Mt Tenandra	▸ 2016 concept alignment ▸ Option C—Box Ridge Road option	2016 concept alignment	▸ Travel time savings ▸ Overall MCA scoring was positive ▸ Capital cost benefits
Mt Tenandra to Baradine	▸ 2016 concept alignment (as refined)	2016 concept alignment	▸ The alignment in this section is constrained by the foothills of the Warrumbungle Range to the east and poor draining 'black' soils to the west. There are few practical corridor options, all of which follow the 2016 concept alignment. Several alignment refinements were proposed to reduce impacts on agricultural land and residential properties.
Baradine to Narrabri	▸ 2016 concept alignment ▸ Option D—Pilliga State Forest option ▸ Option E—Twenty Foot Road option	Option D	▸ Travel time savings ▸ Overall MCA scoring was positive ▸ Capital cost benefits ▸ Avoids higher production land and minimises property impacts

Preferred option

At the end of phase 1, while a preferred option had been selected in some parts, a wide study area was defined to allow for a further phase of investigations to occur prior to finalising a preferred route. The phase 2 study area varied in width, from about 5-km wide south and east of Narromine, to about 500 m in other sections. The study area is shown in Figure A6.6.

Figure A6.6 **Study area for Phase 2 investigations**

A6.2.4 Phase 2 reference design assessment

The aim of the phase 2 assessment was to select a narrow focus area (about 150-m wide) for further targeted consultation with directly affected landholders prior to finalising the preferred alignment.

During phase 2, further investigations were undertaken within the study area shown in Figure A6.6 (where property access was available). This was supported by targeted consultation with stakeholders and landholders.

The process of identifying and assessing options generally involved three stages:

- Stage 1 considered sub-sections of the overall study area where there were no feasible alternatives for the route
- Stage 2 comprised sub-sections where alternatives had been identified but where no land access was available for site investigations to inform the route selection process
- Stage 3 comprised sections where alternatives had been identified and land access was available to undertake further investigations. This stage also included sub-sections where there were no feasible alternatives; however, a focus area could not be defined until the focus area in the adjoining sub-sections had been determined.

Options identification

As noted above, in some parts of the study area there are no feasible route alternatives. In other parts of the study area, a number of options were considered, including those assessed during phase 1. In some parts of the study area, such as areas to the south and east of Narromine, additional options were identified following meetings with landholders and other stakeholders.

Options were identified across five discrete geographic sections, which were further divided into 14 discrete sub-sections, as shown in Figure A6.7.

Key shortlisted options identified during this phase are summarised below.

Stage 1 sub-sections

Four sub-sections were considered—Curban to Mt Tenandra, Black Hollow South, Black Hollow North and Pilliga.

As there were no feasible alternatives, key considerations for selecting the focus area included, minimising property severance and avoiding areas of poor geotechnical conditions.

Stage 2 sub-sections

Three sub-sections were considered:

Gilmours Road

Three options were considered, two that ran parallel with Gilmours Road (one to the east and one to the west) and one that generally followed Nancarrows Road to the east.

Key considerations for identifying feasible options and selecting the focus area for this sub-section included alignment, geotechnical conditions, flooding, availability of material for the rail formation, amenity impacts (e.g. noise, air quality and visual) and property impacts (e.g. severance and acquisition).

Weenya Road

Two options were considered, one that followed Box Ridge Road and Weenya Road to the east of Mt Tenandra, and one to the west that generally followed property boundaries and Goorianawa Road.

Key considerations for identifying feasible options and selecting the focus area, included existing utilities, geotechnical conditions, flooding, construction complexity, availability of material for the rail formation, ecology, amenity and property impacts.

Black Hollow

Two options were considered; one to the east of Flat Top Hill and one to the west.

Key considerations for identifying feasible options and selecting the focus area, included existing utilities, flooding, construction complexity, ecology, amenity and property impacts.

Stage 3 sub-sections

Three sub-sections were considered:

Narromine South

Five options to the south and east of Narromine were considered, with the key differences between the options being the distance from Narromine and the point of crossing of the Macquarie River. Two options generally followed Pinedean Road on the southern edge of the study area before heading north and crossing the Macquarie River. Two options generally followed Craigie Lea Lane before heading north and crossing the Macquarie River. The other option traversed farmland closer to Narromine before heading north to cross the Macquarie River.

Key considerations for identifying feasible options and selecting the focus area for this sub-section included topography and length of bridge required to cross the Macquarie River, connectivity with the existing Parkes to Narromine Line, existing roads, geotechnical conditions, flooding, ecology, Aboriginal heritage, amenity and property impacts.

Eumungerie Road

Three options were considered, two that ran parallel with Eumungerie Road (one to the east and one to the west) before following Cobboco Road, and one that traversed farmland and then followed Cobboco Road to the west.

Key considerations for identifying feasible options and selecting the focus area, included existing roads, property accesses, ecology, visual impacts, amenity and property impacts.

Pilliga East

Three options were considered, two that take a direct route through the north-east corner of the Pilliga East State Forest and one that generally followed Pilliga Forest Way. All options exited the state forest to the north of the proposed location of the Santos water treatment plant before traversing farmland and joining the Newell Highway.

Key considerations for identifying feasible options and selecting the focus area included alignment length, travel time, ecology, amenity and property impacts.

Narrabri

Five options to the south and west of Narrabri were considered with the key differences being distance from the Newell Highway (south of Narrabri) and the point of crossing of the Narrabri Creek/Namoi River floodplain (west to Narrabri). One option generally followed the Newell Highway before heading around the western edge of Narrabri, while the other four options traversed farmland before crossing the floodplain at various distances from Narrabri. Across the floodplain, most options were located relatively close to Narrabri, while one option was located on the western edge of the study area.

