Bruce Highway Upgrade (Cooroy to Curra) Section C (Traveston Road to Keefton Road)

DEPARTMENT OF TRANSPORT AND MAIN ROADS

Review of Environmental Factors

QB10237-N-NA-RP-0001 | Revision 1

TMR Contract Number: WBYD-972

TMR Job Number: 232/10A/2

TMR Region Wide Bay/ Burnett Region

08 April 2014

JACOBS SKM

Bruce Highway Upgrade (Cooroy to Curra) Section C (Traveston Road to Keefton Road)

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Document history and status

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Rev A	04/10/2013	D Wood/ P Black	D Carson	D Wood/ P Black	04/10/2013
Rev B	27/11/2013	Response to TMR comments	D Carson	P Black	27/11/2013
Rev 0	27/11/2013	Final	D Carson	P Black	27/11/2013
Rev 1	08/04/2014	Final updated REF	D Carson	D Carson/ P Black	08/04/2014

Contents

Acronyms

ATSIHP Act	*Aboriginal and Torres Strait Islander Heritage Protection Act 1984*
ACH Act	*Aboriginal Cultural Heritage Act 2003*
LA Act	*Acquisition of Land Act 1967*
AADT	Annual Average Daily Traffic
AATC	Annual Average Time of Closure
ARI	Annual Recurrence Interval
ABS	Australian Bureau of Statistics
AHD	Australian Height Datum
ALS	Australian Laboratory Services
AWQG	Australian Water Quality Guidelines
AWDT	Average Weekday Traffic
BAAM	Biodiversity Assessment and Management
BHAP	Bruce Highway Action Plan
CAMBA	China-Australia Migratory Bird Agreement
DotE	Commonwealth Department of the Environment
CID	Community Infrastructure Designation
EMP(C)	Environmental Management Plan (Construction)
CLR	Contaminated Land Register
DAFF	Department of Agriculture, Fisheries and Forest
DEHP	Department of Environment and Heritage Protection
DEO	Desired Environmental Outcomes
DERM	Department of Environment and Resource Management
DNPRSR	Department of National Parks, Recreation, Sport and Racing
DNRM	Department of Natural Resources and Mines
DSDIP	Department of State Development, Infrastructure and Planning
TMR	Department of Transport and Main Roads
DRO	Desired Regional Outcomes
DO	Dissolved Oxygen
EC	Electrical Conductivity
EVNT	Endangered, Vulnerable or Near Threatened
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
EPP (Air)	*Environment Protection Policy (Air) 2008*
EPP (Noise)	*Environment Protection Policy (Noise) 2008*
EPP (Water)	*Environment Protection Policy (Water) 2008*
EA	Environmental Authority
EIS	Environmental Impact Statement
EMR	Environmental Management Register
EOP	Environmental Offsets Policy
EP Act	*Environmental Protection Act 1994*
EPA	Environmental Protection Agency
ERA	Environmentally Relevant Activity
ESCP	Erosion and Sediment Control Plan
EI	Erosion Index
FRS Act	*Fire and Rescue Service Act 1990*

FHMOP	Fish Habitat Management Operational Policy
GQAL	Good Quality Agricultural Land
GRSTM	Gympie Region Strategic Transport Model
HES Wetland	Wetlands of High Ecological Significance
HVR	High Value Regrowth
IBRA	Interim Biogeographic Regionalisation For Australia
JAMBA	Japan-Australia Migratory Bird Agreement
KRA	Key Resource Area
LP Act	*Land Protection (Pest and Stock Route Management) Act 2002*
LGA	Local Government Area
MNES	Matters of National Environmental Significance
MOU	Memorandum of Understanding
NEPM	National Environmental Protection Measures
NT Act	*Native Title Act 1993*
NC Act	*Nature Conservation Act 1992*
OAMP	Offset Area Management Plan
OGA	Open Graded Asphalt
PTC	Permanent Traffic Counter
PMAV	Property Map of Assessable Vegetation
PER	Public Environment Report
QGEOP	Queensland Government Environmental Offsets Policy 2011-2012 to 2014-2015
QTRIP	Queensland Transport and Roads Investment Program
QWQG	Queensland Water Quality Guidelines
RE	Regional Ecosystem
REDD	Regional Ecosystem Description Database
RCBC	Reinforced Concrete Box Culvert
REF	Review of Environmental Factors
RDDM	Road Drainage Design Manual
RPEPM	Road Project Environmental Processes Manual, 2004
SEQKPA	South East Queensland Koala Protection Area
SMP	Species Management Program
SAT	Spot Assessment Technique
SARA	State Assessment and Referral Agency
SDPWO Act	*State Development and Public Works Organisation Act 1971*
SDAP	State Development Assessment Provisions
SPP	State Planning Policies
SPRP	State Planning Regulatory Provisions
SCL	Strategic Cropping Land
SCL Act	*Strategic Cropping Land Act 2011*
SP Act	*Sustainable Planning Act 2009*
SP Reg	*Sustainable Planning Regulation 2009*
TEC	Threatened Ecological Community
TSP	Total Suspended Particles
TSS	Total Suspended Solids
TI Act	*Transport Infrastructure Act 1994*

UXO	Unexploded Ordnance
VENM	Virgin Excavated Natural Material
VM Act	*Vegetation Management Act 1999*
IIC	Infrastructure Investment Committee
BC	Business Case

Executive Summary

The Bruce Highway Cooroy to Curra project is a 61 kilometre upgrade of the Bruce Highway including a bypass of Gympie. This project has been separated into four sections for the purposes of design development and construction:

Section A – Cooroy southern interchange to Sankeys Road (12.5 kilometres).

Section B – Sankeys Road to Traveston Road (11 kilometres).

Section C – Traveston Road to Keefton Road (11.5 kilometres).

Section D – Keefton Road to Curra including the Gympie bypass (26 kilometres).

Section C of the Bruce Highway Cooroy to Curra project ("the Project") is an 11.5 kilometre realignment of the existing Bruce Highway between Traveston Road and Keefton Road located south of Gympie. The Project includes:

- Integration with the existing Traveston Road Interchange constructed at the northern extremity of Section B of the Bruce Highway Cooroy to Curra Project.
- Approximately 8.4 kilometres of six lane formation to accommodate four lanes of pavement and a central concrete barrier from Traveston Road Interchange to the proposed Woondum Road overpass.
- Waterway crossing structures over Traveston Creek, Kybong Creek, Cobbs Gully and Jackass Creek.
- Overpasses at Tandur Road and Woondum Road, and an intersection upgrade at Keefton Road.
- An interchange to connect the new section of the Bruce Highway to the existing Bruce Highway, known as the Woondum Interchange.
- Upgrade to approximately 1.7 kilometres of the existing Bruce Highway to the southern approach of the existing Six Mile Creek bridge.

The Bruce Highway (Cooroy – Curra) Strategic Planning Study Recommended Corridor Report (July 2008) was the Link Study completed to develop the concept alignment for the Cooroy to Curra project.

This Review of Environmental Factors (REF) has been developed to consider the potential environmental impacts of the Section C of the Bruce Highway Cooroy to Curra Project. The REF has been prepared in accordance with the Department of Transport and Main Roads (TMR) Road Projects Environmental Processes Manual (2004). The development of the REF included desktop and site investigations for environmental aspects appropriate to the level of risk to the Project.

Potential environmental impacts and regulatory implications of the project include:

- Clearing of remnant vegetation including habitat for fauna species listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and Queensland *Nature Conservation Act 1992*.
- Potential to trigger further environmental assessment under the EPBC Act if the project is declared to be a controlled action.
  - A review of potential impacts to matters of environmental significance relevant to the Project concluded that the Project may be declared a controlled action as a result of impacts to threatened terrestrial fauna species, including the Koala, and is to be referred to the Commonwealth Department of the Environment for a determination.
  - Aquatic ecology studies concluded that the presence of EPBC listed aquatic species is unlikely in waterways directly impacted by the Project.

- Impacts to Traveston State Forest and Woondum State Forest and the associated requirement to revoke sections of these State Forests.
  - TMR will be required to provide land at an agreed ratio to compensate for these impacts.
  - Recommendations for this process include the incorporation for additional area of Woondum State Forest that will be impacted by Section D into the Section C revocation process.
- Offsets will be required under the Queensland Biodiversity Offset framework, which is due for release in mid-2014, as a result of impacts to matters of state environmental significance.
- Offsets may be required under the EPBC Act Environmental Offsets Policy if the Project is determined to be a controlled action.
- Minor diversions of Traveston Creek and Kybong Creek to accommodate crossing structures in these locations and associated approval requirements under the *Water Act 2000* and the *Fisheries Act 1994*.
- Water quality impacts resulting from erosion and sedimentation of waterways during construction.
- Rehabilitation of properties acquired by TMR, particularly where industrial activities such as wood chipping have been conducted.

Several positive environmental outcomes were achieved during as a result of the environmental assessment process, including the amendment of the Strategic Planning Alignment resulting in a reduced impact on remnant vegetation, listed flora species, habitat for listed fauna species, and the requirement to divert up to 1.2 kilometres of Jackass Creek.

Cultural heritage aspects of this report have been prepared by TMR and have been included in **Chapter 15**.

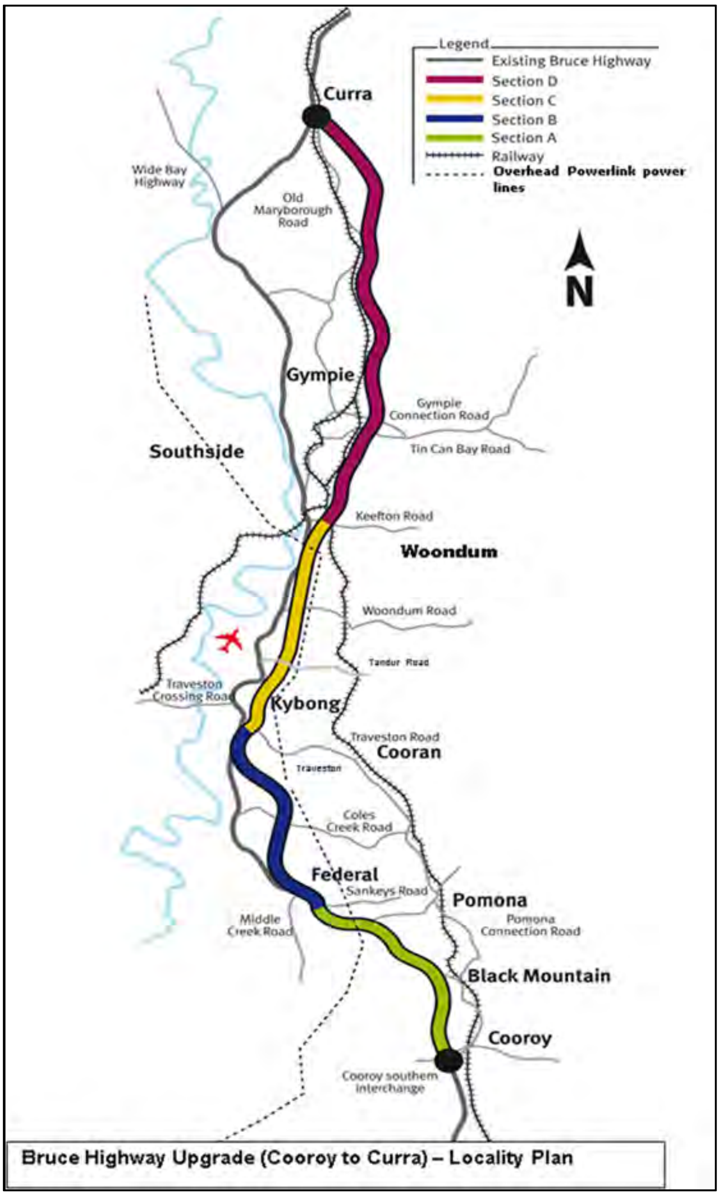
1. Introduction

1.1 Project Background

The Bruce Highway has been progressively upgraded north of Brisbane in response to increasing traffic volumes, higher freight demands and population growth. Today, the highway comprises six-lanes extending north from the Pine River to Caboolture, with four-lanes continuing to Cooroy. The Bruce Highway from Cooroy to Curra generally consists of a two-lane, two-way road in rolling and hilly terrain. There are direct property accesses onto the highway, at-grade intersections and limited safe overtaking opportunities. Major deficiencies exist in the current highway which creates significant safety concerns and prevents the road from functioning effectively as a national highway.

To address this, TMR is currently undertaking the Bruce Highway Upgrade project which involves a 61 kilometre upgrade and realignment from Cooroy to Curra (refer to **Figure 1-1**).

Figure 1-1: Project locality plan and regional setting.



The Bruce Highway upgrade is one of Queensland's highest priority road projects and aims to provide an effective transport link as part of the national highway network with a focus on separating long distance and local traffic movements. This will allow the highway to function as a high capacity transport link for inter-regional movements, particularly freight.

The overall Cooroy to Curra project (Sections A to D) is being delivered in four defined sections as shown in **Table 1-1.**

Table 1-1: Bruce Highway Cooroy to Curra project sections and status.

Section	Description	Status
Section A	Cooroy southern interchange to Sankeys Road Length: approximately 12.5 kilometres.	Construction commenced in 2013.
Section B	Sankeys Road to Traveston Road (approximately 11 kilometres)	Opened to traffic in October 2012.
Section C	Traveston Road to Keefton Road Length: approximately 11.5 kilometres.	PE completed in June 2012. Infrastructure Investment Committee (IIC) approved the commencement of the Business Case (BC) in February 2013. The BC commenced in March 2013.
Section D	Keefton Road to Curra (Gympie bypass) Length: approximately 26 kilometres.	Strategic Assessment of Service Requirements (SASR) finalised in June 2011.

1.2 Need for the Project

1.2.1 Government Commitment

In 2008 the federal government committed $200m toward planning, design and land acquisition for Sections A, C and D of the project, with a further $388m contributed by the federal government toward the final construction cost of Section B (Sankeys Road to Traveston Road).

