



ARTC Inland Rail
Narromine to Narrabri (N2N)

Phase 2 Feasibility Assessment

Stage 3 Focus Area Definition

Revision D

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1. Introduction

1.1 Purpose

This document presents the outcomes from a route selection workshop held on 26 June 2019 to select the Focus Area for Stage 3 sections of the Narromine to Narrabri (N2N) project.

Stage 3 sections have been classified as areas within the N2N Study Area where alternative options were identified and land access was provided for additional environmental and geotechnical investigations. Results from these studies informed the decision making process.

Stage 3 sections are:

- Narromine South
- Eumungerie Road
- Pilliga East
- Narrabri

In addition to the above, this report also defines the Focus Areas for sections of the alignment where no route options were identified, but the Focus Area could not be defined until the preferred Focus Areas had been selected in the adjacent sections. These section are:

- Curban
- Newell Highway
- Narrabri North

1.2 Background

1.2.1 Narromine to Narrabri Project

N2N will link the Parkes to Narromine section located in central western NSW, with the Narrabri to North Star section of Inland Rail located in north western NSW.

The key features of the N2N Project include:

- A new rail corridor for approximately 300-kilometres between Narromine and Narrabri.
- A single standard gauge railway track, track formation and culverts within the new rail corridor.
- Seven crossing loops, at Burroway, Balladoran, Armatree/Tonderburine, Black Hollow/Quanda, Teridgerie, The Pilliga and Bohena Creek/Narrabri.
- Rail overbridges over the Main Western Dubbo to Narromine Line, the Dubbo to Coonamble Line and the Narrabri West to Walgett Railway Line.
- Bridges over waterways, including Macquarie River, Marthaguy Creek, Castlereagh River, Baradine Creek, Bohena Creek, Narrabri Creek and the Namoi River.
- Road underbridges at public and private roads, including Mitchell Highway and Kamilaroi Highway/Wee Waa Road.

The rail corridor will generally be in the order of 60 m wide, with some variation to accommodate particular infrastructure and to cater for local topography, larger cuttings and embankments.

1.3 Narromine to Narrabri Route Refinement

1.3.1 Previous studies

The original route between Narromine and Narrabri was based on the Inland Rail Alignment Study (ARTC, 2010). Alternate Study Areas were subsequently investigated and reported in:

- MCA Workshop Report (NSW_N2NMCAWorkshopReport_Oct2016)
- MCA Workshop Report (NSW_N2NMCAWorkshopReport_Dec2016)
- MCA Workshop Report (NSW_N2NMCAWorkshopReport_May2017)

The above reports along with further background information on the N2N project are available from the Inland Rail website at www.inlandrail.com.au/N2N.

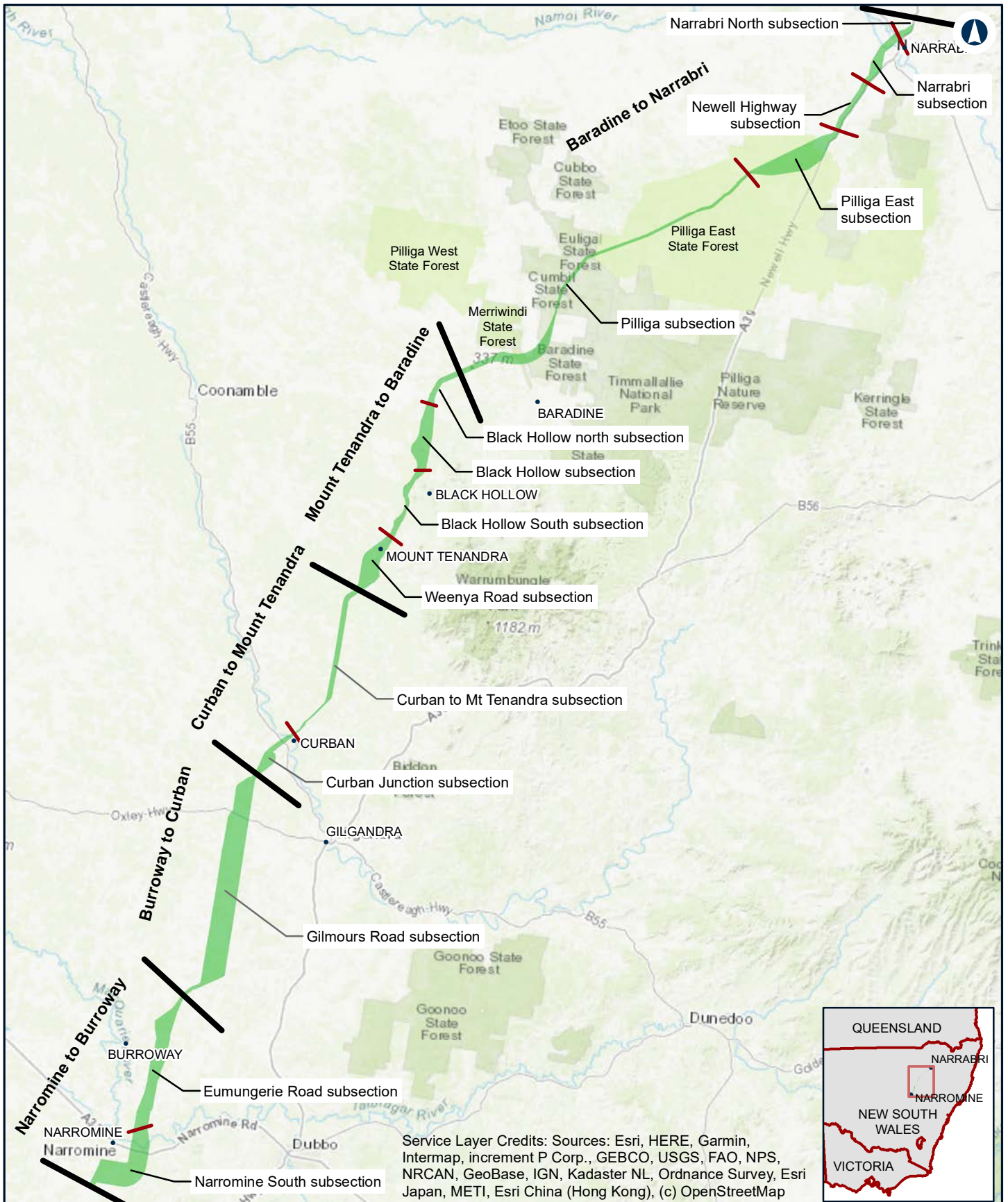
1.3.2 Phase 2 Feasibility Assessment alignment refinements

At the end of Phase 1, the rail alignment had not been confirmed and in some sections, alternative options had been identified that required further investigation as part of the Phase 2 A Study Area had been defined from Phase 1 that was in the order of 2 km wide, but was wider in some locations to allow options to be considered Figure 1-1.

In Phase 2, these sections were assessed in three stages:

- Stage 1 comprised sections of the route where there were no feasible alternatives. The preferred Focus Area of Investigation (FAI) for Stage 1 sections is presented in the report Route Refinement – Study Area With No Alternatives (2-0001-250-CAL-00-RP-0006).
- Stage 2 comprised sections where alternative route options had been identified, but no land access was available or landowners did not grant access for site investigations. The preferred Focus Area for Stage 2 sections is presented in the report Focus Area Definition – Gilmours Road, Weenya Road and Black Hollow (2-0001-250-CAL-00-RP-0004).
- Stage 3 comprised sections where alternative route options had been identified and land access was available to collect additional environmental and geotechnical data to inform the route selection process. The preferred Focus Area for Stage 3 is presented in this report.

The horizontal and vertical design for the railway will continue to be developed within the Focus Areas to confirm the rail corridor.



NARROMINE TO NARRABRI Study Area Overview

Figure 1-1



- LEGEND**
- Phase 2 study area
 - Section break
 - Sub section break

Coordinate System: GDA 1994 MGA Zone 55

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2. Route selection methodology

2.1 General

Factors taken into account when selecting the Study Area are set out in the ARTC's "Process to Refine the Route" fact sheet, available on the [Inland Rail web site](#). This process has been applied consistently across all Inland Rail projects and includes considerations relating to:

- The ability to meet the Inland Rail Service Offering
- Cost
- Technical factors assessed in a Multi-Criteria Analysis (MCA)

2.2 Inland Rail Service Offering

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

Inland Rail is predicated on being able to achieve a Service Offering based on the endorsed business case that ensures freight is moved via rail between Melbourne and Brisbane in less than 24 hours, at a cost comparable to or better than road, with a 98% reliability and is available when the market demands. Achievement of the Inland Rail Service Offering requires a rail line that is as flat and straight and fast as possible. This cannot be achieved by use of existing rail corridors for the whole route so necessarily Inland Rail will involve construction of new rail lines in 'Greenfield' areas.

2.3 Cost

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

2.4 Options assessment criteria

The Study Area for the sections considered in this report was defined in 2017, at the end of Phase 1. Phase 2 refinements have considered the criteria included in the Inland Rail Options Assessment and MCA Procedure (0-0000-900-PEN-00-PR-0002_1).

Within these sections the refinements of the Study Area to a narrower Focus Area of investigation has sought to achieve local improvements, with respect to the assessment criteria, for example to mitigate property impacts or improve level crossing alignments. This assessment criteria is described in Section 3.

2.5 Data inputs

Key data inputs that have informed the recommendations of this report are based on the following information at 26 June 2019:

- Phase 1 MCA reports (as defined in Section 1.3.1).
- Phase 1 and 2 geotechnical desktop studies and field investigations.
- Phase 1 and 2 environment studies and field investigations.
- Phase 2 preliminary level crossing treatment assessments.
- Phase 2 preliminary earthworks design.
- Phase 2 1% AEP flood extents for existing conditions.
- Phase 2 property boundaries based on NSW Land Registry Services Lot and DP information.

- Survey Adjusted Cadastral Modell (SACM) obtained by ARTC.
- Outputs from community drop in sessions and meetings with impacted residents held by ARTC.
- Location of buildings identified from aerial photography within the Study Area.

2.6 Technical drivers

For the sections described in this report, the key criteria and sub-criteria considered to narrow the Study Area to a Focus Area were as follows. This is not an extensive list with the full assessment criteria included in Section 3.2:

- Property impacts.
- Flooding impacts.
- Indigenous cultural heritage.
- Ecological impacts.
- Noise and vibration impacts (and subsequent impacts on communities).
- Geotechnical conditions (and subsequent impacts on construction complexity).
- Road safety interfaces (level crossings).
- Horizontal alignment design standards.
- Vertical alignment: While vertical geometry has been checked and is compliant to vertical design standard, it is not a differentiator in terms of the MCA, and therefore is not considered in this report.

3. Options assessment

3.1 MCA Workshop

Focus Area options were assessed at an MCA workshop held on 26 June 2019 at ARTC's Inland Rail Brisbane office. The following sections were evaluated:

- Narromine South
- Eumungerie Road
- Pilliga East
- Narrabri

Each of these options are illustrated in the subsequent sections.

Attendees at the workshop were:

Name	Representing	Role
[REDACTED]	ARTC	Project Director
[REDACTED]	ARTC	Project Manager
[REDACTED]	ARTC	Design Manager
[REDACTED]	ARTC	Technical Advisor
[REDACTED]	ARTC	Project Engineer
[REDACTED]	ARTC	Community Engagement
[REDACTED]	ARTC	Communications Lead
[REDACTED]	ARTC	Project Engineer
[REDACTED]	ARTC	Environmental Advisor
[REDACTED]	ARTC	Construction Manager
[REDACTED]	JGHD	Project Director
[REDACTED]	JGHD	Project Manager
[REDACTED]	JGHD	Design Manager
[REDACTED]	JGHD	Project Engineer
[REDACTED]	JGHD	Environmental Manager
[REDACTED]	JGHD	Community Engagement
[REDACTED]	JGHD	Geotechnical Lead
[REDACTED]	JGHD	Civil and Drainage Lead
[REDACTED]	JGHD	GIS Lead

3.2 Assessment criteria

The criteria and sub-criteria used within this assessment are summarised in Table 3-1.

Definitions and MCA scoring rationale for each sub-criteria element are included in Appendix A.

Table 3-1 Assessment criteria

Criteria	Sub-Criteria
Technical viability	Alignment Impact on public utilities and other assets Geotechnical conditions Impact on existing road and rail network Flood immunity and hydrology Future proofing
Safety assessment	Operational safety Public safety Road safety interfaces Emergency response Construction safety
Operational approach	Effect/impact on travel time Effect on reliability and availability Network interoperability and connectivity
Constructability and schedule	Construction duration Construction access Construction complexity Resources/material sources Remediation and contamination Interface with operational railway Staging opportunities
Environmental	Ecological impacts Offset liability Visual impacts Noise and vibration impacts Flooding and waterway impacts Effect on air quality Effect on greenhouse gas emissions
Community, heritage and property	Property impacts Indigenous cultural heritage Non indigenous heritage Impact on communities Community response Current and future land use impacts Impact on business and agricultural viability
Approvals and stakeholder risk	Other statutory and regulatory approvals Alignment with State/Federal objectives Alignment with Local Government objectives Service authorities (utilities / other)

3.3 Preferred Focus Area

The preferred Focus Area for each section/sub-section, was determined in accordance with the Inland Rail Options Assessment and MCA Procedure (0-0000-900-PEN-00-PR-0002). The Base Case used for comparison of options was taken from the "[Narromine to Narrabri Options Report November 2017](#)".

4. Narromine South

4.1 Overview

The Narromine South sub-section Study Area traverses to the south and east of Narromine. Being located adjacent to a regional centre there are a number of property constraints, sensitive receivers and utilities typical of a regional suburban environment. The Study Area has key transport interfaces including the Main Western Railway, the Mitchell Highway, Tomingley Road and a number of local roads. The topography is mostly flat and is prone to regional flooding, primarily from the Macquarie River, Backwater Cowal and Wallaby Creek (a tributary of Backwater Cowal).

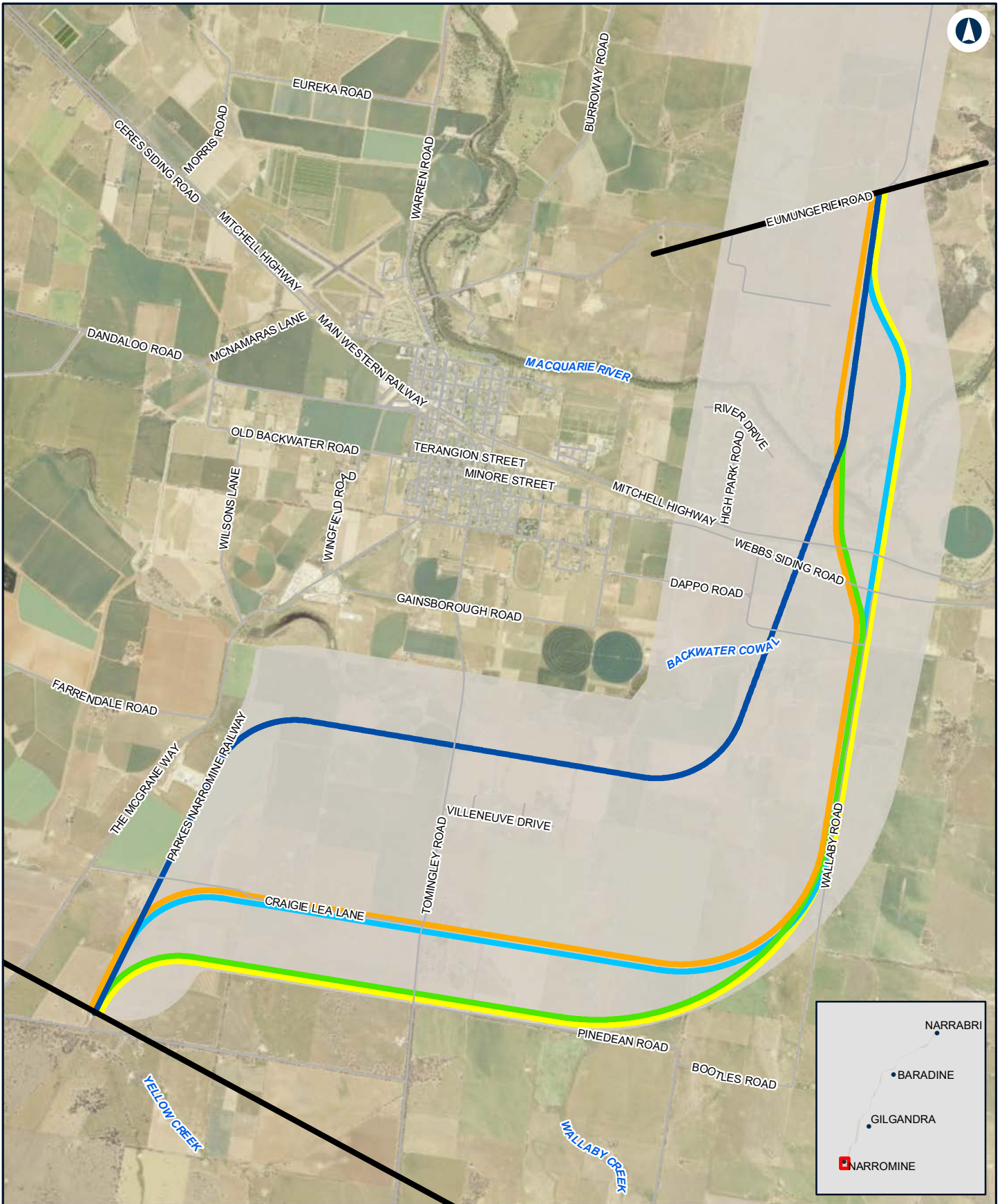
4.2 Options under assessment

Within the Narromine South Study Area, four options have been developed for comparison to the November 2017 Base Case. These options are summarised in Table 4-1 and illustrated in Figure 4-1.

Table 4-1 Narromine South options

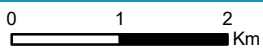
Option	Description
NB-NS-BCA (Base Case, Dark Blue option)	<p>The Base Case commences within the existing Parkes to Narromine rail corridor and continues North before turning East and travels between Villneuve Drive and the Backwater Cowal and turns to the North and crosses the Mitchell Highway, Dubbo Narromine Railway line and Macquarie River. The option is aligned with property boundaries North of the Macquarie river.</p> <p>The Base Case:</p> <ul style="list-style-type: none"> • Is 18.7 km in length • Has a travel time of 9.8 minutes • Impacts 11 properties
NB-NS-CLL (Orange option)	<p>The Orange option commences within the existing rail corridor and turns east for approximately 7 km, following the southern side of Craigie Lea Lane for the first part. The option then turns north adjacent to Wallaby Road, where it veers to the west, crossing the Main Western Railway, Mitchell Highway and Macquarie River. The corridor continues north where it joins the Eumungerie Road sub-section.</p> <p>The Orange option:</p> <ul style="list-style-type: none"> • Is 20.4 km in length • Has a travel time of 10.6 minutes • Impacts 11 properties
NB-NS-PR (Green option)	<p>The Green option commences within the existing rail corridor turning east traversing properties approximately 1 km south of Craigie Lea Lane for 7 km. The option then turns north adjacent to Wallaby Road where it veers to the west crossing the Main Western Railway, Mitchell Highway and Macquarie River. The Green option continues north where it joins the Eumungerie Road sub-section.</p> <p>The Green option:</p> <ul style="list-style-type: none"> • Is 20.2 km in length • Has a travel time of 10.6 minutes • Impacts 11 properties

Option	Description
NB-NS-CE (Light Blue option)	<p>The light-blue option commences within the existing rail corridor and turns east for approximately 7 km following the southern side of Craigie Lea Lane for the first part. The option then turns north adjacent to Wallaby Road, crossing the Main Western Railway, Mitchell Highway and the Macquarie River. It traverses an old oxbow in the Macquarie River before veering west towards Eumungerie Road sub-section.</p> <p>The Light Blue option:</p> <ul style="list-style-type: none"> • Is 20.5 km in length • Has a travel time of 10.7 minutes • Impacts 12 properties
NB-NS-PE (Yellow option)	<p>The Yellow option commences within the existing rail corridor, turning east for approximately 7 km across open farmland and then following the northern side of Pinedean Road. . The option then turns north adjacent to Wallaby Road, crossing the Main Western Railway, Mitchell Highway and the Macquarie River. It traverses an old oxbow in the Macquarie River before veering west towards the Eumungerie Road sub-section.</p> <p>The Yellow option:</p> <ul style="list-style-type: none"> • Is 20.3 km in length • Has a travel time of 10.6 minutes • Impacts 12 properties



NARROMINE TO NARRABRI Options summary - Narramine South

Figure 4.1



LEGEND

- NB-NS-BC
- NB-NS-CLL
- NB-NS-PR
- NB-NS-CE
- NB-NS-PE
- Phase 2 study area

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4.3 Field investigations completed

4.3.1 Geotechnical

Geotechnical investigations have been undertaken and have been positioned to provide data on ground conditions within the study area. Geotechnical investigations corroborate the published mapping, with colluvial soils found over weathered bedrock at the southern extent of the Study Area, and alluvial backplain sediments in the northern extent of the Study Area, towards the Backwater Cowal.

Laboratory testing indicates better subgrade conditions along Craigie Lea Lane, Pinedean Road and the southern end of Wallaby Road (CBRs typically 5% to 7%), as opposed to further north across alluvial backplain sediments (CBRs typically 1% to 3%). An outcrop of metasiltstone bedrock is present along Craigie Lea Lane which testing has indicated is likely suitable for structural fill material.

From a geotechnical perspective, investigation and testing indicates the southern and eastern options are preferable. However, the eastern options crossing the Macquarie River could be less favourable due to the extended length of deep alluvial sediments requiring deep piled foundations and extended structure length along this alignment.

4.3.2 Ecology

Within the Study Area there are eight (8) plant community types (PCTs) identified within the field survey areas. Based on the information available, one Threatened Ecological Community (TEC) listed under both the *Biodiversity Conservation Act 2016* (BC Act) and/or *Environment Protection and Biodiversity Conservation Act* would be impacted by all of the options. Plant community types include:

- Pilliga Box – White Cypress Pine – Buloke Shrubby Woodland in the Brigalow Belt South Bioregion.
- Partly Derived Windmill Grass – Copperburr Alluvial Plains Shrubby Grassland of the Darling Riverine Plains Bioregion and Brigalow Belt South Bioregion.
- Lignum shrubland wetland on regularly flooded alluvial depressions in the Brigalow Belt South Bioregion and Darling Riverine Plains Bioregion.
- River Red Gum Tall to Very Tall Open Forest/Woodland Wetland on Rivers on Floodplains mainly in the Darling Riverine Plains Bioregion.
- Western Grey Box - cypress pine shrub grass shrub tall woodland in the Brigalow Belt South Bioregion.
- Poplar Box – Belah Woodland on Clay-Loam Soils on Alluvial Plains on North Central NSW.
- Blakely's Red Gum – Yellow Box Grassy Tall Woodland on Flats and Hills in the Brigalow Belt South and Nandewar bioregion:
 - Listed as an EEC under the (BC Act and Critical EEC under the EPBC Act).
- Mixed Box Eucalypt Woodland on Low Sandy-Loam Rises on Alluvial Plains in Central Western NSW.

The majority of each option is identified as Crop and/or introduced grassland (between 14.9 and 15.3km).

4.3.3 Cultural Heritage

Cultural heritage field surveys undertaken in the Study Area identified:

- Between one and nine AHIMS sites within 200 metres of all options.
- One sparse artefact scatter within 200 metres associated with Base Case NB-NS-BC only.
- One dense artefact scatter within 200 metres associated with Base Case NB-NS-BC only.
- One ochre quarry within 200 metres associated with Base Case NB-NS-BC only.
- Between 10 and 16 scarred trees within 200 metres, associated with all options.
- Sensitive rivers, including:
 - Backwater Cowal – associated with Base Case NB-NS-BC.
 - Wallaby Creek – associated with all options, except Base Case NB-NS-BC.
 - Macquarie River – associated with all options.
- Culturally sensitive areas, associated with all options (except Base Case NB-NS-BC) in relation to terraced flats alongside the Macquarie River.
- Between 1,108.3 metres and 1,638.9 metres of areas with large number of scarred trees (recommended for wider survey) associated with all options.

4.4 Comparative quantities influencing capital cost

Elements of each option that will influence the capital cost are included in Table 4-2. Order of magnitude quantities for track length and structures are provided as well as an estimate of the complexity of earthworks.

Table 4-2 Narromine South comparative quantities

Option	Track Length	Structure quantity	Earthworks
NB-NS-BC (Base Case, Dark Blue option)	18.7km	More than 5 moderate or large culverts More than 2 underbridges Approximately 500m long grade separation Approximately 1200m bridge length	Approximately 62% of the corridor traverses poor geotechnical conditions. This option presents the most earthworks complexity, when compared to other options.
NB-NS-CLL (Orange option)	20.4km	More than 5 moderate or large culverts More than 2 underbridges Approximately 500m long grade separation Approximately 1200m bridge length	Approximately 24% of the corridor traverses poor geotechnical conditions. This option and option NB-NS-PE present the least complex earthworks, when compared to other options.
NB-NS-PR (Green option)	20.2km	More than 5 moderate or large culverts More than 1 underbridge Approximately 500m long grade separation Approximately 1200m bridge length	Approximately 33% of the corridor traverses poor geotechnical conditions. This is moderately complex when compared to other options.

Option	Track Length	Structure quantity	Earthworks
NB-NS-CE (Light Blue option)	20.5km	More than 5 moderate or large culverts More than 2 underbridges Approximately 500m long grade separation Approximately 2400m bridge length	Approximately 33% of the corridor traverses poor geotechnical conditions. This is moderately complex when compared to other options.
NB-NS-PE (Yellow option)	20.3km	More than 5 moderate or large culverts More than 2 underbridges Approximately 500m long grade separation Approximately 2400m bridge length	Approximately 42% of the corridor traverses poor geotechnical conditions. This option and option NB-NS-CLL present the least complex earthworks, when compared to other options.

4.5 Summary of Narromine South MCA options comparison

A summary of the key issues for each of the Narromine South options is provided in Table 4-3, based on the MCA scoring sub-criteria defined in Section 3.2.

Corresponding maps for each of these key issues are illustrated in Figure 4-2 to Figure 4-9.

Table 4-3 Summary of Narromine South MCA options comparison

	NB-NS-BC (Base Case, Dark Blue option)	NB-NS-CLL (Orange option)	NB-NS-PR (Green option)	NB-NS-CE (Light Blue option)	NB-NS-PE (Yellow option)
Alignment	The Base Case is 18.7km long containing 3.6km of brownfield track requiring upgrade and 15.1km of Greenfield track	The Orange option is 20.4km long containing 1km of brownfield track and 19.4km of Greenfield track. No significant differentiator in alignment geometry from Base Case.	The Green option is 20.2km long containing no brownfield track. No significant differentiator in alignment geometry from Base Case.	The Light Blue option is 20.5km long containing 1km of brownfield track and 19.5km of Greenfield track. No significant differentiator in alignment geometry from Base Case.	The Yellow option is 20.3km long containing no brownfield track. No significant differentiator in alignment geometry from Base Case.
Impact on utilities (Figure 4-2)	<p>The Base Case impacts utilities including:</p> <ul style="list-style-type: none"> • 2 132kV overhead crossings • 6 22kV crossings • 8 telecommunication crossings 	<p>The Orange option impacts utilities including:</p> <ul style="list-style-type: none"> • 2 132kV overhead crossings • 6 22kV crossings • 9 telecommunication crossings 	<p>The Green option impacts utilities including:</p> <ul style="list-style-type: none"> • 2 132kV overhead crossings • 4 22kV crossings • 9 telecommunication crossings 	<p>The Light Blue option impacts utilities including:</p> <ul style="list-style-type: none"> • 2 132kV overhead crossings • 6 22 kV crossings • 8 telecommunication crossings 	<p>The Yellow option impacts utilities including:</p> <ul style="list-style-type: none"> • 2 132kV overhead crossings • 4 22kV crossings • 7 telecommunication crossings
Geotechnical conditions (Figure 4-3)	<p>The Base Case contains 4.3 km that traverses brownfield site conditions. Investigation results indicate approximately 62% of this alignment traverses poor subgrade alluvial soils and vertisols.</p>	<p>The Orange option contains 1 km that traverses brownfield site conditions. Alignment traverses approximately 24% poor subgrade soils, with colluvial and residual soils anticipated elsewhere. Alignment crosses Macquarie River at narrowest point.</p>	<p>The Green option does not traverse any brownfield site conditions. Alignment traverses approximately 33% poor subgrade soils, with colluvial and residual soils anticipated elsewhere. Alignment runs sub-parallel to section of Macquarie River with deep alluvium expected.</p>	<p>The Light Blue option contains a length of 1 km that traverses brownfield site conditions. Alignment traverses approximately 33% poor subgrade soils, with colluvial and residual soils anticipated elsewhere. Alignment runs sub-parallel to section of Macquarie River with deep alluvium expected.</p>	<p>The Yellow option does not traverse any brownfield site conditions. Alignment traverses approximately. 42% poor subgrade soils, with colluvial and residual soils anticipated elsewhere. Alignment crosses Macquarie River at narrowest point.</p>

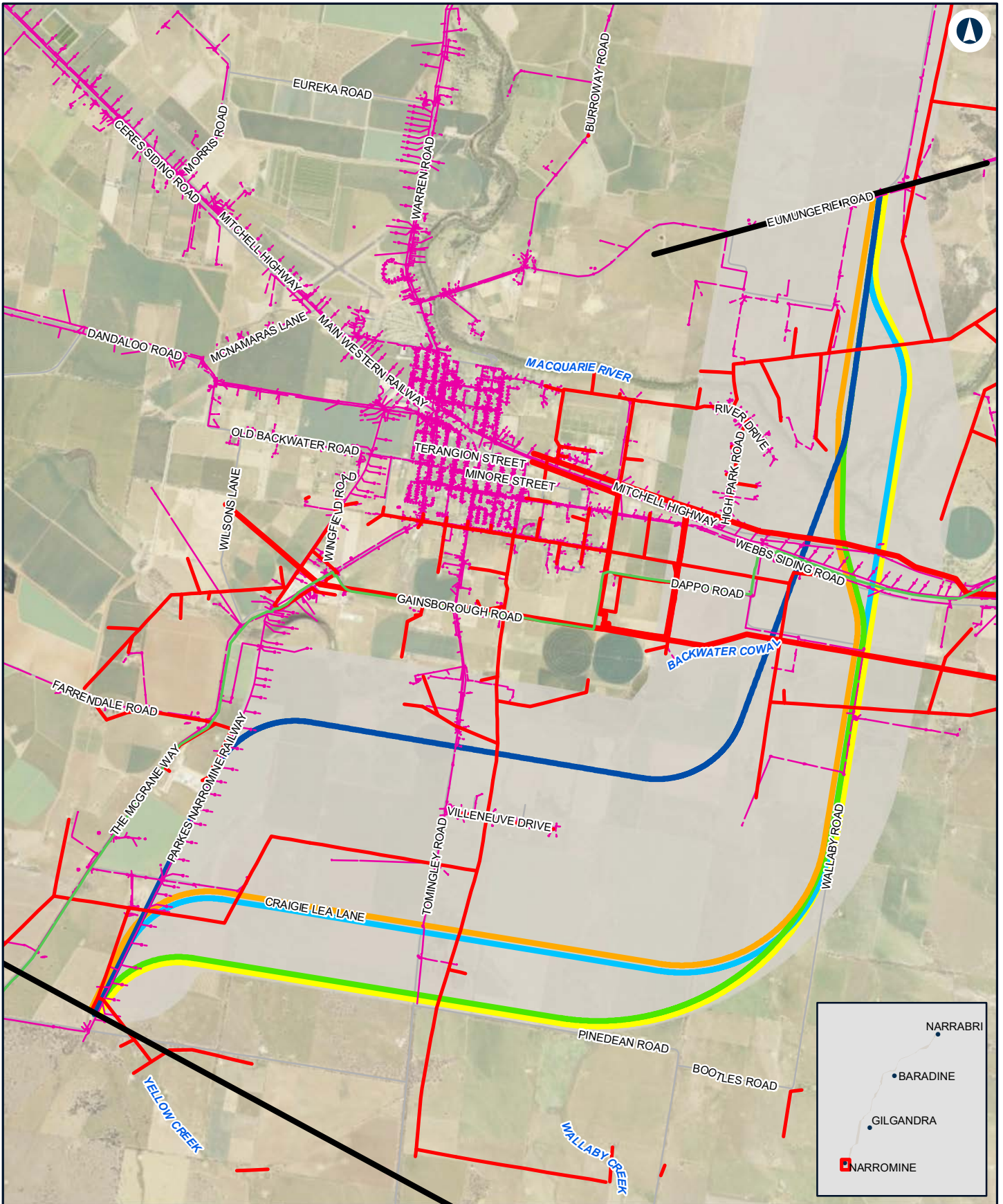
	NB-NS-BC (Base Case, Dark Blue option)	NB-NS-CLL (Orange option)	NB-NS-PR (Green option)	NB-NS-CE (Light Blue option)	NB-NS-PE (Yellow option)
Impact on existing road and rail (Figure 4-4)	<p>The Base Case traverses the Mitchell Highway requiring grade separation.</p> <p>A second grade separation is required to cross Webbs Siding Road and the Main Western Railway.</p> <p>The Base Case also requires a level crossing for Tomingley Road.</p>	<p>This option traverses the Mitchell Highway requiring a grade separation.</p> <p>A second grade separation is required to cross Webbs Siding Road and the Main Western Railway.</p> <p>The option also requires a level crossing for Tomingley Road.</p>	<p>This option traverses the Mitchell Highway requiring a grade separation.</p> <p>A second grade separation is required to cross Webbs Siding Road and the Main Western Railway.</p> <p>The option also requires a level crossing for Tomingley Road.</p> <p>Narwonah siding Road is outside the project extent. Potential LX upgrades were discussed but not scored in the MCA.</p>	<p>This option traverses the Mitchell Highway requiring a grade separation.</p> <p>A second grade separation is required to cross Webbs Siding Road and the Main Western Railway.</p> <p>The option also requires a level crossing for Tomingley Road.</p>	<p>This option traverses the Mitchell Highway requiring a grade separation.</p> <p>A second grade separation is required to cross Webbs Siding Road and the Main Western Railway.</p> <p>The option also requires a level crossing for Tomingley Road.</p>
Flood immunity/hydrology (Figure 4-6)	<p>The Base Case and study area in general are with-in the flood zones of the Macquarie River and Backwater Cowal, subject to regional flood events.</p>	<p>Vertical alignment designed to be above 1/100yr flood event, no significant differentiator from Base Case.</p>	<p>Vertical alignment designed to be above 1/100yr flood event, no significant differentiator from Base Case.</p>	<p>Vertical alignment designed to be above 1/100yr flood event, no significant differentiator from Base Case.</p>	<p>Vertical alignment designed to be above 1/100yr flood event, no significant differentiator from Base Case.</p>
Future Proofing	<p>The Base Case contains no significant constraints that would impact on ability to upgrade the rail infrastructure in the future.</p>	<p>The Orange option contains no significant constraints that would impact on ability to upgrade the rail infrastructure in the future.</p>	<p>The Green option contains no significant constraints that would impact on ability to upgrade the rail infrastructure in the future.</p>	<p>The Light Blue option contains no significant constraints that would impact on ability to upgrade the rail infrastructure in the future.</p>	<p>The Yellow option contains no significant constraints that would impact on ability to upgrade the rail infrastructure in the future.</p>