Key considerations for identifying feasible options and selecting the focus area included length of bridge required to cross the floodplain, existing roads, connectivity with the existing Narrabri to Walgett Line, Narrabri waste management facility, geotechnical conditions, flooding, ecology, amenity and property impacts.

Areas with no feasible alternatives

There were no feasible alternatives for three areas—Curban Junction, Newell Highway and Narrabri North.

Key considerations for selecting the focus area for these areas included flooding, geotechnical conditions, ecology, Aboriginal heritage, amenity and property impacts.

Figure A6.7 **Sections of the Phase 2 study area**

Options assessment

The options were refined and assessed during MCA workshops in 2019, with consideration of the assessment factors and criteria shown in Figure A6.4. Feedback from consultation, including community information sessions (held in September 2018) and over 200 meetings with impacted landholders (held in February 2018), was considered in the MCA workshops. Additional environmental and engineering field surveys were also undertaken and considered in the MCA workshops. A summary of the outcomes of the assessment, including the sections where options were considered, the number of options considered in these sections, and the justification for the preferred option selected, is provided in Table A6.2. It is noted that for some sections, as listed in the table, there were no feasible options available, as the study area was considered to:

- Minimise impacts on properties and limit property severance by following boundaries and road reserves, where practicable
- Appropriately balance property impacts with engineering and environmental constraints while meeting the service offering.

For these sections, adjusting the study area would increase impacts on properties and residents.

The sections are arranged south to north.

TABLE A6.2 PHASE 2 OPTIONS ASSESSMENT

Stage	Section	Sub-section	Number of options considered	Justification for preferred option
3	Narromine to Burroway	Narromine South	Five options were considered	▸ Overall MCA scoring was positive ▸ Shorter length of crossing of the Macquarie River ▸ Less construction complexity ▸ Fewer geotechnical issues ▸ Fewer hydrology and flooding issues
3	Narromine to Burroway	Eumungerie Road	Three options were considered.	▸ Overall MCA scoring outcomes were close and positive for each option ▸ Runs parallel with an existing transport corridor (Eumungerie Road) ▸ Fewer interactions with existing roads and public accesses
2	Burroway to Curban	Gilmours Road	Three options were considered	▸ Overall MCA scoring outcomes were close and positive for each option ▸ Fewer geotechnical issues ▸ Fewer hydrology and flooding issues
3	Curban to Mt Tenandra	Curban Junction	No options were considered.	n/a
1	Curban to Mt Tenandra	Curban to Mt Tenandra	No options were considered.	n/a
2	Mt Tenandra to Baradine	Weenya Road	Two options were considered	▸ Overall MCA scoring outcomes were close and positive for each option ▸ Fewer impacts on existing utilities ▸ Fewer geotechnical issues ▸ Fewer hydrology and flooding issues ▸ Fewer ecological impacts
1	Mt Tenandra to Baradine	Black Hollow South	No options were considered	n/a
2	Mt Tenandra to Baradine	Black Hollow	Two options were considered	▸ Overall MCA scoring was positive ▸ Better constructability and earthworks balance ▸ Less visual impacts due to shallower cuts in Flat Top Hill ▸ Fewer property impacts
1	Mt Tenandra to Baradine	Black Hollow North	No options were considered	n/a

Stage	Section	Sub-section	Number of options considered	Justification for preferred option
1	Baradine to Narrabri	Pilliga	No options were considered	n/a
3	Baradine to Narrabri	Pilliga East	Three options were considered	▸ Overall MCA scoring outcomes were close and positive for each option ▸ Favourable length and transit time ▸ Reduces property severance north of the State forest ▸ A wider focus area was defined near Bohena Creek to allow for further refinements to minimise length within the 1% AEP flood event. This is considered further, below.
3	Baradine to Narrabri	Newell Highway	No options were considered	n/a
3	Baradine to Narrabri	Narrabri	Five options were considered	▸ Overall MCA scoring was positive ▸ Located further to the west from Narrabri (relative to most options) ▸ Shorter connection to the Narrabri to Walgett Line ▸ Appropriately balances property impacts with engineering and environmental constraints, while meeting the service offering ▸ An outcome from the workshop was to investigate refining the focus area to reduce property impact near Yarrie Lake Road where practicable. This is considered further, below.
3	Baradine to Narrabri	Narrabri North	No options were considered	n/a

Preferred option

As an outcome of the phase 2 assessment, a focus area for further investigations was confirmed. The focus area was typically 150-m wide but was wider in some areas to allow for design refinements to occur.

Design refinement

ARTC undertook consultation with directly affected landholders and other key stakeholders based on the focus area. This consultation was used to inform refinement of the reference design. Further information on consultation undertaken is provided in chapter A4.

The following design refinements were undertaken:

- The Macquarie River crossing was reviewed to identify opportunities to maximise shielding (e.g. for noise and visual impacts) behind natural topography on the north side of the river. Realignment at this location was not considered desirable due to engineering and environmental constraints at the crossing location and because it would increase property impacts on the south of the Mitchell Highway.
- The alignment was moved along Eumungerie Road and Newell Highway to provide an offset of 65 m, following further consultation between ARTC and Transport for NSW
- The alignment was reviewed near Yarrie Lake Road to minimise property impacts; however, due to other engineering and environmental constraints, it is not aligned with the property boundaries and would still result in some impacts
- The alignment was refined where it meets the Newell Highway, to minimise the length within the 1% AEP flood event for Bohena Creek
- Various adjustments were made to the horizontal alignment and rail corridor to reflect new survey adjusted cadastre and desired offsets to other infrastructure (e.g. roads and utilities) and residences
- Various adjustments were made to the vertical rail alignment to manage earthwork quantities (i.e. desired cut/fill balance) and minimise grade changes for roads where level crossings would be provided
- A grade-separated crossing would be provided at Kickabil Road
- The rail alignment was adjusted near Cumbil Creek to avoid an Aboriginal heritage site.