In early 2012, the Queensland Government announced a commitment to allocate an additional $1B in state funding over the next ten years to fast-track improvements to the Bruce Highway, including safety and flood immunity among the priorities under the Bruce Highway Action Plan (BHAP). The allocation was conditional on the Australian Government providing matching funding to improve this critical component of the National Land Transport Network.

1.2.2 Bruce Highway Action Plan

The Bruce Highway Action Plan (BHAP) is designed to implement a generational upgrade in the condition of the Bruce Highway and to meet acceptable Australian standards commensurate with this strategic piece of public infrastructure. Deterioration on this part of the National Highway has compounded over many years and has led to the need for a significant investment to fix the Bruce Highway; thereby saving lives, addressing many areas of preventable flooding and creating improved capacity and travel time reliability for road users.

The Queensland Government has responded to community alarm over the condition and operation of the Bruce Highway with an objective to 'Fix the Bruce Highway'. This objective focuses on the three priority areas:

- **Safety improvements** – implementing appropriate safety standards and specific treatments of sections with poor safety ratings and undertaking critical maintenance.
- **Flooding improvements** – reducing flood impacts for highway sections and connections to cities.

- **Capacity improvements** – enhancing or making better use of infrastructure to overcome persistent congestion problems.

The overall Cooroy to Curra Project is also consistent with the following strategic planning documents:

- Nation Building Program (formerly AusLink)
- South East Queensland Regional Plan
- Roads Connecting Queenslanders
- South East Queensland Infrastructure Plan and Program
- Main Roads Strategic Plan

Further consideration of the Project in relation to these documents is provided in the Business Case Report.

1.3 Project Objectives

The following Project objectives were identified during the Preliminary Evaluation and approved by the project Steering Committee:

- Provide a roadway of sufficient standard, capacity and flexibility to meet future road user requirements.
- Improve safety along the corridor for all roads users with provision of a national highway that complies with contemporary operational and design standards.
- Provide an efficient roadway that enhances road network function.
- Provide appropriate connectivity (free-flowing) that in particular meets the needs of broader regional freight movements.
- Minimise disruption through closures and delay by adhering to acceptable flood immunity standards to enhance network resilience.
- Enhance the amenity and liveability of local communities and adjacent land users through design and amelioration treatments and the removal of unwanted traffic intrusions into local urban areas.
- Encourage the use of alternate transport modes.
- Provide enhanced local connectivity and accessibility to support social inclusion within the local community.
- Provide improved capacity and efficiency of the road freight network to contribute to Queensland's continued economic growth (prosperity) in south-east Queensland.
- Mitigate and/or manage any negative environmental impacts along the motorway corridor.

The primary objectives of the REF and supporting technical studies were to:

- Identify risks associated with environmental impacts and associated regulatory requirements.
- Inform the design team of environmental constraints relevant to the Project.
- Facilitate elimination or mitigation of environmental impacts.

1.4 Project Scope

The REF is based on the engineering drawings located in **Appendix A**. The scope of the Project is defined in **Chapter 2 – Project Description**.

1.4.1 Scope of Engineering Design

The engineering design used to assess environmental impacts was developed for the purpose of informing the Business Case. This design will be further refined during the Preliminary and Detailed Design phases.

1.4.2 Scope of the Environmental Assessment

The environmental assessment contained within the REF included desktop and field surveys of relevant environmental aspects. The level of assessment was consistent with the level of risk identified for each environmental aspect in the initial REF Checklist (**Appendix B**).

The environmental aspects considered to represent the greatest environmental risk to the Project were:

- Terrestrial and aquatic ecology.
- Soils and erosion.
- Water quality.
- Surface water hydrology.
- Cultural heritage.

The environmental assessment contained within this REF includes a detailed assessment of these aspects. Information relating to cultural heritage was prepared by TMR.

The TMR *Road Project Environmental Processes Manual*, *2004* (RPEPM) was current at the time of Project initiation and for the majority of technical studies and reporting. This Manual was superseded by the TMR *Environmental Processes Manual* in August 2013. Subsequently, the REF has been conducted in accordance with the requirements of the RPEPM.

1.5 Purpose of the Review of Environmental Factors

Completion of an adequate REF fulfils the requirement contained within section 25 of the State Development and Public Works Organisation Act 1971 which requires that that proper account is taken of the environmental effects of any development. Compliance with this requirement can be demonstrated by following the relevant TMR environmental processes.

1.6 Community Engagement

Community engagement in the form of information and consultation has been conducted for the revisions to the approved "Recommended Corridor - Strategic Planning 2008". This engagement covered the following items:

- The revised alternative western alignment between Tandur Road and Woondum Road (**Sections 2.3** and **2.10.2.3**)
- The revised Woondum interchange location and layout (**Section 2.6.4**)
- The inclusion of the proposed 'left in - left out' treatment through the Keefton Road intersection (**Section 2.6.5**).

The engagement included directly affected landowners including those affected by land resumption and access alteration and those with commercial interests that will be affected. These stakeholders recognise the benefits of these revisions, even though some are adversely affected.

All levels of government including the Local Authority, State member (David Gibson MP) and federal member (Warren Truss MP Minister for Infrastructure and Regional Development) were included in this consultation and acknowledged the benefits of the revisions to the Strategic Planning. All have been advised of the outcomes of the community engagement.

This community engagement has shown an overall acceptance in the community of the revisions to the strategic planning.

2. Project Description

The purpose of this chapter is to describe the Project, its main components and the options considered. The assessment of environmental impacts contained within the Review of Environmental Factors (REF) is based on this Project Description.

2.1 Project Location

The Project is located in TMR's Wide Bay – Burnett Region within the Gympie Regional Council Local Government Area approximately 160 kilometres north of Brisbane (refer to **Figure 2-1**).

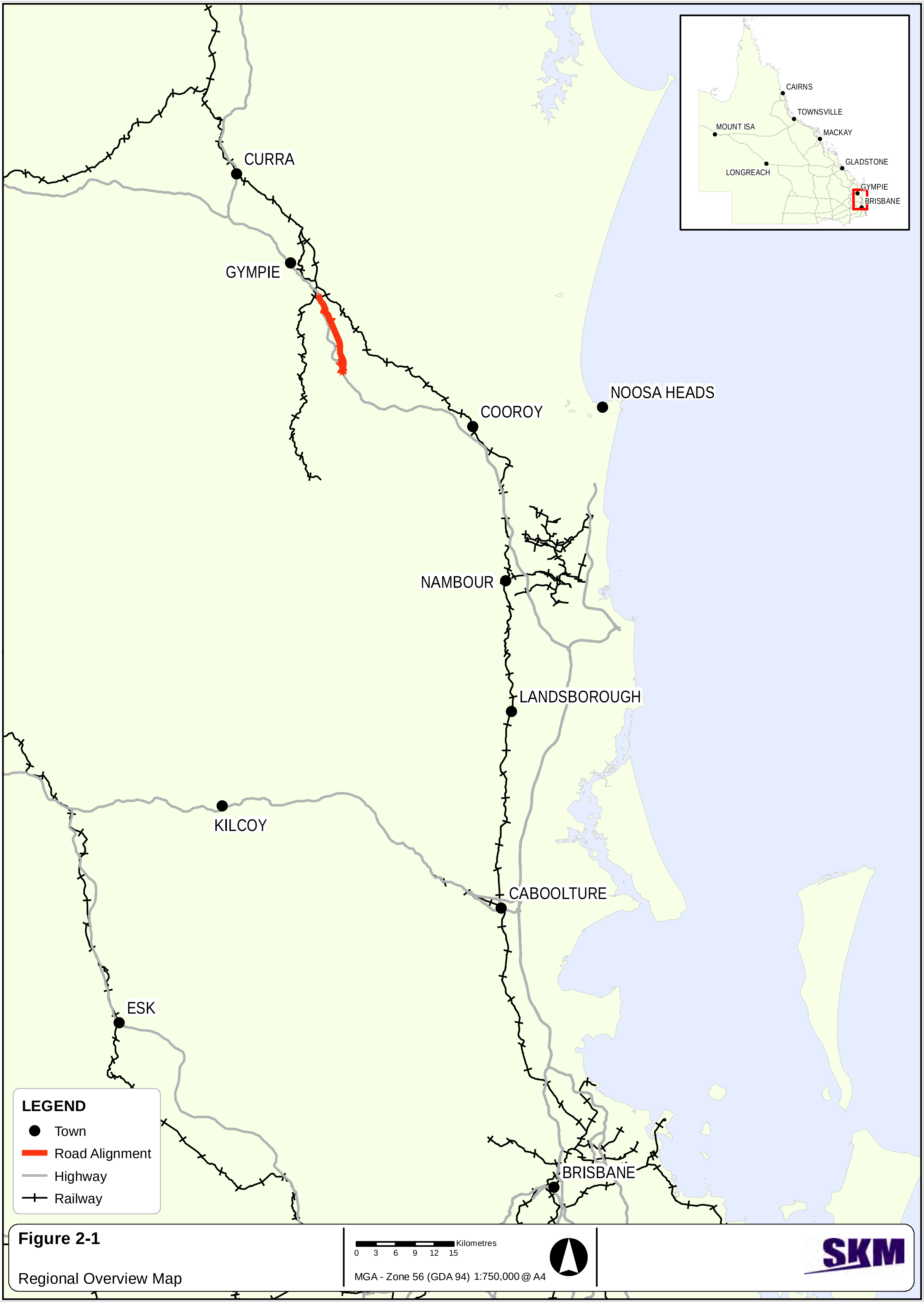


Figure 2-1

Regional Overview Map

2.2 General Description

The Project is comprised of a realignment of the Bruce Highway between the Traveston Interchange at the end of Section B, and the proposed Woondum Interchange north of Woondum Road. The Project also includes an upgrade to the existing Bruce Highway up to the approach to the Six Mile Creek bridge.

The proposed alignment runs parallel to the existing high voltage transmission line easement and crosses Traveston Creek, Kybong Creek, Cobb's Gully, Gresham Road and Jackass Creek, and a number of small drainage lines, before crossing Woondum Road and connecting with the Woondum Interchange.

The proposed alignment and key elements are shown in **Figure 2-2A** to **Figure 2-2D** and described further in **Section 2.3**.

LEGEND

- BRIDGE STRUCTURE
- BOX CULVERT STRUCTURE
- CONCRETE ARCH STRUCTURE
- PROJECT DEFINITION EXTENTS

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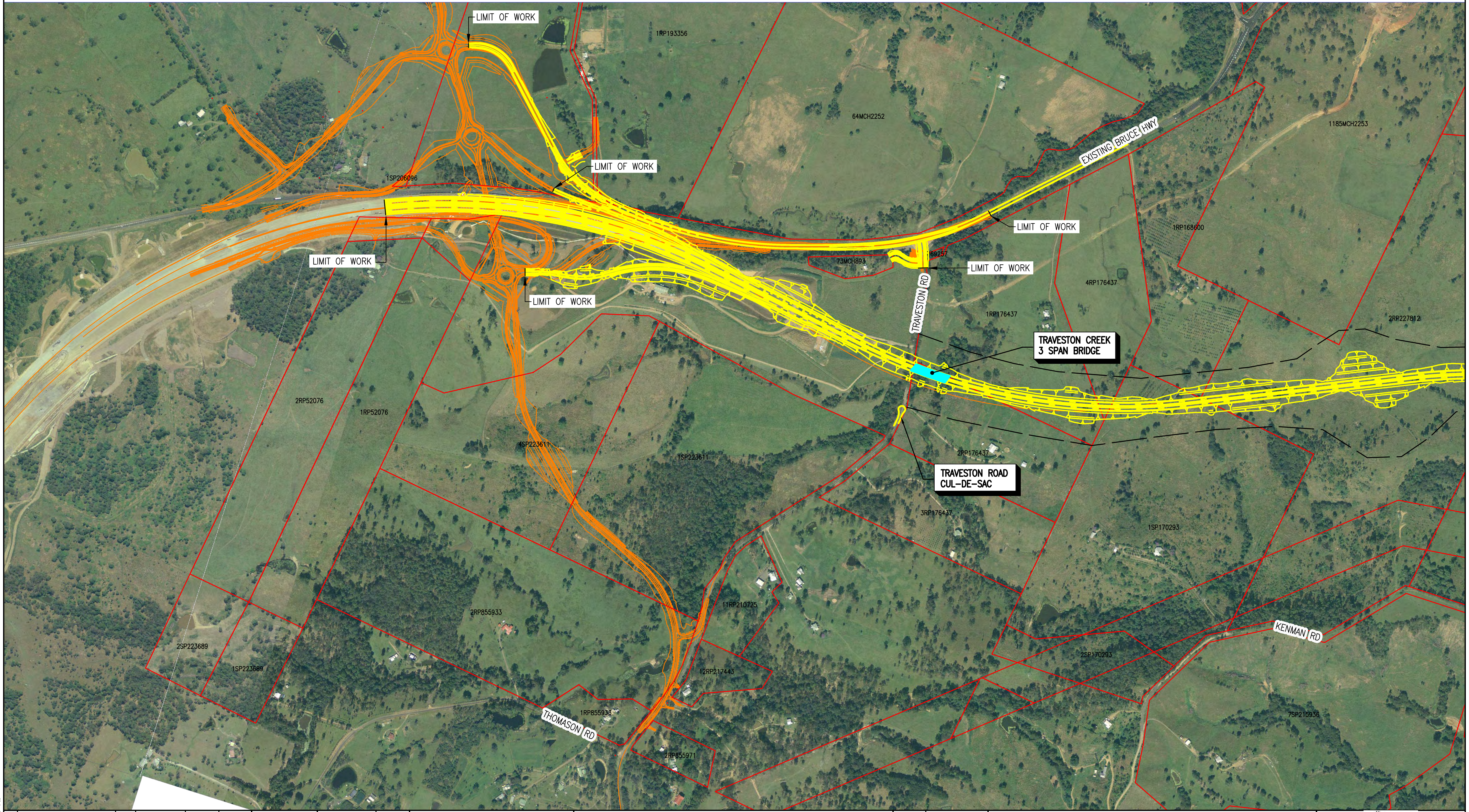