	NB-NS-BC (Base Case, Dark Blue option)	NB-NS-CLL (Orange option)	NB-NS-PR (Green option)	NB-NS-CE (Light Blue option)	NB-NS-PE (Yellow option)
Road Safety Interface	<p>The Base Case interfaces with:</p> <ul style="list-style-type: none"> • 1 state road • 3 council roads • 15 private roads 	<p>The Orange option interfaces with:</p> <ul style="list-style-type: none"> • 1 state road • 3 council roads inc. Craigie Lea Lane north fork. • 13 private roads <p>Presents no material difference to safety over the Base Case.</p>	<p>The Green option interfaces with:</p> <ul style="list-style-type: none"> • 1 state road • 2 council roads inc. Craigie Lea Lane north fork. • 14 private roads <p>Presents no material difference to safety over the Base Case.</p>	<p>The Light Blue option interfaces with:</p> <ul style="list-style-type: none"> • 1 state road • 3 council roads inc. Craigie Lea Lane north fork. • 13 private roads <p>Presents no material difference to safety over the Base Case.</p>	<p>The Yellow option interfaces with:</p> <ul style="list-style-type: none"> • 1 state road • 2 council roads • 14 private roads <p>Presents no material difference to safety over the Base Case.</p>
Effect/ Impact on travel time	The estimated travel time for the Base Case is 9.8 minutes.	Less than 1 minute difference in travel time for all options, no material difference to reliability and/or connectivity.	Less than 1 minute difference in travel time for all options, no material difference to reliability and/or connectivity.	Less than 1 minute difference in travel time for all options, no material difference to reliability and/or connectivity.	Less than 1 minute difference in travel time for all options, no material difference to reliability and/or connectivity.
Construction complexity	<p>Complex construction elements include:</p> <ul style="list-style-type: none"> • Poor geotechnical conditions for 62% of the corridor resulting in increased civil works • Complex structures crossing the Mitchell Highway and Macquarie River 	<p>Complex construction elements include:</p> <ul style="list-style-type: none"> • Poor geotechnical conditions for 24% of the corridor resulting in increased civil works • Complex structures crossing the Mitchell Highway and Macquarie River 	<p>Complex construction elements include:</p> <ul style="list-style-type: none"> • Poor geotechnical conditions for 33% of the corridor resulting in increased civil works • Complex structures crossing the Mitchell Highway and Macquarie River 	<p>Complex construction elements include:</p> <ul style="list-style-type: none"> • Poor geotechnical conditions for 33% of the corridor resulting in increased civil works • Complex structures crossing the Mitchell Highway and Macquarie River, longer in length than other options 	<p>Complex construction elements include:</p> <ul style="list-style-type: none"> • Poor geotechnical conditions for 42% of the corridor resulting in increased civil works • Complex structures crossing the Mitchell Highway and Macquarie River, longer in length than other options

	NB-NS-BC (Base Case, Dark Blue option)	NB-NS-CLL (Orange option)	NB-NS-PR (Green option)	NB-NS-CE (Light Blue option)	NB-NS-PE (Yellow option)
Ecological impacts (Figure 4-5)	<p>It impacts approximately:</p> <ul style="list-style-type: none"> 14.9km of non-native vegetation 3.8km of native vegetation (but not TEC) Nil native vegetation listed as a TEC under the BC Act and/or EPBC Act <p>Three threatened fauna identified within 200 m, including Eastern Bentwing Bat, Grey-crowned Babbler and Spotted Harrier.</p>	<p>It impacts approximately:</p> <ul style="list-style-type: none"> 15.3km of non-native vegetation 5.1km of native vegetation (but not TEC) 0.28 km of native vegetation listed as a TEC under the BC Act and/or EPBC Act <p>Three threatened fauna identified within 200 m, including Eastern Bentwing Bat, Grey-crowned Babbler and Spotted Harrier.</p>	<p>It impacts approximately:</p> <ul style="list-style-type: none"> 15.1km of non-native vegetation 5.1km of native vegetation (but not TEC) 0.46 km of native vegetation listed as a TEC under the BC Act and/or EPBC Act <p>Three threatened fauna identified within 200 m, including Eastern Bentwing Bat, Grey-crowned Babbler and Spotted Harrier.</p>	<p>It impacts approximately:</p> <ul style="list-style-type: none"> 15.1km of non-native vegetation 5.4km of native vegetation (but not TEC) 0.46 km of native vegetation listed as a TEC under the BC Act and/or EPBC Act <p>Three threatened fauna identified within 200 m, including Eastern Bentwing Bat, Grey-crowned Babbler and Spotted Harrier.</p>	<p>It impacts approximately:</p> <ul style="list-style-type: none"> 14.9km of non-native vegetation 5.4km of native vegetation (but not TEC) 0.55 km of native vegetation listed as a TEC under the BC Act and/or EPBC Act <p>Three threatened fauna identified within 200 m, including Eastern Bentwing Bat, Grey-crowned Babbler and Spotted Harrier.</p>
Visual Impacts	The Base Case has 46 receivers within 1000m	The Orange option has 22 receivers within 1000m	The Green option has 18 receivers within 1000m	The Light Blue option has 15 receivers within 1000m	The Yellow option has 12 receivers within 1000m
Flooding / waterway impacts (Figure 4-6)	<p>The Base Case traverses one unnamed waterway and three named waterways for a total of four waterway crossings including the Macquarie River.</p> <p>Approximately 10.3 km (55%) of the Base Case is within a 1% AEP flood area.</p>	<p>This option traverses five unnamed waterway and two named waterways for seven total waterway crossings including the Macquarie River.</p> <p>Approximately 9.9 km (49%) of the Orange option is within a 1% AEP flood area.</p>	<p>This option traverses five unnamed waterway and two named waterways for seven total waterway crossings including the Macquarie River.</p> <p>Approximately 9.5 km (47%) of the Green option is within a 1% AEP flood area.</p>	<p>This option traverses five unnamed waterway and two named waterways for seven total waterway crossings including the Macquarie River.</p> <p>Approximately 11.3 km (55%) of the Light Blue option is within a 1% AEP flood area.</p>	<p>This option traverses five unnamed waterway and two named waterways for seven total waterway crossings including the Macquarie River.</p> <p>Approximately 10.6 km (52%) of the Yellow option is within a 1% AEP flood area.</p>

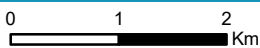
	NB-NS-BC (Base Case, Dark Blue option)	NB-NS-CLL (Orange option)	NB-NS-PR (Green option)	NB-NS-CE (Light Blue option)	NB-NS-PE (Yellow option)
Sensitive Receivers - Noise and Vibration / Effect on Air Quality (Figure 4-7)	<ul style="list-style-type: none"> There are 4 residential receivers within 200m The Base Case is the closest option to Narromine 	<ul style="list-style-type: none"> There is 1 residential receiver within 200m The Orange option is further away from Narromine and Villeneuve than the Base Case 	<ul style="list-style-type: none"> There is 1 residential receiver within 200m The Green option is further away from Narromine and Villeneuve than the Base Case 	<ul style="list-style-type: none"> There are no receivers within 200m The Light Blue option is further away from the centre of town than the Base Case and Villeneuve 	<ul style="list-style-type: none"> There are no receivers within 200m The Yellow option is further away from Narromine than the Base Case and Villeneuve
Property impacts (Figure 4-8)	The Base Case directly impacts 11 properties and severs 9 of these impacted properties. Potentially 1 residence removed.	This option directly impacts 11 properties and severs 8 of these impacted properties.	This option directly impacts 11 properties and severs 9 of these impacted properties.	This option directly impacts 12 properties and severs 8 of these impacted properties.	This option directly impacts 12 properties and severs 9 of these impacted properties.

	NB-NS-BC (Base Case, Dark Blue option)	NB-NS-CLL (Orange option)	NB-NS-PR (Green option)	NB-NS-CE (Light Blue option)	NB-NS-PE (Yellow option)
Cultural Heritage impacts (Figure 4-9)	<ul style="list-style-type: none"> One AHIMS site within 200 metres of all options One sparse artefact scatter within 200 metres One dense artefact scatter within 200 metres One ochre quarry within 200 metres No scarred trees within 200 metres Two sensitive rivers associated with Backwater Cowal and the Macquarie River 	<ul style="list-style-type: none"> Seven AHIMS sites within 200 metres of all options No sparse artefact scatters within 200 metres No dense artefact scatters within 200 metres No ochre quarries within 200 metres 16 scarred trees within 200 metres Two sensitive rivers associated with Wallaby Creek and the Macquarie River 1,108 metres of culturally sensitive areas, in relation to terraced flats alongside the Macquarie River 1,108 metres with large number of scarred trees (recommended for wider survey) associated with all options 	<ul style="list-style-type: none"> Eight AHIMS sites within 200 metres of all options No sparse artefact scatters within 200 metres No dense artefact scatters within 200 metres No ochre quarries within 200 metres 16 scarred trees within 200 metres Two sensitive rivers associated with Wallaby Creek and the Macquarie River 1,108 metres of culturally sensitive areas, in relation to terraced flats alongside the Macquarie River 1,108 metres with large number of scarred trees (recommended for wider survey) associated with all options 	<ul style="list-style-type: none"> Seven AHIMS sites within 200 metres of all options No sparse artefact scatters within 200 metres No dense artefact scatters within 200 metres No ochre quarries within 200 metres 10 scarred trees within 200 metres Two sensitive rivers associated with Wallaby Creek and the Macquarie River 1,638 metres of culturally sensitive areas, in relation to terraced flats alongside the Macquarie River 1,638 metres with large number of scarred trees (recommended for wider survey) associated with all options 	<ul style="list-style-type: none"> Nine AHIMS sites within 200 metres of all options No sparse artefact scatters within 200 metres No dense artefact scatters within 200 metres No ochre quarries within 200 metres 10 scarred trees within 200 metres Two sensitive rivers associated with Wallaby Creek and the Macquarie River 1,638 metres of culturally sensitive areas, in relation to terraced flats alongside the Macquarie River 1,638 metres with large number of scarred trees (recommended for wider survey) associated with all options



NARROMINE TO NARRABRI Constraints - Utilities - Narromine South

Figure 4.2



Coordinate System: GDA 1994 MGA Zone 55

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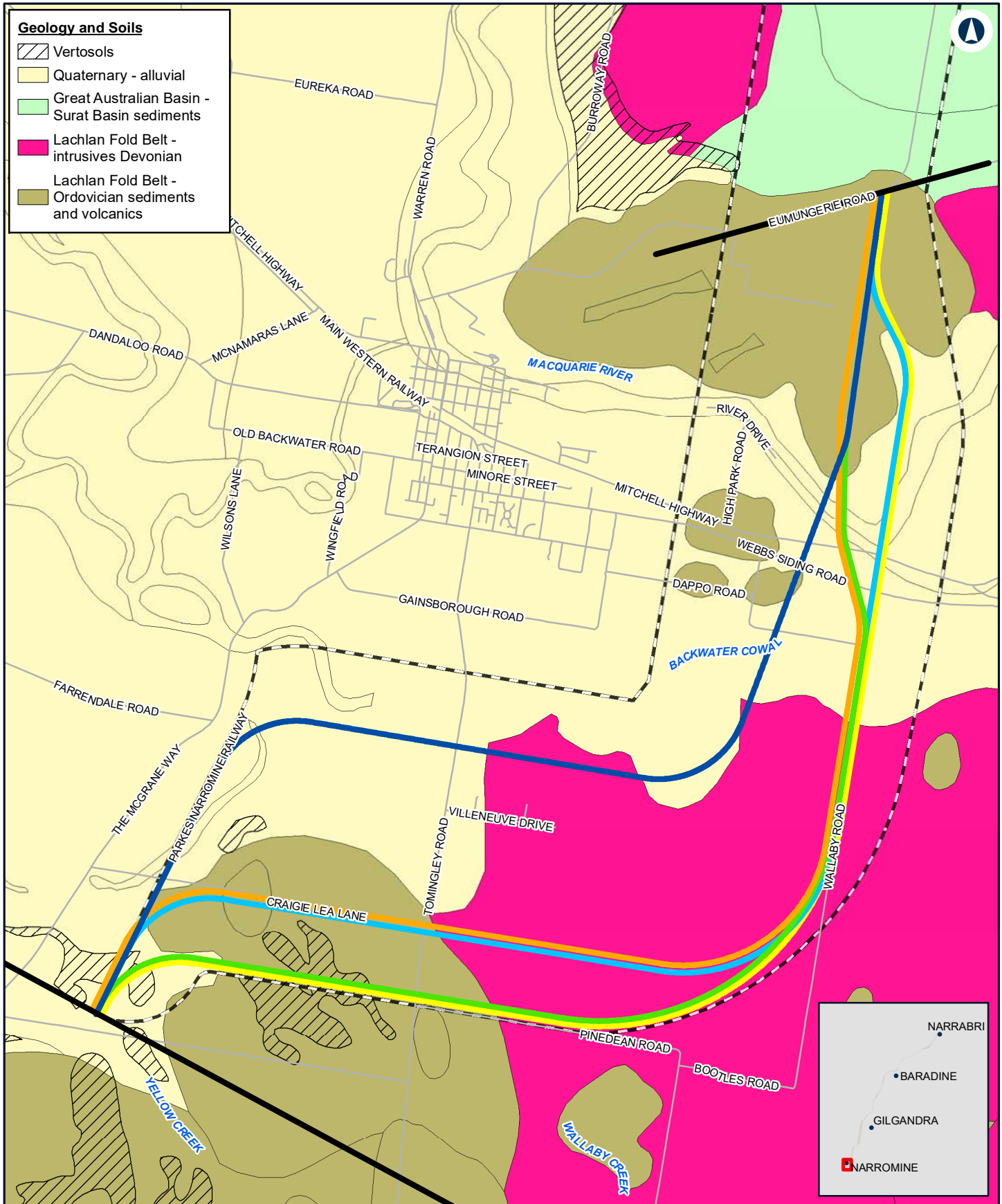
Data Sources: Imagery, road names: NSW Spatial Services; Utilities: ARTC; all other layers: JacobsGHD

LEGEND

- NB-NS-BC
- NB-NS-CLL
- NB-NS-PR
- NB-NS-CE
- NB-NS-PE
- Phase 2 study area
- Electricity 22kV - 66kV
- Comms (Telstra)
- High pressure gas
- Electricity 132kV



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NARROMINE TO NARRABRI Constraints - Geology and Soils - Narromine South

Figure 4.3

0 1 2 Km

LEGEND

- NB-NS-BC
- NB-NS-CLL
- NB-NS-PR
- NB-NS-CE
- NB-NS-PE
- Study area

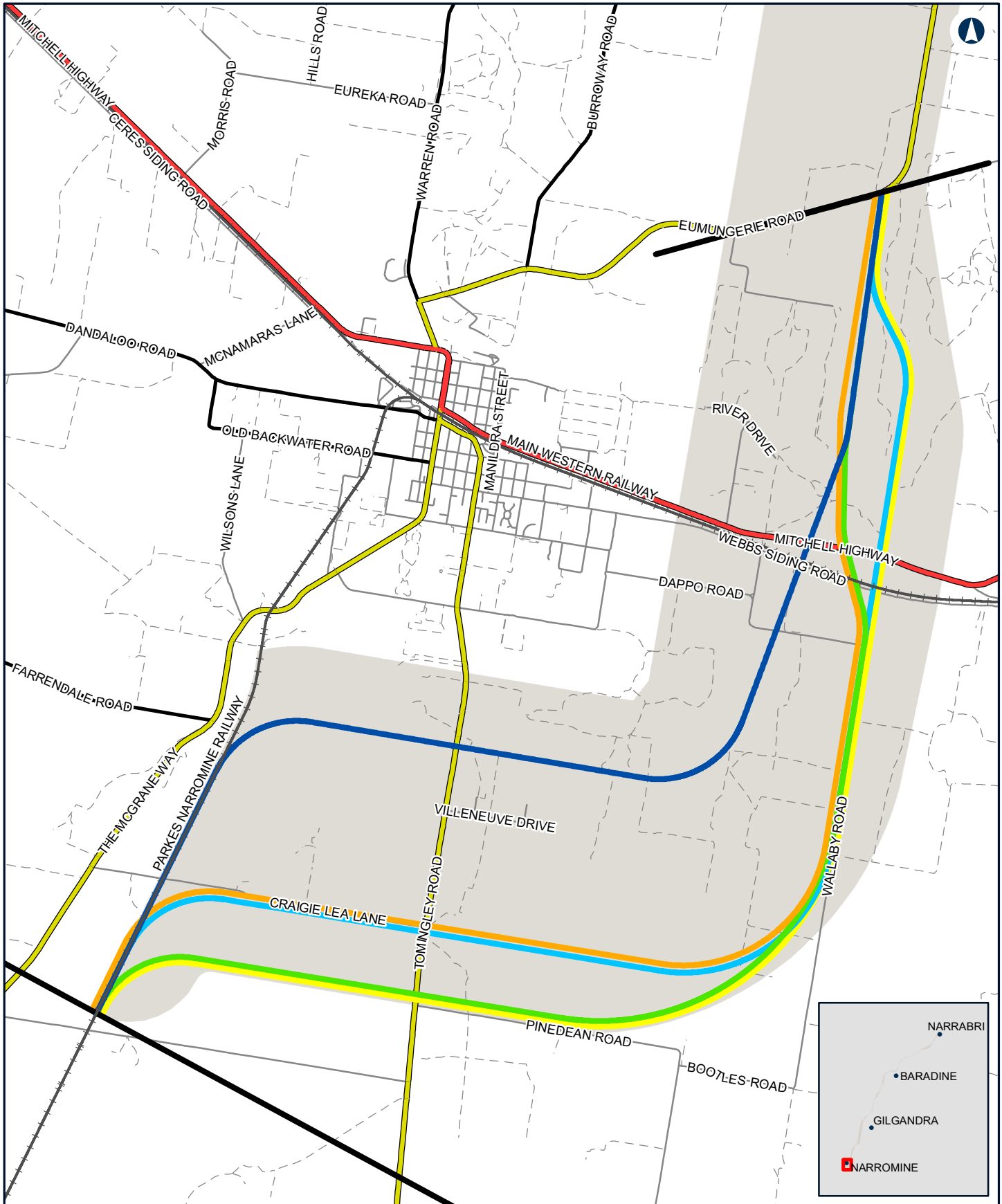
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 Author: GM (GHD) Scale: 1:70,000

Data Sources: Road names: NSW Spatial Services; geology, soils; Dept Industry Resources and Energy; all other layers: JacobsGHD



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NARROMINE TO NARRABRI Constraints - Road and rail network - Narromine South Figure 4.4

0 1 2 Km

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Date: 16/09/2019 Paper: A4
 Author: GM (GHD) Scale: 1:70,000

Data Sources: Road and rail: NSW Spatial Services; all other layers: JacobsGHD

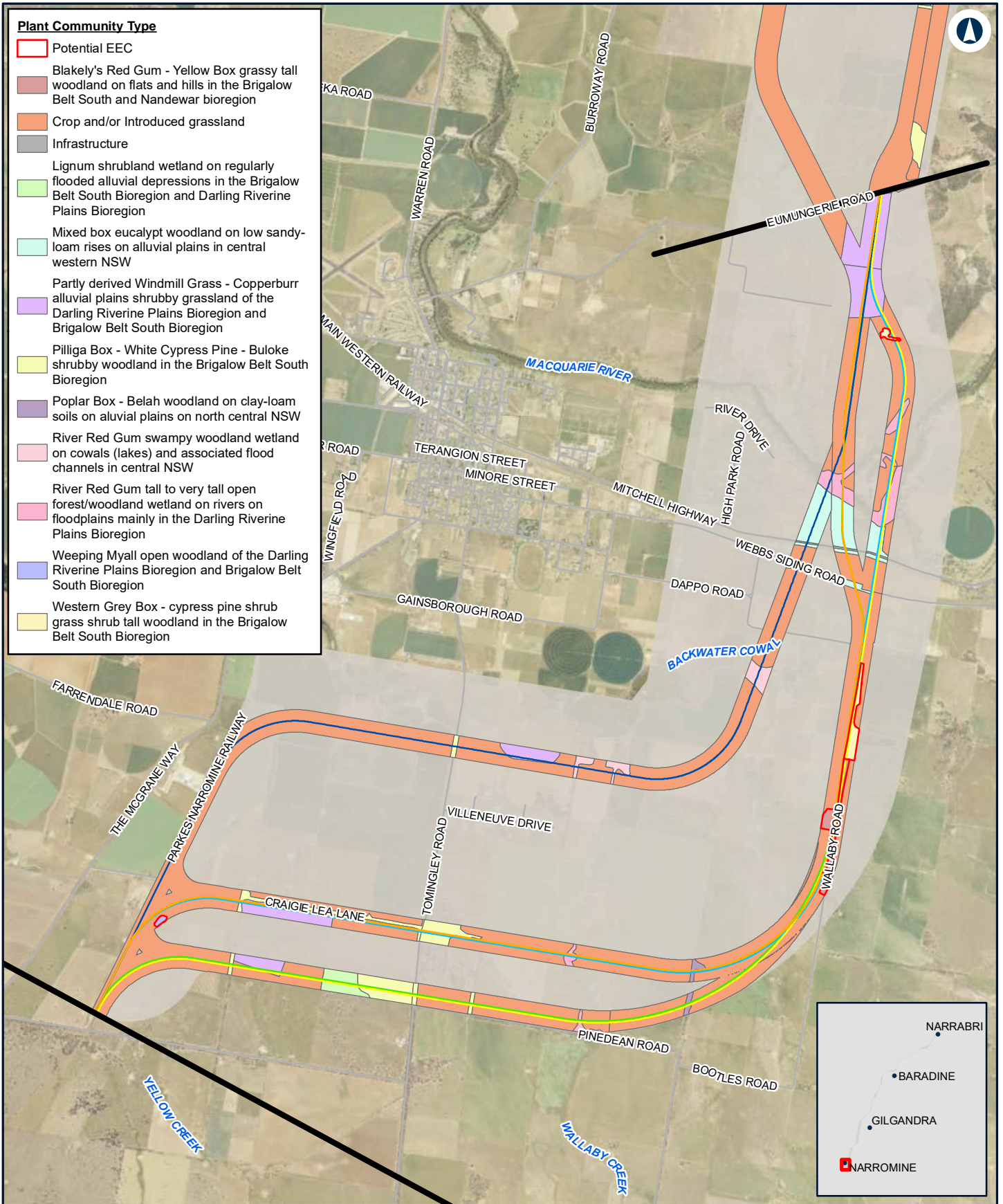
LEGEND	
—	NB-NS-BC
—	NB-NS-CLL
—	NB-NS-PR
—	NB-NS-CE
—	NB-NS-PE
	Study area
—	Primary Road
—	Arterial Road
—	Sub-Arterial Road
—	Local Road
- - -	Track
—+—	Railway



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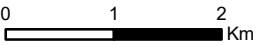
Plant Community Type

- Potential EEC
- Blakely's Red Gum - Yellow Box grassy tall woodland on flats and hills in the Brigalow Belt South and Nandewar bioregion
- Crop and/or Introduced grassland
- Infrastructure
- Lignum shrubland wetland on regularly flooded alluvial depressions in the Brigalow Belt South Bioregion and Darling Riverine Plains Bioregion
- Mixed box eucalypt woodland on low sandy-loam rises on alluvial plains in central western NSW
- Partly derived Windmill Grass - Copperburr alluvial plains shrubby grassland of the Darling Riverine Plains Bioregion and Brigalow Belt South Bioregion
- Pilliga Box - White Cypress Pine - Buloke shrubby woodland in the Brigalow Belt South Bioregion
- Poplar Box - Belah woodland on clay-loam soils on alluvial plains on north central NSW
- River Red Gum swampy woodland wetland on cowals (lakes) and associated flood channels in central NSW
- River Red Gum tall to very tall open forest/woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion
- Weeping Myall open woodland of the Darling Riverine Plains Bioregion and Brigalow Belt South Bioregion
- Western Grey Box - cypress pine shrub grass shrub tall woodland in the Brigalow Belt South Bioregion



NARROMINE TO NARRABRI Constraints - ecology - Narromine South

Figure 4.5



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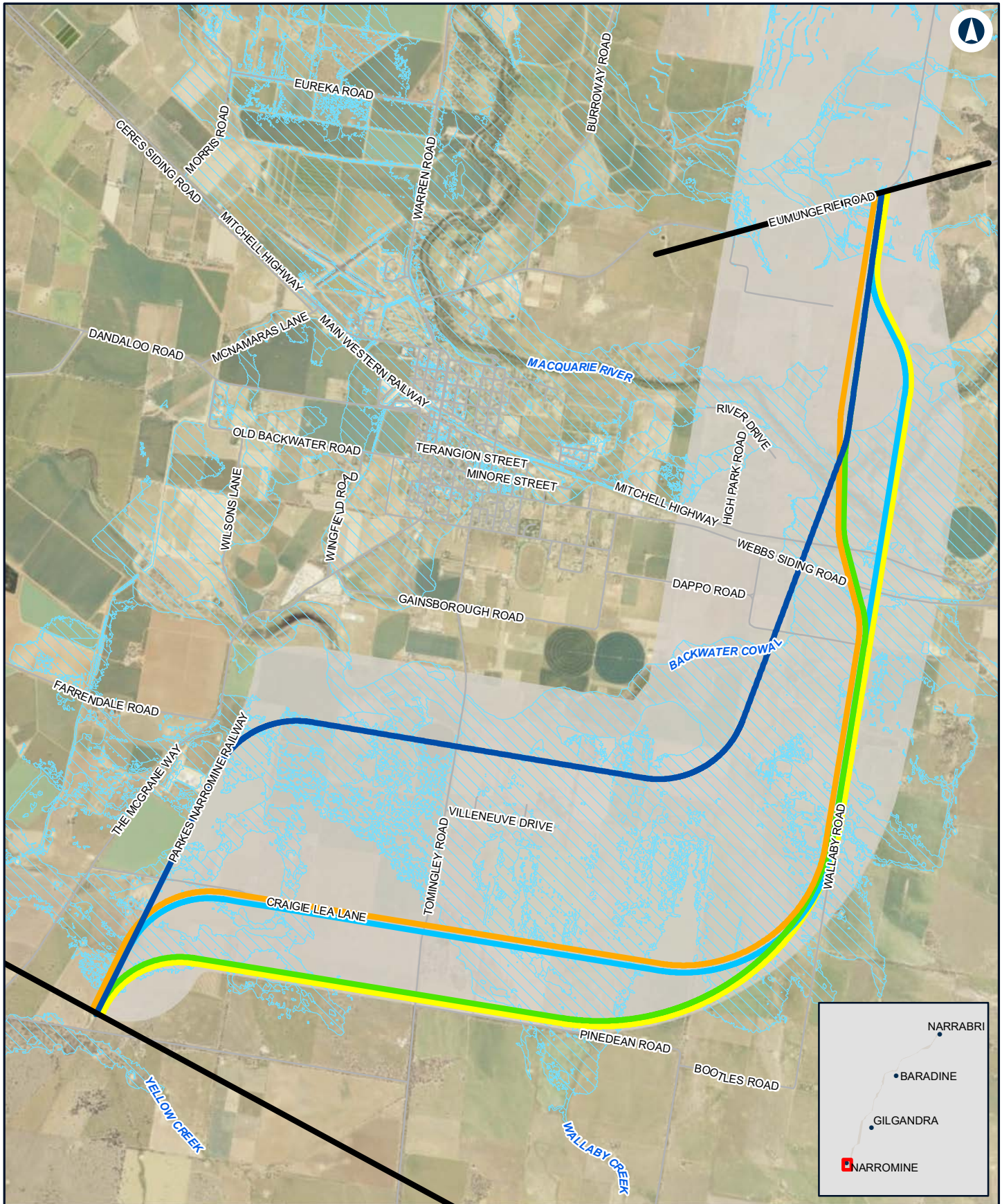
- LEGEND**
- NB-NS-BC
 - NB-NS-CLL
 - NB-NS-PR
 - NB-NS-CE
 - NB-NS-PE
 - Phase 2 study area

Date: 16/09/2019 Paper: A4
 Author: GM (GHD) Scale: 1:70,000

Data Sources: Imagery, road names: NSW Spatial Services; all other layers: JacobsGHD

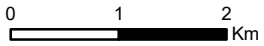


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NARROMINE TO NARRABRI Constraints - Flooding - Narromine South

Figure 4.6



LEGEND

- NB-NS-BC
- NB-NS-CLL
- NB-NS-PR
- NB-NS-CE
- NB-NS-PE
- Flood extent - 1% AEP
- Phase 2 study area

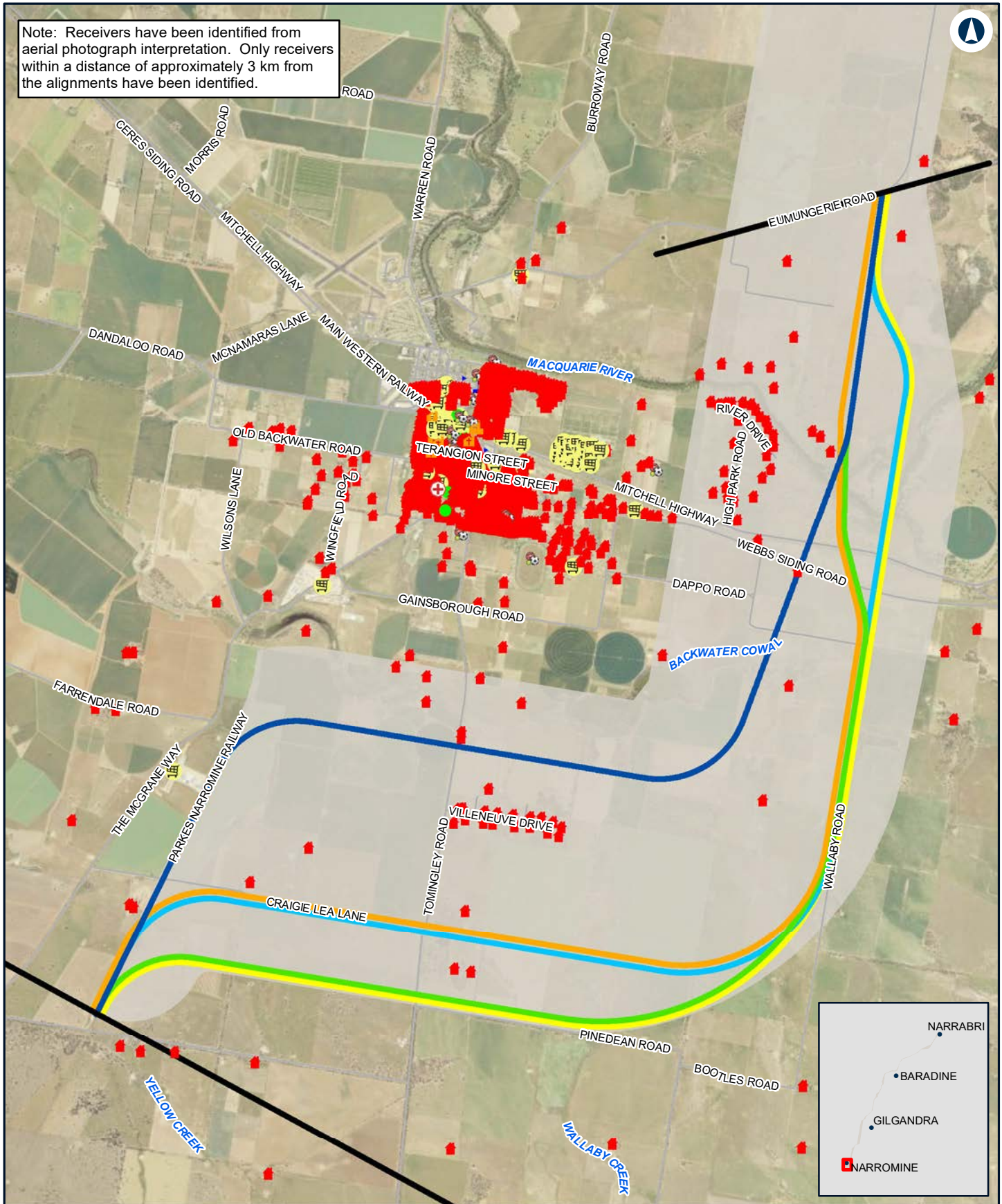
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 Author: GM (GHD) Scale: 1:70,000
 Data Sources: Imagery, road names: NSW Spatial Services; all other layers: JacobsGHD



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Note: Receivers have been identified from aerial photograph interpretation. Only receivers within a distance of approximately 3 km from the alignments have been identified.