A6.3 Options considered for proposal features

Options assessments were undertaken for the following features of the proposal:

- Connections with other rail lines
- Crossing loops
- Public road interactions
- Private road interactions
- Construction material—borrow pits to supply material and options for disposal of spoil
- Construction water.

A6.3.1 Connections with other rail lines

Connectivity and interoperability are key characteristics of the Inland Rail program and its outcomes. Inland Rail is a strategic enhancement of the national freight supply chain, which allows connectivity for regional Australia. In accordance with that strategic intent, the following connectivity principles provide guidance for connecting Inland Rail to the existing rail network:

- ARTC is committed to working collaboratively with stakeholders to ensure efficient connectivity is provided
- Direct connectivity is only provided when no reasonably efficient connection is already available, or will be available, once Inland Rail is constructed.

It is acknowledged that connecting regional Australia is an important consideration for Inland Rail; however, the connections must also be genuinely needed, with enough existing or future rail traffic to ensure that the value-for-money criteria can also be demonstrated.

Options identification

ARTC has undertaken consultation with Transport for NSW and other relevant stakeholders about the connectivity requirements between Inland Rail and the existing rail lines. Location and configuration options for the new connections were identified, with consideration given to the following criteria:

- Operational speed
- Environmental impacts
- Impacts on the existing rail line
- Impacts on existing roads and existing level crossings
- Length of new track required
- Volume of earthworks required
- Number and type of properties impacted
- Services relocations required.

Options for connections were identified and considered for three of the rail lines crossed by the proposal, as described below.

The majority of the proposed junctions are possible future connections. Approval for these connections is sought as part of the proposal. The possible future connections would be constructed by ARTC, as required.

Narromine to Cobar Line

To the west of Narromine, a new junction is proposed as a possible future connection, to provide connectivity between the Parkes to Narromine Line and the Narromine to Cobar Line (the Narromine West connection). The new junction would allow trains from the west to access Inland Rail. Access to Inland Rail (and the proposal) is provided by existing track for trains from the east.

The following options were identified for further assessment, as shown in Figure A6.8.

Option 1—involves 700 m of new track within a new rail corridor. It would deviate from the Parkes to Narromine Line immediately north of the existing level crossing on Dandaloo Road, pass through the GrainCorp grain facility, and then join the Narromine to Cobar Line about 1.1 km east of McNamaras Lane. This option requires upgrading about 200 m of existing track and formation on the Narromine to Cobar Line.

Option 2—involves 1.2 km of new track within a new rail corridor. It would deviate from the Parkes to Narromine Line about 110 m north of the existing level crossing on Old Backwater Road. It would then traverse farmland, passing immediately to the west of the GrainCorp grain facility, before joining the Narromine to Cobar Line, about 870 m east of McNamaras Lane, near an irrigation channel. This option requires upgrading about 550 m of existing track and formation on the Narromine to Cobar Line.

Option 3—involves 1.2 km of new track within a new rail corridor. It would deviate from the Parkes to Narromine Line immediately north of the existing level crossing on Old Backwater Road, traversing farmland, before passing through the south-west corner of GrainCorp grain facility. It would then cross an irrigation channel before joining the Narromine to Cobar Line about 500 m east of McNamaras Lane. This option requires upgrading about 200 m of existing track and formation on the Narromine to Cobar Line.

Figure A6.8 **Narromine to Cobar Line connection options**

Dubbo to Coonamble Line

Near Curban, a new junction is proposed to provide connectivity between the proposal and Dubbo to Coonamble Line. The new junction would allow trains to move between the two lines. Parts of the new junction are possible future connections that may be constructed at a later date.

The following options were identified for further assessment, as shown in Figure A6.9.

Option 1—a grade-separated junction with the proposal, passing over the Dubbo to Coonamble Line on a bridge. Full connectivity would be provided by at-grade legs between the lines providing for all train movements. The new junction would include about 5.3 km of new track.

Option 2—an at-grade junction, which would provide connectivity between the proposal and the Dubbo to Coonamble Line. The junction would provide a route from east to south and from west to north. The new junction would include about 4.6 km of new track. Two of the legs of the junction that enable movements from west to south and east to north are possible future connections that may be constructed at a later date. The junction would also require realignment of Wyuna Road and Bardens Road.

Narrabri to Walgett Line

To the west of Narrabri, the proposal crosses the Narrabri to Walgett Line on a bridge. A new junction is proposed as a possible future connection, to provide connectivity between the proposal and the Narrabri to Walgett Line. The new junction is a possible future connection that may be constructed at a later date. Other connection options were also considered as part of selecting the preferred option for the proposal to the west of Narrabri, as discussed in section A6.2.4. Only those connection options for the preferred alignment option are discussed in this section.

The following options were identified for further assessment, as shown in Figure A6.10.

Option 1—about 1.8 km of new track would be provided to allow train movements from north to east and south to west, with low speed curves. For this option, both the proposal and the new connection would be at the same grade as the Narrabri to Walgett Line. All legs on this option would need to be constructed at the same time as the proposal, to maintain train movements on the Narrabri to Walgett Line.

Option 2—about 1.8 km of new track would be provided to allow trains from the west to access the proposal and travel south. For this option, the proposal would pass over the Narrabri to Walgett Line on a bridge, with the connection providing an at-grade connection. Access for trains from west to north would be possible via the existing track through Narrabri. The new junction is a possible future connection that may be constructed at a later date.