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Auxiliary Drg Nos	

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Dimensions shown in metres except where shown otherwise

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Reference Points				
Preceding RP	Dist. to start of job (km)	From start to end of job	From end to Following RP	Following RP

Through Chainage from Brisbane 125.24km to 137.20km

Drawn	RRL
Checked	
Designed	MRG
Verified	
Design Reviews (RPEQ)	
No.	Date. / /

FIGURE 2–2A: PROPOSED ALIGNMENT AND KEY PROJECT ELEMENTS

ENGINEERING CERTIFICATION (RPEQ)				
ENG. AREA	NAME	SIGNATURE	NO.	DATE
CIVIL				

For scheme approval status refer Drg. No. (of)

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Job No.	232/10A/2
Contract. No.	
Drawing No.	SK–0035 P1
Series Number	1 of 4

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LEGEND

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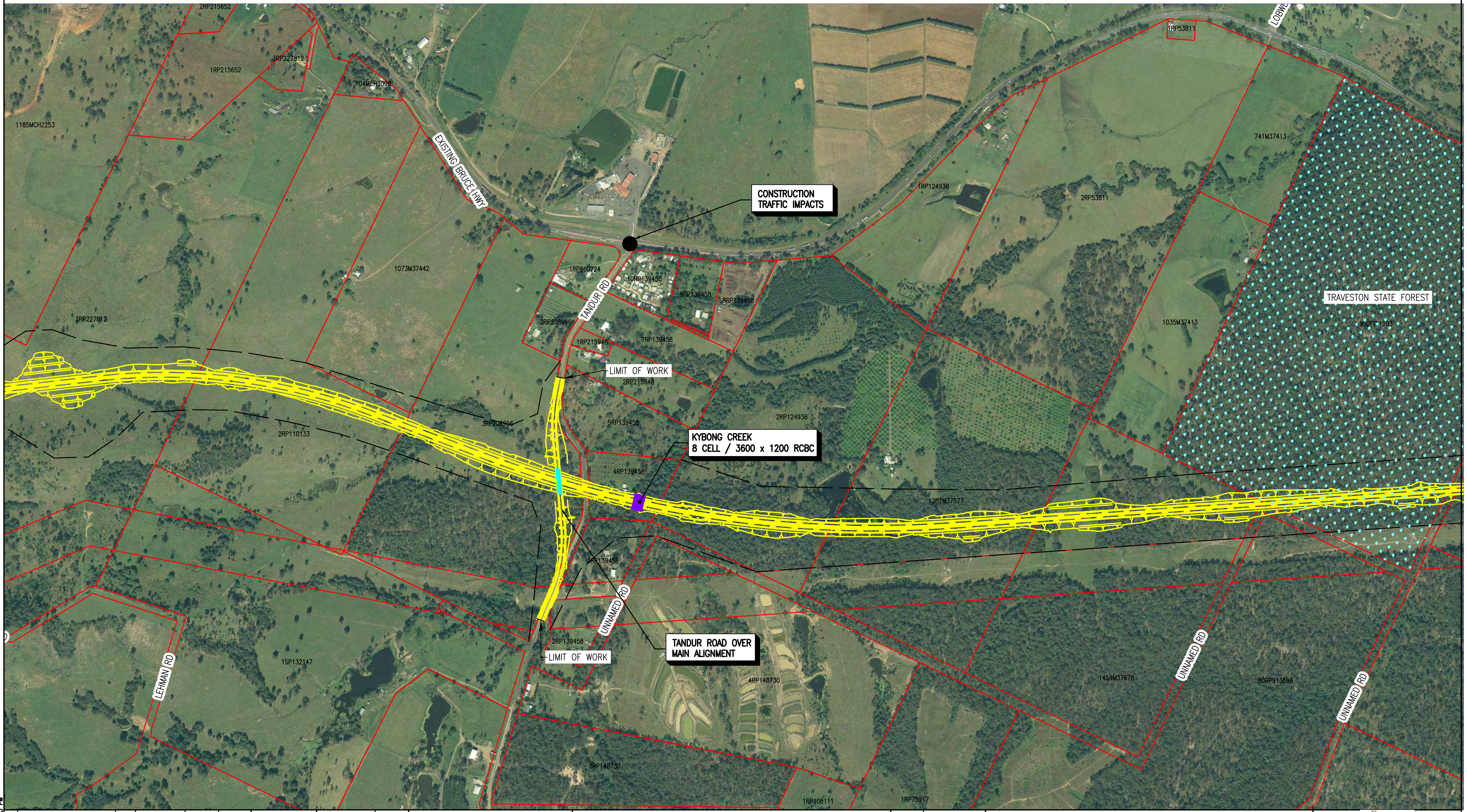

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Reference Points

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Through Chainage from Brisbane 125.24km to 137.20km

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Designed	MRG
Verified	

Design Reviews (RPEQ)
No. Date. / /

FIGURE 2–2B: PROPOSED ALIGNMENT AND KEY PROJECT ELEMENTS

ENGINEERING CERTIFICATION (RPEQ)

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Series Number	2 of 4

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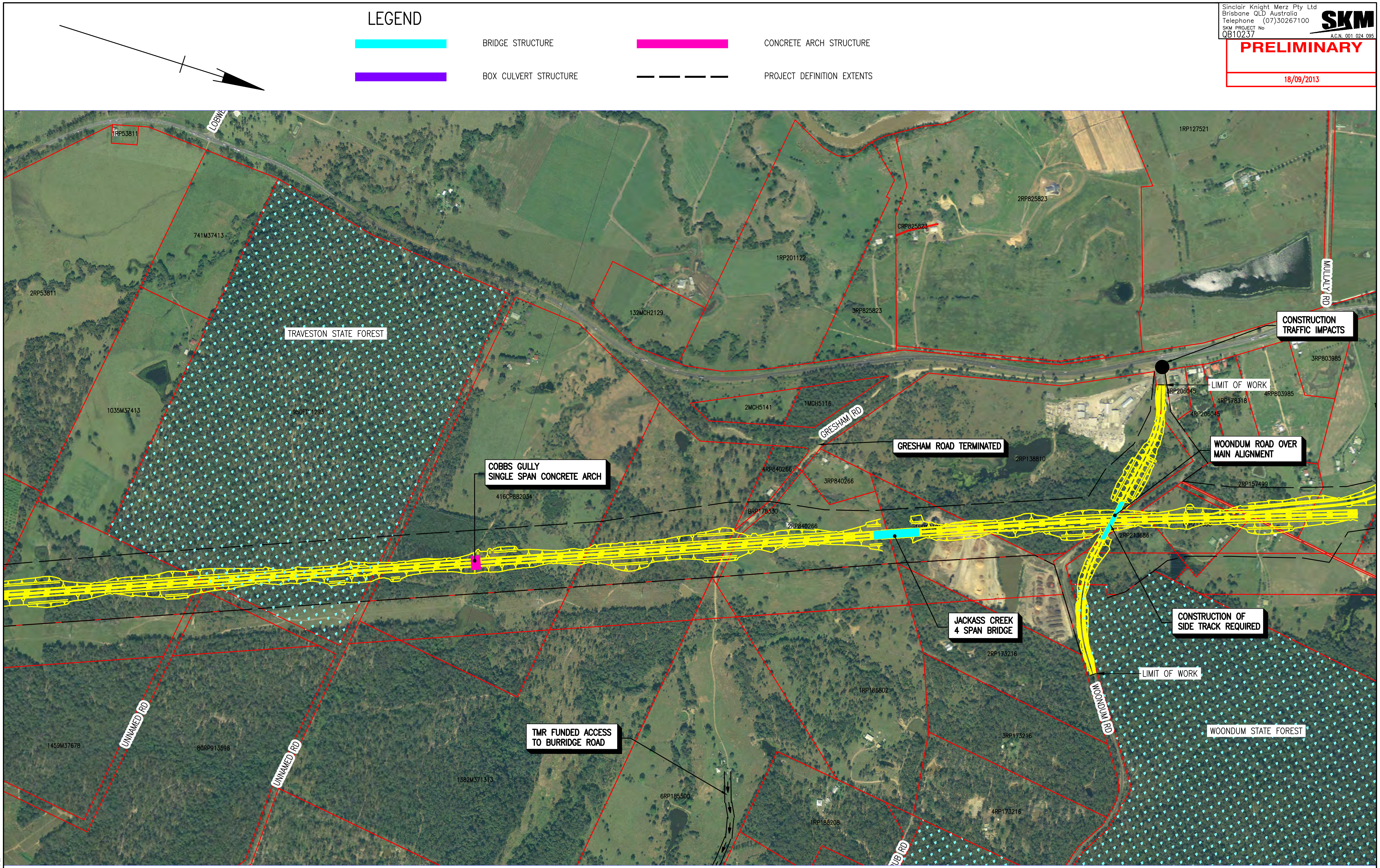

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Reference Points

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Through Chainage from Brisbane 125.24km to 137.20km

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Designed	MRG
Verified	
Design Reviews (RPEQ)	
No.	Date. / /

FIGURE 2–2C: PROPOSED ALIGNMENT AND KEY PROJECT ELEMENTS

ENGINEERING CERTIFICATION (RPEQ)

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CIVIL				

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LEGEND

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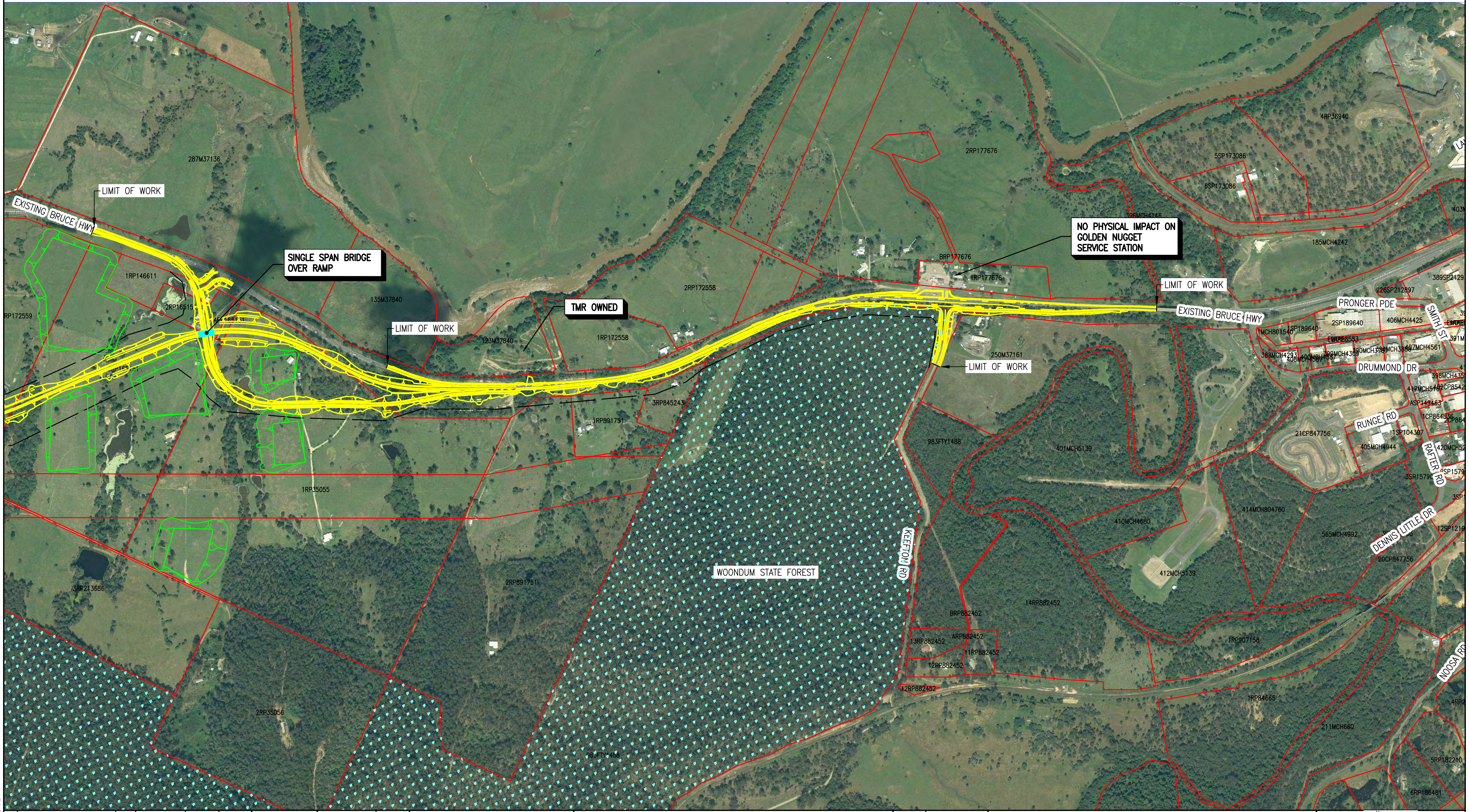

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Designed	MRG
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Design Reviews (RPEQ)	
No.	Date. / /

FIGURE 2–2D: PROPOSED ALIGNMENT AND KEY PROJECT ELEMENTS

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Transport and Main Roads

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Contract. No.	
Drawing No.	SK–0038 P1
Series Number	4 of 4

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2.3 Key Elements of the Project

The key elements of the Project include:

- Northbound and southbound ramps connecting from the proposed alignment to the existing roundabouts at the Traveston Road Interchange. Includes minor realignment to provide direct local access from the western most roundabout at the interchange to the existing Bruce Highway.
- 8.4 kilometres of six lane formation to accommodate four lanes of pavement and a central concrete barrier from Traveston Road Interchange to the proposed Woondum Road overpass.
- 2.3 kilometres of single carriageway from the proposed Woondum Road overpass to connect to the existing Bruce Highway.
- 1.7 kilometres of upgrade of the existing Bruce Highway to the southern approach of the existing Six Mile Creek bridge.
- Removal of access across the alignment at Traveston Road by provision of a cul-de-sac on the eastern side and provision of local road access on the western side of the alignment.
- A 90 metre, four lane, three-span bridge of approximately 12 metres height over Traveston Creek requiring realignment of approximately 240 metres of Traveston Creek, and the associated stabilisation of the realigned waterway.
- A 60 metre, two lane, two span overpass for Tandur Road and realignment of approximately 700 metres of Tandur Road to the south.
- An eight cell reinforced concrete box culvert (RCBC) over Kybong Creek requiring realignment of approximately 120 metres of Kybong Creek, and the associated stabilisation of the realigned waterway.
- A 21 metre long, 7 metre high single span concrete arch over Cobbs Gully.
- Termination of Gresham Road at the proposed western boundary of the alignment. Alternative access for the resident east of the alignment on Gresham Road has been provided by TMR and is outside of the scope of this Project.
- A 120 metre, four lane, four span bridge of approximately 18 metres height over Jackass Creek.
- A 120 metre, two lane, four span overpass for Woondum Road and realignment of approximately 900 metres of Woondum Road.
- A grade separation of the existing Bruce Highway by providing a 35 metres, 2 lane, single span bridge over a new southbound exit ramp. A northbound entry ramp is provided from the existing Bruce Highway.
- An upgrade of the existing Bruce Highway including an upgrade of Keefton Road intersection and access to the existing Caltex Service Station with realignment of approximately 200 metres of Keefton Road.
- Minor road works to maintain or establish access to properties impacted by the Project.