NARROMINE TO NARRABRI Constraints - Sensitive Receivers - Narromine South

Figure 4.7

0 1 2 Km

Coordinate System: GDA 1994 MGA Zone 55

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Paper: A4
Scale: 1:70,000

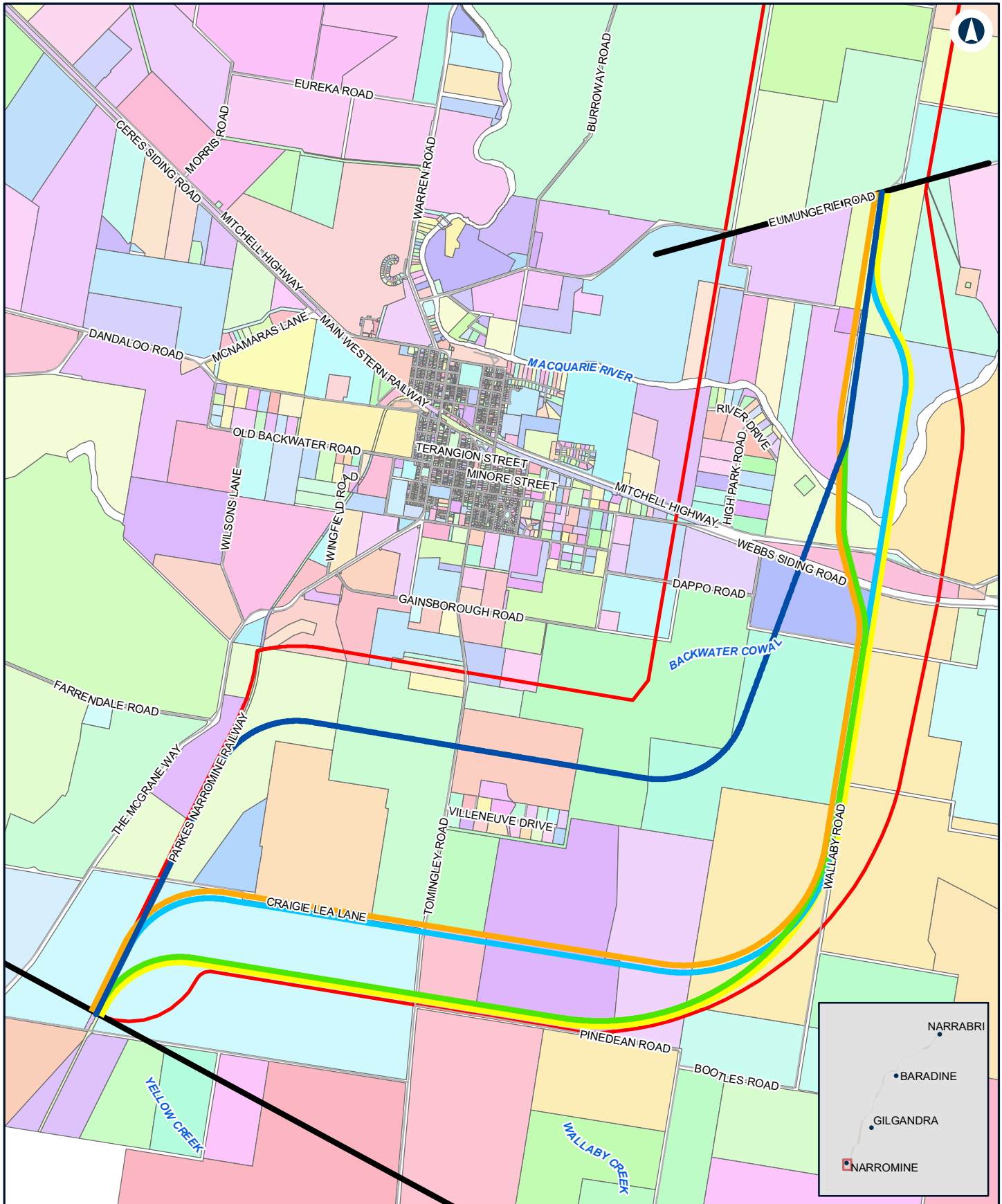
Data Sources: Imagery, road names: NSW Spatial Services; all other layers: JacobsGHD

LEGEND

- NB-NS-BC
- NB-NS-CLL
- NB-NS-PR
- NB-NS-CE
- NB-NS-PE
- Phase 2 study area
- Commercial
- Community
- ⚓ Education
- ⊕ Health
- ⛶ Recreation
- ⛪ Religious
- 🏠 Residence

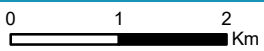


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NARROMINE TO NARRABRI Constraints - Property - Narromine South

Figure 4.8



- LEGEND**
- NB-NS-BC
 - NB-NS-CLL
 - NB-NS-PR
 - NB-NS-CE
 - NB-NS-PE
 - Phase 2 study area

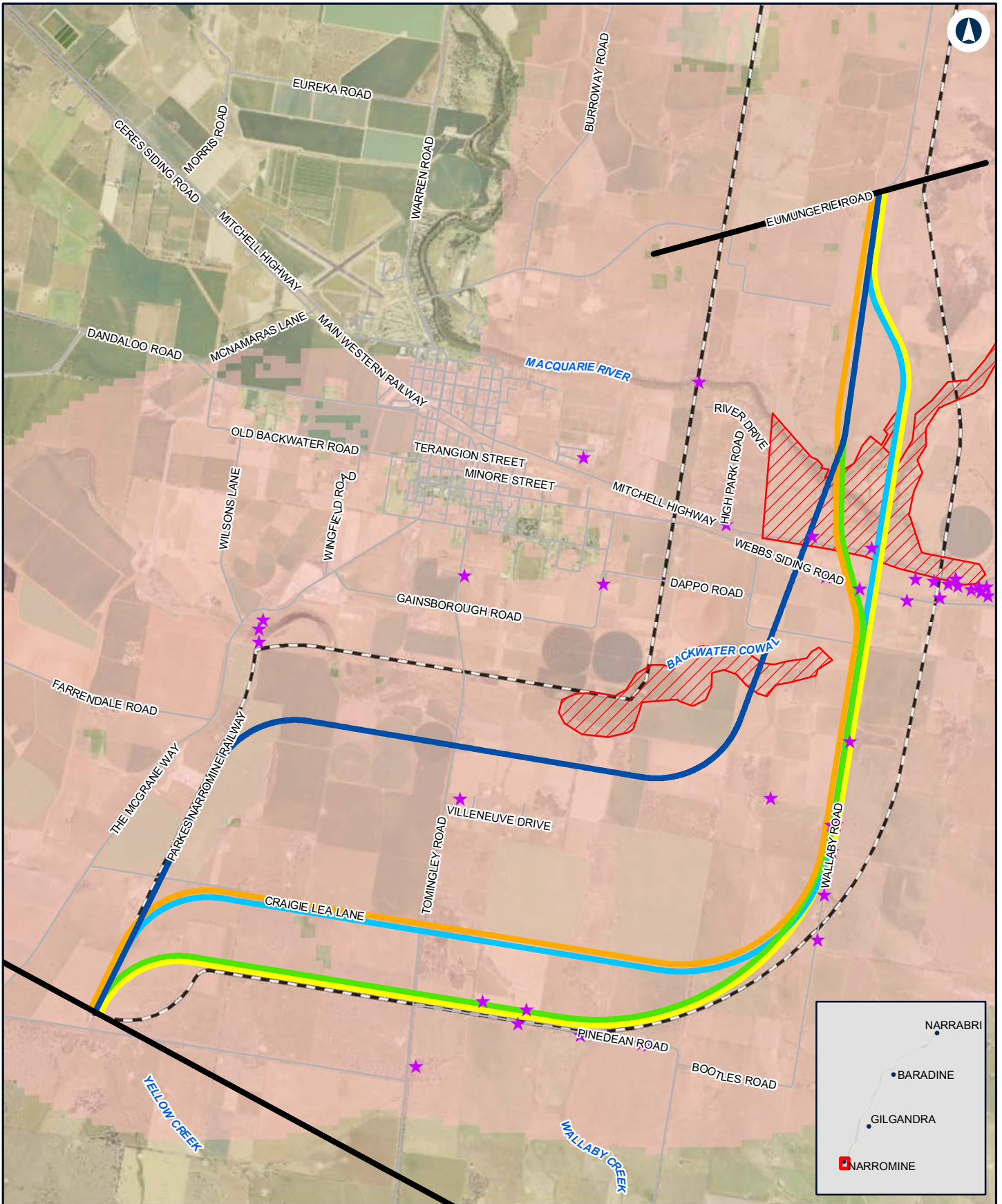
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Data Sources: Road names: NSW Spatial Services; property; ARTC; all other layers: JacobsGHD



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NARROMINE TO NARRABRI Constraints - Cultural Sensitivity - Narromine South

Figure 4.9



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Data Sources: Imagery,Road names: NSW Spatial Services; AHIIMS sites, ASDT data: OEH; all other layers: JacobsGHD

LEGEND

- NB-NS-BC
- NB-NS-CLL
- NB-NS-PR
- NB-NS-CE
- NB-NS-PE
- Phase 2 study area

- ★ AHIIMS site
- Culturally sensitive survey area
- Medium to high sensitivity areas (ASDT - DECCW)



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4.6 MCA Scoring

The MCA scoring of Narromine South options is presented in Appendix A. Summary results for Narromine South options are presented in Table 4-4.

Table 4-4 Narromine South - MCA Results

Option	MCA Score	Rank
NB-NS-BC (Base Case, Dark Blue option)	0	
NB-NS-CLL (Orange option)	0.71	2
NB-NS-PR (Green option)	0.76	1
NB-NS-CE (Light Blue option)	0.45	4
NB-NS-PE (Yellow option)	0.59	3

4.6.1 MCA Scores analysis

Compared to the Base Case all options scored positively in technical viability, environmental impact and community, property and heritage. The Base Case ranked the lowest due to its proximity to Narromine which results in a greater number of receivers potentially impacted by noise and vibration, air quality and visual impact. The Base Case also directly impacts the most number of properties.

The only area the Base Case scored positively over the other options was in constructability and schedule due to the shorter track length in a “Green field” environment, poor access for all options and shorter bridge structures required to cross the Macquarie Rive for the Yellow and light blue options.

The Green option was the highest ranking due to its reduced impact on utilities, and shorter bridge structure required to cross the Macquarie River than the Yellow or Light Blue options, reducing construction duration and cost. The Green option is also a greater distance from Narromine than the Base Case which reduces the number of receivers subject to visual impacts.

4.6.2 Sensitivity analysis (MCA weightings)

A sensitivity analysis was carried out, this considered; increasing the weightings for each of the key criteria to 40%, whilst re-weighting the remaining criteria to 10% each. The outcomes are summarised in

Table 4-5 and Appendix A, with key observations being:

1. The Green option ranked first for technical viability, safety, operations, community and approval categories.
2. The Yellow option ranked first for Environmental.
3. The Orange option ranked first for constructability and schedule.

The sensitivity analysis ranking reflects and supports the MCA scoring and comments noted above.

Table 4-5 Narromine South - Sensitivity Analysis

Sensitivity	Top Option	Top Option Score	Base Case Rank
Technical	Green option	1.27	5
Safety	Green option	0.52	5
Operations	Green option	0.52	5
Constructability and schedule	Orange option	0.29	3
Environmental	Yellow option	0.85	5
Community	Green option	1.16	5
Approvals	Green option	0.89	5

4.7 Preferred option

The preferred option is the Green Option (NB-NS-PR).

All options scored relatively closely using the MCA assessment procedure. The Green option ranked first with a score of 0.76, followed by the Orange option with a score of 0.71.

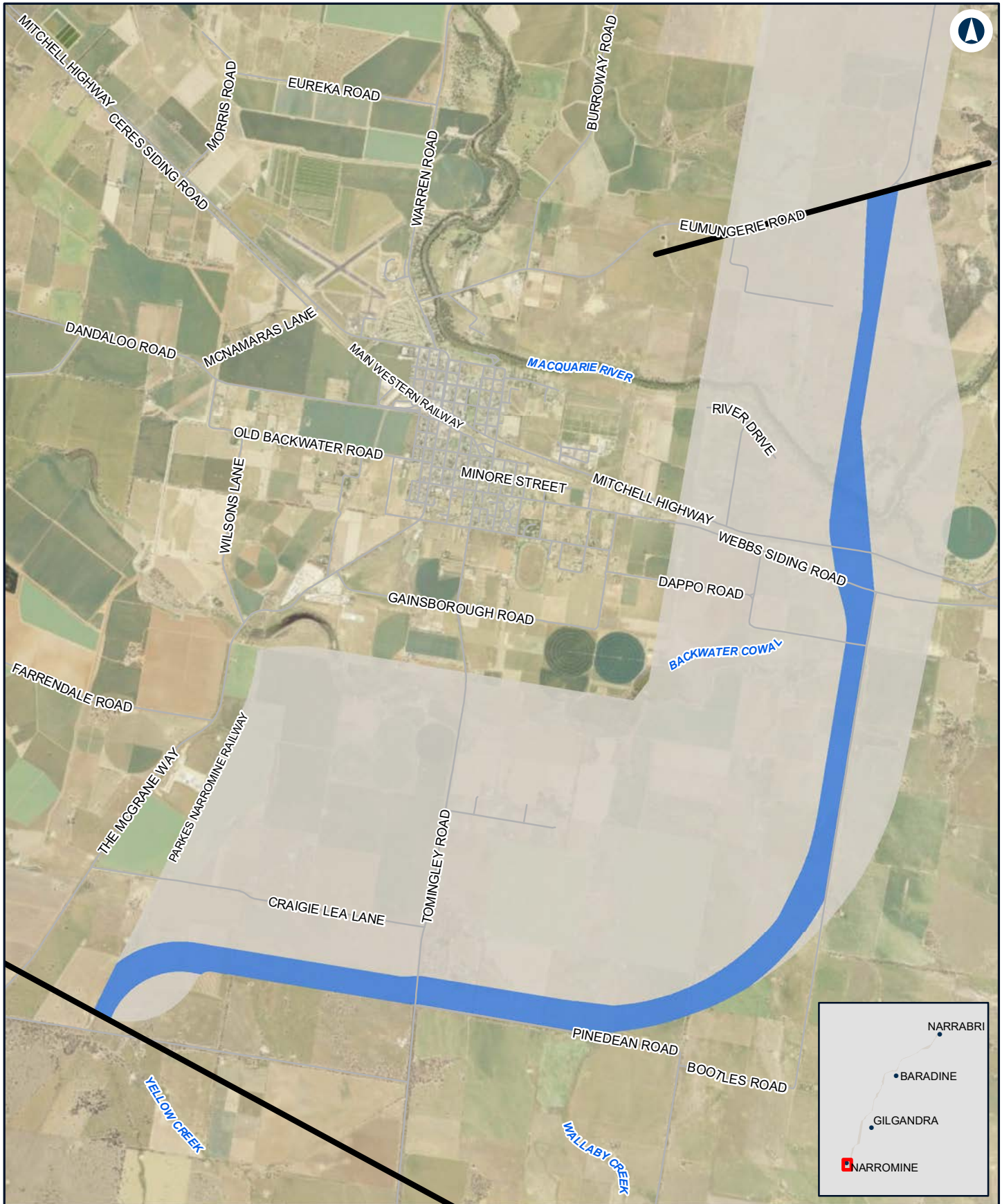
The options generally follow similar alignments, with the key differences being at the northern and southern ends.

At the northern end, the Green and Orange options both cross the Macquarie River with a shorter bridge structure, in the order of 1200m long. The Blue and Yellow options cross the river further to the east, over flatter terrain that result in a longer structure, approximately 2400m in length. This additional structure length would result in additional cost and construction duration. This is however countered by moving the alignment further away from sensitive receivers, particularly around High Park Road and River Drive. On balance, it was considered that the alignment of the Green and Orange options crossing of the Macquarie River was preferred to avoid a more extensive structure in the flood plain.

To the south, the key differentiator between the options is the departure point from the Parkes to Narromine railway and whether the alignment should generally follow the line of Craigie Lea Lane or Pinedean Road. The Orange and Blue options follow the Craigie Lea Lane alignment. This has approximately 1km more of brownfield track on P2N and 1km less of greenfield track. The interfaces with the Parkes to Narromine railway were also considered. If a future rail connection were to be constructed from Inland Rail towards Narromine, Craigie Lea Lane may require closure, diversion and/or an active level crossing installed. Adopting the Green option would extend the impacts of the N2N project further south and result in the requirement for an active level crossing on Narwonah Siding Road.

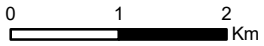
Noting that the impacts assessed for both the Craigie Lea Lane and Pinedean Road routes were similar, reference was made the geological mapping Figure 4-3 and geotechnical test results and flood mapping Figure 4-6. While the differentiators were not major, there was a general trend for ground conditions to improve further to the south. Reference to the flood mapping also indicated that the further south the alignment, the greater the length of track that would be above the 1% AEP Flood Level. On balance therefore, the southern option was considered to be generally preferred.

The above outcomes are reflected in the MCA scoring that considered both quantitative and qualitative criteria, with the Green option following the Pinedean Road alignment and crossing the Macquarie River at the shorter, eastern, crossing point.



NARROMINE TO NARRABRI Focus area - Narromine South

Figure 4.10



LEGEND

	Focus area
	Phase 2 study area

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5. Eumungerie Road

5.1 Overview

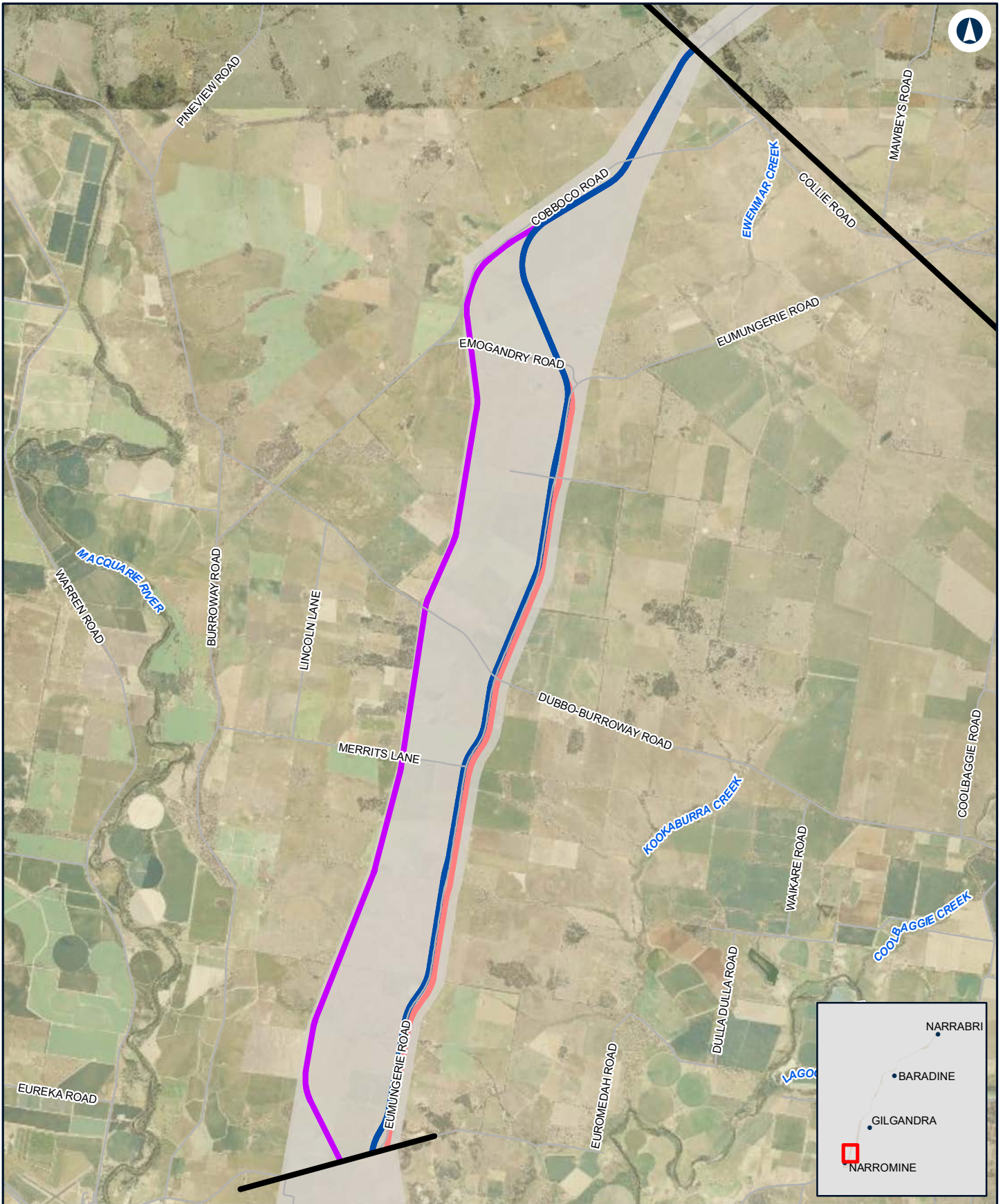
The Eumungerie Road sub-section runs from south of Eumungerie Road to Collie Road. The Study Area generally follows Eumungerie Road crosses includes a number of rural and farming properties, sensitive receivers and road crossings (Eumungerie Road, Dubbo-Burroway Road and Cobboco Road). This sub-section is along the ridge line and has topography that is mostly undulating.

5.2 Options under assessment

Within the Eumungerie Road Study Area two option were developed for comparison against the Base Case. These options are summarised in Table 5-1 and illustrated in Figure 5-1.

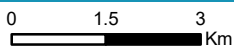
Table 5-1 Eumungerie Road options

Option	Description
NB-ER-BC (Base Case, Dark Blue option)	<p>The Base Case runs northward following the western boundary of Eumungerie Road crossing Dubbo Burroway Road. Near the intersection of Emongandry Road, it turns in a north westerly direction towards Cobboco Road crossing Emongandry Road whilst running parallel to property boundaries. The Base Case then runs adjacent to the eastern boundary of Cobboco Road where it joins the adjacent Gilmours Road section.</p> <p>The Base Case:</p> <ul style="list-style-type: none">• Is 28.1 km in length• Has a travel time of 14.7 minutes• Impacts 17 properties
NB-ER-E (Pink option)	<p>This option is similar to the Base Case except it follows the eastern boundary of Eumungerie Road. Near the intersection of Emongandry Road, it turns in a north westerly direction towards Cobboco Road crossing Eumungerie Road and Emongandry Road whilst running parallel to property boundaries. It then runs adjacent to the eastern boundary of Cobboco Road where it joins the adjacent Gilmours Road section.</p> <p>The Pink option:</p> <ul style="list-style-type: none">• Is 27.7 km in length• Has a travel time of 14.5 minutes• Impacts 14 properties
NB-ER-BB (Purple option)	<p>The Purple is generally between 1km-2km west of Eumungerie Road. It continues north crossing Dubbo Burroway Road and Emongandry Road where it joins the eastern boundary of Cobboco Road. It continues north adjacent to this boundary where it joins the adjacent Gilmours Road section.</p> <p>The Purple option:</p> <ul style="list-style-type: none">• Is 28.6 km in length• Has a travel time of 14.9 minutes• Impacts 17 properties



NARROMINE TO NARRABRI Options summary - Eumungerie Road

Figure 5.1



LEGEND

- NB-ER-BC
- NB-ER-BB
- NB-ER-E
- Phase 2 study area

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5.3 Field investigations completed

5.3.1 Geotechnical

The majority of geotechnical investigations were performed along Eumungerie Road with some additional investigations undertaken to inform the back-boundary option on Merrits Lane and Burroway Road. Ground conditions encountered include a deep residual soil profile over extremely weathered bedrock to significant depth (>15m). These ground conditions were encountered at all investigation locations, both along Eumungerie Road and at the back boundary. Materials encountered typically exhibited CBRs ranging between 4% and 6%; these materials are likely to be suitable for general fill only.

Geotechnical conditions are anticipated to be similar along both the Eumungerie Road and back boundary options. There are no differentiators between the options from a geotechnical perspective.

5.3.2 Ecology

Within the Study Area there are 10 PCTs identified within the field survey areas. Based on the information available, no TECs listed under the BC Act or EPBC Act would be impacted by any of the options. Native plant community types include:

- Pilliga Box – White Cypress Pine – Buloke Shrubby Woodland in the Brigalow Belt South Bioregion
- Derived Wire Grass Grassland of the NSW Brigalow Belt South Bioregion and Nandewar Bioregion
- Poplar Box Grassy Woodland on Alluvial Clay-Loam Soils Mainly in the Temperate (hot summer) Climate Zone of Central NSW (wheatbelt)
- Poplar Box – Belah Woodland on Clay-Loam Soils on Alluvial Plains on North Central NSW
- Partly derived Windmill Grass - Copperburr alluvial plains shrubby grassland of the Darling Riverine Plains Bioregion and Brigalow Belt South Bioregion Total
- Belah woodland on alluvial plains and low rises in the central NSW wheatbelt to Pilliga and Liverpool Plains regions
- Lignum shrubland wetland on regularly flooded alluvial depressions in the Brigalow Belt South Bioregion and Darling Riverine Plains Bioregion
- Derived tussock grassland of the central western plains and lower slopes of NSW
- Derived Kurrajong grassy open woodland / isolated trees in the BBS and Nandewar Bioregion
- Silver-leaved Ironbark - White Cypress Pine shrubby open forest of Brigalow Belt South Bioregion and Nandewar Bioregion

The majority of the length of options under assessment do not impact these plant community types, with the main plant community type impacted being crop and/or introduced grassland (between 19.7 and 21.7 kilometres).

5.3.3 Cultural Heritage

Cultural heritage field surveys undertaken in the Study Area identified:

- No AHIMS sites within 200 metres of any of the options
- No known Artefact scatters within 200 metres of any of the options
- No known Ochre quarries within 200 metres of any of the options
- No known culturally sensitive sites within 200 metres of any of the options
- No known grindstone within 200 metres of any of the options
- No known scarred trees within 200 metres any of the options
- No known sensitive rivers within 200 metres of any of the options
- No known culturally sensitive areas within 200 metres of any of the options

5.4 Comparative quantities influencing capital cost

Elements of each option that will influence the capital cost are included in Table 5-2. Order of magnitude quantities for track length and structures are provided as well as the complexity of earthworks.

Table 5-2 Eumungerie Road comparative quantities

Option	Track Length	Structure quantity	Earthworks
NB-ER-BC (Base Case, Dark Blue option)	28.1km	More than 10 moderate or large culverts No grade separations	Approximately 7% of corridor traverses poor geotechnical conditions. This option and option NB-ER-E present the most complex earthworks, when compared to other options.
NB-ER-E (Pink option)	27.7km	More than 10 moderate or large culverts No grade separations	Approximately 8% of corridor traverses poor geotechnical conditions. This option and option NB-ER-BC present the most complex earthworks, when compared to other options.
NB-ER-BB (Purple option)	28.6km	More than 10 moderate or large culverts No grade separations	Approximately 0% of corridor traverses poor geotechnical conditions. The option presents the least complex earthworks, when compared with other options.

5.5 Summary of Eumungerie Road MCA options comparison

A summary of the key issues for each of the Eumungerie Road options is provided in Table 5-3, based on the MCA scoring sub-criteria defined in Section 3.2.

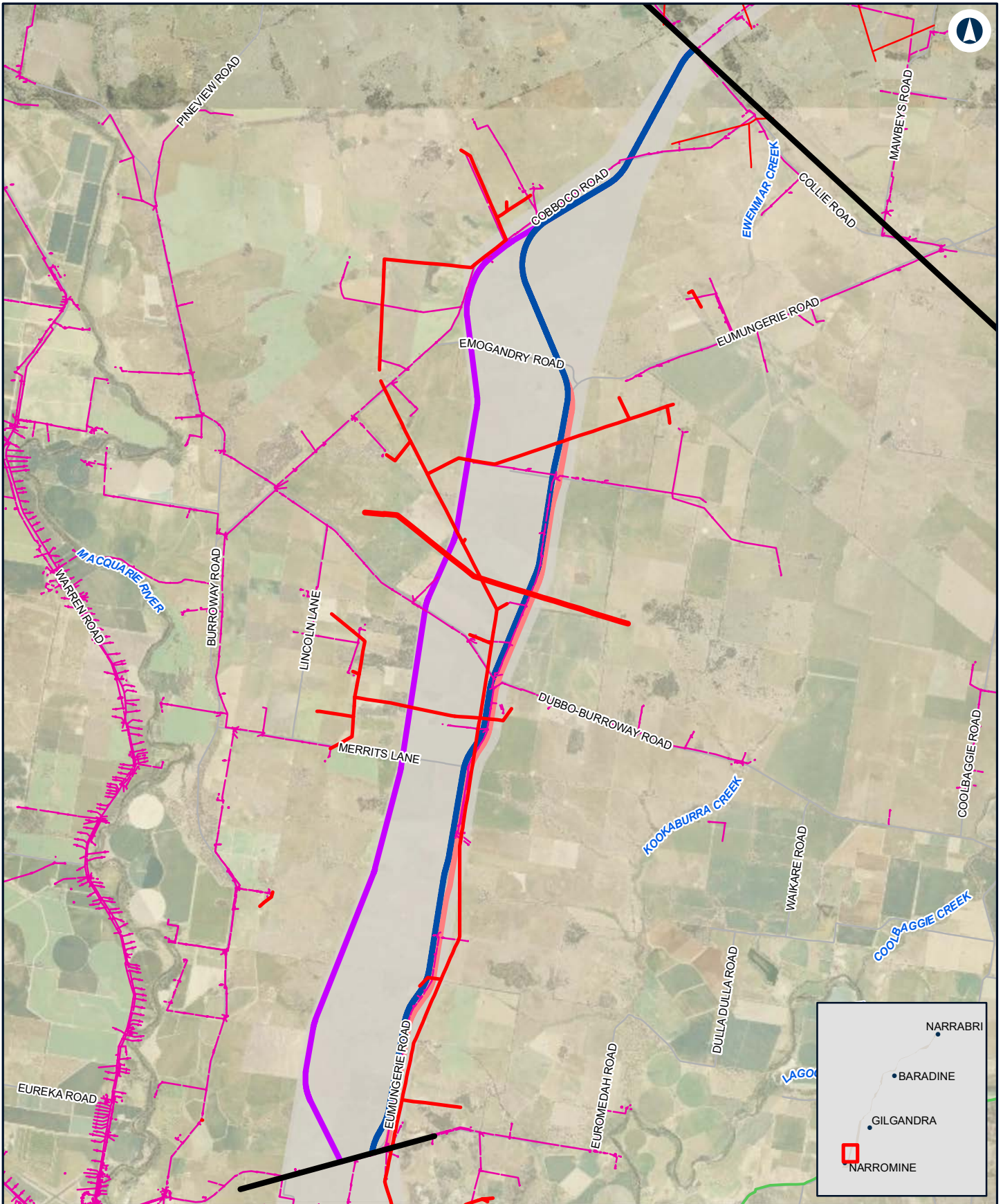
Corresponding maps for each of these key issues are provided in Figure 5-2 to Figure 5-9.