Figure A6.9 **Dubbo to Coonamble Line connection options**

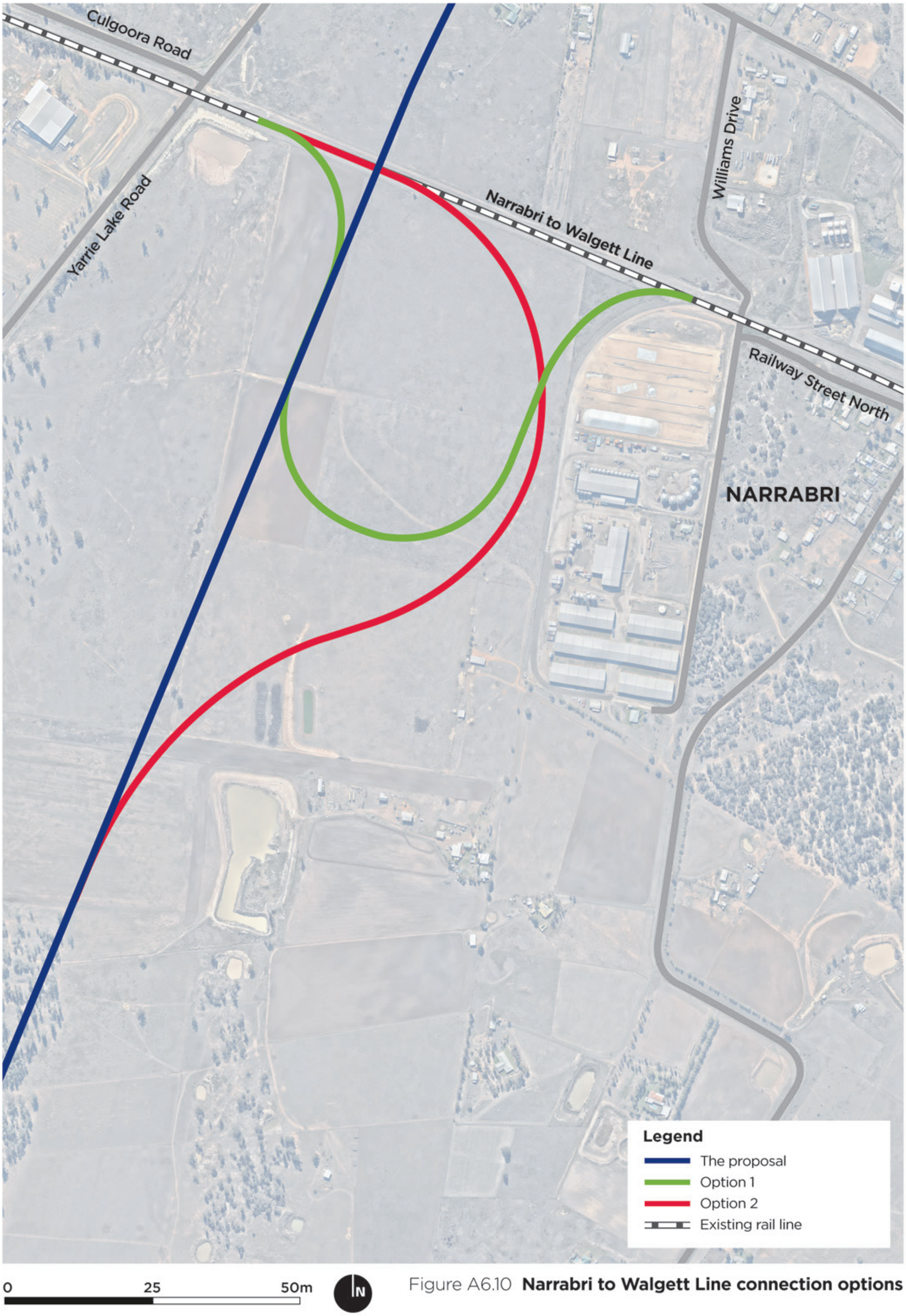

Figure A6.10 **Narrabri to Walgett Line connection options**

Options assessment

The identified options were reviewed with consideration of the criteria listed above. The results of the review are summarised in Table A6.3.

TABLE A6.3 CONNECTIONS WITH OTHER RAIL LINES—OPTIONS ASSESSMENT

Connection	Options considered	Preferred option	Justification for preferred option
Narromine to Cobar Line	Option 1 Option 2 Option 3	Option 2	▸ Avoids direct impacts on the GrainCorp facility ▸ Minimise property impacts ▸ Avoids a new crossing of the irrigation channel
Dubbo to Coonamble Line	Option 1 Option 2	Option 2	▸ No bridge structure ▸ Minimises earthworks ▸ Minimises property impacts ▸ Ease of maintenance
Narrabri to Walgett Line	Option 1 Option 2	Option 2	▸ Achieves operational requirements with simplest solution ▸ Permits the junction to be constructed at a later date, when required ▸ Minimises property impacts ▸ Fewer geotechnical issues ▸ Fewer hydrology and flooding issues

Preferred options

The preferred options are:

- Narromine to Cobar Line—option 2
- Dubbo to Coonamble Line—option 2
- Narrabri to Walgett Line—option 2.

These options form part of the proposal, as described in chapter A7.

A6.3.2 Crossing loops

Options identification

A crossing loop is a section of track off to the side of the main track that allows a train to move to the side so that another train can pass along the main track. Trains move to the crossing loop via turnouts.