2.4 Sensitive Receptors

Sensitive receptors are defined in the *Environmental Protection (Noise) Policy 2008* (EPP (Noise)) as any of the following:

- Dwelling.
- Library and educational institution (including a school, college and university).
- Childcare centre or kindergarten.
- School or playground.
- Hospital, surgery or other medical institution.
- Commercial and retail activity.

- Protected area, or an area identified under a conservation plan under the *Nature Conservation Act 1992* (NC Act) as a critical habitat or an area of major interest.
- Marine park under the *Marine Parks Act 2004.*
- Park or garden that is open to the public (whether or not on payment of an amount) for use other than for sport or organised entertainment.

In addition, the Main Roads Technical Standard MRTS51 – Environmental Management defines a 'vibration sensitive receptor' as:

- Any structure or sensitive equipment (above or below ground) susceptible to damage or person subject / susceptible to discomfort caused by vibration.

Sensitive receptors in the vicinity of the Project and associated works are shown in **Figure 2-3A** to **Figure 2-3D** and property details are listed in **Appendix C**.

P1	PRELIMINARY				
Revisions/Descriptions		Ref	Certification	Date	Microfiled

Associated Job Nos

Auxiliary Drg Nos

SURVEY DATA	
Horiz. Grid	MGA94 ZONE 56
Height Origin	AHD (Derived)
Survey Books	

Scales

1:5000 (A1)
1:10000 (A3)

0 50 100 150 200m

Dimensions shown in metres except where shown otherwise

GYMPIE REGION

BRUCE HIGHWAY (BRISBANE – GYMPIE)

CTL CHGE

Reference Points				
Preceding RP	Dist. to start of job (km)	From start to end of job	From end to Following RP	Following RP

Through Chainage from Brisbane 125.24km to 137.20km

Drawn	RRL
Checked	
Designed	MRG
Verified	

Design Reviews (RPEQ)

No. Date. / /

FIGURE 2–3A: SENSITIVE RECEPTORS RELEVANT TO THE PROJECT

ENGINEERING CERTIFICATION (RPEQ)

ENG. AREA	NAME	SIGNATURE	NO.	DATE
CIVIL				

For scheme approval status refer Drg. No. (of)

Queensland Government

Transport and Main Roads

Job No.	232/10A/2
Contract. No.	
Drawing No.	SK-0014 P1
Series Number	1 of 1

MRR_Detail (01/10)

CAD FILES C:\users\bthorne\appdata\local\projectwise\qld_main_roads\dms00892\QB10237-2030-ECC-SK-0014.dwg

Last Modified :- 26/09/2013 11:57:39 AM

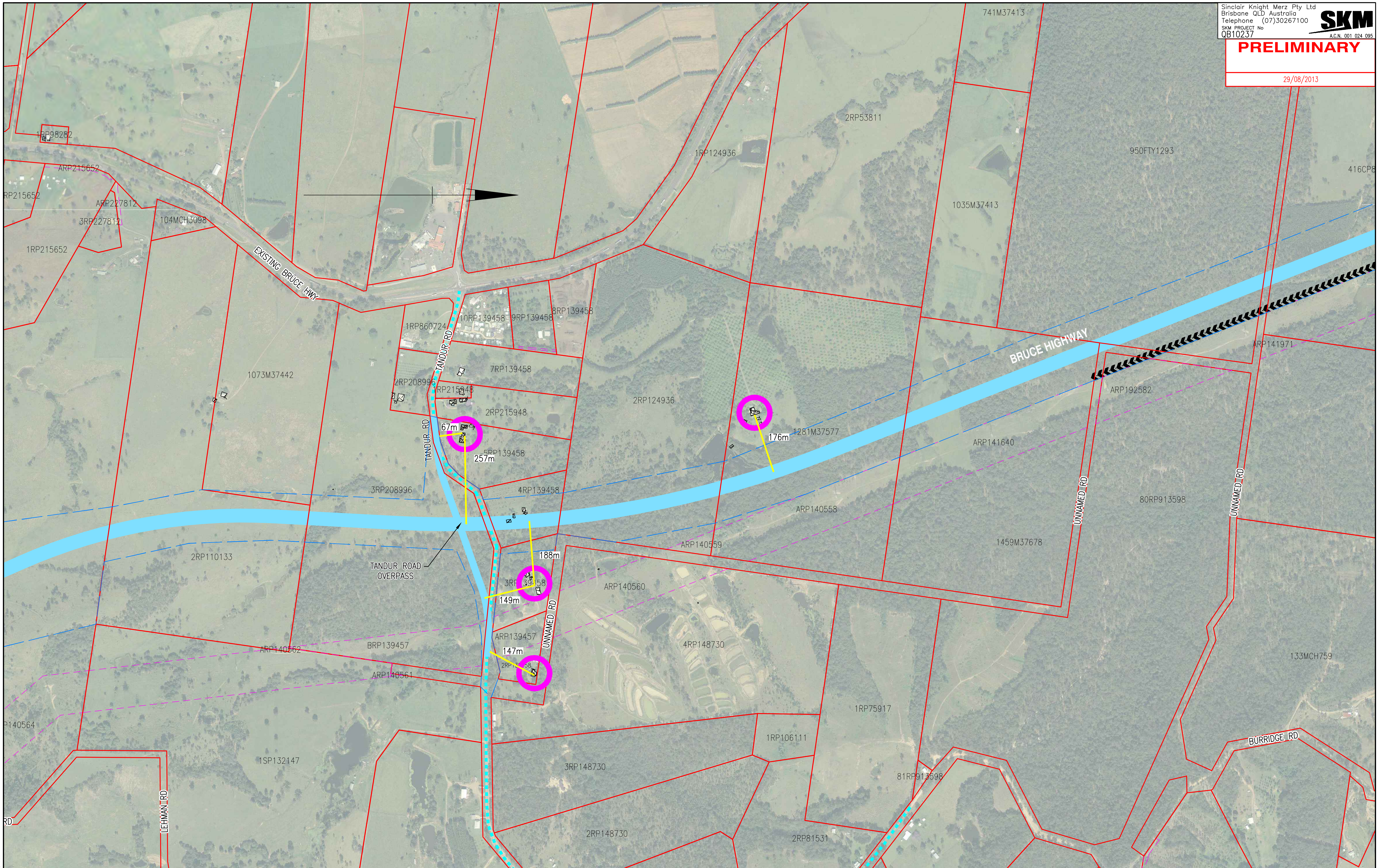

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FIGURE 2-3B: SENSITIVE RECEPTORS RELEVANT TO THE PROJECT

GYMPIE REGION

BRUCE HIGHWAY (BRISBANE – GYMPIE)

CTL CHGE

Reference Points				
Preceding RP	Dist. to start of job (km)	From start to end of job	From end to Following RP	Following RP

Through Chainage from Brisbane 125.24km to 137.20km

Drawn	RRL
Checked	
Designed	MRG
Verified	
Design Reviews (RPEQ)	
No.	Date. / /

ENGINEERING CERTIFICATION (RPEQ)				
ENG. AREA	NAME	SIGNATURE	NO.	DATE
CIVIL				

For scheme approval status refer Drg. No. (of)

Transport and Main Roads

Job No.	232/10A/2
Contract. No.	
Drawing No.	SK-0015 P1
Series Number	1 of 1

MRR_Detail (01/10)

Associated Job Nos

Auxiliary Drg Nos

SURVEY DATA	
Horiz. Grid	MGA94 ZONE 56
Height Origin	AHD (Derived)
Survey Books	

Scales
1:5000 (A1) 1:10000 (A3)
0 50 100 150 200m

Dimensions shown in metres except where shown otherwise

P1	PRELIMINARY				
Revisions/Descriptions		Ref	Certification	Date	Microfied

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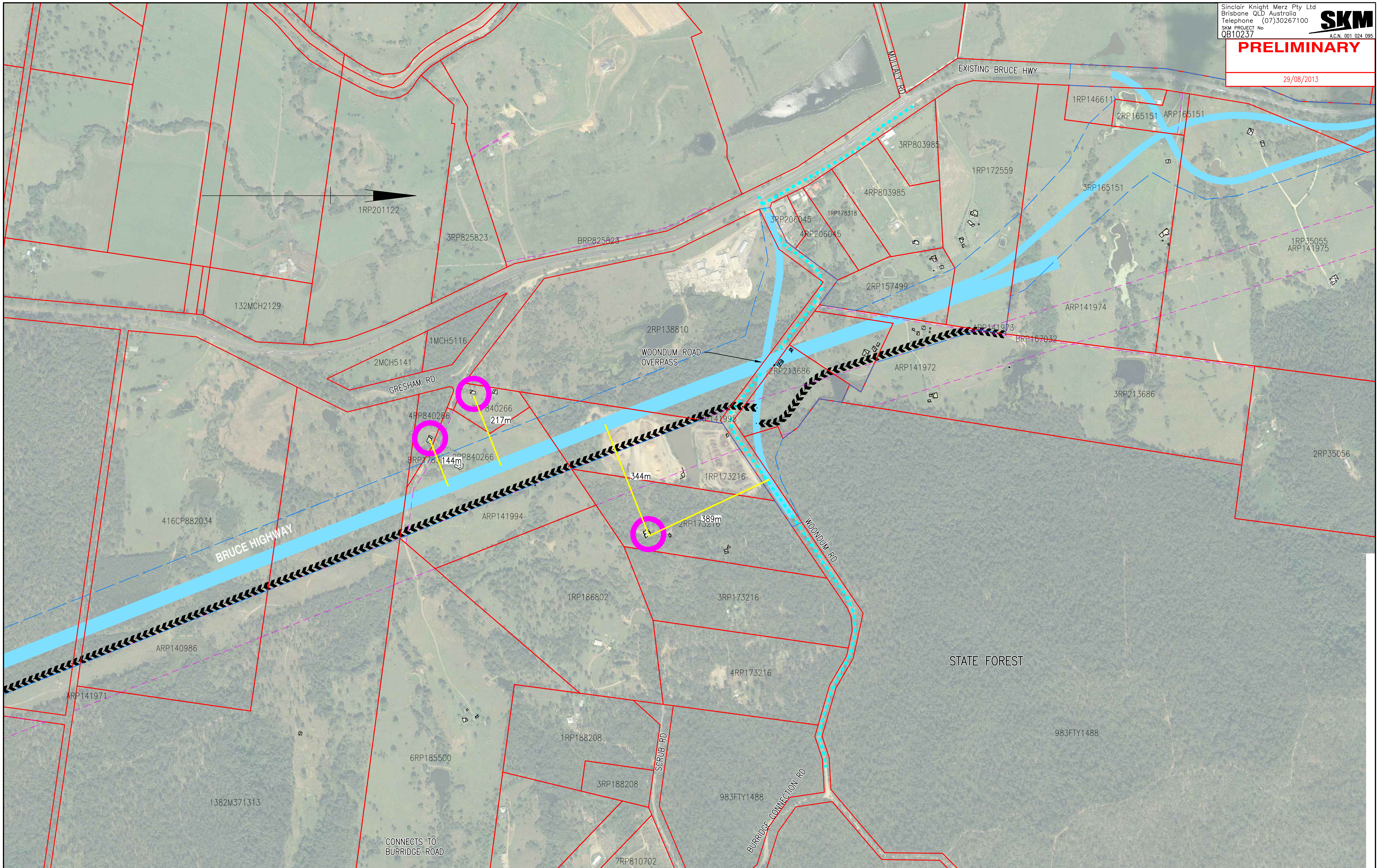
Last Modified :- 26/09/2013 11:57:05 AM



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P1	PRELIMINARY					
	Revisions/Descriptions	Ref	Certification	Date	Microfied	

Associated Job Nos

Auxiliary Drg Nos

SURVEY DATA	
Horiz. Grid	MGA94 ZONE 56
Height Origin	AHD (Derived)
Survey Books	

Scales

1:5000 (A1) 1:10000 (A3)

0 50 100 150 200m

Dimensions shown in metres except where shown otherwise

GYMPIE REGION

BRUCE HIGHWAY (BRISBANE – GYMPIE)

CTL CHGE

Reference Points

Preceding RP	Dist. to start of job (km)	From start to end of job	From end to Following RP	Following RP

Through Chainage from Brisbane 125.24km to 137.20km

Drawn	RRL
Checked	
Designed	MRG
Verified	
Design Reviews (RPEQ)	

No. Date. / /

FIGURE 2–3C: SENSITIVE RECEPTORS RELEVANT TO THE PROJECT

ENGINEERING CERTIFICATION (RPEQ)

ENG. AREA	NAME	SIGNATURE	NO.	DATE
CIVIL				

For scheme approval status refer Drg. No. (of)