Table 5-3 Summary of Eumungerie Road MCA options comparison

	NB-ER-BC (Base Case, Dark Blue option)	NB-ER-E (Pink option)	NB-ER-BB (Purple option)
Alignment	The Base Case is 28.1km long.	The Pink option is 27.7km long. No significant difference in track geometry compared to the Base Case.	The Purple option is 28.6km long. No significant difference in track geometry compared to the Base Case.
Impact on utilities (Figure 5-2)	<p>The utilities affected by the Base Case include:</p> <ul style="list-style-type: none"> • 1 132kV overhead crossings • 4 22kV crossings • 11 telecommunication crossings 	<p>The utilities affected by the Pink option include:</p> <ul style="list-style-type: none"> • 1 132kV overhead crossings • 4 22kV crossings • 1 11kV crossing • 14 telecommunication crossings 	<p>The utilities affected by the Purple option include:</p> <ul style="list-style-type: none"> • 1 132kV overhead crossings • 3 22kV crossings • 1 11kV crossing • 7 telecommunication crossings
Geotechnical conditions (Figure 5-3)	<p>The Base Case traverses 26.2 km of sedimentary soil conditions and 1.9 km traverses alluvium or colluvial soil conditions.</p> <p>General fill materials only anticipated within cuttings along Eumungerie Road. Potential need to excavate and replace materials with low CBRs in cut floor.</p>	<p>The Pink option traverses 25.4 km of sedimentary soil conditions and 2.3 km traverses alluvium or colluvial soil conditions.</p> <p>General fill materials only anticipated within cuttings along Eumungerie Road. Potential need to excavate and replace materials with low CBRs in cut floor.</p>	<p>The Purple option traverses 28.5 km of sedimentary soil conditions and 0.1 km traverses alluvium or colluvial soil conditions.</p> <p>General fill materials only anticipated within cuttings along Eumungerie Road back boundary. Potential need to excavate and replace materials with low CBRs in cut floor.</p>
Impact on existing road and rail (Figure 5-4)	Crosses 5 public roads	Crosses 7 public roads	Crosses 5 public roads
Flood immunity/hydrology (Figure 5-6)	Portions of the Base are within the 1% AEP flood area for local drainage along the ridge line.	Less than 10% difference in exposure to the 1% AEP flood affected area, when compared to the Base Case.	Less than 10% difference in exposure to the 1% AEP flood affected area, when compared to the Base Case.
Future Proofing	The Base Case contains no significant constraints that would impact on ability to upgrade the rail infrastructure in the future.	The Pink option contains no significant constraints that would impact on ability to upgrade the rail infrastructure in the future.	The Purple option contains no significant constraints that would impact on ability to upgrade the rail infrastructure in the future.

	NB-ER-BC (Base Case, Dark Blue option)	NB-ER-E (Pink option)	NB-ER-BB (Purple option)
Road Safety Interface	The Base Case interfaces with: <ul style="list-style-type: none"> • 5 council roads • 17 private roads 	The Pink option interfaces with: <ul style="list-style-type: none"> • 7 council roads • 14 private roads The Pink option presents no material difference to safety over the Base Case.	The Purple option interfaces with: <ul style="list-style-type: none"> • 5 council roads • 16 private roads The Purple option presents no material difference to safety over the Base Case.
Effect/ Impact on travel time	Estimated travel time of the Base Case is 14.7 minute.	Less than 1 minute difference in travel compared to Base Case, no material difference to reliability and/or connectivity.	Less than 1 minute difference in travel compared to Base Case, no material difference to reliability and/or connectivity.
Construction complexity	<ul style="list-style-type: none"> • More than 10 moderate or large culverts • No grade separations • presents the most complex earthworks, when compared to other options 	The Pink option is similar to the Base Case with; <ul style="list-style-type: none"> • More than 10 moderate or large culverts • No grade separations • Similar earth works to base case 	The Purple option is similar to the Base Case with; <ul style="list-style-type: none"> • More than 10 moderate or large culverts • No grade separations • Slightly less complex earth works compared to base case, however not enough to score positively
Ecological impacts (Figure 5-5)	The Base Case impacts: <ul style="list-style-type: none"> • 21.6km of non-native vegetation • 6.3km of native vegetation (but not TEC) • Nil native vegetation listed as a TEC under the BC Act and/or EPBC Act 	The Pink option impacts: <ul style="list-style-type: none"> • 23.2km of non-native vegetation • 4.5km of native vegetation (but not TEC) • Nil native vegetation listed as a TEC under the BC Act and/or EPBC Act 	The Purple option impacts: <ul style="list-style-type: none"> • 19.8km of non-native vegetation • 8.8km of native vegetation (but not TEC) • Nil native vegetation listed as a TEC under the BC Act and/or EPBC Act
Flooding / waterway impacts (Figure 5-6)	The Base Case traverses no unnamed waterways and two named waterways, for a total of two waterway crossings.	The Pink option traverses no unnamed waterways and four named waterways for a total of four waterway crossings.	The Purple option traverses no unnamed waterways and seven named waterways for a total of seven waterway crossings.
Visual Impacts	The base case has 17 potential receivers with-in 1000m.	The Pink option has 17 potential receivers with-in 1000m.	The Purple option has 16 potential receivers with-in 1000m.
Sensitive receivers – Noise and Vibration / Effect on Air Quality (Figure 5-7)	<ul style="list-style-type: none"> • The Base Case has 1 residential receiver within 200m. 	<ul style="list-style-type: none"> • The Pink option has 3 residential receivers within 200m. 	<ul style="list-style-type: none"> • The Purple option has 2 residential receivers within 200m. (Note: 1 residences would be directly impacted and are not considered receivers).
Property impacts (Figure 5-8)	The Base Case directly impacts 17 properties, severing 4 of these.	The Pink option directly impacts 14 properties, severing 3 of these.	The Purple option directly impacts 17 properties severing 12 of these.

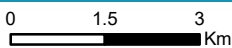
	NB-ER-BC (Base Case, Dark Blue option)	NB-ER-E (Pink option)	NB-ER-BB (Purple option)
Cultural Heritage impacts (Figure 5-9)	<ul style="list-style-type: none"> No AHIMS sites within 200 metres of any of the options No Artefact scatters within 200 metres of any of the options No Ochre quarries within 200 metres of any of the options No culturally sensitive sites within 200 metres of any of the options No grindstone within 200 metres of any of the options No scarred trees within 200 metres any of the options No sensitive rivers within 200 metres of any of the options 	<ul style="list-style-type: none"> No AHIMS sites within 200 metres of any of the options No Artefact scatters within 200 metres of any of the options No Ochre quarries within 200 metres of any of the options No culturally sensitive sites within 200 metres of any of the options No grindstone within 200 metres of any of the options No scarred trees within 200 metres any of the options No sensitive rivers within 200 metres of any of the options 	<ul style="list-style-type: none"> No AHIMS sites within 200 metres of any of the options No Artefact scatters within 200 metres of any of the options No Ochre quarries within 200 metres of any of the options No culturally sensitive sites within 200 metres of any of the options No grindstone within 200 metres of any of the options No scarred trees within 200 metres any of the options No sensitive rivers within 200 metres of any of the options



NARROMINE TO NARRABRI

Constraints - Utilities - Eumungerie Road

Figure 5.2



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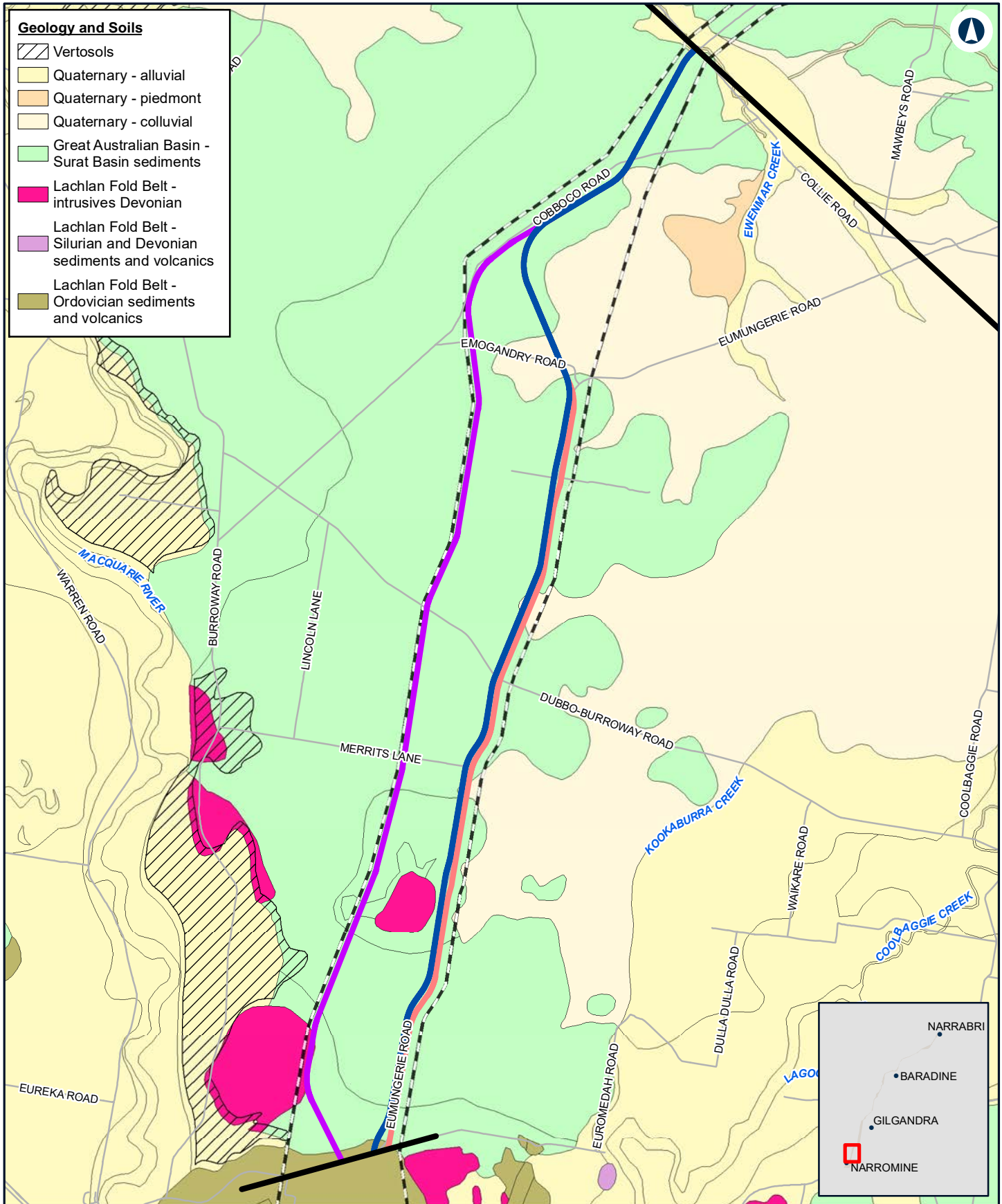
Data Sources: Imagery, road names: NSW Spatial Services; Utilities: ARTC; all other layers: JacobsGHD

LEGEND

- NB-ER-BC
- NB-ER-BB
- NB-ER-E
- Phase 2 study area
- Electricity 132kV
- Electricity 22kV - 66kV
- Electricity 11kV - 22kV
- Comms (Telstra)
- High pressure gas



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- Geology and Soils**
- Vertosols
 - Quaternary - alluvial
 - Quaternary - piedmont
 - Quaternary - colluvial
 - Great Australian Basin - Surat Basin sediments
 - Lachlan Fold Belt - intrusives Devonian
 - Lachlan Fold Belt - Silurian and Devonian sediments and volcanics
 - Lachlan Fold Belt - Ordovician sediments and volcanics

NARROMINE TO NARRABRI Constraints - Geology and Soils - Eumungerie Road

Figure 5.3

0 1.5 3 Km

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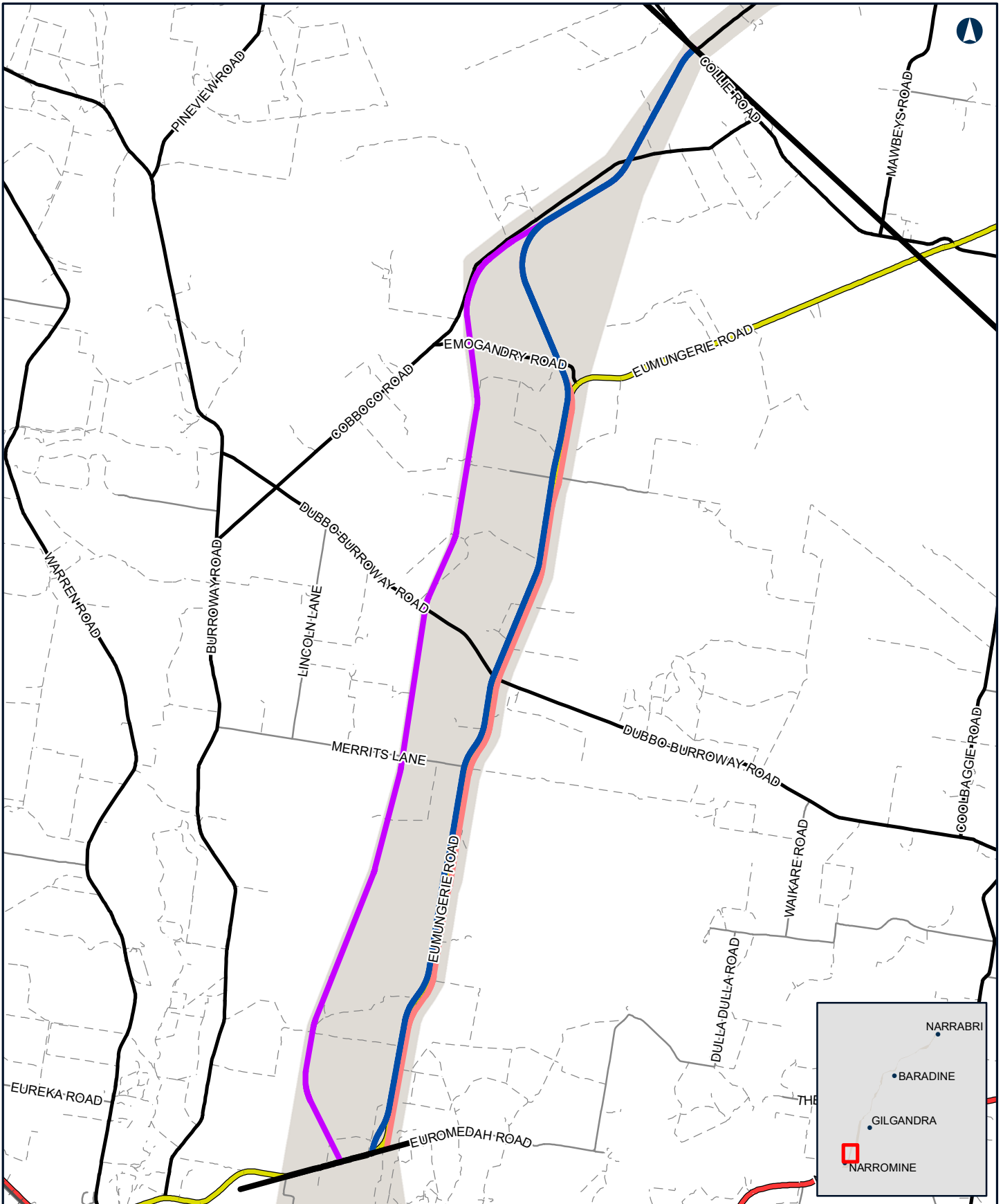
- LEGEND**
- NB-ER-BC
 - NB-ER-BB
 - NB-ER-E
 - Study area

Date: 16/09/2019 Paper: A4
 Author: GM (GHD) Scale: 1:120,000

Data Sources: Road names: NSW Spatial Services; geology, soils; Dept Industry Resources and Energy; all other layers: JacobsGHD



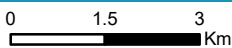
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NARROMINE TO NARRABRI

Constraints - Road and rail network - Eumungerie Road

Figure 5.4



Coordinate System: GDA 1994 MGA Zone 55

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Author: GM (GHD)

Scale: 1:120,000

Data Sources: Road and rail: NSW Spatial Services; all other layers: JacobsGHD

LEGEND

- NB-ER-BC
- NB-ER-BB
- NB-ER-E
- Study area
- Primary Road
- Arterial Road
- Sub Arterial Road
- Local Road
- Track
- Railway

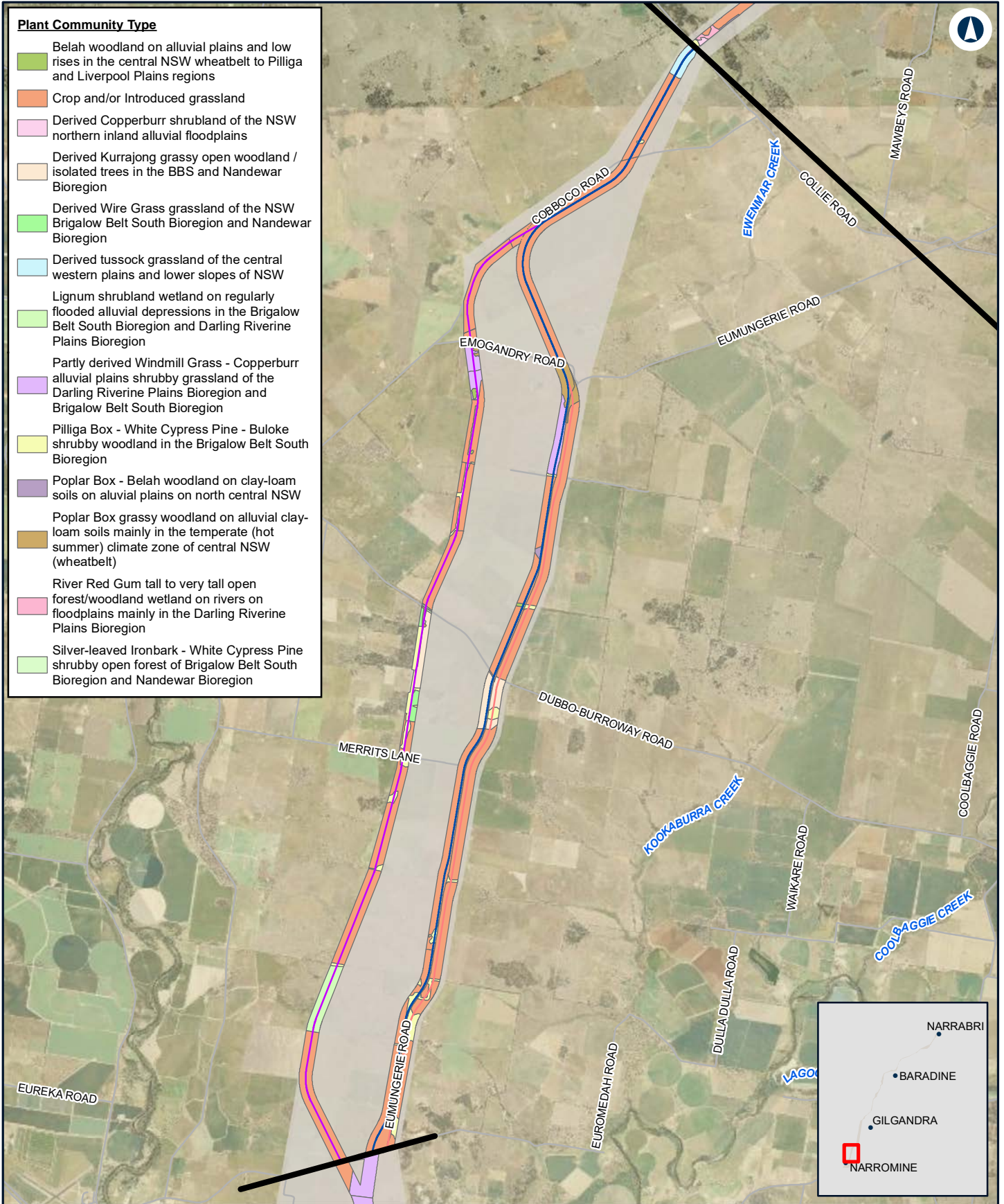
INLAND RAIL

ARTC

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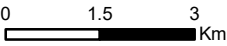
Plant Community Type

- Belah woodland on alluvial plains and low rises in the central NSW wheatbelt to Pilliga and Liverpool Plains regions
- Crop and/or Introduced grassland
- Derived Copperburr shrubland of the NSW northern inland alluvial floodplains
- Derived Kurrajong grassy open woodland / isolated trees in the BBS and Nandewar Bioregion
- Derived Wire Grass grassland of the NSW Brigalow Belt South Bioregion and Nandewar Bioregion
- Derived tussock grassland of the central western plains and lower slopes of NSW
- Lignum shrubland wetland on regularly flooded alluvial depressions in the Brigalow Belt South Bioregion and Darling Riverine Plains Bioregion
- Partly derived Windmill Grass - Copperburr alluvial plains shrubby grassland of the Darling Riverine Plains Bioregion and Brigalow Belt South Bioregion
- Pilliga Box - White Cypress Pine - Buloke shrubby woodland in the Brigalow Belt South Bioregion
- Poplar Box - Belah woodland on clay-loam soils on alluvial plains on north central NSW
- Poplar Box grassy woodland on alluvial clay-loam soils mainly in the temperate (hot summer) climate zone of central NSW (wheatbelt)
- River Red Gum tall to very tall open forest/woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion
- Silver-leaved Ironbark - White Cypress Pine shrubby open forest of Brigalow Belt South Bioregion and Nandewar Bioregion



NARROMINE TO NARRABRI Constraints - ecology - Eumungerie Road

Figure 5.5



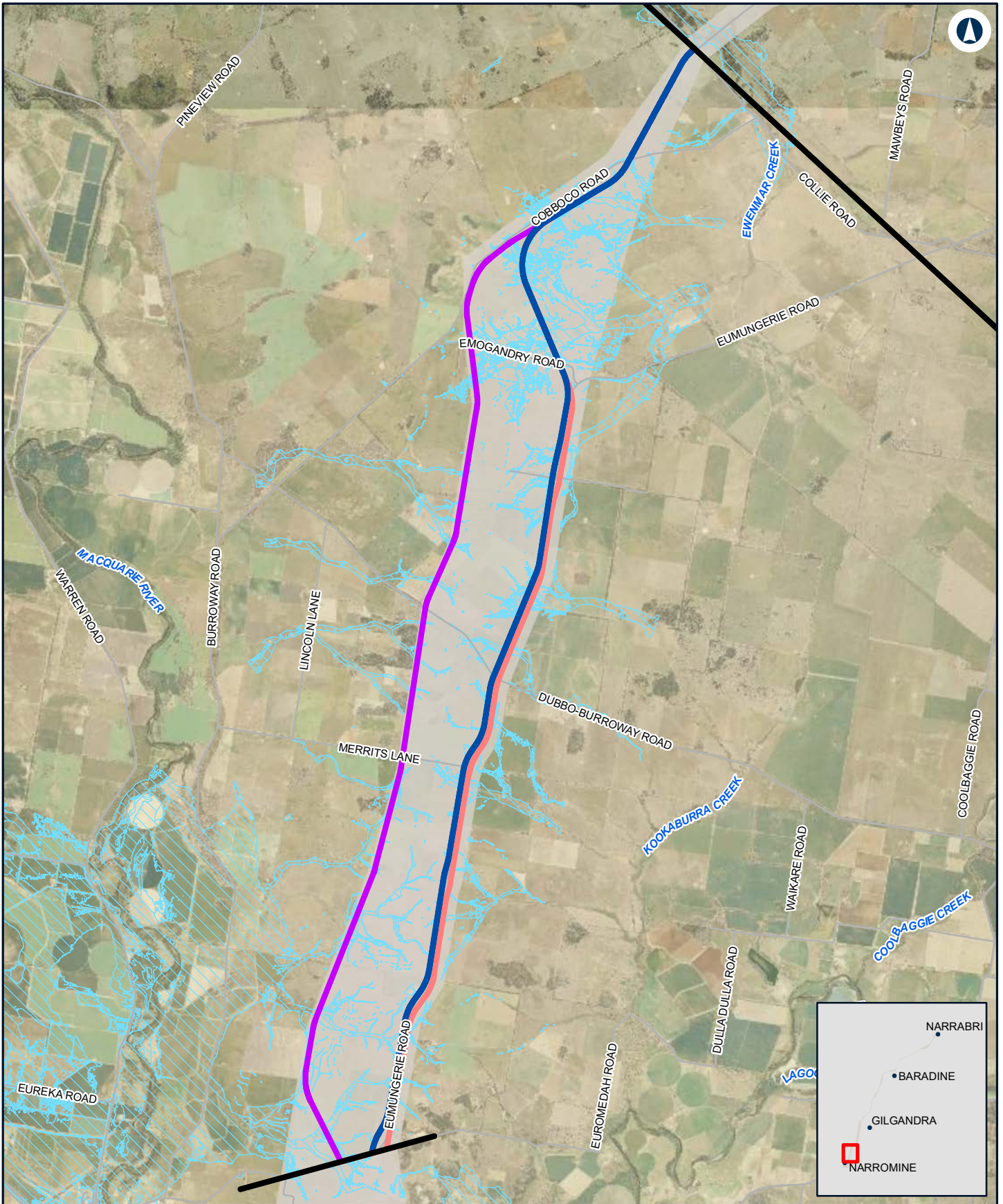
- LEGEND**
- NB-ER-BC
 - NB-ER-BB
 - NB-ER-E
 - Phase 2 study area

Coordinate System: GDA 1994 MGA Zone 55
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NARROMINE TO NARRABRI Constraints - Flooding - Eumungerie Road

Figure 5.6

0 1.5 3 Km

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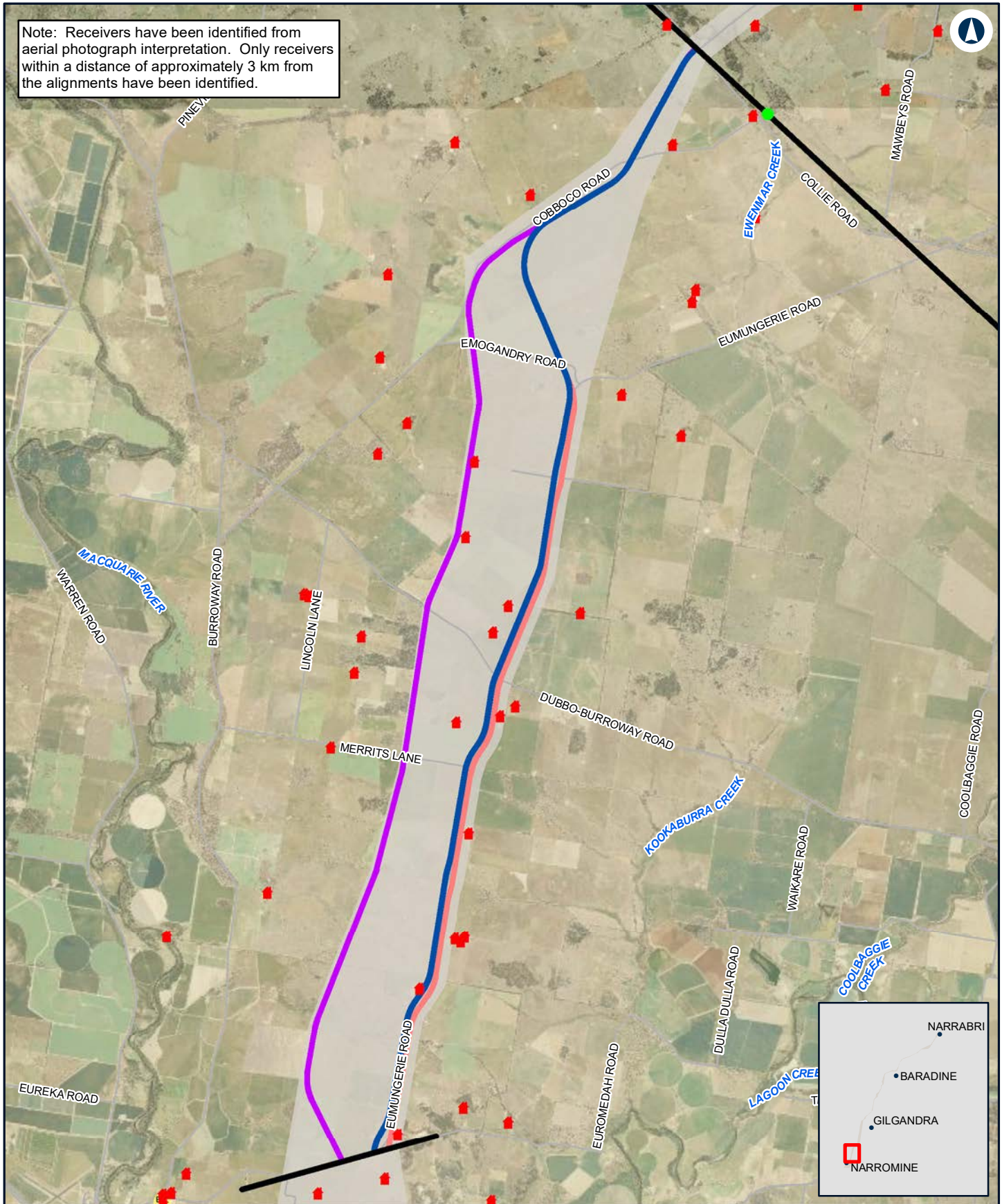
LEGEND

- NB-ER-BC
- NB-ER-BB
- NB-ER-E
- Flood extent - 1% AEP
- Phase 2 study area



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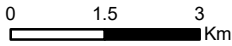
Note: Receivers have been identified from aerial photograph interpretation. Only receivers within a distance of approximately 3 km from the alignments have been identified.