Crossing loops are positioned along a rail line using a network modelling methodology. This identifies locations, to provide the maximum number of possible 'train paths' on the network. The number of potential train paths on a network represents the capacity of that network. For Inland Rail, a crossing loop is required about every 40 km.

The loops required for the proposal would be parallel to the new main line within the new rail corridor. They would each be up to 2.2 km long, to fit the design length of the trains (1,800 m). The design of each loop has also considered possible future expansion for 3,600-m long trains. A maintenance siding is also required at each crossing loop. These sidings would provide for temporary storage of maintenance trains (250 m long) when the main line and crossing loop is required for train movements.

Crossing loop locations were initially identified based mainly on network modelling and track geometry.

Following further review of engineering and environmental constraints, additional location options were identified for some loops. The following options were considered:

- Crossing loop 1 (Burroway)—no alternative options identified
- Crossing loop 2 (Balladoran)—five options were considered, with the main differences between the options being the arrangement of the loop and maintenance siding relative to Milpulling Road, with some requiring realignment of the road. Key considerations for identifying and assessing feasible options included impacts on Milpulling Road, formation earthworks volumes, length of operational access road required, proximity to bridges and property impacts.
- Crossing loop 3 (Curban)—three options were considered, with the key differences being the arrangement of the loop and maintenance siding relative to a private road and proposed private level crossing, with some requiring realignment of the road. Key considerations for identifying and assessing feasible options included impacts on the private road and proposed private level crossing and property impacts.

- Crossing loop 4 (Black Hollow/Quanda)—three options were considered, with key differences being the arrangement of the loop and maintenance siding relative to residences. Key considerations for identifying and assessing feasible options included formation earthworks volumes, length of operational access road required and amenity (e.g. noise, air quality and visual) impacts.
- Crossing loop 5 (Baradine)—no alternative options identified
- Crossing loop 6 (the Pilliga)—no alternative options identified
- Crossing loop 7 (Bohena Creek/Narrabri)—four options were considered, with key differences being the arrangement of the loop and maintenance siding relative to Cains Crossing Road, with some requiring realignment of the road. Key considerations for identifying and assessing feasible options included impacts on Cains Crossing Road, formation earthworks volumes, proximity to proposed level crossings, proximity to bridges, flooding and property impacts.

Options assessment

A review of the identified options was undertaken with consideration of the following criteria:

- Network modelling
- Train length
- Main line track curves and grades
- Avoiding proposed locations for bridges and large lengths of culverts
- Avoiding proposed locations for level crossings
- Minimising property impacts
- Earthwork cut-and-fill volumes
- Maintenance access
- Residential receivers
- Minimising utility impacts
- Availability of power.

The results of the review are summarised in Table A6.4.

TABLE A6.4 CROSSING LOOP LOCATIONS—OPTIONS ASSESSMENT

Crossing loop	Options considered	Preferred option	Justification for preferred option
Loop 1 Burroway	Initial option	Initial option	The initial option is the preferred option as it meets network modelling requirements and no significant engineering or environmental issues have been identified.
Loop 2 Balladoran	Initial option Option 2a Option 2b Option 2c Option 2d	Option 2b	Option 2b was selected as the preferred option as it avoids impacts on Milpulling Road and minimises earthworks and property impacts.
Loop 3 Curban	Initial option Option 3a Option 3b	Option 3b	Option 3b was selected as the preferred option as it avoids impacts on the private road and proposed private level crossing and minimises property impacts.
Loop 4 Black Hollow/ Quanda	Initial option Option 4a Option 4b	Option 4b	Option 4b was selected as the preferred option as it avoids proposed bridges and provides good access; however, with this option, the maintenance siding is located closer to residences.
Loop 5 Baradine	Initial option	Initial option	The initial option is the preferred option as it meets network modelling requirements and no significant engineering or environmental issues have been identified.
Loop 6 The Pilliga	Initial option	Initial option	The initial option is the preferred option as it meets network modelling requirements and no significant engineering or environmental issues have been identified.
Loop 7 Bohena Creek/ Narrabri	Initial option Option 7a Option 7b Option 7c	Option 7a	Option 7a was selected as the preferred option as it avoids conflicts with Cains Crossing Road through realignment of the road. The realignment provides for all traffic movements on the road that could not be achieved for other options; however, with this option, there would be increased earthworks and property impacts.

Preferred option

Based on this assessment, seven new crossing loop locations were selected to allow trains to pass safely—at Burroway, Balladoran, Curban, Black Hollow/Quanda, Baradine, the Pilliga, and Bohena Creek/Narrabri.

These form part of the proposal, and further information is provided in chapter A7.

A6.3.3 Public road interactions

The proposed rail corridor interacts with (crosses) about 125 roads and tracks. These include about 83 'made' roads (defined as roads that have been graded but may or may not be sealed) and about 42 tracks and unmade road reserves ('paper roads').

A summary of the interactions with public-made roads is provided in Table A6.5.

TABLE A6.5 SUMMARY OF NUMBER OF INTERACTIONS WITH PUBLIC MADE ROADS

Road type	Agency	Number of interactions
State-controlled	Transport for NSW (previously Roads and Maritime Services)	4
	Transport for NSW (rail)	2
	Forestry Corporation of NSW	33
Council-controlled	Narromine Shire Council	9
	Gilgandra Shire Council	17
	Coonamble Shire Council	4
	Warrumbungle Shire Council	2
	Narrabri Shire Council	12
Total		**83**

Options identification

Policy framework

The approach to considering level crossing options has taken into account relevant NSW and Australian level crossing policies, which emphasise the need to minimise the number of level crossings, as far as reasonably practicable. The Office of the National Rail Safety Regulator's (ONRSR) level crossing policy (*ONRSR Policy: Level Crossings* (ONRSR, 2019)) sets out the approach and broader expectations for improving the safety of railway operations, with regard to existing level crossings, and the early design of future road and rail intersections. In terms of managing risks to safety, ONRSR's level crossing policy upholds that no new level crossings should be constructed. The policy notes that where a new crossing is necessary, safety risks must be eliminated or minimised by designing new infrastructure consistent with requirements of the Rail Safety National Law.
The NSW Government's level crossing policy (*Construction of New Level Crossings Policy* (Transport for NSW, n.d.)) notes that building new level crossings is to be avoided wherever possible and all other options, including grade separation and use of existing level crossings, should be explored before a new crossing is proposed.
ARTC's approach is consistent with these policies.