Queensland Government

Transport and Main Roads

Job No.	232/10A/2
Contract. No.	
Drawing No.	SK–0016 P1
Series Number	1 of 1

MRR_Detail (01/10)

CAD FILES C:\users\bthorne\appdata\local\projectwise\qld_main_roads\dms00892\QB10237-2030-ECC-SK-0016.dwg

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29/08/2013

Revisions/Descriptions	Ref	Certification	Date	Microfiled
P1 PRELIMINARY				

CAD FILES C:\users\bthorne\appdata\local\projectwise\qld_main_roads\dms00892\QB10237-2030-ECC-SK-0017.dwg

Associated Job Nos

Auxiliary Drg Nos

SURVEY DATA

Horiz. Grid	MGA94 ZONE 56
Height Origin	AHD (Derived)
Survey Books	

Scales
1:5000 (A1) 1:10000 (A3) 0 50 100 150 200m

Dimensions shown in metres except where shown otherwise

GYMPIE REGION

BRUCE HIGHWAY (BRISBANE – GYMPIE)

CTL CHGE

Reference Points

Preceding RP	Dist. to start of job (km)	From start to end of job	From end to Following RP	Following RP

Through Chainage from Brisbane 125.24km to 137.20km

Drawn	RRL
Checked	
Designed	MRG
Verified	

Design Reviews (RPEQ)

No. Date. / /

FIGURE 2–3D: SENSITIVE RECEPTORS RELEVANT TO THE PROJECT

ENGINEERING CERTIFICATION (RPEQ)

ENG. AREA	NAME	SIGNATURE	NO.	DATE
CIVIL				

For scheme approval status refer Drg. No. (of)

Queensland Government

Transport and Main Roads

Job No.	232/10A/2
Contract. No.	
Drawing No.	SK–0017 P1
Series Number	1 of 1

MRR_Detail (01/10)

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2.5 Waterway Structures

A number of structures will be required to cross the waterways and drainage lines intersected by the Project. This section details the crossing structures to be provided at the main waterway crossings impacted by the Project:

- Traveston Creek (approximate chainage 126840).
- Kybong Creek (approximate chainage 129700).
- Cobbs Gully (approximate chainage 132220).
- Jackass Creek (approximate chainage 133460).

In addition to these main crossings, the Project will impact on several small drainage lines located along the alignment. Hydraulic analysis will be completed for each of these drainage lines to determine the most appropriate approach to managing drainage.

Selection of the most appropriate structures at the four main waterway crossings listed above was based on the analysis of options detailed in **Section 2.10.4**.

2.5.1 Traveston Creek

Traveston Creek is a permanent waterway with distinct banks bordering intact native riparian vegetation and cleared grazing land. The channel habitat is composed of a meandering run with wider and deeper pooled sections. It has two channels which merge into one directly upstream of the alignment, and there is a high degree of meandering where the creek crosses the alignment. The project crosses Traveston Creek approximately 2.6 kilometres upstream of its confluence with the Mary River.

It was not possible to provide a bridge span configuration that avoided impact to the existing low flow channel. The optimal design solution for the crossing structure, a three by 30 metre span bridge, provided a configuration that minimised the impact on this low flow channel. However, this option will require the removal of part of the low flow channel to accommodate the northern abutment and road approaches, resulting in the realignment of approximately 240 metres of Traveston Creek (refer to **Figure 2-4**).

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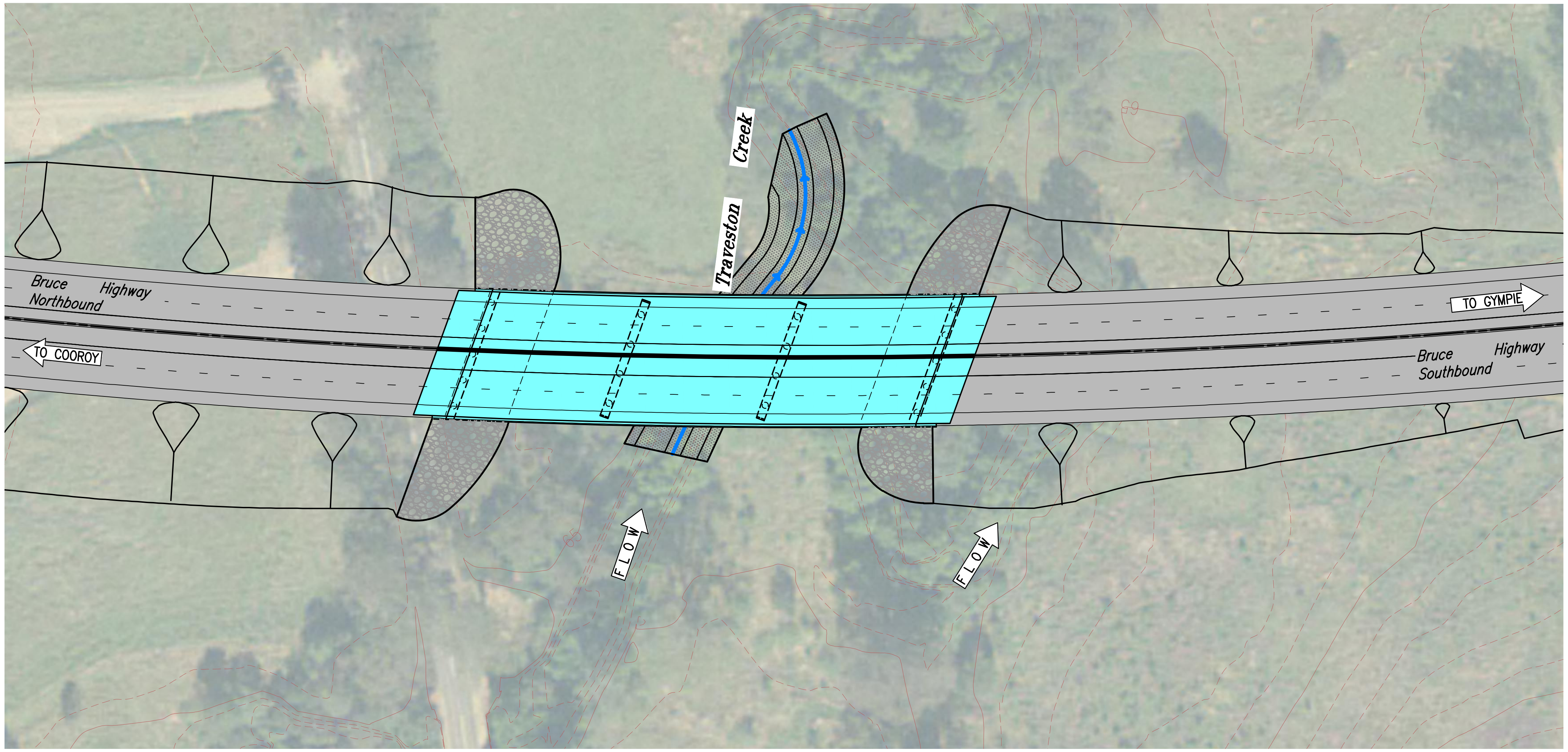
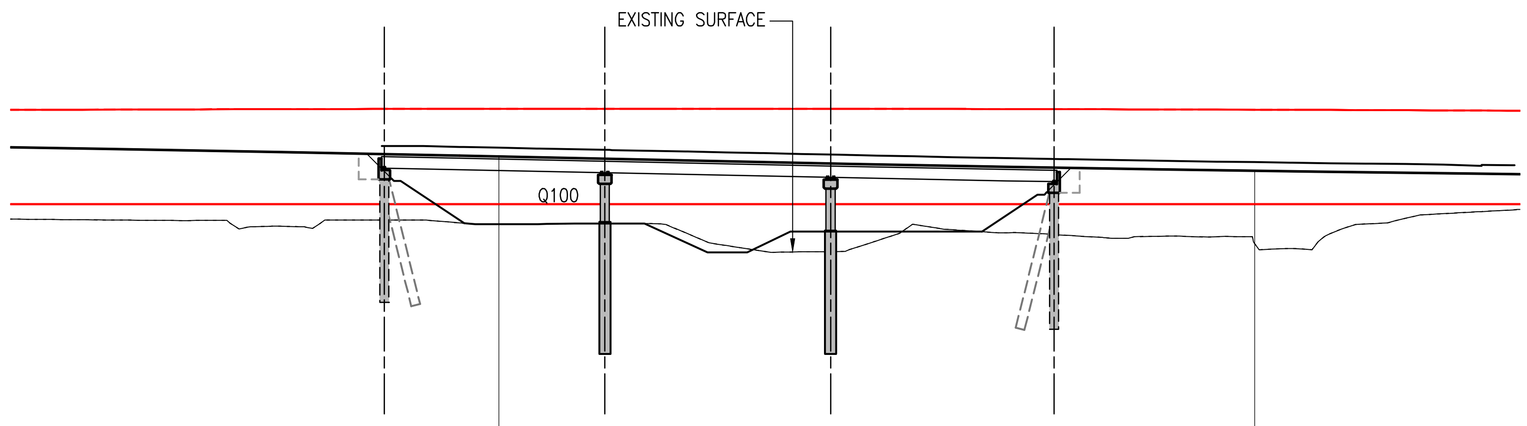


TRAVESTON CREEK BRIDGE



TRAVESTON CREEK BRIDGE – LONGITUDINAL SECTION

P1	PRELIMINARY			
	Revisions/Descriptions	Ref	Certification	Date	Microfied

Associated Job Nos
Auxiliary Drg Nos

SURVEY DATA
Horiz. Grid	MGA94 ZONE 56
Height Origin	AHD (Derived)
Survey Books	

Scales
1:500 (A1) 1:1000 (A3) 0 5 10 15 20m
Dimensions shown in metres except where shown otherwise

GYMPIE REGION
BRUCE HIGHWAY (BRISBANE – GYMPIE)
CTL CHGE

Reference Points
Preceding RP	Dist. to start of job (km)	From start to end of job	From end to Following RP	Following RP

Through Chainage from Brisbane 125.24km to 137.20km

Drawn	RRL
Checked	
Designed	MRG
Verified	
Design Reviews (RPEQ)	
No.	Date. / /

FIGURE 2–4: PROPOSED TRAVESTON CREEK CROSSING LOCATION, STRUCTURES AND REALIGNMENT WORKS

ENGINEERING CERTIFICATION (RPEQ)
ENG. AREA	NAME	SIGNATURE	NO.	DATE
CIVIL				

For scheme approval status refer Drg. No. (of)

Queensland Government
Transport and Main Roads
Job No.	232/10A/2
Contract. No.	
Drawing No.	SK–0005 P1
Series Number	1 of 4

MRR_Detail (01/10)

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2.5.2 Kybong Creek

Kybong Creek is a highly modified watercourse running through partly cleared native forest with pool habitats present and no continuous runs. The project crosses Kybong Creek approximately 3.7 kilometres upstream of its confluence with the Mary River.

The height of fill at Kybong Creek of approximately two metres determined the requirement for a culvert. An eight cell, 3600 mm long by 1200 mm high RCBC was selected as the most appropriate crossing and drainage structure at this location.

The morphology of Kybong Creek at the proposed crossing location is characterised by a crescent shaped meander bend which will require realignment of approximately 120 metres of the watercourse to accommodate the proposed RCBC (refer to **Figure 2-5**).

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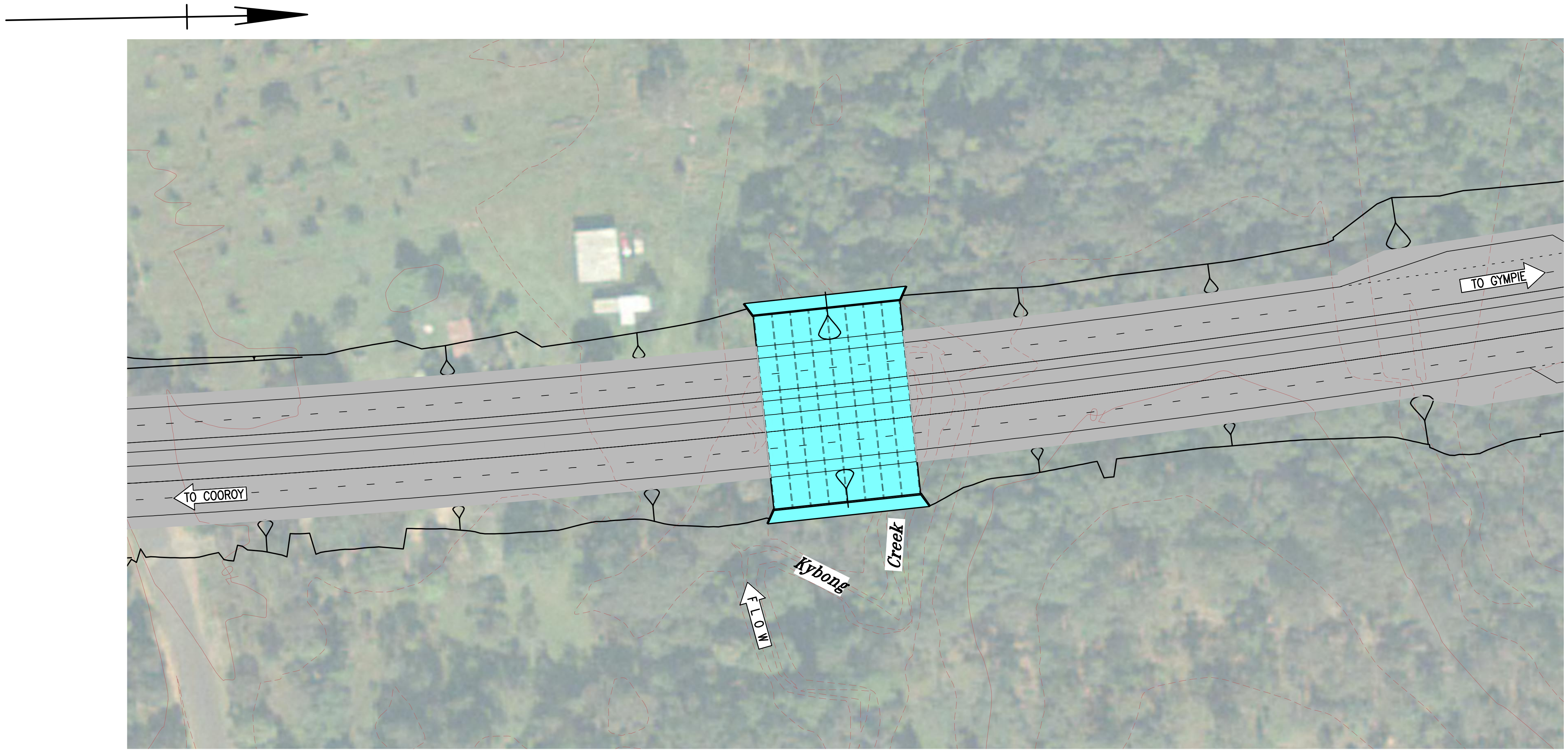