NARROMINE TO NARRABRI

Constraints - Sensitive Receivers - Eumungerie Road

Figure 5.7



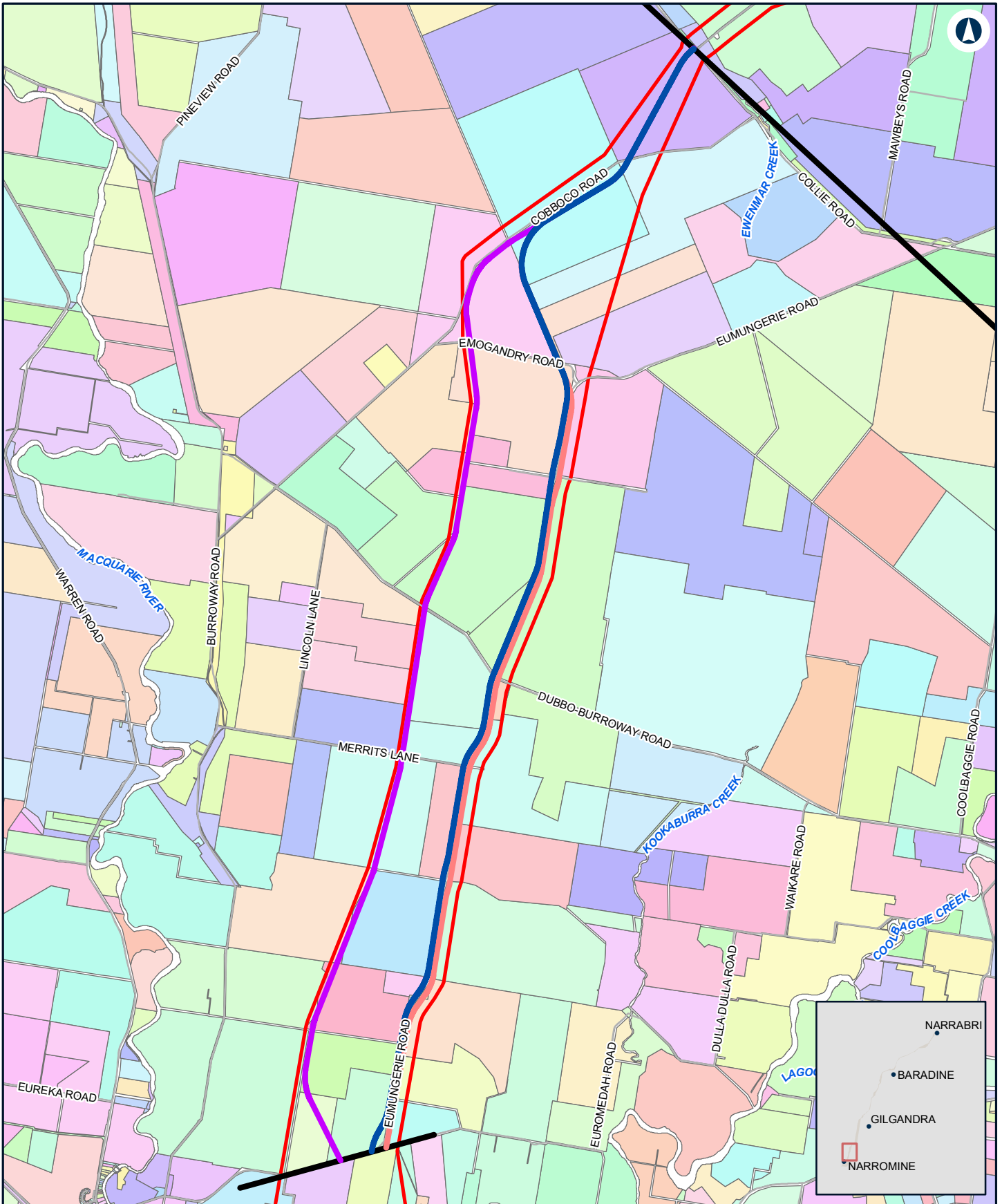
- LEGEND**
- NB-ER-BC
 - NB-ER-BB
 - NB-ER-E
 - Phase 2 study area
 - 🏠 Commercial
 - 🟢 Community
 - 🏠 Residence

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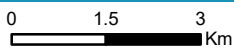


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NARROMINE TO NARRABRI Constraints - Property - Eumungerie Road

Figure 5.8



LEGEND

- NB-ER-BC
- NB-ER-BB
- NB-ER-E
- Phase 2 study area

Coordinate System: GDA 1994 MGA Zone 55

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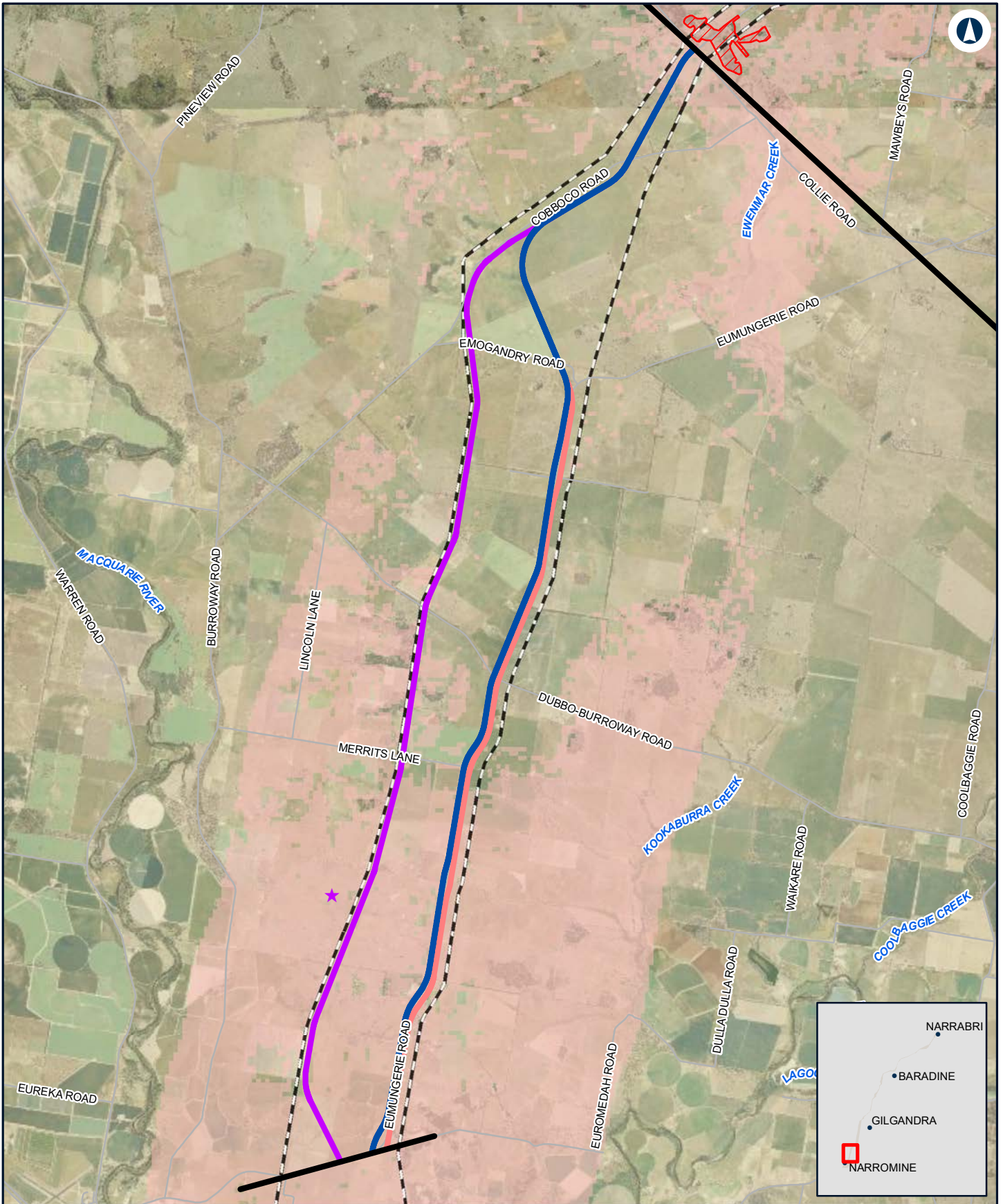
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Data Sources: Road names: NSW Spatial Services; property; ARTC; all other layers: JacobsGHD



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NARROMINE TO NARRABRI Constraints - Cultural Sensitivity - Eumungerie Road

Figure 5.9

0 1.5 3 Km

Coordinate System: GDA 1994 MGA Zone 55

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Data Sources: Imagery,Road names: NSW Spatial Services; AHIMS sites, ASDT data: OEH; all other layers: JacobsGHD

LEGEND

- NB-ER-BC
- NB-ER-BB
- NB-ER-E
- Phase 2 study area
- ★ AHIMS site
- Culturally sensitive survey area
- Medium to high sensitivity areas (ASDT - DECCW)



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5.6 MCA Scoring

The MCA scoring of Eumungerie Road options is presented in Appendix C. Summary results for Eumungerie Road options are presented in Table 5-4.

Table 5-4 Eumungerie Road - MCA Results

Option	MCA Score	Rank
NB-ER-BC (Base Case, dark-blue option)	0	1
NB-ER-E (Pink option)	-0.17	3
NB-ER-BB (Purple option)	-0.13	2

5.6.1 MCA Scores analysis

The Base Case ranked first based on the MCA scoring criteria as all options scored negatively compared to the base case. The scoring was very close ranging from 0 (base case) to -0.17 (Pink Option).

The Purple option scored marginally worse than the Base Case due to the number of properties severed and impact on ecological sensitive areas.

The Pink option scored worse due to the greater number of public road interfaces and greater number of receivers potentially impacted by air quality, noise and vibration.

5.6.2 Sensitivity analysis (MCA weightings)

A sensitivity analysis was carried out that considered increasing the weightings for each of the key criteria to 40%, whilst re-weighting the remaining criteria to 10% each. The outcomes are summarised in Table 5-5 and Appendix C, with the key observations being that the Base Case ranked first for all criteria except technical and community.

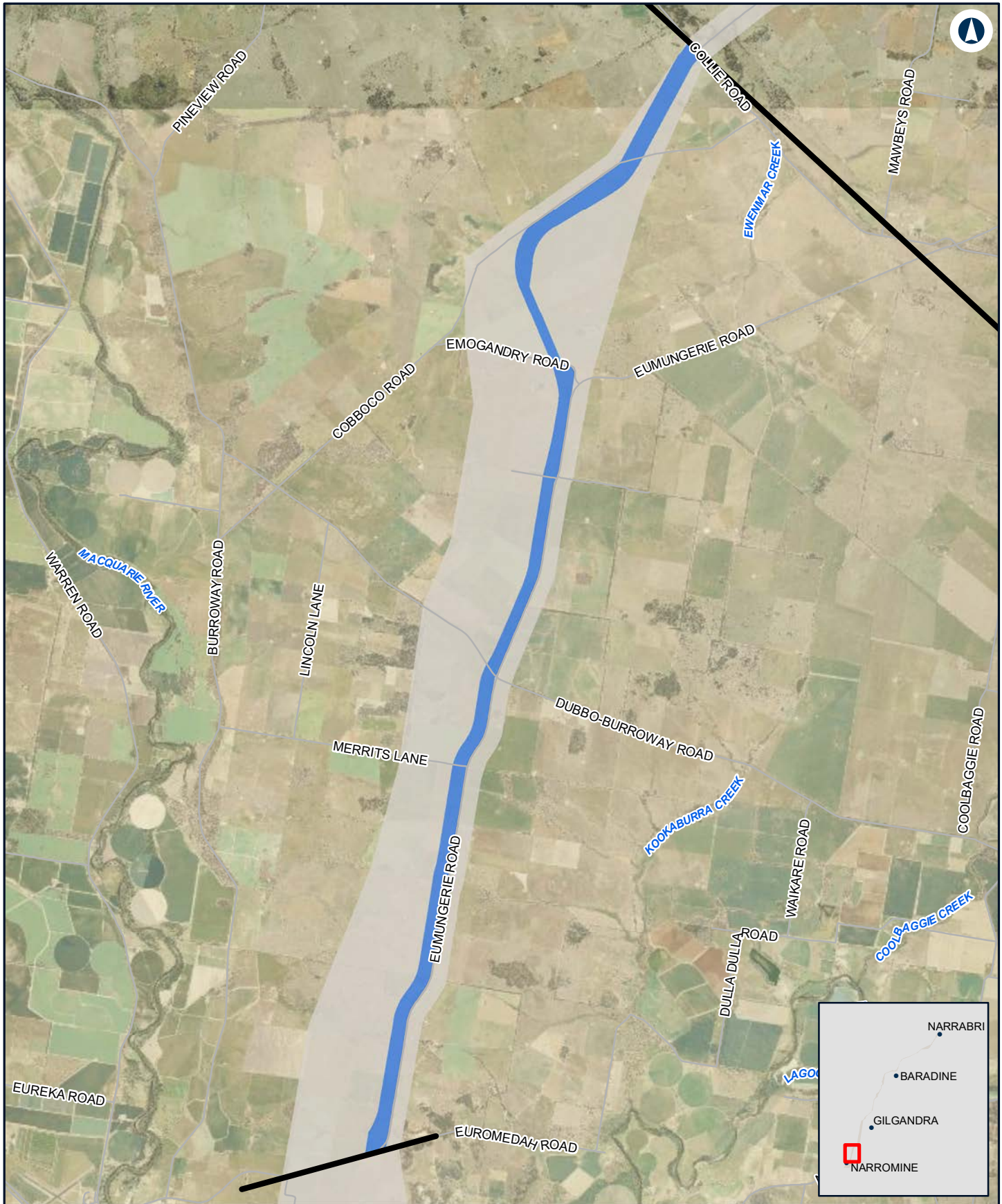
Table 5-5 Eumungerie Road - Sensitivity Analysis

Sensitivity	Top Option	Top Option Score	Base Case Rank
Technical	Purple option	0.12	2
Safety	Base case	0.00	1
Operations	Base case	0.00	1
Constructability	Base case	0.00	1
Environmental	Base case	0.00	1
Community	Pink option	0.33	2
Approvals	Base case	0.00	1

5.7 Preferred option

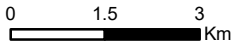
The preferred option for the Eumungerie Road section of the Study Area is the Base Case.

Whilst the scoring was very close for all options considered, no option scored higher than the Base Case and the Base Case ranked first in the sensitivity analysis for 5 out of 7 criteria. It was agreed amongst the attendees of the MCA workshop that the Base Case was the preferred option as it runs along an existing transport corridor (Eumungerie Road).



NARROMINE TO NARRABRI Focus area - Eumungerie Road

Figure 5.10



LEGEND

█	Focus area
█	Phase 2 study area

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6. Pilliga East

6.1 Overview

The Study Area for the Pilliga East sub-section traverses the northern end of the Pilliga East State Forest, approximately 20km south west of Narrabri. The topography is flat to undulating with a number of minor watercourses.

The majority of the Study Area is within the state forest and there are few physical constraints. On the eastern side, Santos has existing coal seam gas exploration infrastructure and has proposed a gas processing facility at Leewood, on the corner of Old Mill Road / Dog Proof Fence Road and Newell Highway. If approved, this would present a significant constraint to Inland Rail and an alignment between the gas facility and the Newell Highway is unlikely to be technically feasible within the limited space available.

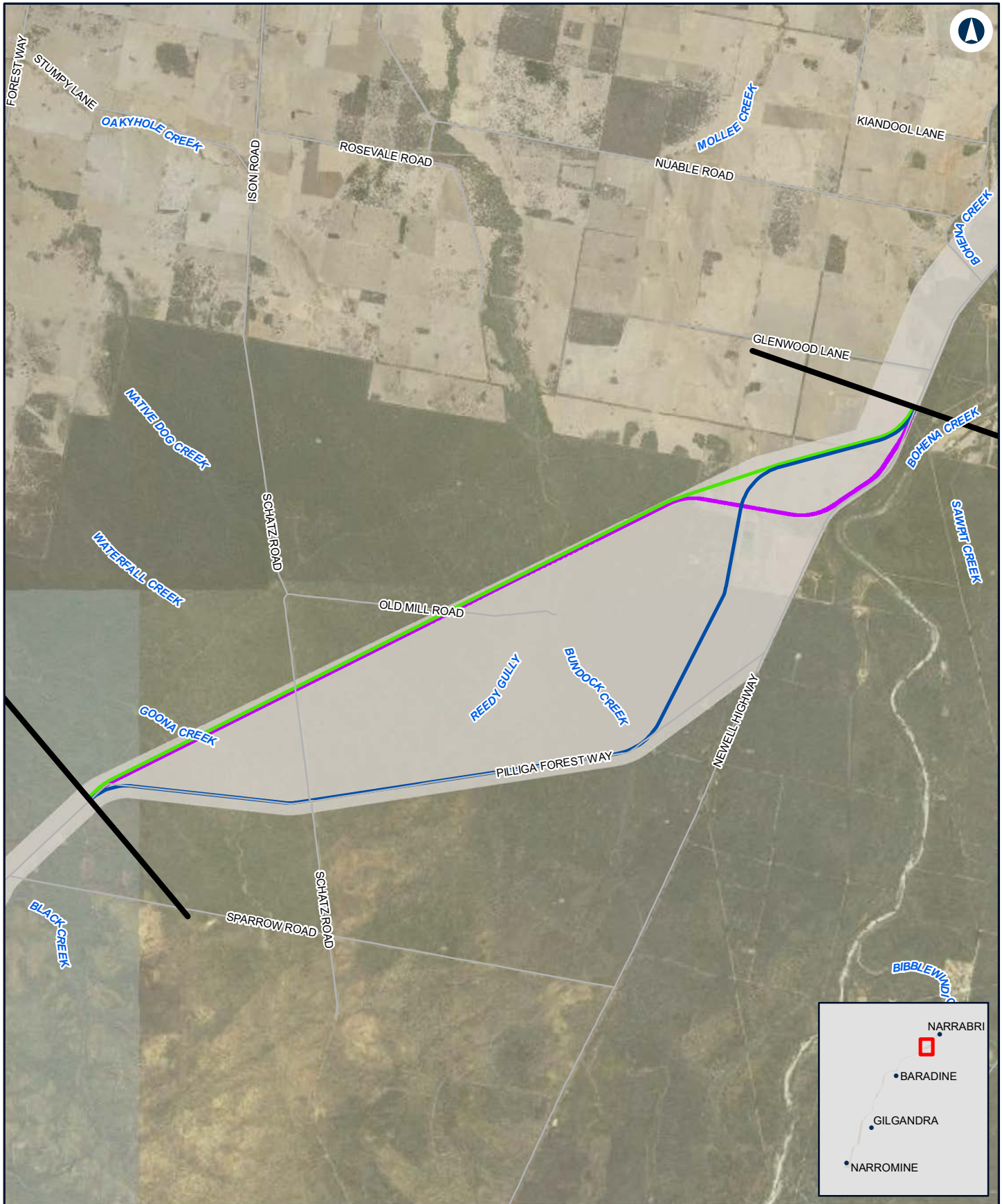
6.2 Options under assessment

Within the Pilliga East Study Area, Two options were developed for comparison with the Base Case. These options are summarised in Table 6-1 and illustrated in Figure 6-1.

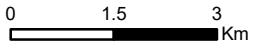
Table 6-1 Pilliga East options

Option	Description
BN-PE-BC (Base Case, Dark Blue option)	<p>At the southern end of the Study Area, the Base Case follows the north west boundary of Pilliga Forest Way to the Newell Highway then turns north prior to the Newell Highway intersection paralleling forest access tracks. Upon leaving the state forest, it continues North where it traverses a number of properties before re-joining the Base Case alignment.</p> <p>The Base Case:</p> <ul style="list-style-type: none"> • Is 21.7km in length the majority of which is within the state forest • Has a travel time of 11.3 minutes • Impacts 5 properties (including severance of 2) • Crosses no major roads or major watercourses • Would not impact on Santos' proposed gas facility
BN-PE-S (Green option)	<p>The Green option follows the northern edge of the Study Area, diverging from the Base Case and Pilliga Forest Way near Lucky Flat Bore. The option continues north on a direct route to the northern boundary of the state forest, where it continues north joining the Base Case alignment at the Newell Highway, traversing and severing several properties in the process.</p> <p>The Green option:</p> <ul style="list-style-type: none"> • Is 19.4km in length (the shortest of the options) the majority of which is within the state forest • Has a travel time of 10.1 minutes • Impacts 5 properties (including severance of 3) • Crosses no major roads or major watercourses • Would not impact on Santos' proposed gas facility

Option	Description
BN-PE-SPB (Purple option)	<p>The Purple option follows the northern edge of the Study Area, diverging from the Base Case and Pilliga Forest Way near Lucky Flat Bore. The option continues north on a direct route to the northern boundary of the state forest, where it turns east following property boundaries towards the Newell Highway.</p> <p>The Purple option:</p> <ul style="list-style-type: none"> • Is 20km in length the majority of which is within the state forest • Has a travel time of 10.4 minutes • Impacts 5 properties • Crosses no major roads or major watercourses • Would not impact on Santos' proposed gas facility



NARRABRI TO NARRABRI Options summary - Pilliga East Figure 6.1



- LEGEND**
- BN-PE-BC
 - BN-PE-S
 - BN-PE-SPB
 - Phase 2 study area

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6.3 Field investigations completed

6.3.1 Geotechnical

Test pitting was performed along the Pilliga Forest Way and on various tracks within the Pilliga Forest to the north of the Pilliga Forest Way. Ground conditions encountered are relatively consistent with piedmont alluvium dominated by clays and clayey sands derived from weathering of the adjacent Pilliga Sandstone highland areas. Subgrade conditions assessed from the test pitting and associated laboratory testing indicate subgrade CBRs typically in the range of 4% to 5%. An area of mapped vertisols along the northern alignment options are supported by a very low CBR result (1%) in this area.

Investigations confirm that geotechnical conditions between the Pilliga Forest Way option and northern options are not significantly different. The reduced length of soils with anticipated poor subgrade conditions along the base case makes this option more favourable.

6.3.2 Ecology

Within the Study Area there are four (4) PCTs identified within the field survey areas. Based on the information available, no TECs listed under the BC Act or EPBC Act would be impacted by any of the options. Plant community types include:

- Pilliga Box – White Cypress Pine – Buloke Shrubby Woodland in the Brigalow Belt South Bioregion.
- Narrow-leaved Ironbark - White Cypress Pine - Buloke tall open forest on lower slopes and flats in the Pilliga Scrub and surrounding forests in the central north Brigalow Belt South Bioregion.
- Red gum - Rough-barked Apple +/- tea tree sandy creek woodland (wetland) in the Pilliga – Goonoo sandstone forests, Brigalow Belt South Bioregion.
- Derived Wire Grass grassland of the NSW Brigalow Belt South Bioregion and Nandewar Bioregion.

The majority of the options under assessment impacted the Narrow-leaved Ironbark - White Cypress Pine - Buloke tall open forest on lower slopes and flats in the Pilliga Scrub and surrounding forests in the central north Brigalow Belt South Bioregion (between approximately 11.6 and 14.2 kilometres).

6.3.3 Cultural Heritage

Cultural heritage field surveys undertaken in the Study Area identified:

- No AHIMS sites within 200 metres of any of the options under assessment.
- No Artefact scatters within 200 metres of any of the options under assessment.
- No Ochre quarries within 200 metres of any of the options under assessment.
- One scarred tree within 200 metres of Option BN-E-BC and Option BN-PE-SPB.
- One culturally sensitive site (scarred tree) within 200 metres of Option BN-E-BC and Option BN-PE-SPB.
- One sensitive river associated with Bundock Creek for all options.
- Sensitivity for cultural heritage for all options, between approximately 135 metres to 642 metres.
- Culturally sensitive areas associated with all options except BN-PE-SB, between approximately 56 metres to 2,331 metres.

No known areas with a large number of scarred trees (recommended for wider survey).

6.4 Comparative quantities influencing capital cost

Elements of each option that will influence the capital cost are included in Table 6-2. Order of magnitude quantities for track length and structures are provided as well as the complexity of earthworks.

Table 6-2 Pilliga East comparative quantities

Option	Track Length	Structure quantity	Earthworks
BN-PE-BC (Base Case, Dark Blue option)	21.7km	More than 1 moderate or large culverts More than 5 underbridges	Approximately 29% of the corridor traverses poor geotechnical conditions.
BN-PE-S (Green option)	19.4km	More than 1 moderate or large culverts More than 5 underbridges	Approximately 51% of the corridor traverses poor geotechnical conditions. This option is moderately complex, compared to other options.
BN-PE-SPB (Purple option)	20km	More than 1 moderate or large culverts More than 5 underbridges	Approximately 52% of the corridor traverses poor geotechnical conditions. This option is moderately complex, compared to other options.

6.5 Summary of Pilliga East MCA options comparison

The MCA sub-criteria defined in Section 3.2 has assisted in defining the key issues which will influence the selection of a Focus Area. A summary of these key issues for each of the Pilliga East options is provided in Table 6-3.

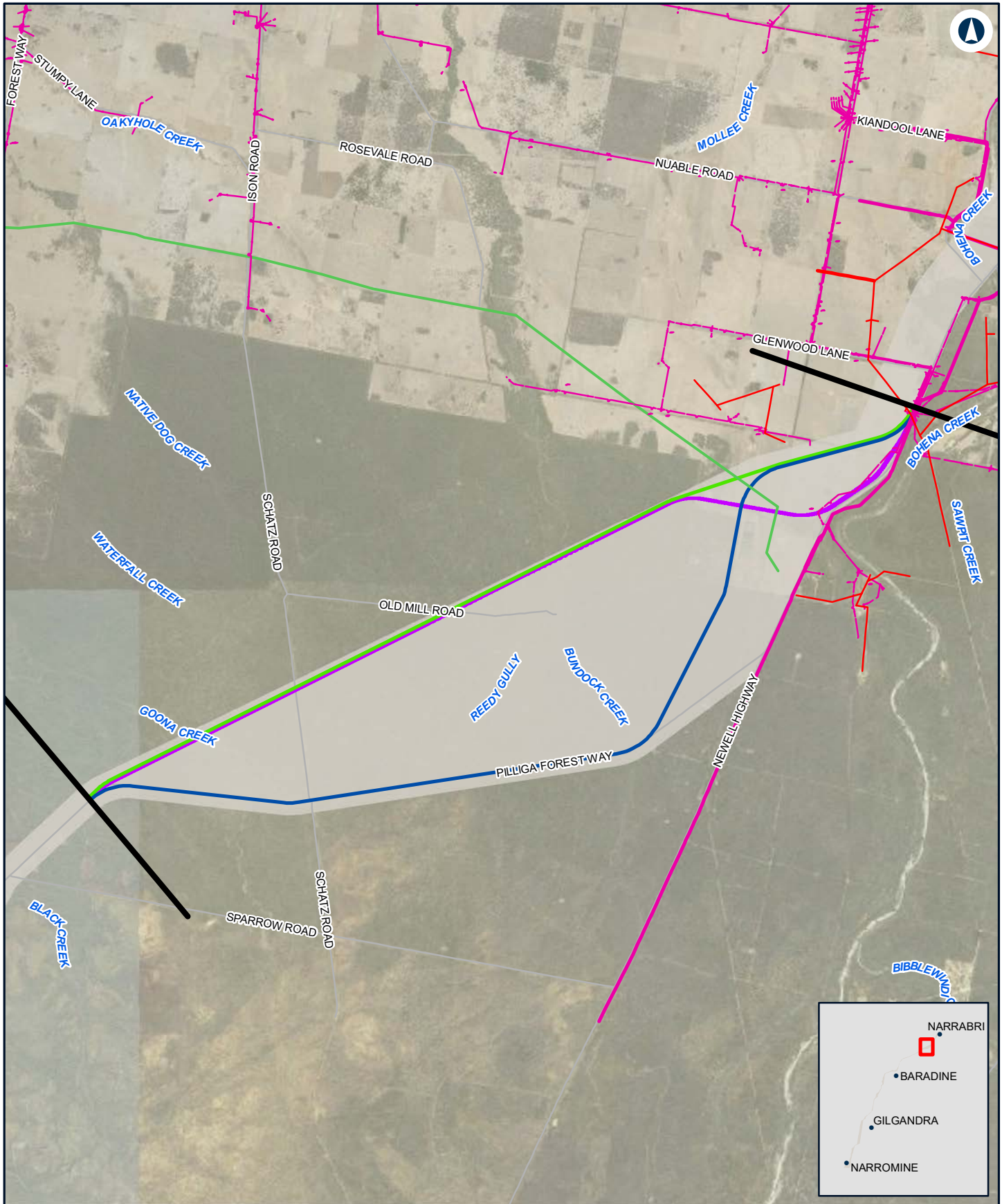
Corresponding maps for each of these key issues are illustrated in Figure 6-2 to Figure 6-9.

Table 6-3 Summary of Pilliga East MCA options comparison

	BN-PE-BC (Base Case, Dark Blue option)	BN-PE-S (Green option)	BN-PE-SPB (Purple option)
Alignment	The Base Case option has a track length of 21.7km, no significant difference in track geometry to the Base Case.	The Green option has a track length of 19.4km, and has 2 fewer curves than the Base Case resulting in a less complex track geometry.	The Purple option has a track length of 20km, and has 1 fewer curve than the Base Case resulting in a less complex track geometry.
Impact on utilities (Figure 6-2)	The utilities affect by the Base Case include: <ul style="list-style-type: none"> • 1 11kV overhead crossings • 1 <11kV overhead crossing • 2 telecommunication crossings 	The utilities affected by the Green option include: <ul style="list-style-type: none"> • 1 11kV overhead crossings • 1 <11kV overhead crossing • 2 telecommunication crossings 	The utilities affected by the Purple option include: <ul style="list-style-type: none"> • 1 11kV overhead crossings • 1 <11kV overhead crossing • 7 telecommunication crossings
Geotechnical conditions (Figure 6-3)	The Base Case traverses approximately 29% of soils where poor subgrade conditions are anticipated.	The Green option traverses approximately 51% of soils where poor subgrade conditions are anticipated.	The Purple option traverses approximately 52% of soils where poor subgrade conditions are anticipated.
Impact on existing road and rail (Figure 6-4)	The Base Case does not affect any existing road or rail networks.	The Green option does not affect any existing road or rail networks.	The Purple option does not affect any existing road or rail networks.
Future Proofing	The Base Case contains no significant constraints that would impact on ability to upgrade the rail infrastructure in the future.	The Green option contains no significant constraints that would impact on ability to upgrade the rail infrastructure in the future.	The Purple option contains no significant constraints that would impact on ability to upgrade the rail infrastructure in the future.
Road Safety Interface	The Base Case interfaces with: <ul style="list-style-type: none"> • 3 council roads • 5 private roads 	The Green option interfaces with: <ul style="list-style-type: none"> • 2 council roads • 5 private roads No material difference to safety compared to Base Case.	The Purple option interfaces with: <ul style="list-style-type: none"> • 2 council roads • 6 private roads No material difference to safety compared to Base Case.
Effect/ Impact on travel time	Base Case has a travel time of 11.3 minutes.	1 minute less travel time compared to Base Case, no material difference to reliability and/or connectivity.	Less than 1 minute difference in travel time compared to Base Case, no material difference to reliability and/or connectivity.

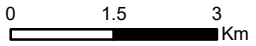
	BN-PE-BC (Base Case, Dark Blue option)	BN-PE-S (Green option)	BN-PE-SPB (Purple option)
Construction complexity	Options are similar with regards to construction complexity based on the type of geotechnical conditions encountered, required structures and surrounding interfaces.	Options are similar with regards to construction complexity based on the type of geotechnical conditions encountered, required structures and surrounding interfaces. Green option has reduce construction access compared to Base Case.	Options are similar with regards to construction complexity based on the type of geotechnical conditions encountered, required structures and surrounding interfaces. Purple option has reduce construction access compared to Base Case.
Ecological impacts (Figure 6-5)	It impacts: <ul style="list-style-type: none"> • 2.9km of non-native vegetation • 18.8km of native vegetation (but not TEC) • Nil native vegetation listed as a TEC under the BC Act and/or EPBC Act 	It impacts: <ul style="list-style-type: none"> • 2.9km of non-native vegetation • 16.5km of native vegetation (but not TEC) • Nil native vegetation listed as a TEC under the BC Act and/or EPBC Act 	It impacts: <ul style="list-style-type: none"> • 1.1km of non-native vegetation • 18.9km of native vegetation (but not TEC) • Nil of native vegetation listed as a TEC under the BC Act and/or EPBC Act
Flooding / waterway impacts (Figure 6-6)	The Base Case traverses no unnamed waterways and two named waterways for a total of two waterway crossings. 8.4km (39%) of the Base Case is within a 1% AEP flood area.	The Green option traverses one unnamed waterway and two named waterways for a total of three waterway crossings. 9.4km (48%) of the Base Case is within a 1% AEP flood area.	The Purple option traverses two unnamed waterways and two named waterways for a total of four waterway crossings. 11.7km (59%) of the Base Case is within a 1% AEP flood area.
Visual Impact	The Base Case has 2 potential receivers with-in 1000m.	The green option has 3 potential receivers with-in 1000m.	The Purple option has 2 potential receivers with-in 1000m.
Sensitive receivers – Noise and Vibration / Effect on Air Quality (Figure 6-7)	<ul style="list-style-type: none"> • The Base Case has no receivers within 200m. 	<ul style="list-style-type: none"> • The Green option has no receivers within 200m. 	<ul style="list-style-type: none"> • The Purple option has no receivers within 200m.
Property impacts (Figure 6-8)	The Base Case directly impacts 5 properties and severs 2 of these impacted properties. Potentially 1 residence removed.	The Green option directly impacts 5 properties and severs 3 of these impacted properties. Potentially 1 residence removed.	The Purple option directly impacts 5 properties and severs none of these impacted properties. Potentially 1 residence removed.