Options considered

The treatment options for the interaction of public roads and the rail corridor consist of:

- Grade-separated crossings—for these crossings, the road and rail line cross each other at different heights (one via a bridge) so that traffic flow is not affected. Grade separations involve building either:
  - A road bridge, to enable the road to pass over the rail corridor
  - A rail bridge, to enable the rail line to pass over the road.
- Level crossings—for these crossings, the road and rail line cross each other at the same level ('at grade'). Level crossings would be provided with warning signage, line marking, and other relevant controls, in accordance with the relevant ARTC and Australian standards, incorporating either:
  - Passive crossings, which involve static warning signs (e.g. stop and give-way signs) that are visible on approach. This signage does not change, and there are no mechanical aspects or light devices.
  - Active crossings, which involve flashing lights, warning bells and boom barriers for motorists. These devices are activated prior to and during the movement of a train through the level crossing.

The other relevant consideration is crossing consolidation, road relocation, diversion or realignment. This involves considering where roads could be:

- Closed to avoid the need to cross the road corridor, such as where safe access cannot be provided, or to consolidate crossing points to avoid multiple level crossings in close proximity to each other
- Relocated or realigned (diverted)—to avoid or minimise the need for new level crossings or to provide for safe access to a new level crossing.

Option development and assessment

The process for identifying and assessing feasible options for public road interactions broadly involved the following main steps:

- Identifying opportunities for grade separation
- Determining locations where provision of a level crossing would not be practicable and where road closures or realignments are likely to be required
- Determining the preferred type of level crossings treatments (i.e. active or passive).

Further information on these steps is provided below.

Opportunities for grade separations

ARTC's policy is that rail–road interfaces would be automatically grade separated in the following three instances:

- Rail–road crossings with four rail tracks
- Rail–road crossings of freeways and highways of four or more lanes (current and committed future plans)
- Where grade separation is the logical option for topographical or engineering reasons.

Provision of grade separations were considered where the height between the existing road and the proposed rail line was sufficient to provide for the required legal clearance for road traffic.

Within the proposal site, there are no instances where existing roads that cross the proposal are elevated relative to the rail line. The provision of a rail bridge over the road (and other existing features, as required) was determined to be the only viable option for consideration at these locations.

Locations where provision of a level crossing would not be reasonably practicable

This step involved identifying where:

- Provision of a new level crossing was not possible due to height differences between the road and rail
- Provision of a new level crossing was not possible due to the location of crossing loops
- Road crossings were closely spaced along the rail line and could be consolidated into a single crossing.

Generally, public roads would be retained wherever possible; however, where public roads cross the proposed rail corridor, the road would need to be closed in the following instances:

- The road exists only as a road reserve on paper and is not being used for access purposes
- Grade separation and raising/lowering the road is not feasible
- Providing a level crossing on the existing road alignment would not be possible
- There is a nearby grade separation or level crossing enabling diversion of the road.

Made public roads would only be proposed for closure where the impact of diversions or consolidations is considered acceptable, or the existing location is not considered safe and cannot be reasonably made safe.

Options for closing public roads were considered for the following roads, in consultation with the relevant road manager, along with the other potential options listed below:

- Dappo Road:
  1. Close road and divert traffic around Webbs Siding Road
  2. Provide a non-conforming underpass beneath the rail with a reduced height limit
  3. Raise the height of the rail and provide a conforming underpass.
- Brooks Road:
  1. Close road and provide alternative access via National Park Road about 900 m to the south
  2. Provide a level crossing on the existing alignment.

- Nalders Access Road:
  1. Close road and provide alternative access via National Park Road about 2.6 km to the south
  2. Provide a level crossing on the existing alignment.
- Munns Road
  1. Close road and provide a realignment to the north to a new level crossing
  2. Provide a level crossing on the existing alignment.

There are numerous forestry tracks and access roads through the Pilliga East State Forest that would be crossed by the proposal site, including Pilliga Forest Way. To minimise the number of level crossings within the State forest, some of these are proposed to be closed or realigned; in particular, options for the realignment of Pilliga Forest Way were considered in consultation with the Forestry Corporation. Options included realignment of the road to be parallel with the proposed rail corridor or closure of the road, with an alternate route provided along other existing forestry tracks.

Determining the preferred level crossing treatments

Where it has been determined that a level crossing is the preferred solution, a consistent methodology that aligns with ONRSR's policies and guidelines has been used to determine proposed level crossing treatments (active or passive). The approach to this involves applying the Australian Level Crossing Assessment Model (ALCAM) to determine the 'risk score' for each level crossing, and then undertaking cost-benefit analysis to assess whether higher levels of protection are justified.

ALCAM is the nationally accepted risk tool for level crossings, which looks at a range of factors, including road and rail volumes and speeds, heavy vehicle use, sighting distances and road/rail geometry. The road inputs are validated by the relevant road manager through the stakeholder consultation process.