KYBONG CREEK

P1	PRELIMINARY			
	Revisions/Descriptions	Ref	Certification	Date	Microfied

Associated Job Nos

Auxiliary Drg Nos

SURVEY DATA

Horiz. Grid	MGA94 ZONE 56
Height Origin	AHD (Derived)
Survey Books	

Scales

1:500 (A1) 1:1000 (A3) 0 5 10 15 20m

SCALE A

Dimensions shown in metres except where shown otherwise

GYMPIE REGION

BRUCE HIGHWAY (BRISBANE – GYMPIE)

CTL CHGE

Reference Points

Preceding RP	Dist. to start of job (km)	From start to end of job	From end to Following RP	Following RP

Through Chainage from Brisbane 125.24km to 137.20km

Drawn	RRL
Checked	
Designed	MRG
Verified	

Design Reviews (RPEQ)

No. Date. / /

FIGURE 2–5: PROPOSED KYBONG CREEK CROSSING LOCATION, STRUCTURES AND REALIGNMENT WORKS

ENGINEERING CERTIFICATION (RPEQ)

ENG. AREA	NAME	SIGNATURE	NO.	DATE
CIVIL				

For scheme approval status refer Drg. No. (of)

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Job No.	232/10A/2
Contract. No.	
Drawing No.	SK–0006 P1
Series Number	2 of 4

MRR_Detail (01/10)

CAD FILES C:\Users\bthorne\AppData\Local\projectwise\qld_main_roads\dms00892\QB10237-2030-ECC-SK-0006.dwg

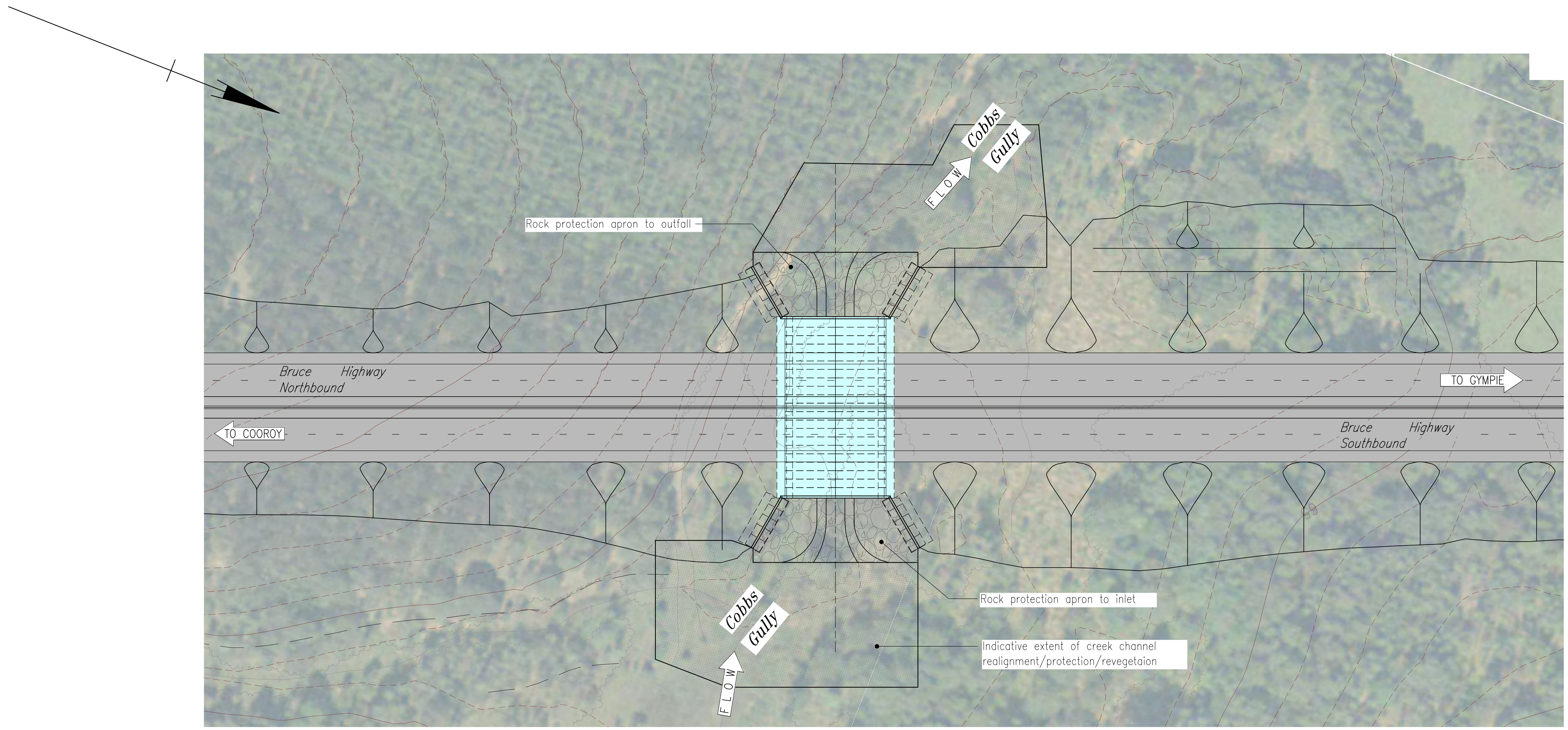
Last Modified :- 26/09/2013 11:32:16 AM

2.5.3 Cobbs Gully

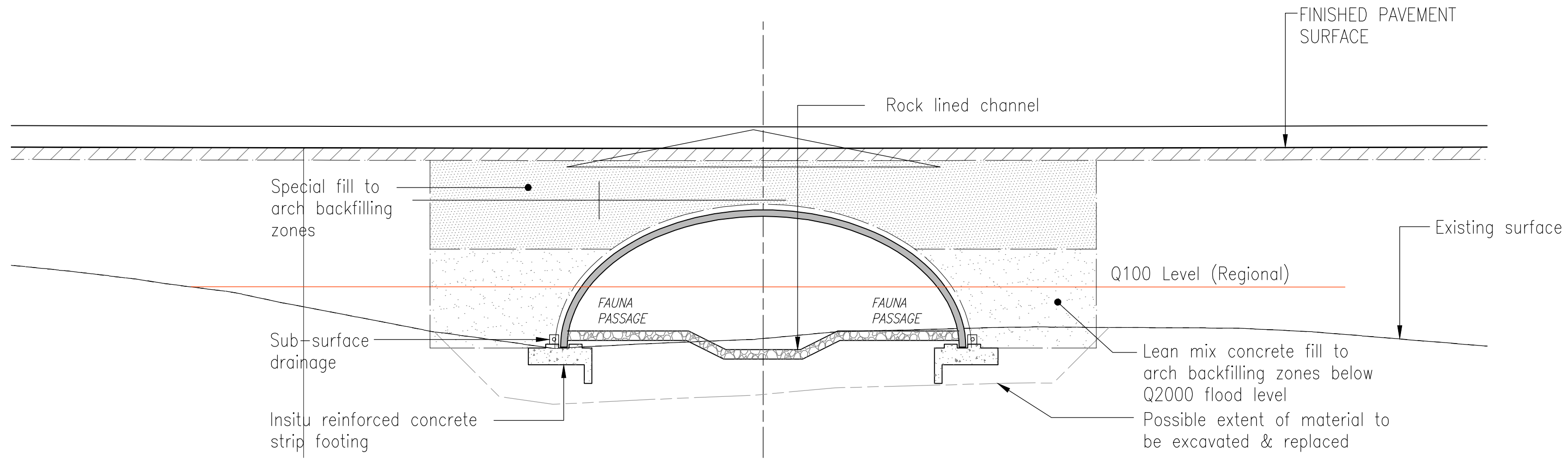
The Project alignment crosses Cobbs Gully approximately 1.6 kilometres upstream from its confluence with the Mary River. Cobbs Gully is a heavily modified, wide ephemeral drainage gully flowing through terrestrial and non-native vegetation.

A large manmade dam upstream of the proposed alignment contains significantly established aquatic fauna and a bund wall has diverted the natural flow path of the main channel. Downstream dams, channel modification and culverts under the existing Bruce Highway are a barrier to fish passage and have significantly simplified the upstream channel habitat.

A 21 metre span, 7 metre high reinforced concrete arch with a large elliptical opening that spans the low flow channel will be provided at this location (refer to **Figure 2-6**).



COBBS GULLY BRIDGE



COBBS GULLY CULVERT – LONGITUDINAL SECTION (MC01)

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P1	PRELIMINARY			
	Revisions/Descriptions	Ref	Certification	Date	Microfied

Associated Job Nos

Auxiliary Drg Nos

SURVEY DATA

Horiz. Grid	MGA94 ZONE 56
Height Origin	AHD (Derived)
Survey Books	

Scales

A (1:500 A1) 0 5 10 15 20m

Dimensions shown in metres except where shown otherwise

GYMPIE REGION

BRUCE HIGHWAY (BRISBANE – GYMPIE)

CTL CHGE

Reference Points

Preceding RP	Dist. to start of job (km)	From start to end of job	From end to Following RP	Following RP

Through Chainage from Brisbane 125.24km to 137.20km

Drawn	RRL
Checked	
Designed	MRG
Verified	
Design Reviews (RPEQ)	
No.	Date. / /

FIGURE 2–6: PROPOSED COBBS GULLY CROSSING LOCATION, STRUCTURES

ENGINEERING CERTIFICATION (RPEQ)

ENG. AREA	NAME	SIGNATURE	NO.	DATE
CIVIL				

For scheme approval status refer Drg. No. (of)

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Transport and Main Roads

Job No.	232/10A/2
Contract. No.	
Drawing No.	SK–0007 P1
Series Number	3 of 4

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2.5.4 Jackass Creek

The alignment crosses Jackass Creek approximately 1.6 kilometres upstream from its confluence with the Mary River. Jackass Creek is a permanent waterway with defined banks, running through mostly cleared land with abundant non-native ground cover. Downstream existing culverts under the Bruce Highway and Woondum Road, plus a large dam located downstream from the crossing location, are a barrier to fish passage and have significantly simplified the upstream channel habitat.

Due to the relatively straight alignment of the low flow channel and the steeper slopes to the channel a four by 30 metre span bridge is provided that spans the extents of the high flow channel (refer to **Figure 2-7**). Impacts to the bed and banks of Jackass Creek are likely to be restricted to construction phase activities.

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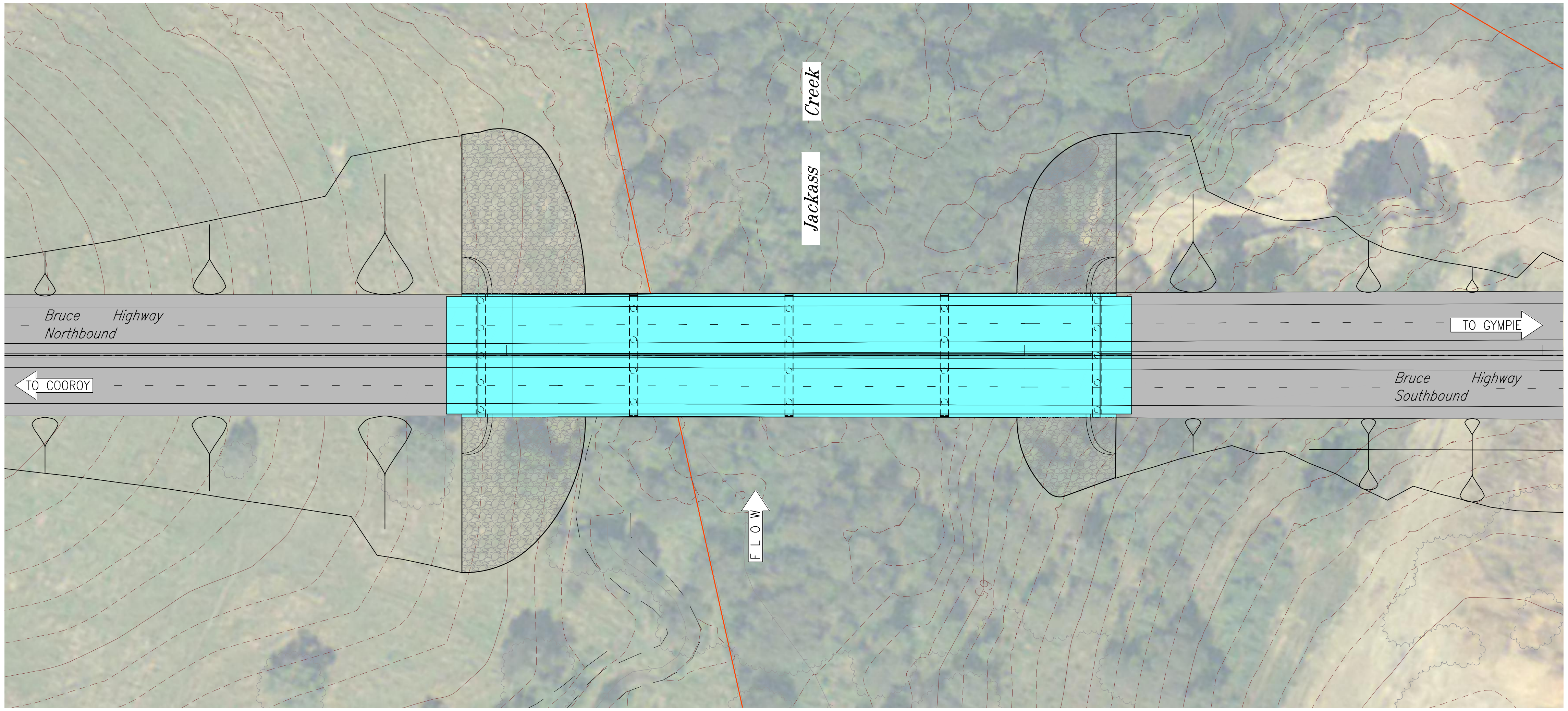
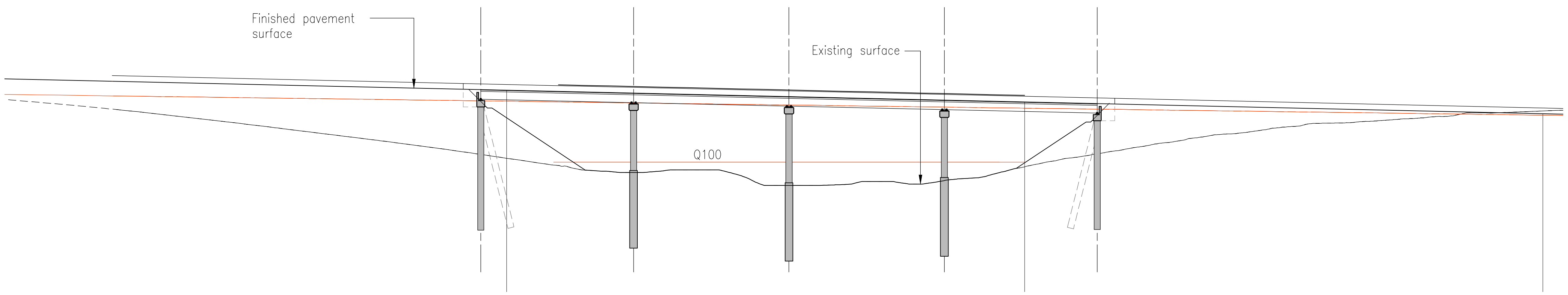