	BN-PE-BC (Base Case, Dark Blue option)	BN-PE-S (Green option)	BN-PE-SPB (Purple option)
Cultural Heritage impacts (Figure 6-9)	<ul style="list-style-type: none"> No AHIMS sites within 200 metres No artefact scatters identified within 200 metres No ochre quarries within 200 metres No scarred trees within 200 metres No culturally sensitive sites associated with option One sensitive river associated with Bundock Creek Sensitivity for cultural heritage, of approximately 135.8m No culturally sensitive areas associated with option No areas with large number of scarred trees (recommended for wider survey) 	<ul style="list-style-type: none"> No AHIMS sites within 200 metres No artefact scatters identified within 200 metres No ochre quarries within 200 metres No scarred trees within 200 metres No culturally sensitive sites associated with option One sensitive river associated with Bundock Creek Sensitivity for cultural heritage, of approximately 135.8 m Culturally sensitive areas of approximately 56.3m No areas with large number of scarred trees (recommended for wider survey) 	<ul style="list-style-type: none"> No AHIMS sites within 200 metres No artefact scatters identified within 200 metres No ochre quarries within 200 metres One scarred trees within 200 metres One culturally sensitive site (scarred tree) within 200m One sensitive river associated with Bundock Creek Sensitivity for cultural heritage, of approximately 630.4m Culturally sensitive areas of approximately 1,839.3m No areas with large number of scarred trees (recommended for wider survey)



NARROMINE TO NARRABRI Constraints - Utilities - Pilliga East

Figure 6.2



LEGEND

- BN-PE-BC
- BN-PE-S
- BN-PE-SPB
- Phase 2 study area
- Electricity 22kV - 66kV
- Electricity 11kV - 22kV
- Optic fibre
- Comms (Telstra)
- High pressure gas

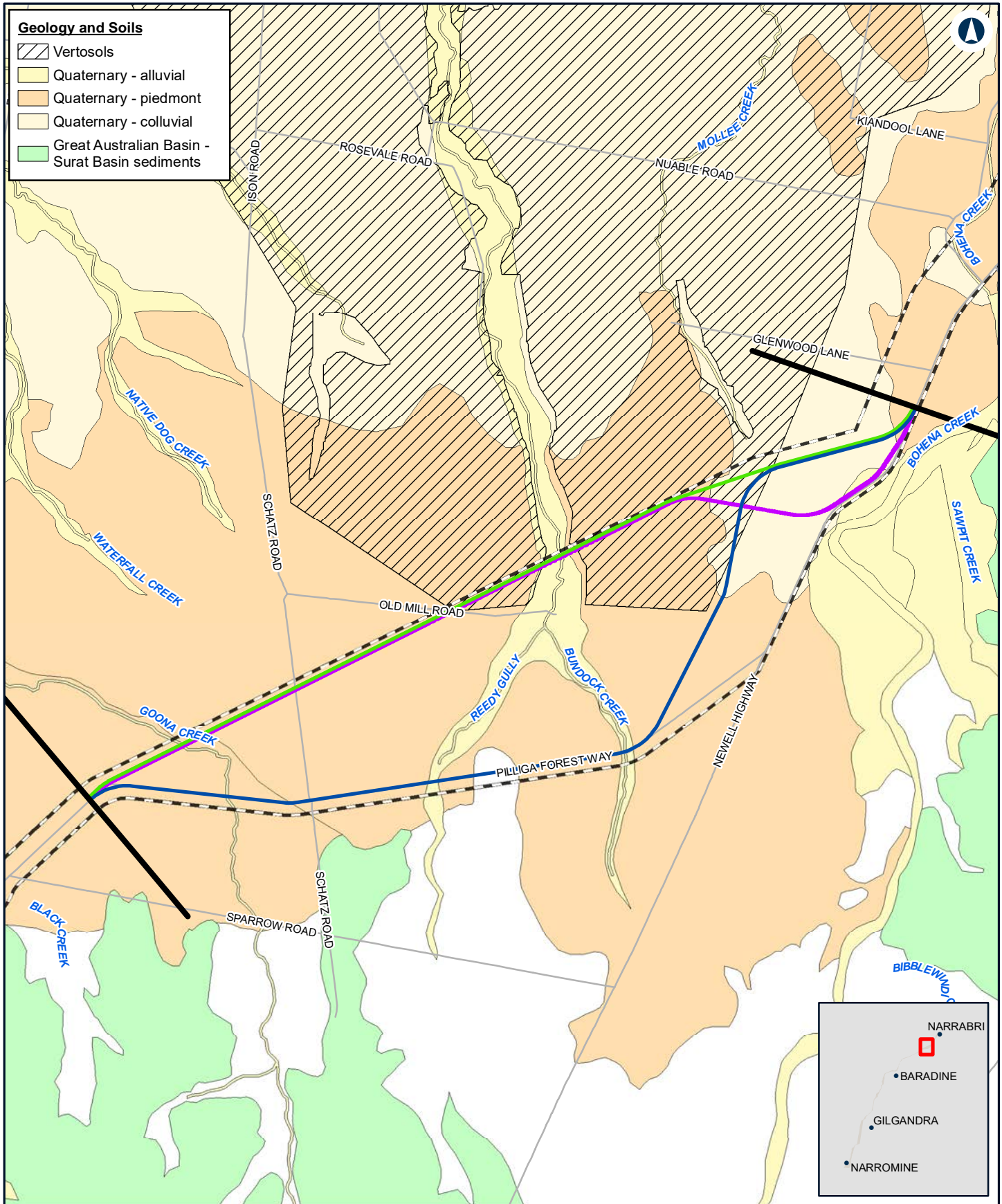
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NARROMINE TO NARRABRI Constraints - Geology and Soils - Pilliga East

Figure 6.3

0 1.5 3 Km

LEGEND

- BN-PE-BC
- BN-PE-S
- BN-PE-SPB
- Study area

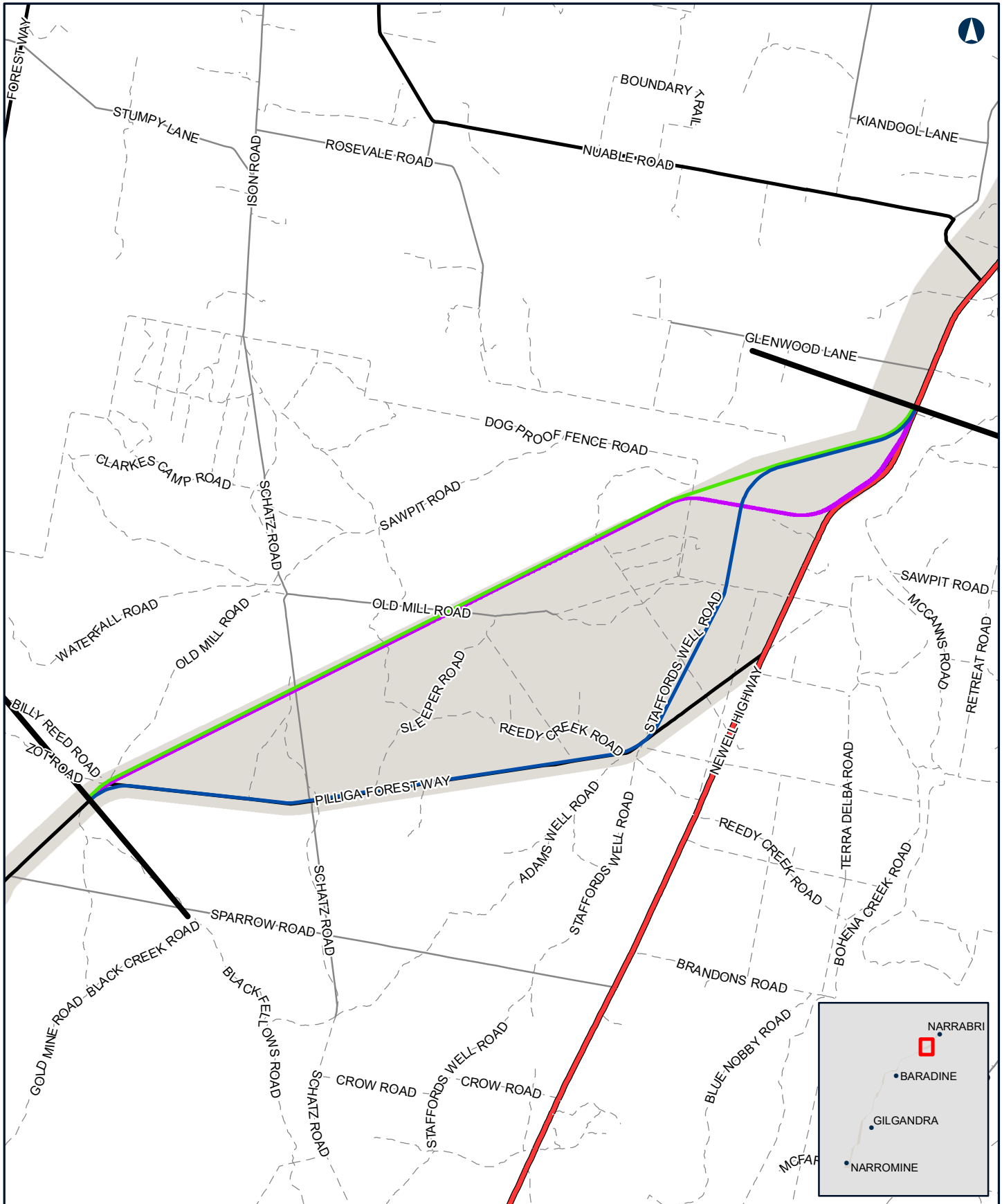
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Data Sources: Road names: NSW Spatial Services; geology, soils; Dept Industry Resources and Energy; all other layers: JacobsGHD



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NARROMINE TO NARRABRI Constraints - Road and rail network - Pilliga East Figure 6.4

0 1.5 3 Km

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 Data Sources: Road and rail: NSW Spatial Services; all other layers: JacobsGHD

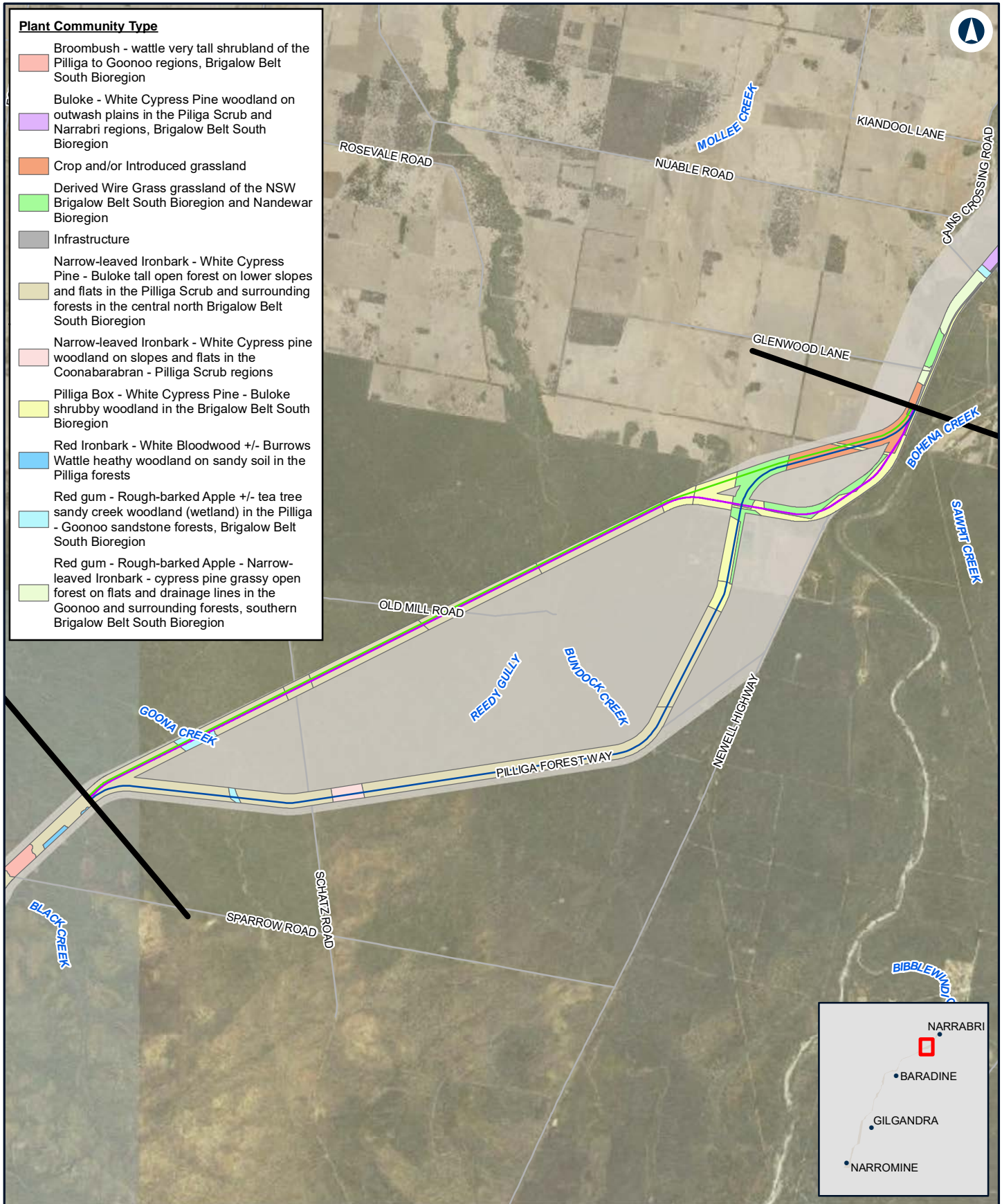
- LEGEND**
- BN-PE-BC
 - BN-PE-S
 - BN-PE-SPB
 - Study area
 - Primary Road
 - SubArterial Road
 - Local Road
 - Track



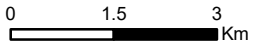
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Plant Community Type

- Broombush - wattle very tall shrubland of the Pilliga to Goonoo regions, Brigalow Belt South Bioregion
- Buloke - White Cypress Pine woodland on outwash plains in the Pilliga Scrub and Narrabri regions, Brigalow Belt South Bioregion
- Crop and/or Introduced grassland
- Derived Wire Grass grassland of the NSW Brigalow Belt South Bioregion and Nandewar Bioregion
- Infrastructure
- Narrow-leaved Ironbark - White Cypress Pine - Buloke tall open forest on lower slopes and flats in the Pilliga Scrub and surrounding forests in the central north Brigalow Belt South Bioregion
- Narrow-leaved Ironbark - White Cypress pine woodland on slopes and flats in the Coonabarabran - Pilliga Scrub regions
- Pilliga Box - White Cypress Pine - Buloke shrubby woodland in the Brigalow Belt South Bioregion
- Red Ironbark - White Bloodwood +/- Burrows Wattle heathy woodland on sandy soil in the Pilliga forests
- Red gum - Rough-barked Apple +/- tea tree sandy creek woodland (wetland) in the Pilliga - Goonoo sandstone forests, Brigalow Belt South Bioregion
- Red gum - Rough-barked Apple - Narrow-leaved Ironbark - cypress pine grassy open forest on flats and drainage lines in the Goonoo and surrounding forests, southern Brigalow Belt South Bioregion



NARROMINE TO NARRABRI Constraints - ecology - Pilliga East Figure 6.5



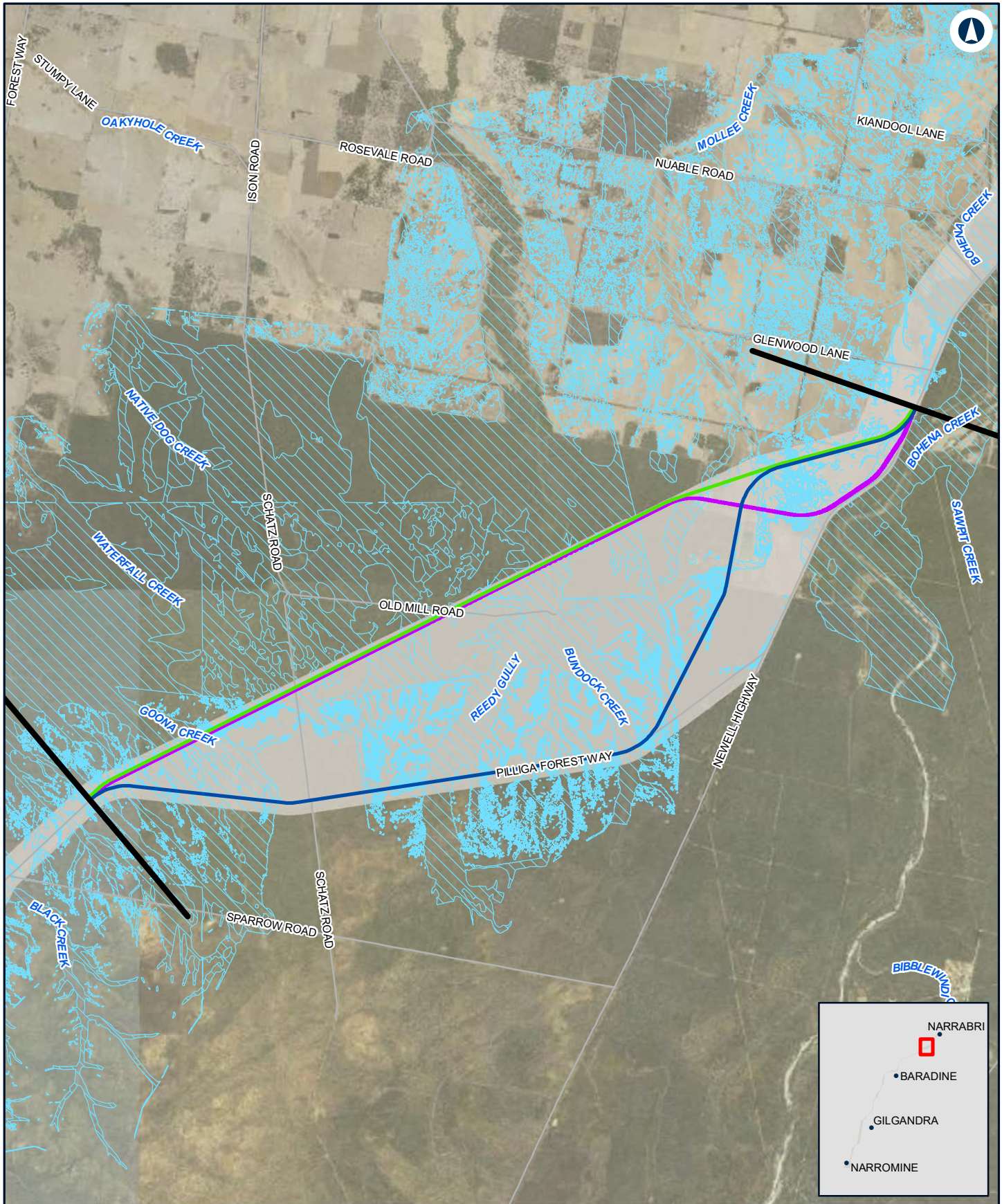
- LEGEND**
- BN-PE-BC
 - BN-PE-S
 - BN-PE-SPB
 - Phase 2 study area

Coordinate System: GDA 1994 MGA Zone 55
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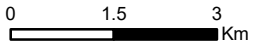


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NARROMINE TO NARRABRI Constraints - Flooding - Pilliga East

Figure 6.6



- LEGEND**
- BN-PE-BC
 - BN-PE-S
 - BN-PE-SPB
 - Flood extent - 1% AEP
 - Phase 2 study area

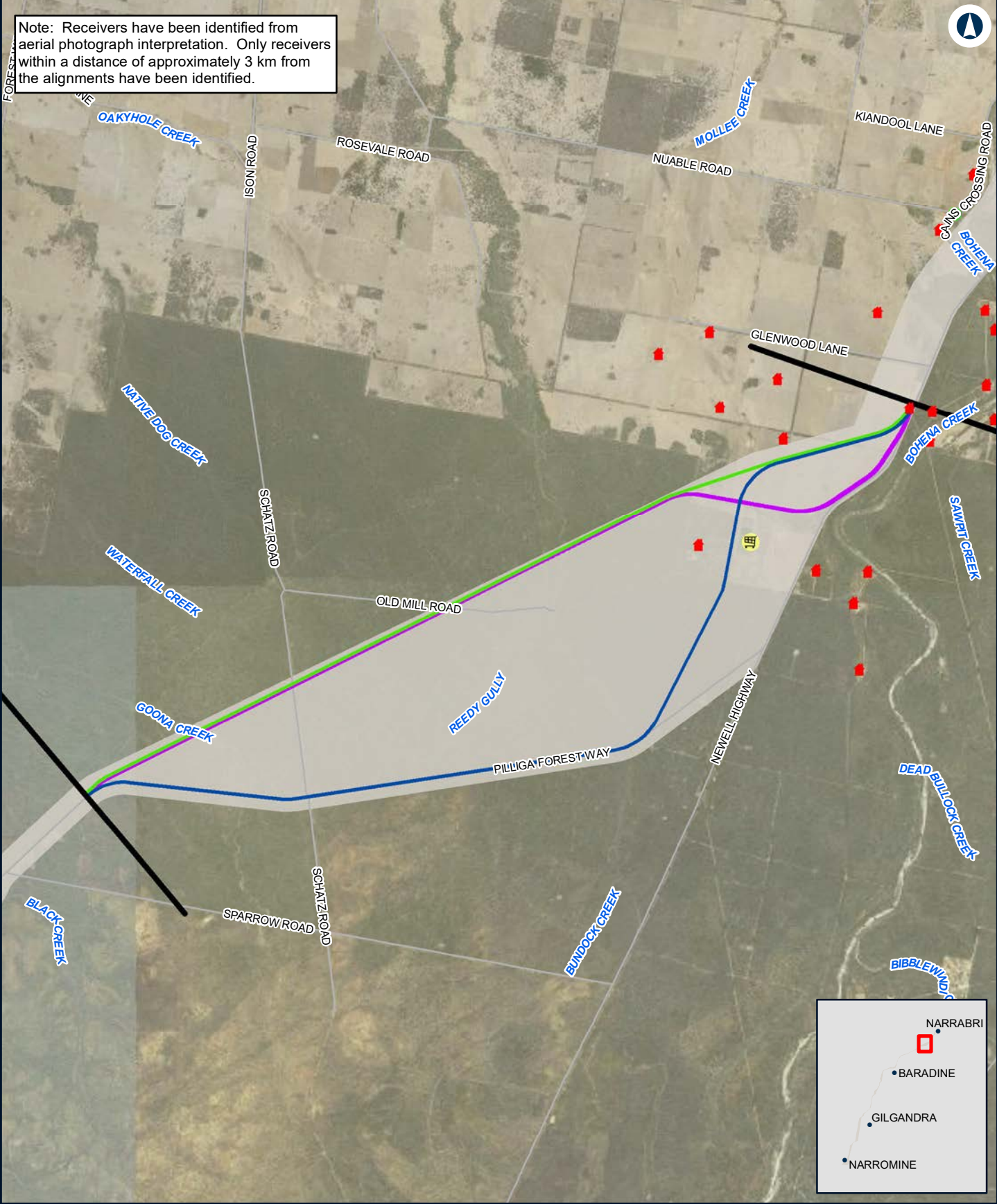
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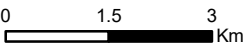


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Note: Receivers have been identified from aerial photograph interpretation. Only receivers within a distance of approximately 3 km from the alignments have been identified.



NARROMINE TO NARRABRI Constraints - Sensitive Receivers - Pilliga East Figure 6.7



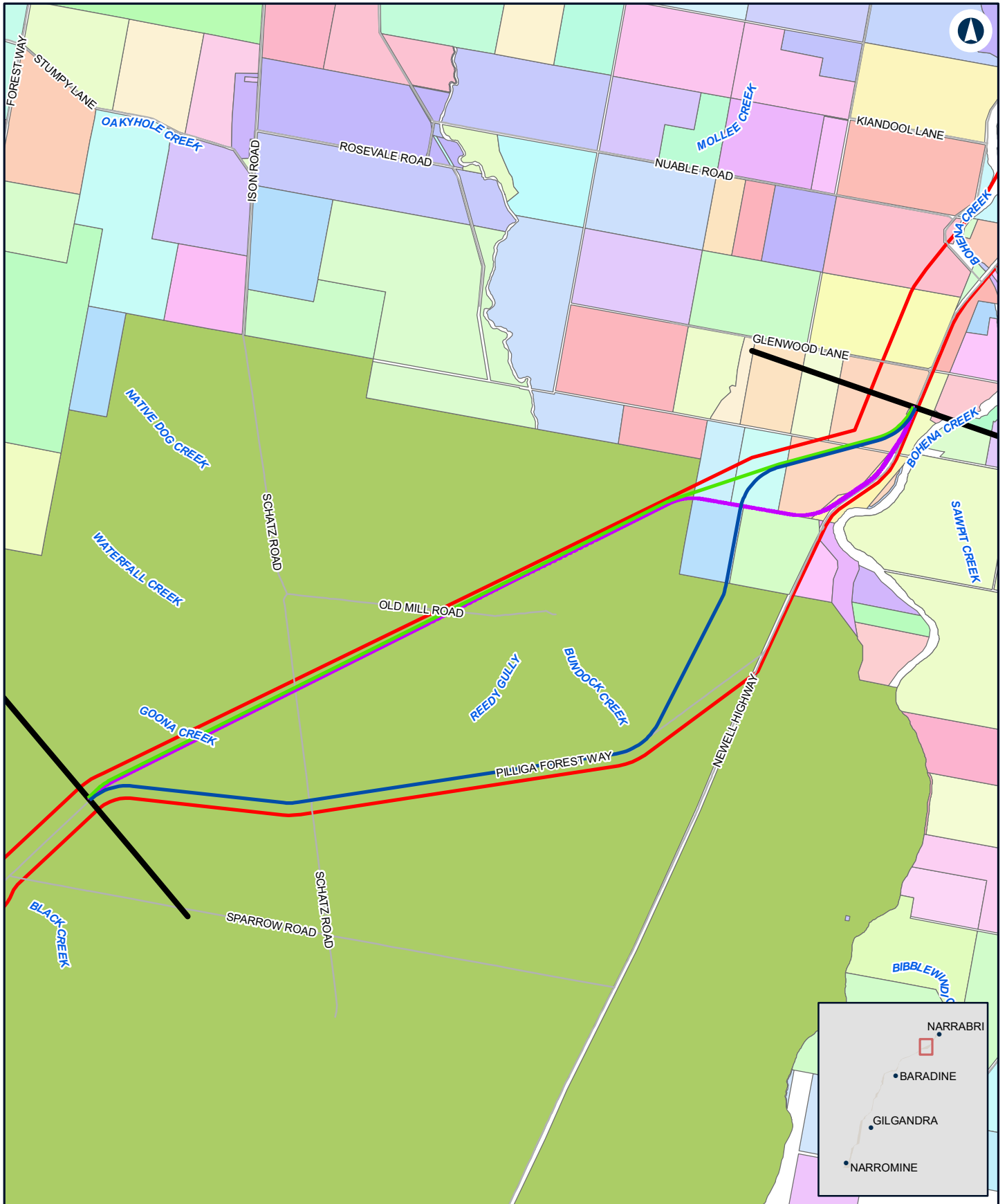
- LEGEND**
- BN-PE-BC
 - BN-PE-S
 - BN-PE-SPB
 - Phase 2 study area
 - 🏠 Commercial
 - Community
 - 🏠 Residence

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 Data Sources: Imagery, road names: NSW Spatial Services; all other layers: JacobsGHD

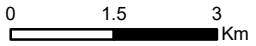


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NARROMINE TO NARRABRI Constraints - Property - Pilliga East

Figure 6.8



LEGEND

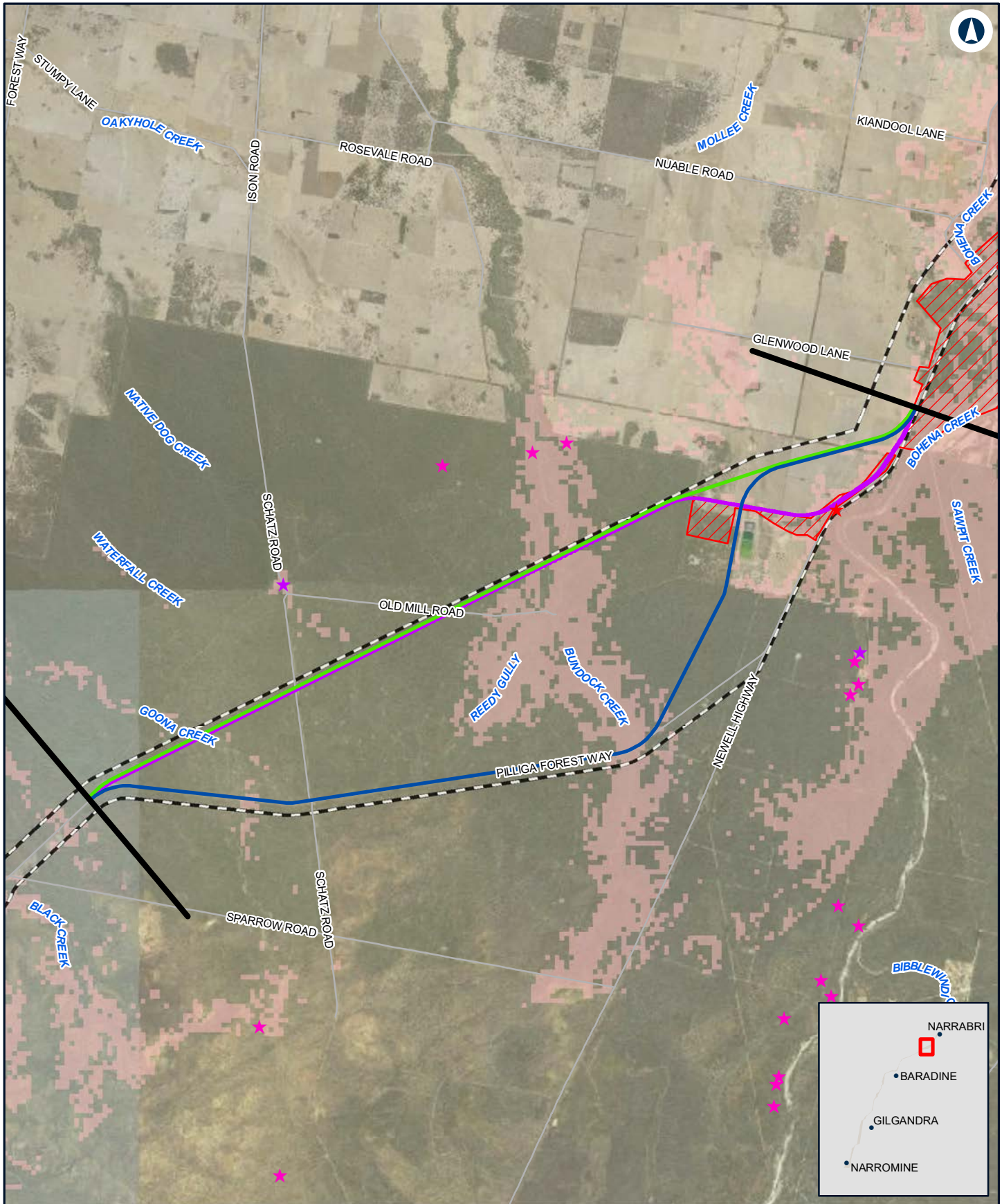
	BN-PE-BC
	BN-PE-S
	BN-PE-SPB
	Phase 2 study area

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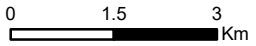
Date: 16/09/2019 Paper: A4
 Author: GM (GHD) Scale: 1:110,000
 Data Sources: Road names: NSW Spatial Services; property; ARTC; all other layers: JacobsGHD



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NARROMINE TO NARRABRI Constraints - Cultural Sensitivity - Pilliga East Figure 6.9



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 Data Sources: Imagery,Road names: NSW Spatial Services; AHIMS sites, ASDT data: OEH; all other layers: JacobsGHD

- LEGEND**
- BN-PE-BC
 - BN-PE-S
 - BN-PE-SPB
 - Phase 2 study area
 - ★ AHIMS site
 - ★ LALC site
 - ★ Culturally sensitive survey site
 - Culturally sensitive survey area
 - Medium to high sensitivity areas (ASDT - DECCW)



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6.6 MCA Scoring

The MCA scoring of Pilliga East options is presented in Appendix D. Summary results for Pilliga East options are presented in Table 6-4.

Table 6-4 Pilliga East - MCA Results

Option	MCA Score	Rank
BN-PE-BC (Base Case, Dark Blue option)	0	2
BN-PE-S (Green option)	0.08	1
BN-PE-SPB (Purple option)	-0.39	4

6.6.1 Raw score analysis

The scoring for all of the options considered is very close ranging from 0.08 to -0.39, this is reflective of the options having only minor differences, and the very similar site conditions. The Green option scored higher than the Base Case due to it achieving a 1 minute less travel time, potentially shorter construction duration and slightly less area in ecologically sensitive area. The Purple option scored the lowest as it has a slightly larger area within the 1% AEP flood levels, encounters worse geological conditions and has worse construction access compared to the base case.

6.6.2 Sensitivity analysis (MCA weightings)

A sensitivity analysis was carried out considered increasing the weightings for each of the key criteria to 40%, whilst re-weighting the remaining criteria to 10% each. The outcomes are summarised in Table 6-5 and Appendix D, with the key observations being that the Green option ranked first for 4 out of 7 criteria, which reflects and supports the scores and comments above.