Preferred options

The preferred option for public road interactions across the proposal site, based on the considerations described above, involves a mix of active and passive level crossings, crossing consolidation, realignments or diversions and grade separation. The preferred option is listed in Table A6.6. Further details are provided in chapter A7.

ARTC would continue consultation with relevant road managers during detailed design, to finalise preferred treatments at each location. The appropriate treatment would be assessed on a case-by-case basis for design purposes, with consideration given to the results of consultation; current and future usage of the asset; its location relative to other crossings of the rail corridor; and the road and rail geometry at the crossing location. Approval for closures, where required, would be progressed in accordance with relevant legislative requirements and in consultation with the road manager/authority.

TABLE A6.6 SUMMARY OF PREFERRED OPTION FOR EXISTING PUBLIC ROAD INTERACTIONS

Treatment	Number
Grade separation (rail over road)—at the Mitchell and Kamilaroi highways, Webbs Siding Road, Old Mill Road, Kickabil Road, Cains Crossing Road, Yarrie Lake Road and The Island Road	8
Road closures (made roads) (see Table A6.7)	4
New passive level crossing	39
New active level crossing	12

TABLE A6.7 JUSTIFICATION OF PUBLIC (MADE) ROADS PROPOSED FOR CLOSURE

Road proposed for closure	Justification
Dappo Road	The proposed diversion (via Webbs Siding Road) provides a reasonable length of deviation, meets road design guidelines and provides for movements of all traffic.
Brooks and Nalders Access roads	Closing these roads would minimise the number of level crossings required. It would also avoid for new crossings close to the Curban crossing loop and allow for the possible future expansion of the Curban crossing loop.
Munns Road	Closing this road is required, as retention of the existing alignment is not possible.

In the majority of locations where level crossings are proposed, some realignment of the existing road would be required to provide safe crossing of the new rail corridor. There are limited options for these realignments as the locations are generally highly constrained, with minor variations in horizontal and vertical alignment being the only differences. The proposals for each road were identified based on minimising property impacts and the length of realignment, while meeting road and rail design safety guidelines.

The proposed realignment of Pilliga Forest Way to be parallel with the new rail corridor was selected as the preferred option. This option maintains the existing through access within the state forest and minimises the potential for ecological and property impacts associated with upgrading other tracks if an alternative route was provided.

Further information on the proposed closures and road realignments is provided in section A7.4.

A6.3.4 Construction material and borrow pits

Construction of the proposal would require a range of materials. One of the most significant requirements is for good quality material to be used for fill; the majority of the fill is required for the rail formation. Other fill requirements include embankments and levelling of roads; both structural fill (used to create a strong stable base for proposal infrastructure) and general fill would be required.

Significant design work has been undertaken to minimise the amount of fill that would need to be imported to the site from other sources, as far as practicable. Preliminary estimates of the amount of fill that would be required to construct the proposal are provided in Table A6.8. Options to supply this material considered during design work undertaken to date are described below.

TABLE A6.8 PRELIMINARY MATERIAL BALANCE

Requirement	Estimated volume required to construct the proposal (m^3)	Estimated volume generated during excavation (m^3)	Additional material required (m^3)
Ballast and capping	1 million	none	1 million
Structural fill	1.3 million	0.9 million	0.4 million
General fill	3.5 million	3.2 million	1 million
Totals	5.8 million	4.1 million	2.4 million

Spoil is excess soil, rock or dirt excavated from the site. The majority of excavated material obtained during construction (about 3.4 million m^3) can be reused as fill; however, it is estimated that about 0.69 million (690,000) m^3 of excavated material, consisting of general fill, would be generated during construction that would not be suitable for reuse as fill. Options to manage this material have been considered as described below.

Options identification

Material supply

Potential sources of construction material include:

- Areas of cut (where material is removed (excavated) to construct the proposal
- Existing commercial quarries
- Establishing borrow pits.

Managing spoil

Options to manage spoil include:

- Reuse within the proposal site
- Reuse for borrow pit rehabilitation
- Stockpiling spoil on ARTC-owned land for reuse on a future project or maintenance
- Reuse for another ARTC project
- Constructing spoil mounds within the rail corridor
- Widening the rail formation
- Offsite disposal and/or reuse (such as at mine site, disused quarry and/or licensed waste facility).

Options assessment

Material supply

The majority of fill would be obtained from areas of cut. About 3.4 million m^3 of material would be reused to construct the proposal; however, haulage distances along the proposal site, together with the expected quality of material generated during cuts, mean that it would not be economically feasible to move all material excavated from cuts to areas requiring fill. As noted in Table A6.8, about 400,000 m^3 of structural fill and 1 million m^3 of general fill would not be able to be obtained from cuts within the proposal site.

No ballast or capping would be obtainable from cuts and these materials would need to be sourced from commercial quarries.

A desktop review of commercial quarries was undertaken to determine the nature and quality of material available and any restrictions on annual extraction rates. The review indicated that existing quarries would be able to supply the ballast and capping requirements. While a number of potential commercial quarries were identified that could supply the required fill material, due to the transport distances, it would not represent value for money and was therefore determined to not be feasible; however, the supply of capping and ballast (which are higher quality materials) from commercial quarries was determined to be feasible, particularly as it is not expected that any of this material would be excavated along the proposal site.

The review of options indicated that borrow pits would need to be established to supply the additional fill material required.

Potential sites for borrow pits were initially identified through a public expression of interest released by ARTC in early 2019. Landowners were asked to nominate an interest in establishing a borrow pit on their property to supply material for the proposal.