JACKASS CREEK BRIDGE



JACKASS CREEK BRIDGE

GYMPIE REGION

BRUCE HIGHWAY (BRISBANE – GYMPIE)

CTL CHGE

FIGURE 2–7: PROPOSED JACKASS CREEK CROSSING LOCATION, STRUCTURES

P1	PRELIMINARY			
Revisions/Descriptions	Ref	Certification	Date	Microfied

Associated Job Nos

Auxiliary Drg Nos

SURVEY DATA	
Horiz. Grid	MGA94 ZONE 56
Height Origin	AHD (Derived)
Survey Books	

Scales

A (1:500 A1) 0 5 10 15 20m

Dimensions shown in metres except where shown otherwise

Reference Points				
Preceding RP	Dist. to start of job (km)	From start to end of job	From end to Following RP	Following RP

Through Chainage from Brisbane 125.24km to 137.20km

Drawn	RRL
Checked	
Designed	MRG
Verified	
Design Reviews (RPEQ)	
No.	Date. / /

ENGINEERING CERTIFICATION (RPEQ)

ENG. AREA	NAME	SIGNATURE	NO.	DATE
CIVIL				

For scheme approval status refer Drg. No. (of)

Transport and Main Roads

Job No.	232/10A/2
Contract. No.	
Drawing No.	SK–0008 P1
Series Number	4 of 4

MRR_Detail (01/10)

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2.6 Connections to Existing Roads

The Project crosses a number of local roads for which alternative arrangements will be provided.

2.6.1 Traveston Interchange including Traveston Road

The Traveston Road Interchange was recently constructed as part of the Cooroy to Curra Project, (Section B) and provides a new access road to the existing Traveston Road to the east and to the new Mary Valley Link Road to the west. Section B connects back to the current Bruce Highway north of the Traveston Interchange.

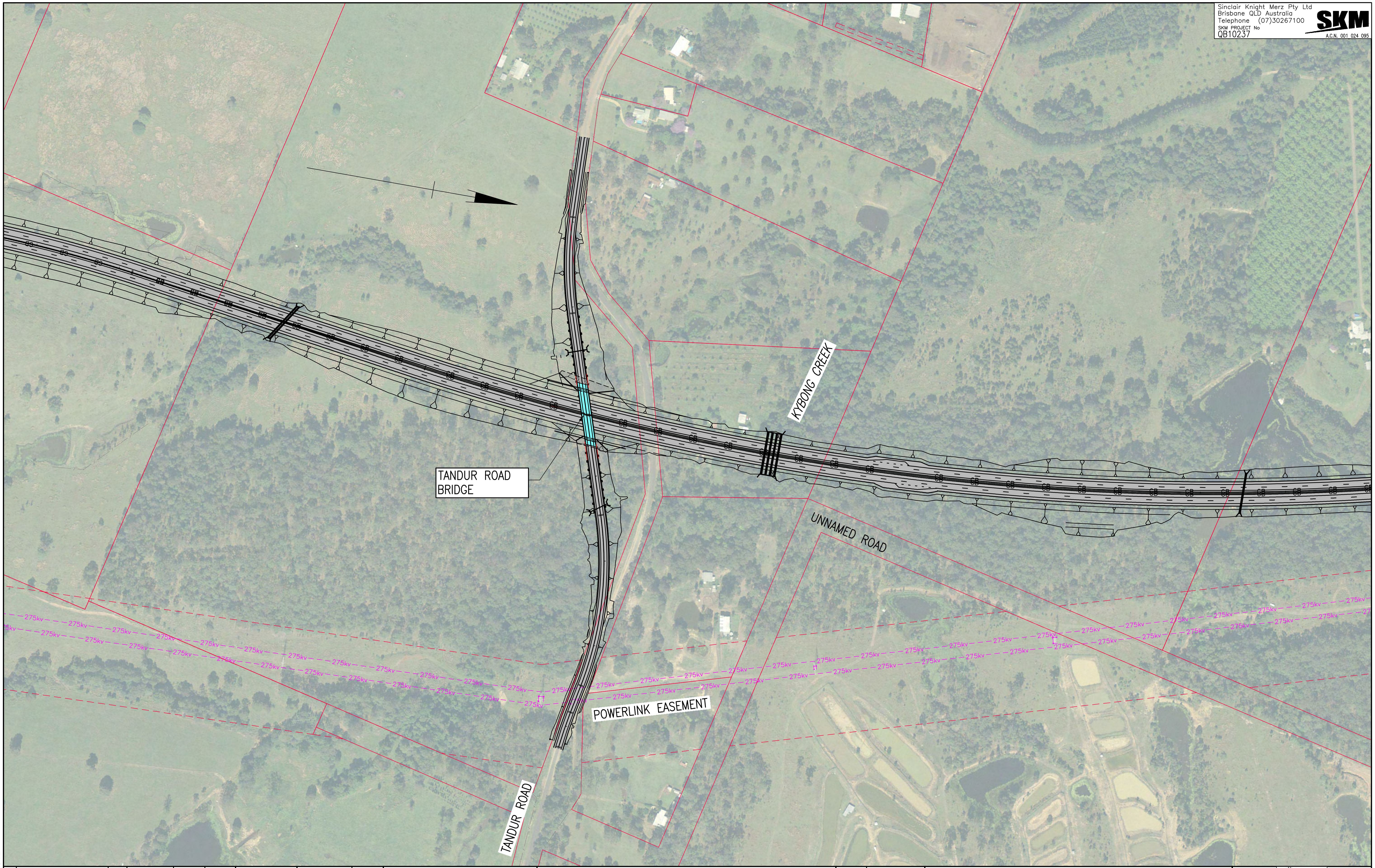
The proposed alignment diverges from the Traveston Interchange and crosses the existing Traveston Road, east of the current Bruce Highway. Access along this section of Traveston Road will be removed and a cul-de-sac is to be provided on the eastern side and local access provided on the western side of the alignment. Access from the eastern side of Traveston Road to the Project will be via the Traveston Interchange.

Northbound and southbound ramps connecting the Traveston Interchange to the existing Bruce Highway will be modified to connect to the proposed alignment.

2.6.2 Tandur Road

Tandur Road is a rural collector road running generally in an east-west direction between the existing Bruce Highway and Tandur-Traveston Road. The two-lane, 4.5 kilometre sealed rural road encompasses an undulating terrain with a posted speed limit of 80 km/h. Typical horizontal curves ranging from 145 metres to 600 metres are broken up by straight sections of road up to 450 metres in length.

Tandur Road is to be realigned to the south and comprises a two by 30 metre span bridge over the main alignment (refer to **Figure 2-8**). This provides an improved alignment with construction clear of the existing Tandur Road, minimising disruption during construction. It also minimises property impacts and the risks associated with working around high voltage electricity infrastructure.



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Associated Job Nos		SURVEY DATA	
Auxiliary Drg Nos		Horiz. Grid	MGA94 ZONE 56
		Height Origin	AHD (Derived)
		Survey Books	

P1	PRELIMINARY			
	Revisions/Descriptions	Ref	Certification	Date	Microfiled

Scales
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Dimensions shown in metres except where shown otherwise

GYMPIE REGION
BRUCE HIGHWAY (BRISBANE – GYMPIE)
CTL CHGE

Reference Points

Preceding RP	Dist. to start of job (km)	From start to end of job	From end to Following RP	Following RP

Through Chainage from Brisbane 125.24km to 137.20km

Drawn	RRL
Checked	
Designed	MRG
Verified	

Design Reviews (RPEQ)
No. Date / /

FIGURE 2–8: PROPOSED TANDUR ROAD OVERPASS & REALIGNMENT

ENGINEERING CERTIFICATION (RPEQ)

ENG. AREA	NAME	SIGNATURE	NO.	DATE
CIVIL				

For scheme approval status refer Drg. No. (of)

Queensland Government
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Job No.	232/10A/2
Contract. No.	
Drawing No.	SK–0018 P1
Series Number	1 of 1

MRR_Detail (01/10)

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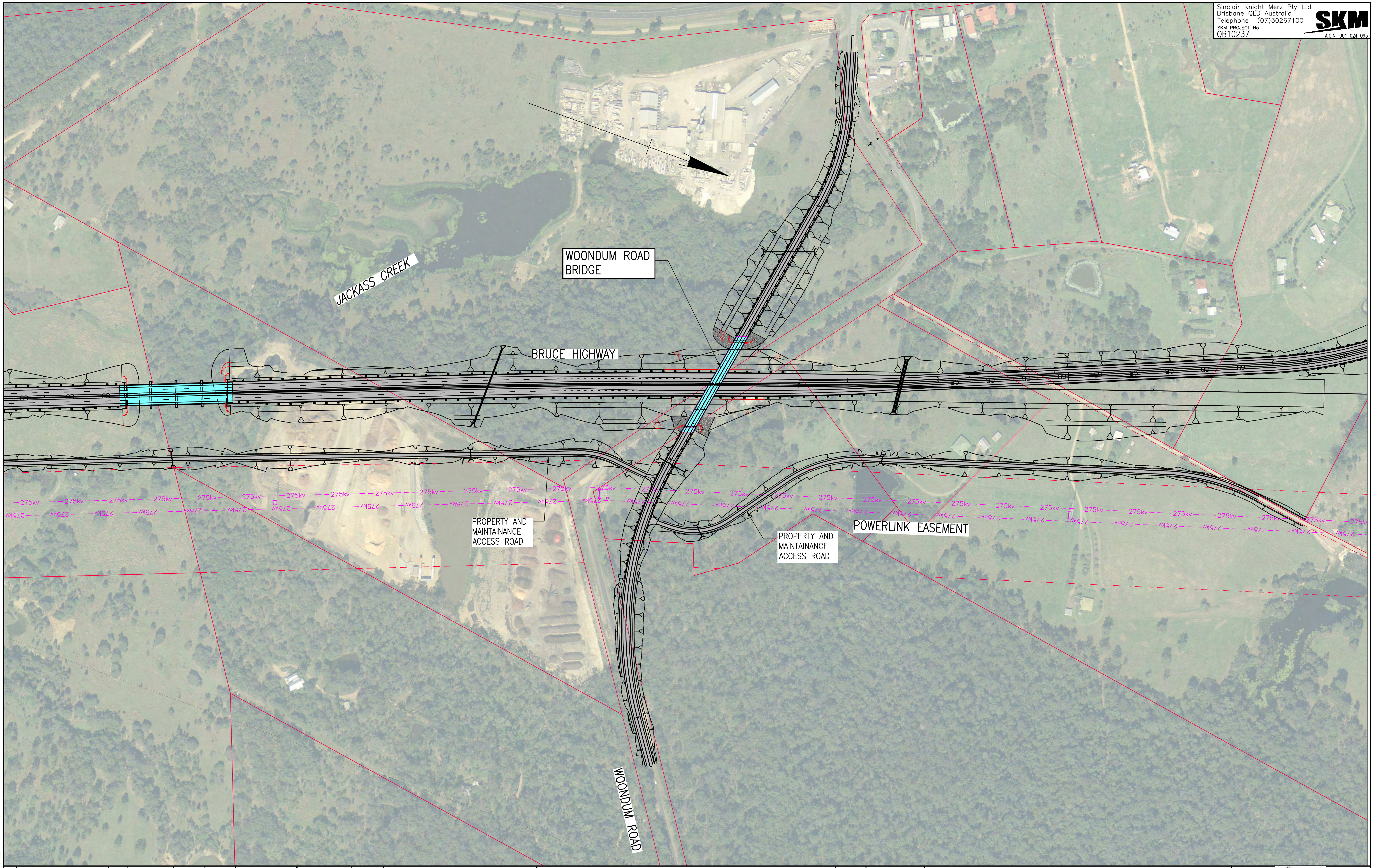
2.6.3 Woondum Road

Woondum Road is a rural collector road running generally in an east-west direction between the existing Bruce Highway and Burridge Connection Road. The two-lane, sealed two kilometre rural road encompasses a rolling terrain with no posted speed limit. Typical horizontal curves ranging from 60 metres to 210 metres are broken up by straight sections of road up to 550 metres in length.