Table 6-5 Pilliga East - Sensitivity Analysis

Sensitivity	Top Option	Top Option Score	Base Case Rank
Technical	Base Case	0.00	1
Safety	Green option	0.07	2
Operations	Green option	0.57	2
Constructability	Green option	0.07	2
Environmental	Green option	0.50	2
Community	Purple option	0.45	2
Approvals	Green option	0.07	2

6.7 Preferred option

The preferred option is the Purple option (BN-PE-SPB).

The results of the MCA analysis between the options were very close. The Green option ranked first, principally because of the shorter distance and transit time through this sub-section. The Green option is 1 minute, 12 seconds faster than the Base Case, resulting in a positive score of 5 when compared to the Purple option at 54 seconds faster, resulting in an even score of zero. It was noted in the workshop that there was only 18 seconds difference in transit time between the Green and Purple options, but by virtue of the discrete MCA assessment criteria, the Green option scored higher.

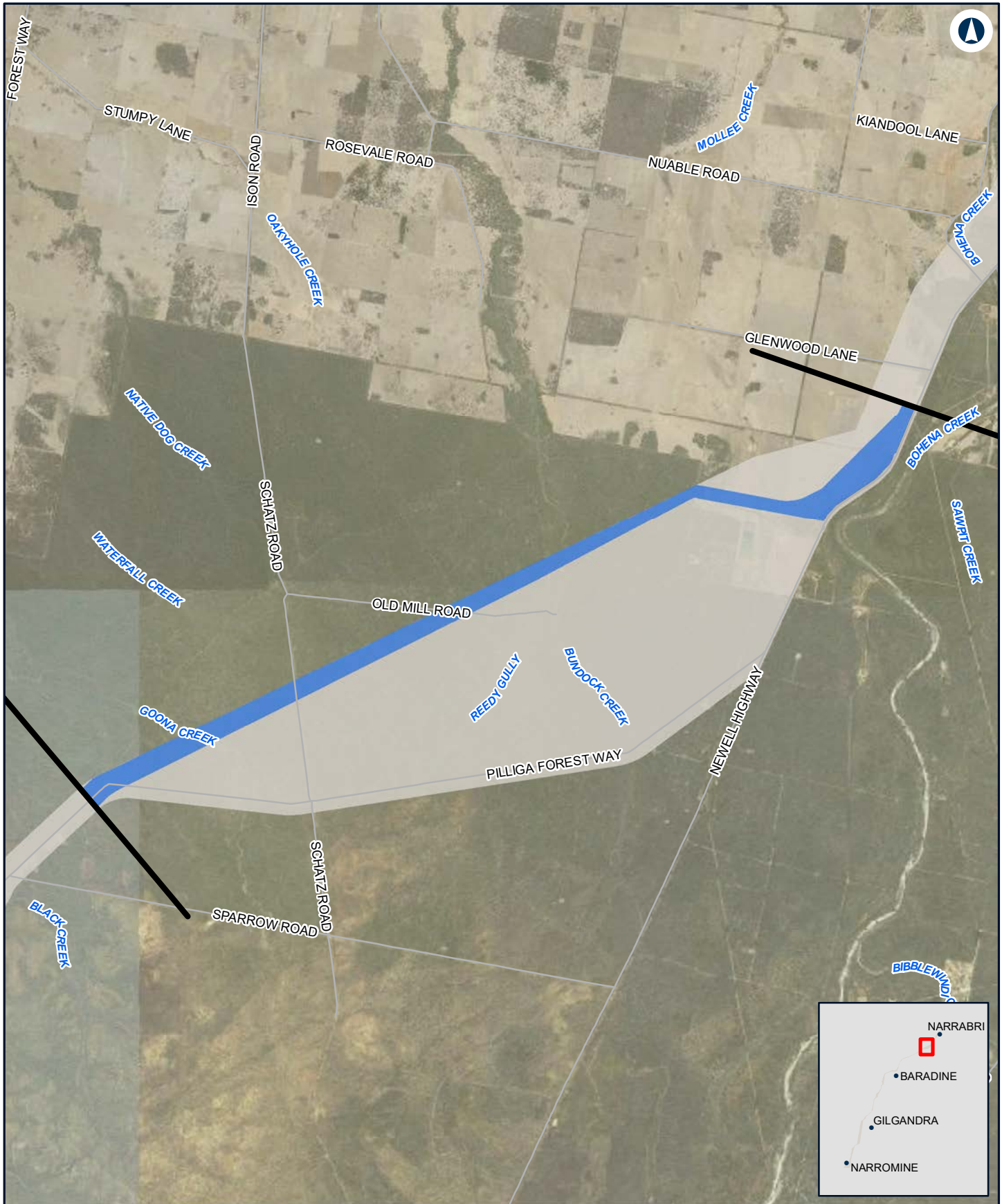
Property impacts were also considered at the northern end of the alignment. The Purple option reduces property severance by following the property boundaries, rather than taking a direct line followed by the Green option, the number of properties impacted however is the same for both options. On balance however, the MCA workshop participants agreed that the reduced property severance at this location outweighed the 18 second advantage in transit time provided by the Green option.

The MCA workshop participants therefore determined that the Purple option, was the preferred option for the Pilliga East section due to:

- Reduced track length of 1.7km providing faster transit time than the Base Case but noting that it is 600m longer than the Green option.
- Reduced property severance when compared to the Green option.

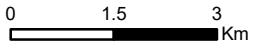
6.7.1 Preferred option Focus Area refinement

An additional outcome of the workshop was to investigate refining the Purple option to reduce the length of exposure to the 1% AEP flood event on Bohena Creek. The Focus Area has been widened to allow refinement of the rail corridor to close to Bohena Creek and the Newell Highway.



NARROMINE TO NARRABRI Focus area - Pilliga East

Figure 6.10



LEGEND

 Focus area
 Phase 2 study area

Coordinate System: GDA 1994 MGA Zone 55

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7. Narrabri

7.1 Overview

The Narrabri sub-section Study Area commences at the Newell Highway, to the south of Narrabri, and heads in a northerly direction around the west of the town, finishing at the Kamilaroi Highway. There are a number of property constraints, sensitive receivers and utilities typical of regional suburban and commercial environment. The Study Area has a number of major transport crossings including the Walgett Railway line, the Kamilaroi Highway as well as several local roads such as Yarrie Lake Road and Culgoora Road. The topography is generally flat to undulating farmland with alluvium soils and is prone to regional flood events from the Namoi River and Narrabri Creek and the flood plain from these rivers must be crossed.

A west to south connection from the Walgett Railway Line to Inland Rail is under investigation to provide greater interconnectivity with the existing Country Rail Network. Possible connections for each option are illustrated in Figure 7-1.

7.2 Options under assessment

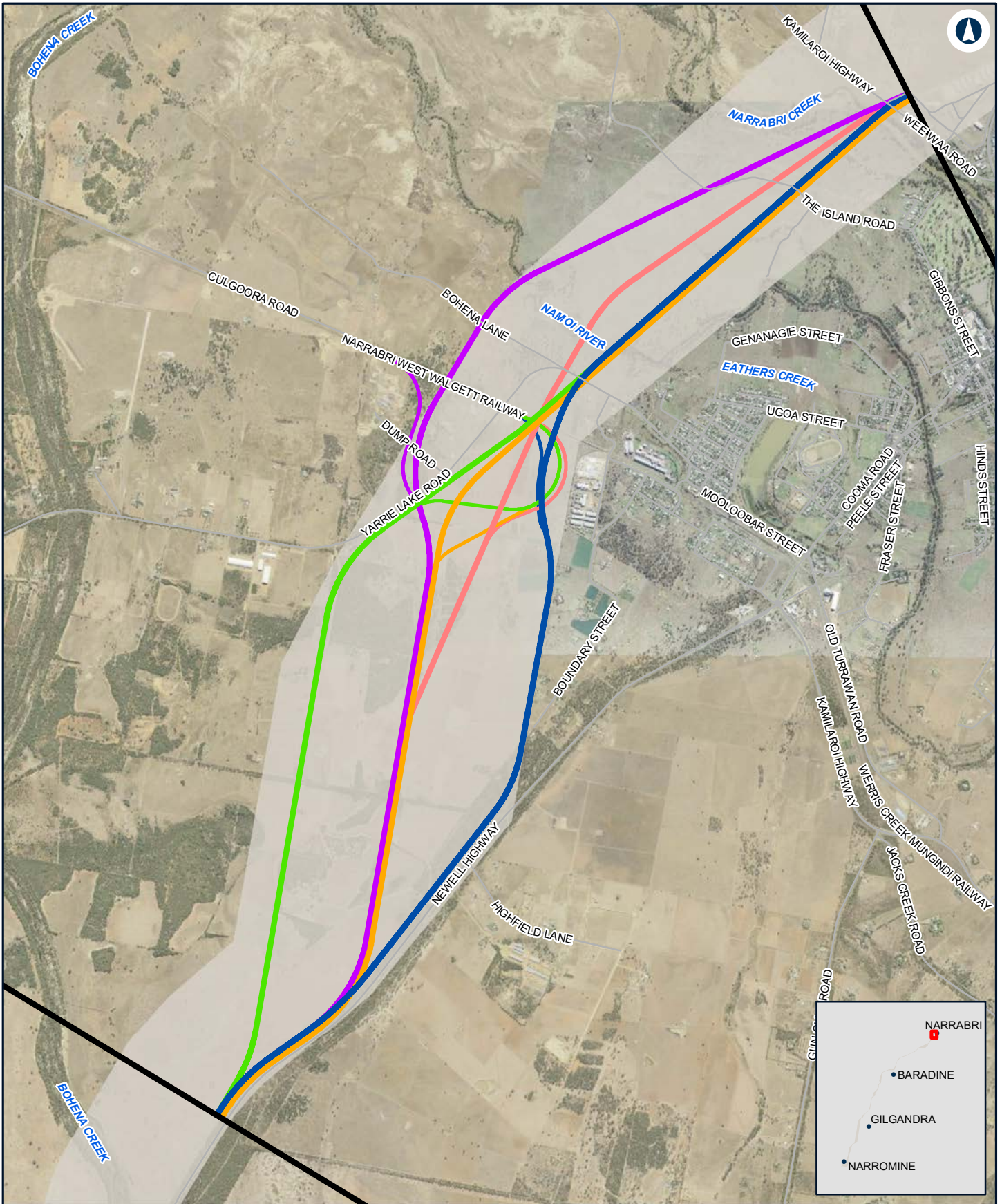
Within the Narrabri Study Area, four options have been developed for comparison to the base case. These options are summarised in Table 7-1 and illustrated in Figure 7-1.

Table 7-1 Narrabri options

Option	Description
BN-N-BC (Base Case, Dark Blue option)	<p>Starting at the southern end of the Study Area, the Base Case follows the western side of the Newell Highway corridor for approximately 4 km. It then turns to the north west following property boundaries where it crosses the Walgett Railway Line and Yarrie Lake Road. Continuing north east the Base Case crosses the Namoi River and Narrabri Creek flood plain and the Kamilaroi Highway where it joins the Narrabri to Moree rail corridor.</p> <p>The Base Case:</p> <ul style="list-style-type: none">• Is 11.2km in length.• Has a travel time of 5.8 minutes.• Impacts 18 properties.• Impacts 2 major roads; Yarrie Lake Road and the Kamilaroi Highway and Walgett Railway Line A grade separated crossing is required at the Kamilaroi Highway and Walgett Railway Line crossing. Yarrie Lake road and Island Road is also treated with a grade separation as it lies within the viaduct extent.• Requires a viaduct of approximately 3.6km to cross the Namoi River and Narrabri Creek flood plain between Yarrie Lake Road and the Kamilaroi Highway.

Option	Description
BN-N-C (Orange option)	<p>The Orange option follows the western side of the Newell Highway corridor for approximately 1 km where it turns to the north west crossing the Walgett Railway Line and Yarrie Lake Road. At Yarrie Lake Road it follows an alignment the same as the Base Case crossing the Namoi River and Narrabri Creek flood plain as well as the Kamilaroi Highway where it re-joins the Newell Highway corridor.</p> <p>The Base Case:</p> <ul style="list-style-type: none"> • Is 11.2km in length. • Has a travel time of 5.8 minutes. • Impacts 16 properties. • Impacts 2 major roads; Yarrie Lake Road and the Kamilaroi Highway and Walgett Railway Line. A grade separated crossing is required at the Kamilaroi Highway and Walgett Railway Line crossing. Yarrie Lake road and Island Road is also treated with a grade separation as it lies within the viaduct extent. • Requires a viaduct of approximately 3.6km to cross the Namoi River and Narrabri Creek flood plain between Yarrie Lake Road and the Kamilaroi Highway
BN-N-W (Green option)	<p>From the Newell Highway corridor the Green option veers north towards Yarrie Lake Road. It then follows the eastern side of the Yarrie Lake Road corridor crossing the Walgett Railway Line. To the north of the Walgett Railway Line it crosses Yarrie Lake Road then follows an alignment the same as the Base Case crossing the Namoi River and Narrabri Creek flood plain as well as the Kamilaroi Highway where it re-joins the Newell Highway corridor</p> <p>The Green option:</p> <ul style="list-style-type: none"> • Is 11.2km in length. • Has a travel time of 5.9 minutes. • Impacts 17 properties. • Impacts 2 major roads; Yarrie Lake Road and the Kamilaroi Highway and Walgett Railway Line A grade separated crossing is required at the Kamilaroi Highway and Walgett Railway Line crossing. Yarrie Lake road and Island Road is also treated with a grade separation as it lies within the viaduct extent. • Requires a viaduct of approximately 3.6km to cross the Namoi River and Narrabri Creek flood plain between Yarrie Lake Road and the Kamilaroi Highway.

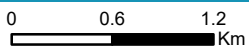
Option	Description
BN-N-D (Purple option)	<p>Similar to the Orange option, the Purple option follows the western side of the Newell Highway corridor for approximately 1 km where it turns to the north west. It then veers to the western edge of the Study Area crossing Yarrie Lake Road, the Walgett Railway Line and Culgoora Road, bisecting the Narrabri Waste Management Centre in the process. The Purple option crosses the Namoi River and Narrabri Creek flood plain and the Kamilaroi Highway where it re-joins the Newell Highway corridor at the same location as the Base Case.</p> <p>The Purple option:</p> <ul style="list-style-type: none"> • Is 11.8km in length. • Has a travel time of 6.1 minutes. • Impacts 18 properties. • Impacts 2 major roads; Yarrie Lake Road and the Kamilaroi Highway and Walgett Railway Line A grade separated crossing is required at the Kamilaroi Highway and Walgett Railway Line crossing. The Island Road is also treated with a grade separation as it lies within the viaduct extent. Yarrie Lake road is treated with a grade crossing and the Dump road requires relocation. • Requires a viaduct of approximately 4.2km to cross the Namoi River and Narrabri Creek flood plain.
BN-N-CRN (Pink option)	<p>The Pink option follows a more direct northerly route towards the Walgett Railway Line creating severance issues on several properties before crossing the Walgett Railway Line and Yarrie Lake Road. It continues across the Namoi River and Narrabri Creek flood plain further west than the Base Case before crossing the Kamilaroi Highway and re-joining the Newell Highway corridor.</p> <p>The Pink option:</p> <ul style="list-style-type: none"> • Is 11.1km in length. • Has a travel time of 5.8 minutes. • Impacts 19 properties. • Impacts 2 major roads; Yarrie Lake Road and the Kamilaroi Highway and Walgett Railway Line A grade separated crossing is required at the Kamilaroi Highway and Walgett Railway Line crossing. Yarrie Lake road and Island Road is also treated with a grade separation as it lies within the viaduct extent. • Requires a viaduct of approximately 3.8km to cross the Namoi River and Narrabri Creek flood plain.



NARRABRI TO NARRABRI

Options summary - Narrabri

Figure 7.1



LEGEND

- BN-N-BC
- BN-N-C
- BN-N-W
- BN-N-D
- BN-N-CRN
- Phase 2 study area

Coordinate System: GDA 1994 MGA Zone 55

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7.3 Field investigations completed

7.3.1 Geotechnical

Ground conditions encountered in the geotechnical investigations are consistent with the published mapping for the area, with test pits in mapped colluvial sheet wash areas (vertisols) showing evidence for fissuring and colouration consistent with reactive soils prone to gilgai development. Distinctive areas of gilgai can be observed from aerial imagery alone that coincide with mapped colluvial sheet wash (vertisol) areas. Laboratory test results received to date indicate relatively consistent subgrade conditions, with CBR results in the range of 3% to 5%.

Once the Namoi River and Narrabri Creek alluvial channels and associated meander plain are reached, ground conditions are expected to be broadly similar irrespective of the alignment. Geotechnical investigation and laboratory results to the north of Narrabri Creek indicate reactive soils and poor subgrade conditions (CBR ~1%) though this is common to all options.

Therefore whilst there are differences in the lengths of encountered alluvial and colluvial soils when the options are compared to the base case, as per the above the geotechnical investigations results indicate that the actual material properties encountered are similar across all options (including the base case). As such all options are considered similar to the base case from a geotechnical viewpoint based upon the available data.

7.3.2 Ecology

- Within the Study Area there are six (6) PCTs identified within the field survey areas. Based on the information available, one TEC listed under both the BC Act and EPBC Act would be impacted by Option BN-N-BC, Option BN-N-C and Option BN-N-D. PCTs include:
- Brigalow – Belah open forests / woodland on alluvial often gilgaied clay from pilliga scrub to Goondiwindi, Brigalow Belt South Bioregion:
 - Listed as an EEC under the BC Act and EPBC Act.
- River Red Gum riparian tall woodland / open forest wetland in the Nandewar Bioregion and Brigalow Belt South Bioregion.
- Pilliga Box - White Cypress Pine - Buloke shrubby woodland in the Brigalow Belt South Bioregion.
- Dirty Gum - Buloke - White cypress pine - ironbark shrubby woodland of the deep sandy soils on the Liverpool Plains Region of the Brigalow Belt South Bioregion.
- Derived Copperburr shrubland of the NSW northern inland alluvial floodplains.
- Derived Wire Grass grassland of the NSW Brigalow Belt South Bioregion and Nandewar Bioregion.

Significant areas of the options under assessment do not impact these plant community types, with between 700 metres and 4 kilometres being identified as Crop and/or introduced grassland for each option.

7.3.3 Cultural Heritage

Cultural heritage field surveys undertaken in the Study Area identified:

- One AHIMS site within 200 metres, associated with Option BN-N-D only
- No known Artefact scatters within 200 metres
- No known ochre quarries within 200 metres
- No known scarred trees within 200 metres

- No known culturally sensitive sites within 200 metres
- One sensitive river associated with Namoi River for all options
- One culturally sensitive area associated with Bohena Creek
- One culturally sensitive area associated with Namoi River
- No known areas with a large number of scarred trees (recommended for wider survey)

7.4 Comparative quantities influencing capital cost

Elements of each option that will influence the capital cost are included in Table 7-2. Order of magnitude quantities for track length and structures are provided as well as the complexity of earthworks.

Table 7-2 Narrabri comparative quantities

Option	Track Length	Structure quantity	Earthworks
BN-N-BC (Base Case, Dark Blue option)	11.2km	More than 1 moderate or large culverts Approximately 3.6km long viaduct	99% of the corridor traverses poor geotechnical conditions. This option presents the most complex earthworks, when compared to other options.
BN-N-C (Orange option)	11.2km	More than 1 moderate or large culverts Approximately 3.6km long viaduct	Approximately 70% of the corridor traverse poor geotechnical conditions. This option presents moderate earthworks complexity, when compared with other options.
BN-N-W (Green option)	11.2km	More than 1 moderate or large culverts Approximately 3.6km long viaduct	Approximately 54% of the corridor traverse poor geotechnical conditions. This option presents less complex earthworks, when compared with other options.
BN-N-D (Purple option)	11.8km	More than 1 moderate or large culverts Approximately 4.2km long viaduct	Approximately 62% of the corridor traverse poor geotechnical conditions. This option presents the least complex earthworks, when compared with other options.
BN-N-CRN (Pink option)	11.1km	More than 1 moderate or large culverts Approximately 3.8km long viaduct	Approximately 79% of the corridor traverse poor geotechnical conditions. This option presents greater earthworks complexity, when compared with other options.

7.5 Summary of Narrabri MCA options comparison

The MCA sub-criteria defined in Section 3.2 has assisted in defining the key issues which will influence the selection of a Focus Area. A summary of these key issues for each of the Narrabri options are provided in Table 7-1.

Corresponding maps for each of these key issues are illustrated in Figure 7-2 to Figure 7-9.

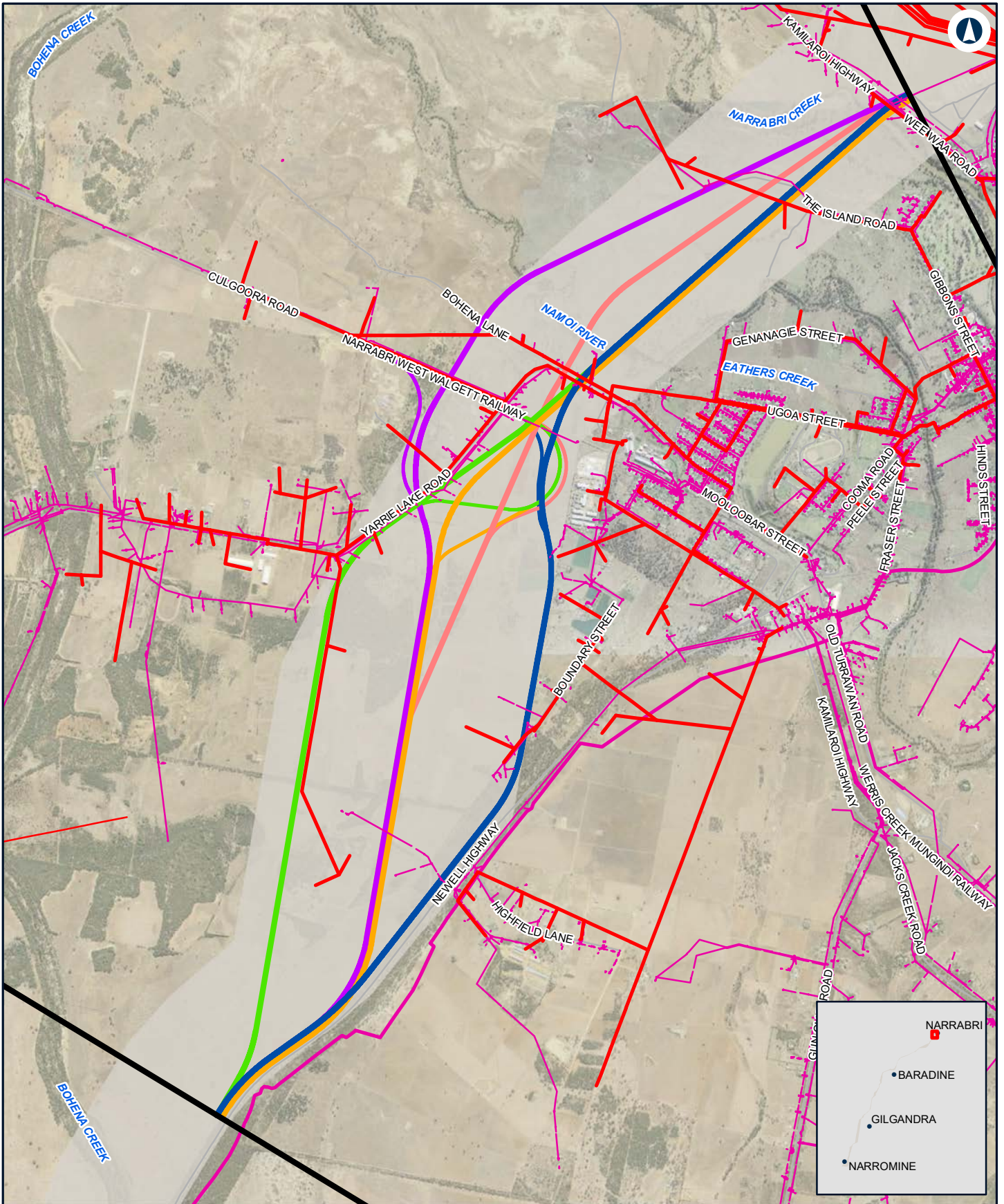
Table 7-3 Summary of Narrabri MCA options comparison

	BN-N-BC (Base Case, Dark Blue option)	BN-N-C (Orange option)	BN-N-W (Green option)	BN-N-D (Purple option)	BN-N-CRN (Pink option)
Alignment	The Base Case has a track length of 11.2km.	The Orange option has a track length of 11.2km, no significant difference in track geometry to the Base Case.	The Green option has a track length of 11.2km, no significant difference in track geometry to the Base Case.	The Purple option has a track length of 11.8km, no significant difference in track geometry to the Base Case.	The Pink option has a track length of 11.1km, no significant difference in track geometry to the Base Case.
Impact on utilities (Figure 7-2)	The utilities affected by the Base Case include: <ul style="list-style-type: none"> 6 22kV overhead crossings 18 telecommunication crossings 	The utilities affected by the Orange option include: <ul style="list-style-type: none"> 5 22kV overhead crossings 13 telecommunication crossings 	The utilities affected by the Green option include: <ul style="list-style-type: none"> 8 22kV overhead crossings 17 telecommunication crossings 	The utilities affected by the Purple option include: <ul style="list-style-type: none"> 8 22kV overhead crossings 10 telecommunication crossings 	The utilities affected by the Pink option include: <ul style="list-style-type: none"> 4 22kV overhead crossings 1 11kV crossing 9 telecommunication crossings
Geotechnical conditions (Figure 7-3)	Geotechnical investigations and published mapping suggest approx. 99% of this alignment may be on poor subgrade soils (vertisols).	Geotechnical investigations and published mapping suggest approx. 70% of this alignment may be on poor subgrade soils (vertisols).	Geotechnical investigations and published mapping suggest approx. 54% of this alignment may be on poor subgrade soils (vertisols).	Geotechnical investigations and published mapping suggest approx. 62% of this alignment may be on poor subgrade soils (vertisols).	Geotechnical investigations and published mapping suggest approx. 79% of this alignment may be on poor subgrade soils (vertisols).
Impact on existing road and rail (Figure 7-4)	The Base Case contains one grade separated rail crossing and three grade separated road crossings.	The Orange option contains one grade separated rail crossing and three grade separated road crossings.	The Green option contains one grade separated rail crossing and three grade separated road crossings.	The Purple option contains one grade separated rail crossing and two grade separated road crossings.	The Pink option contains one grade separated rail crossing and three grade separated road crossings.
Future Proofing	The Base Case contains no significant constraints that would impact on ability to upgrade the rail infrastructure in the future.	The Orange option contains no significant constraints that would impact on ability to upgrade the rail infrastructure in the future.	The Green option contains no significant constraints that would impact on ability to upgrade the rail infrastructure in the future.	The Purple option contains no significant constraints that would impact on ability to upgrade the rail infrastructure in the future.	The Pink option has the ability for an at grade crossing of the Walgett Railway Line which will allow for less complex and cheaper connect east in the future.

	BN-N-BC (Base Case, Dark Blue option)	BN-N-C (Orange option)	BN-N-W (Green option)	BN-N-D (Purple option)	BN-N-CRN (Pink option)
Road Safety Interface	<p>The Base Case interfaces with:</p> <ul style="list-style-type: none"> • 1 state road • 3 council road • 18 private roads 	<p>The Orange option interfaces with:</p> <ul style="list-style-type: none"> • 1 state road • 2 council roads • 17 private roads <p>The Orange option presents no material difference to safety over the Base Case.</p>	<p>The Green option interfaces with:</p> <ul style="list-style-type: none"> • 1 state road • 2 council roads • 17 private roads <p>The Green option presents no material difference to safety over the Base Case.</p>	<p>The Purple option interfaces with:</p> <ul style="list-style-type: none"> • 1 state road • 4 council roads • 20 private roads <p>The Purple option presents no material difference to safety over the Base Case.</p>	<p>The Pink option interfaces with:</p> <ul style="list-style-type: none"> • 1 state road • 3 council roads • 19 private roads <p>The Pink option presents no material difference to safety over the Base Case.</p>
Effect/ Impact on travel time	<p>The estimated travel time for the Base Case is 6.5 minutes.</p>	<p>Less than 1 minute difference in travel time for all options, no material difference to reliability and/or connectivity.</p>	<p>Less than 1 minute difference in travel time for all options, no material difference to reliability and/or connectivity.</p>	<p>Less than 1 minute difference in travel time for all options, no material difference to reliability and/or connectivity.</p>	<p>Less than 1 minute difference in travel time for all options, no material difference to reliability and/or connectivity.</p>
Construction complexity	<p>Complex construction elements include:</p> <ul style="list-style-type: none"> • Poor geotechnical conditions for 99% of the corridor resulting in increased civil works • 3 complex road grade separations • 3.6km long viaduct over the Namoi River 	<p>Complex construction elements include:</p> <ul style="list-style-type: none"> • Poor geotechnical conditions for 70% of the corridor resulting in increased civil works • 3 complex road grade separations • 3.6km long viaduct over the Namoi River 	<p>Complex construction elements include:</p> <ul style="list-style-type: none"> • Poor geotechnical conditions for 54% of the corridor resulting in increased civil works • 3 complex road grade separations • 3.6km long viaduct over the Namoi River 	<p>Complex construction elements include:</p> <ul style="list-style-type: none"> • Poor geotechnical conditions for 62% of the corridor resulting in increased civil works • 3 complex road grade separations • 4.2km long viaduct over the Namoi River <p>Traverses Narrabri tip, possible contamination issues.</p>	<p>Complex construction elements include:</p> <ul style="list-style-type: none"> • Poor geotechnical conditions for 79% of the corridor resulting in increased civil works • 3 complex road grade separations • 3.8km long viaduct over the Namoi River

	BN-N-BC (Base Case, Dark Blue option)	BN-N-C (Orange option)	BN-N-W (Green option)	BN-N-D (Purple option)	BN-N-CRN (Pink option)
Ecological impacts (Figure 7-5)	<p>It impacts:</p> <ul style="list-style-type: none"> 3.5km of non-native vegetation 9.0km of native vegetation (but not threatened ecological community (TEC)) 1km of native vegetation listed as a TEC under the BC Act and/or EPBC Act 	<p>It impacts:</p> <ul style="list-style-type: none"> 3.3km of non-native vegetation 10.4km of native vegetation (but not threatened ecological community) 0.1km of native vegetation listed as a TEC under the BC Act and/or EPBC Act 	<p>It impacts:</p> <ul style="list-style-type: none"> 2.9km of non-native vegetation 10.9km of native vegetation (but not threatened ecological community) Nil native vegetation listed as a TEC under the BC Act and/or EPBC Act 	<p>It impacts:</p> <ul style="list-style-type: none"> 3.9km of non-native vegetation 9.7km of native vegetation (but not threatened ecological community) 0.06km of native vegetation listed as a TEC under the BC Act and/or EPBC Act 	<p>It impacts:</p> <ul style="list-style-type: none"> 4.7km of non-native vegetation 8.4km of native vegetation (but not threatened ecological community) Nil native vegetation listed as a TEC under the BC Act and/or EPBC Act
Flooding / waterway impacts (Figure 7-6)	<p>The Base Case traverses 8 unnamed waterways and 2 named waterways for a total of 10 waterway crossings.</p> <p>Approximately 6.6km (53%) of the Base Case is within a 1% AEP flood area.</p>	<p>The Orange option traverses 6 unnamed waterways and 2 named waterways for a total of 8 waterway crossings.</p> <p>Approximately 8.4km (61%) of the Orange option is within a 1% AEP flood area.</p>	<p>The Green option traverses 6 unnamed waterways and 2 named waterways for a total of 8 waterway crossings.</p> <p>Approximately 9.6km (70%) of the Green option is within a 1% AEP flood area.</p>	<p>The Purple option traverses 8 unnamed waterways and 2 named waterways for a total of 10 waterway crossings.</p> <p>Approximately 9.9km (73%) of the Purple option is within a 1% AEP flood area.</p>	<p>The Pink option traverses 6 unnamed waterways and 2 named waterways for a total of 8 waterway crossings.</p> <p>Approximately 6.4km (49%) of the Pink option is within a 1% AEP flood area.</p>
Sensitive receivers – Noise and Vibration / Effect on Air Quality (Figure 7-7)	<p>The Base Case is the closest option to the centre of the town. The Base Case has 14 residential and 5 commercial receivers within 200m.</p>	<p>The Orange option has 6 residential and 5 commercial receivers within 200m.</p>	<p>The Green option has 9 residential and 6 commercial receivers within 200m.</p>	<p>The Purple option is the furthest option from the centre of the town. The Purple option has 3 residential and 3 commercial receivers within 200m.</p>	<p>The Pink option has 8 residential and 5 commercial receivers within 200m.</p>
Property impacts (Figure 7-8)	<p>The Base Case directly impacts 18 properties and severs 12 of these impacted properties. Potentially 1 residence removed.</p>	<p>The Orange option directly impacts 16 properties and severs 12 of these impacted properties. Potentially 1 residence removed.</p>	<p>The Green option directly impacts 17 properties and severs 12 of these impacted properties. Potentially 1 residence removed.</p>	<p>The Purple option directly impacts 18 properties and severs 13 of these impacted properties.</p>	<p>The Pink option directly impacts 19 properties and severs 13 of these impacted properties. Potentially 1 residence removed.</p>