The options assessment process generally proceeded as follows:

- Review of feedback from the public expression of interest to identify a shortlist of potential sites. A total of 26 sites were identified through this process as being potentially suitable based on geological mapping and proximity to the proposal.
- Geotechnical and environmental investigations and analysis of the 26 shortlisted potential borrow pit sites to determine the nature and quality of material present. This resulted in a total of 16 sites being identified as containing material that would be suitable for use in the rail formation.
- Detailed review of suitable sites based on the areas of the proposal where fill material could not be feasibly transported between cuts and fills along the alignment. This resulted in a total of four sites being identified as being feasible.

Managing spoil

Of the 690,000 m^3 of excess general fill that would be generated during construction, it is estimated that about 445,000 m^3 of excess general fill could be used to fill borrow pit C and borrow pit D.

There remains an excess of 245,000 m^3 general fill that would need to be managed. The options to manage the spoil were reviewed. At this stage of the design process, it was identified that that the follow options are not preferred:

- Stockpiling spoil for reuse during maintenance or on other projects was not considered to be desirable or practicable. Transport distances would make these options economically unfeasible. In addition, the long-term stockpiling of material creates ongoing maintenance issues. Material stockpiles could also result in undesirable changes to flood conditions.
- Constructing spoil mounds and/or widening the formation were not considered to be desirable. These options could result in unacceptable impacts on flooding and surface water flows. They would also have the potential to increase the visual impacts of the proposal.
- Disposal options were not considered desirable or practicable at this stage of the design and construction planning process. The transport distances involved mean that offsite disposal is a potentially expensive option. Disposal is also the least preferred option according to the waste hierarchy under the *Waste Avoidance and Resource Recovery Act 2001* (NSW); however, disposal options may need to be considered further in the event that spoil remains and all other options are discounted due to economic, environmental or social factors.

Preferred options

Material supply

Borrow pits were identified as the preferred option to supply general and structural fill material not able to be obtained from cuts within the proposal site. Four borrow pits are proposed:

- Borrow pit A—Tantitha Road, Narromine
- Borrow pit B—Tomingley Road, Narromine
- Borrow pit C—Euromedah Road, Narromine
- Borrow pit D—Perimeter Road, Narrabri.

These borrow pits form part of the proposal for which approval is sought. Further information about the proposed borrow pits, and the estimated amount of fill that could be obtained from each, is provided in section A8.9.1 and chapter C3.

The final material supply strategy would be confirmed during detailed design and construction planning. If the construction contractor decides to use other borrow pits during construction, separate planning approval would be required.

Managing spoil

Reusing spoil to rehabilitate borrow pits has been identified as the preferred strategy to manage spoil. This is a result of:

- The remoteness of the proposal site, which makes options that involve managing spoil within or close to the proposal site preferable from an economic perspective
- Resource recovery (including reuse and recycling) is preferable to disposal according to the waste hierarchy
- The need to find material to reshape and rehabilitate the borrow pits and return the landform as close as possible to the pre-existing condition.

As the proposed borrow pits are located on private land and would be subject to lease agreements with the landowner, the extent to which this option could be used would be confirmed during detailed design and construction planning.

Further assessment of spoil management options would be undertaken during detailed design and construction planning, as required.

The earthworks requirements for the proposal would be subject to further refinement during detailed design and construction planning and following detailed geotechnical investigations. This would seek to minimise, as far as practicable, the final volume of spoil.

A6.3.5 Water supplies during construction

Water would be required during construction for a range of activities, including earthworks, dust suppression, concrete, wash down, site amenities and temporary workforce accommodation.

The water requirements are subject to weather conditions and the construction methodology selected by the construction contractor. As this stage of construction planning, it has been estimated that about 4,635 mega litres (ML) of water would be required over the duration of construction. The vast majority of this water (about 4,165 ML) would be required to construct the proposal, with water for earthworks and dust suppression comprising the bulk of these water requirements (see section A8.10.2).

A number of potential options for the source of construction water have been investigated:

- Local potable water supply networks—connection to local water supply networks to meet the majority of water needs for the proposal is not considered feasible due to the increased demand this would place on these services
- Existing watercourses—based on recent drought conditions and the availability of surface water licences, it is not considered feasible to take water from the existing surface water systems
- Shallow groundwater aquifer systems—based on recent drought conditions and the availability of shallow aquifer groundwater licences, it is not considered feasible to take water from the shallow groundwater aquifer systems (i.e. aquifers associated with creeks and rivers)
- Deep groundwater aquifer systems—extraction of groundwater from deep aquifers was identified to be feasible due to the availability of groundwater licences and limited use of these aquifers by landholders.

As such, extraction of groundwater from deep aquifers is proposed as the main source of construction water. Other options would continue to be explored during detailed design, including use of treated water from the Narrabri Gas Project (if approved), leasing or purchase of existing licences from nearby landholders and excess water from other facilities in the area.

Based on available information, the deep aquifers have low yields, meaning that a network of bores would need to be established along the proposal site to meet the water demands.

Water for earthworks and dust suppression comprises the bulk of the water requirements and the need varies along the proposal site based on the areas of cut and fill. Opportunities to reduce the need for water would be further explored during detailed design and construction planning, including use of additives, alternative compaction/construction techniques, improved reuse of excavated material, and use of different materials for haul roads.

The estimated volumes for dust suppression are based on assumed weather conditions (i.e. less water would be required when it is raining) and typical rates used to minimise the generation of nuisance dust outside the construction footprint and provide for safe operation (i.e. driver visibility) of haul roads. Subject to consideration of potential offsite impacts and safety of haul road operations, a reduced dust suppression regime may be possible along parts of the proposal site.

It is proposed that potable water would be supplied by treated groundwater from groundwater bores or mains connections.