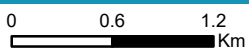
	BN-N-BC (Base Case, Dark Blue option)	BN-N-C (Orange option)	BN-N-W (Green option)	BN-N-D (Purple option)	BN-N-CRN (Pink option)
Cultural Heritage impacts (Figure 7-9)	<ul style="list-style-type: none"> No AHIMS sites within 200 metres No Artefact scatters within 200 metres No ochre quarries within 200 metres No scarred trees within 200 metres No culturally sensitive sites within 200 metres One sensitive river associated with Namoi River One culturally sensitive areas (Namoi River) within 200 metres One culturally sensitive areas (Bohena Creek) within 200 metres No areas with a large number of scarred trees (recommended for wider survey) 	<ul style="list-style-type: none"> No AHIMS sites within 200 metres No Artefact scatters within 200 metres No ochre quarries within 200 metres No scarred trees within 200 metres No culturally sensitive sites within 200 metres One sensitive river associated with Namoi River One culturally sensitive areas (Namoi River) within 200 metres One culturally sensitive areas (Bohena Creek) within 200 metres No areas with a large number of scarred trees (recommended for wider survey) 	<ul style="list-style-type: none"> No AHIMS sites within 200 metres No Artefact scatters within 200 metres No ochre quarries within 200 metres No scarred trees within 200 metres No culturally sensitive sites within 200 metres One sensitive river associated with Namoi River One culturally sensitive areas (Namoi River) within 200 metres One culturally sensitive areas (Bohena Creek) within 200 metres No areas with a large number of scarred trees (recommended for wider survey) 	<ul style="list-style-type: none"> One AHIMS site within 200 metres No Artefact scatters within 200 metres No ochre quarries within 200 metres No scarred trees within 200 metres No culturally sensitive sites within 200 metres One sensitive river associated with Namoi River One culturally sensitive areas (Bohena Creek) within 200 metres No areas with a large number of scarred trees (recommended for wider survey) 	<ul style="list-style-type: none"> No AHIMS sites within 200 metres No Artefact scatters within 200 metres No ochre quarries within 200 metres No scarred trees within 200 metres No culturally sensitive sites within 200 metres One sensitive river associated with Namoi River One culturally sensitive areas (Bohena Creek) within 200 metres No areas with a large number of scarred trees (recommended for wider survey)



NARROMINE TO NARRABRI

Constraints - Utilities - Narrabri

Figure 7.2



Coordinate System: GDA 1994 MGA Zone 55

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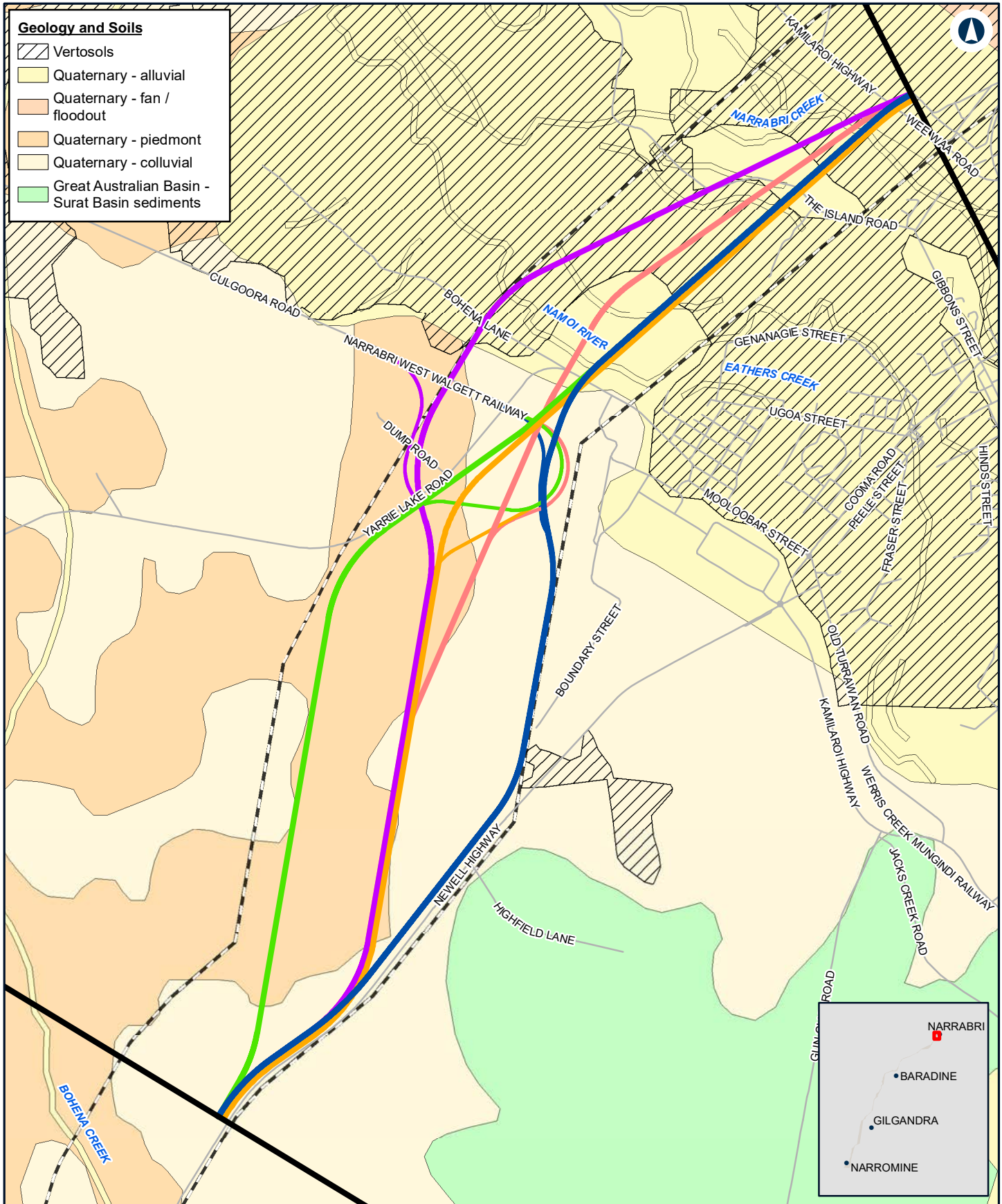
Data Sources: Imagery, road names: NSW Spatial Services; Utilities: ARTC; all other layers: JacobsGHD

LEGEND

- BN-N-BC
- BN-N-C
- BN-N-W
- BN-N-D
- BN-N-CRN
- Phase 2 study area
- Electricity 22kV - 66kV
- Electricity 11kV - 22kV
- Comms (Telstra)



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0 0.6 1.2 Km

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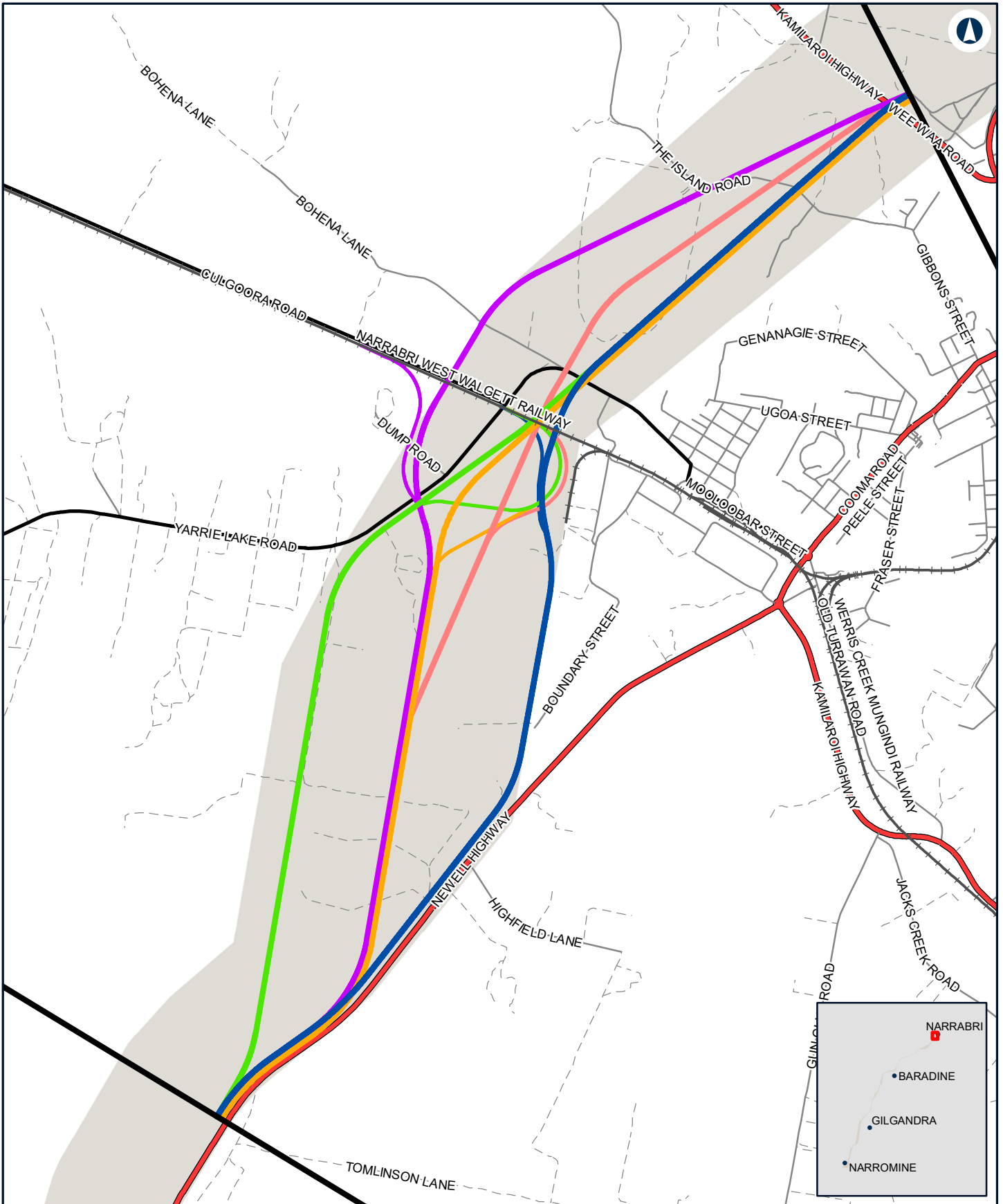
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Data Sources: Road names: NSW Spatial Services; geology, soils; Dept Industry Resources and Energy; all other layers: JacobsGHD



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NARROMINE TO NARRABRI Constraints - Road and rail network - Narrabri

Figure 7.4

0 0.6 1.2
Km

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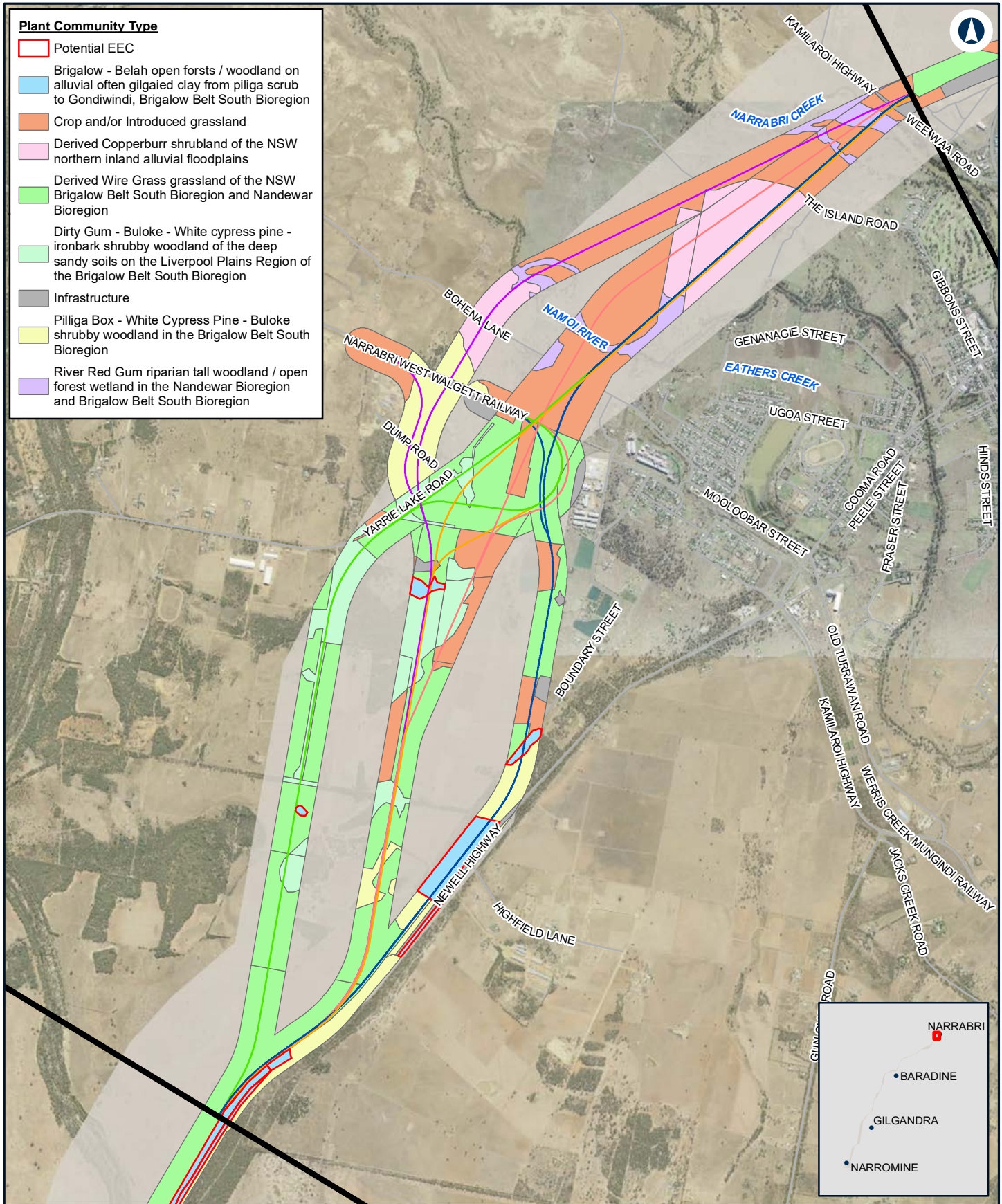
Data Sources: Road and rail: NSW Spatial Services; all other layers: JacobsGHD

LEGEND

- BN-N-BC
- BN-N-C
- BN-N-W
- BN-N-D
- BN-N-CRN
- Study area
- Primary Road
- Sub Arterial Road
- Local Road
- Track
- +— Railway



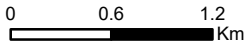
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NARROMINE TO NARRABRI

Constraints - ecology - Narrabri

Figure 7.5

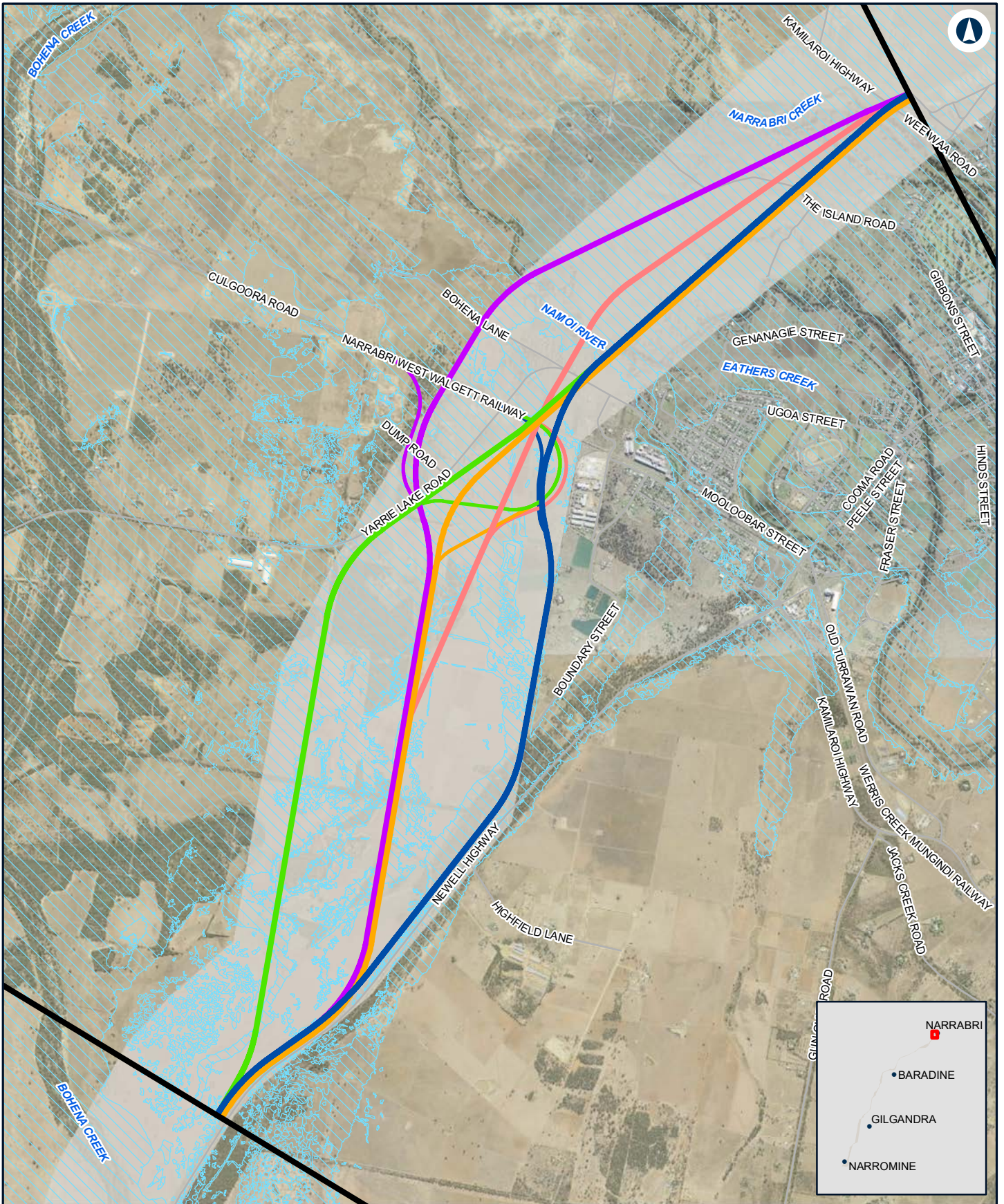


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NARROMINE TO NARRABRI Constraints - Flooding - Narrabri

Figure 7.6

0 0.6 1.2
Km

LEGEND

- BN-N-BC
- BN-N-C
- BN-N-W
- BN-N-D
- BN-N-CRN
- ▨ Flood extent - 1% AEP
- Phase 2 study area

Coordinate System: GDA 1994 MGA Zone 55

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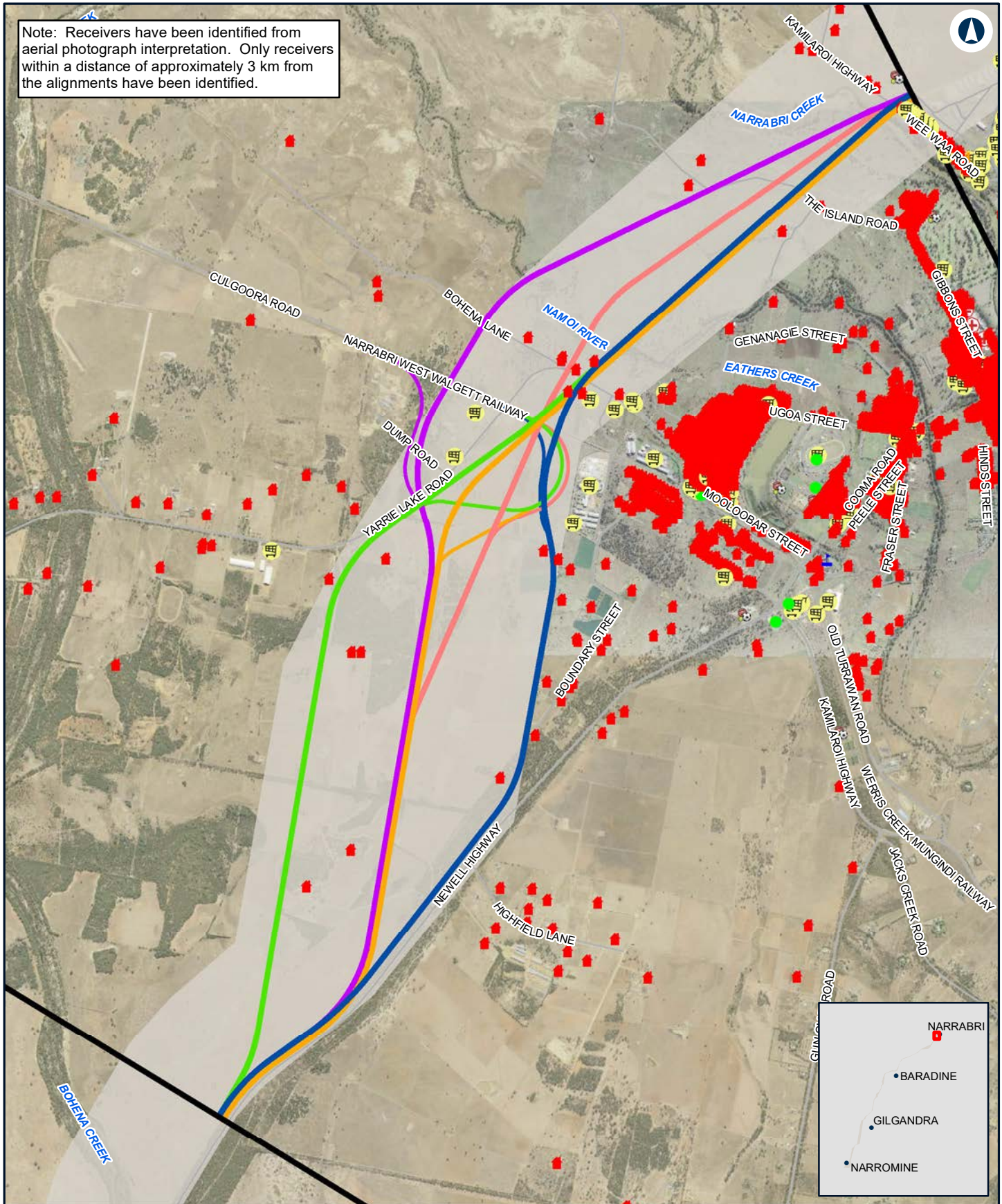
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Data Sources: Imagery, road names: NSW Spatial Services; all other layers: JacobsGHD



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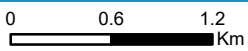
Note: Receivers have been identified from aerial photograph interpretation. Only receivers within a distance of approximately 3 km from the alignments have been identified.



NARROMINE TO NARRABRI

Constraints - Sensitive Receivers - Narrabri

Figure 7.7



LEGEND

- BN-N-BC
- BN-N-C
- BN-N-W
- BN-N-D
- BN-N-CRN
- Phase 2 study area
- Commercial
- Community
- ⚙ Education
- ⊕ Health
- ⚽ Recreation
- ⛪ Religious
- 🏠 Residence

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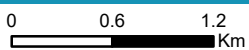
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NARROMINE TO NARRABRI

Constraints - Property - Narrabri

Figure 7.8



LEGEND

- BN-N-BC
- BN-N-C
- BN-N-W
- BN-N-D
- BN-N-CRN
- Phase 2 study area

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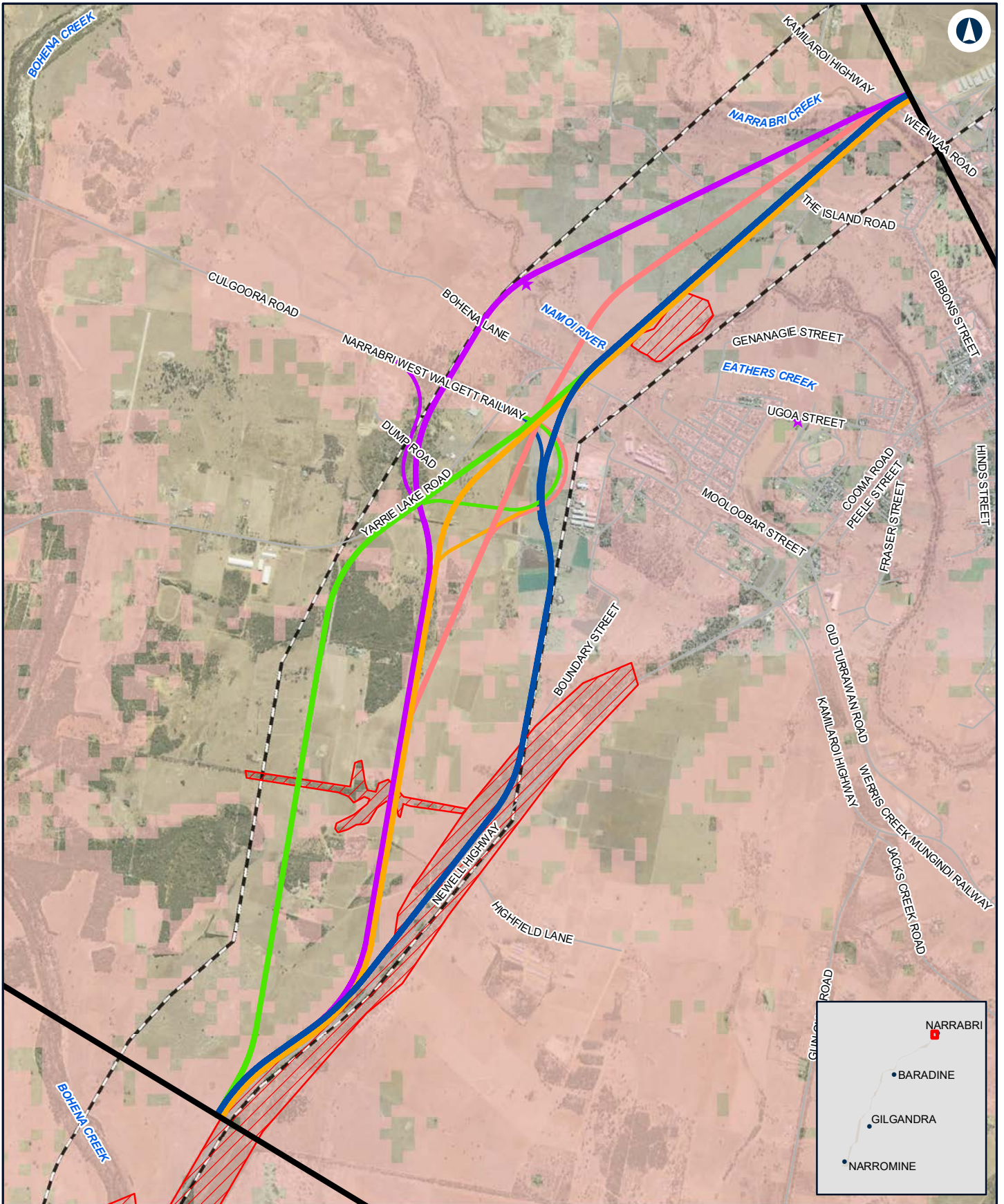
Author: GM (GHD)

Scale: 1:45,000

Data Sources: Road names: NSW Spatial Services; property; ARTC; all other layers: JacobsGHD



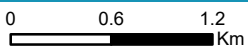
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NARROMINE TO NARRABRI

Constraints - Cultural Sensitivity - Narrabri

Figure 7.9



LEGEND

Coordinate System: GDA 1994 MGA Zone 55

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Data Sources: Imagery,Road names: NSW Spatial Services; AHIMS sites, ASDT data: OEH; all other layers: JacobsGHD

BN-N-BC

BN-N-C

BN-N-W

BN-N-D

BN-N-CRN

Phase 2 study area

AHIMS site

Culturally sensitive survey area

Medium to high sensitivity areas (ASDT - DECCW)

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7.6 MCA Scoring

The MCA scoring of Narrabri options is presented in Appendix E. Summary results for Narrabri options are presented in Table 7-4.

Table 7-4 Narrabri - MCA Results

Option	MCA Score	Rank
BN-N-BC (Base Case, Dark Blue option)	0	3
BN-N-C (Orange option)	0.49	=1
BN-N-W (Green option)	-0.14	4
BN-N-D (Purple option)	0.31	2
BN-N-CRN (Pink option)	0.64	=1

7.6.1 MCA score analysis

The Pink options scored first with a score of 0.64, The Orange option second with 0.49 and the Purple option third with a score of 0.31. These three options all scored positively compared to the Base Case. The Green option scored less than the Base Case.

Higher rankings were influenced by scoring criteria based on the number of sensitive receivers within 200 m of the proposed corridors.

The Purple option scored the highest for community feedback, being the furthest from Narrabri. All options scored +10 for noise and vibration and air quality, whilst this reflected the difference to the Base Case, it did not differentiate internally between the options. The Purple option is approximately 600 m longer than the Base Case, Orange and Pink options. The additional length of viaduct required over the Namoi River / Narrabri Creek flood plain would be 450 m. This would add significant additional cost to the Purple option which would also be compounded by a new active level crossing on Yarrie Lake Road and a new road into Narrabri Council's waste management facility. Potential construction risks were also identified with the nearby dump and construction within the proposed Walgett Railway Line connection in a flood channel.

The Orange and Pink options are very similar reflected by the scoring, the differentiators between these two options and the Base Case were marginal and resulted from the Pink option having fewer impacts on public utilities but severing one more property and the Orange option more potential to impact on environmentally sensitive areas but impacting 2 less properties.

7.6.2 Sensitivity analysis (MCA weightings)

A sensitivity analysis was carried out considered increasing the weightings for each of the key criteria to 40%, whilst re-weighting the remaining criteria to 10% each. The outcomes are summarised in Table 7-5 and Appendix E, with the key observations being that the Pink option ranks first in 5 out of the 7 criteria. The Base Case did not score higher than third for any criteria.

Table 7-5 Narrabri - Sensitivity Analysis

Sensitivity	Top Option	Top Option Score	Base Case Rank
Technical	Pink option	1.12	4
Safety	Pink option	0.62	4
Operations	Pink option	0.62	4
Constructability	Pink option	1.12	3
Environmental	Purple option	1.56	4
Community	Orange option	0.80	4
Approvals	Pink option	0.62	4

7.7 Preferred option

The preferred option is the Pink option (BN-N-CRN).

The scoring for the top three options (Orange, Purple and Pink) was very close, with the Pink ultimately scoring first.

The Purple option had the lowest impact on residential receivers, but was the longest option that included an additional 450 m of viaduct to cross the Naomi River / Narrabri Creek flood plain. It would require an additional active level crossing on Yarrie Lake Road and construction of a new access road into Council's waste management facility. The proximity to the tip could also result in construction risks from historic dumping activities and leachate. The connection to the Walgett Railway Line would also have to be managed within the 1% AEP flood zone. The above issues were discussed in the workshop and the Purple option was not considered to be preferred.

The Orange and Pink options are very similar as outlined above, with the floodplain crossing for the Pink option being slightly further to the west, away from Narrabri. Key considerations between these options were:

- The Pink option has one less 22kV crossings than the Orange option.
- The Pink option connection to the Walgett Railway Line is approximately 600m shorter in length.
- The Pink option is within 200m of 13 residences, compared to 11 residences for the Orange option. It was noted that the number of properties impacted near Yarrie Lake Road was very sensitive to the final alignment and rail corridor extents.

Having considered the above, the workshop consensus was that the Pink option was preferred as it scored highest and:

- Is further to the west
- Has a shorter connection to the Walgett Railway Line

7.7.1 Preferred option Focus Area refinement

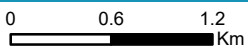
An outcome from the workshop was to investigate refining the Pink Option to reduce property impact near Yarrie Lake Road.



NARROMINE TO NARRABRI

Focus area - Narrabri

Figure 7.10



LEGEND

- Focus area
- Phase 2 study area

Coordinate System: GDA 1994 MGA Zone 55

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