An existing high voltage electricity tower is located in very close proximity to the northern side of Woondum Road adjacent to the proposed main alignment. The restriction on any road construction within a 20 metre square dimension from the transmission tower footings was a constraint in the realignment of this road.

The proposed Woondum Road overpass and realignment provides an improved alignment with a minor skew provided for the four by 16 metre span bridge over the alignment (refer to **Figure 2-9**). It also increases the operating speed from 65 km/h to 80 km/h.



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Revisions/Descriptions	Ref	Certification	Date	Microfilmed
P1 PRELIMINARY				

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Last Modified :- 26/09/2013 12:03:48 PM

Associated Job Nos

Auxiliary Drg Nos

SURVEY DATA
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Height Origin: AHD (Derived)
Survey Books

Scales
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Dimensions shown in metres except where shown otherwise

GYMPIE REGION
BRUCE HIGHWAY (BRISBANE – GYMPIE)
CTL CHGE

Reference Points

Preceding RP	Dist. to start of job (km)	From start to end of job	From end to Following RP	Following RP

Through Chainage from Brisbane 125.24km to 137.20km

Drawn RRL
Checked
Designed MRG
Verified
Design Reviews (RPEQ)
No. Date. / /

FIGURE 2–9: PROPOSED WOONDUM ROAD OVERPASS & REALIGNMENT

ENGINEERING CERTIFICATION (RPEQ)

ENG. AREA	NAME	SIGNATURE	NO.	DATE
CIVIL				

For scheme approval status refer Drg. No. (of)

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Job No. 232/10A/2
Contract. No.
Drawing No. SK–0019 P1
Series Number 1 of 1
MRR_Detail (01/10)

2.6.4 Woondum Interchange

The Project main alignment connects to the existing Bruce Highway at the Woondum Interchange. The alignment is grade separated over a new southbound exit ramp to the current Bruce Highway with a 35 metre, two lane, single span bridge.

A northbound entry ramp from the current Bruce Highway is also provided (refer to **Figure 2-10**).

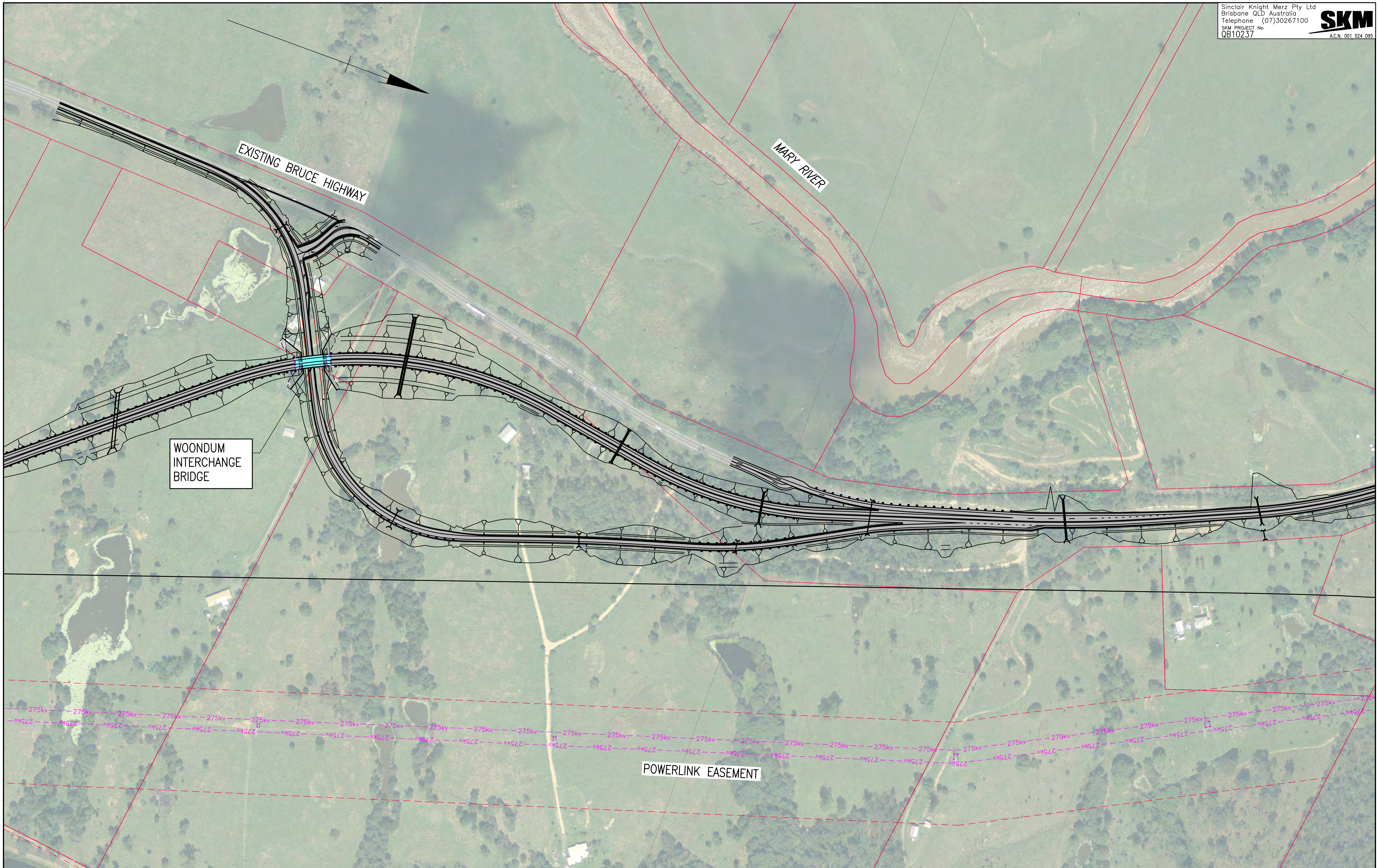

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FIGURE 2–10: PROPOSED WOONDUM INTERSECTION UPGRADE

GYMPIE REGION
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CTL CHGE

SURVEY DATA
Horiz. Grid: MGA94 ZONE 56
Height Origin: AHD (Derived)
Survey Books

Associated Job Nos
Auxiliary Drg Nos

Scales 1:2000 0 20 40 60 80m
Dimensions shown in metres except where shown otherwise

Reference Points: Preceding RP | Dist. to start of job (km) | From start to end of job | From end to Following RP | Following RP
Through Chainage from Brisbane 125.24km to 137.20km

Drawn: RRL
Checked
Designed: MRG
Verified
Design Reviews (RPEQ)
No. Date. / /

ENGINEERING CERTIFICATION (RPEQ)
ENG. AREA | NAME | SIGNATURE | NO. | DATE
CIVIL

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Job No. 232/10A/2
Contract. No.
Drawing No. SK–0020 P1
Series Number 1 of 1
MRR_Detail (01/10)

P1 PRELIMINARY
Revisions/Descriptions | Ref | Certification | Date | Microfied

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2.6.5 Keefton Road

The Keefton Road intersection is situated near the northern extremity of the Project. Adjacent to, and offset from Keefton Road, is the entry and exit to the ‘Gold Nugget’ Caltex service station. This service station experiences high volumes of turning traffic, with a high percentage of heavy vehicles. The turning volumes at Keefton Road are comparatively very low.

A signalised, four-way intersection is to be provided at the intersection with provision of two lanes in both directions on the existing Bruce Highway, tapering back to one lane in each direction beyond the intersection.

Realignment of Keefton Road is required to achieve a symmetrical four-way junction with protected right turn lanes into Keefton Road and the service station (refer to **Figure 2-11**).

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FIGURE 2–11: PROPOSED KEEFTON ROAD INTERSECTION UPGRADE

GYMPIE REGION

BRUCE HIGHWAY (BRISBANE – GYMPIE)

CTL CHGE

Preceding RP	Dist. to start of job (km)	From start to end of job	From end to Following RP	Following RP

Reference Points

Through Chainage from Brisbane 125.24km to 137.20km

Drawn	RRL
Checked	
Designed	MRG
Verified	

Design Reviews (RPEQ)

No. Date. / /

ENGINEERING CERTIFICATION (RPEQ)

ENG. AREA	NAME	SIGNATURE	NO.	DATE
CIVIL				

For scheme approval status refer Drg. No. (of)

Transport and Main Roads

Job No.	232/10A/2
Contract. No.	
Drawing No.	SK–0021 P1
Series Number	1 of 1

MRR_Detail (01/10)

Scales 1:2000 0 20 40 60 80m

Dimensions shown in metres except where shown otherwise

SURVEY DATA

Horiz. Grid	MGA94 ZONE 56
Height Origin	AHD (Derived)
Survey Books	

Associated Job Nos

Auxiliary Drg Nos

	Revisions/Descriptions	Ref	Certification	Date	Microfied
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2.7 Traffic

The existing Bruce Highway is a two lane rural highway with little opportunity for overtaking due to the existing painted central median for a large extent. This section of highway has a high crash rate and is subject to flooding at a number of locations.

The existing Bruce Highway, in the Kybong area, carried approximately 15,400 vehicles per day (vpd) annual average daily traffic (AADT) in 2010 of which 22% were commercial vehicles, with an annual growth rate of 2.6% p.a. over the last 10 years.

As the main highway connecting south-east Queensland to central and northern coastal Queensland the route carries very high commercial vehicle (freight) traffic as well as recreational holiday traffic and inter-regional business travellers.

The component of the total traffic that represents articulated trucks or larger constitutes 16.5% of the total daily traffic. The existing traffic averages more than 500 vehicles per hour (vph) in each direction for almost the entire daytime period (8am – 6pm).

2.7.1 Traffic Analysis

The traffic analysis for the Project was undertaken using the Gympie Region Strategic Transport Model (GRSTM).

The key years for the traffic assessment were:

- **Year of opening:** 2020
- **The ultimate design horizon:** 2050

A summary of the estimated AADT and peak volumes for the Project are summarised in **Table 2-1**.

Table 2-1: Forecast AADT and Peak Hour Volume summary.

Year	AWDT peak one-way volume (vph)	Daily AADT volumes (vpd)
2020	840	17,800
2030	1,240	25,400
2050	2,240	45,800

AWDT = average weekday traffic

Based on the traffic analysis the Project would operate satisfactorily as a four-lane motorway for the extent of its design life depending on the long-term growth rate.

2.8 Land Tenure Impacts

A road reserve will be gazetted for the proposed alignment which will impact on land tenure along the alignment. Land tenures which will be impacted as a result of the Project include:

- Freehold land acquired by TMR
- State Forests
- Local road reserves
- Easements

Changes to land tenure will be managed via the appropriate legislative processes as summarised below.

2.8.1 State Forests

The gazettal of the road corridor for the Project alignment will impact on the existing tenure for the Traveston State Forest and Woondum State Forest.

2.8.1.1 Traveston State Forest

Traveston State Forest comprises a total area of 85.19 hectares and is described as Lot 950 on FTY1293. The Traveston State Forest is declared under section 25 of the *Forestry Act 1959*, but is not a protected area under the NC Act.

The Project will require the revocation of approximately 11.2 hectares of the Traveston State Forest.

The declaration of the area of Traveston State Forest impacted by the Project will need to be revoked in accordance with section 26 of the *Forestry Act 1959* prior to the Project being constructed.

2.8.1.2 Woondum State Forest

Woondum State Forest comprises a total area of 452 hectares and is described as Lot 983 on FTY1488. The Woondum State Forest is declared under section 25 of the *Forestry Act 1959*, but is not a protected area under the NC Act.

The Project will require the revocation of approximately 3.2 hectares of the Woondum State Forest at the location of the Woondum Road upgrade and in the vicinity of the Keefton Road intersection upgrade.

An additional 8.9 hectares of Woondum State Forest will be required to accommodate the Section D main alignment.

The declaration of the area of Woondum State Forest impacted by the Project will need to be revoked in accordance with section 26 of the *Forestry Act 1959* prior to the Project being constructed.

2.8.2 Local Roads

The Project will impact on a number of local roads, including:

- Traveston Road
- Tandur Road
- Unnamed Road between Tandur Road and Gresham Road
- Gresham Road
- Woondum Road
- Keefton Road.

New road reserves will be gazetted to accommodate the Project, including the proposed upgrades to Traveston Road, Tandur Road, Woondum Road and the intersection at Keefton Road. In addition, Gresham Road will be terminated at the extent of the existing road reserve. Access to the high voltage transmission line easement via the access easement on the adjoining property (Lot 2, RP840266) will also be terminated as a result of the Project.

The Project will also impact on two small areas of ‘unnamed road’ adjacent to Traveston State Forest. No constructed road is currently contained within this ‘unnamed road’ corridor, which has a width of 20 metres.

The Traveston Interchange and associated works on the southern extremity of the Project are located within the existing State-controlled road corridor. The upgrade to the existing Bruce Highway at the northern section of the

Project between the Woondum Interchange and the Six Mile Creek bridge is also located within the existing State-controlled road.

2.8.3 Property Impacts

All properties directly impacted by the Project will be acquired by TMR prior to the commencement of construction works. Impacted properties are generally rural residential and a small number of commercial premises will be directly impacted by the project.

2.8.4 Property Access

The majority of property accesses are well maintained gravel roads into rural residential properties, commercial properties and grazing paddocks. Accesses into the high voltage transmission line easement are intermittently used to maintain the high voltage infrastructure and are generally poorly maintained.

While heavy vehicle use is not required for most of these accesses, light commercial vehicles use the driveways intermittently. In general, the majority of property accesses are not directly impacted by the Project as access along Traveston, Tandur, Woondum and Keefton Roads maintain local access to the current Bruce Highway.

A total of nine property accesses listed in **Table 2-2** will be affected by the Project.

Table 2-2: Property accesses affected by the Project.

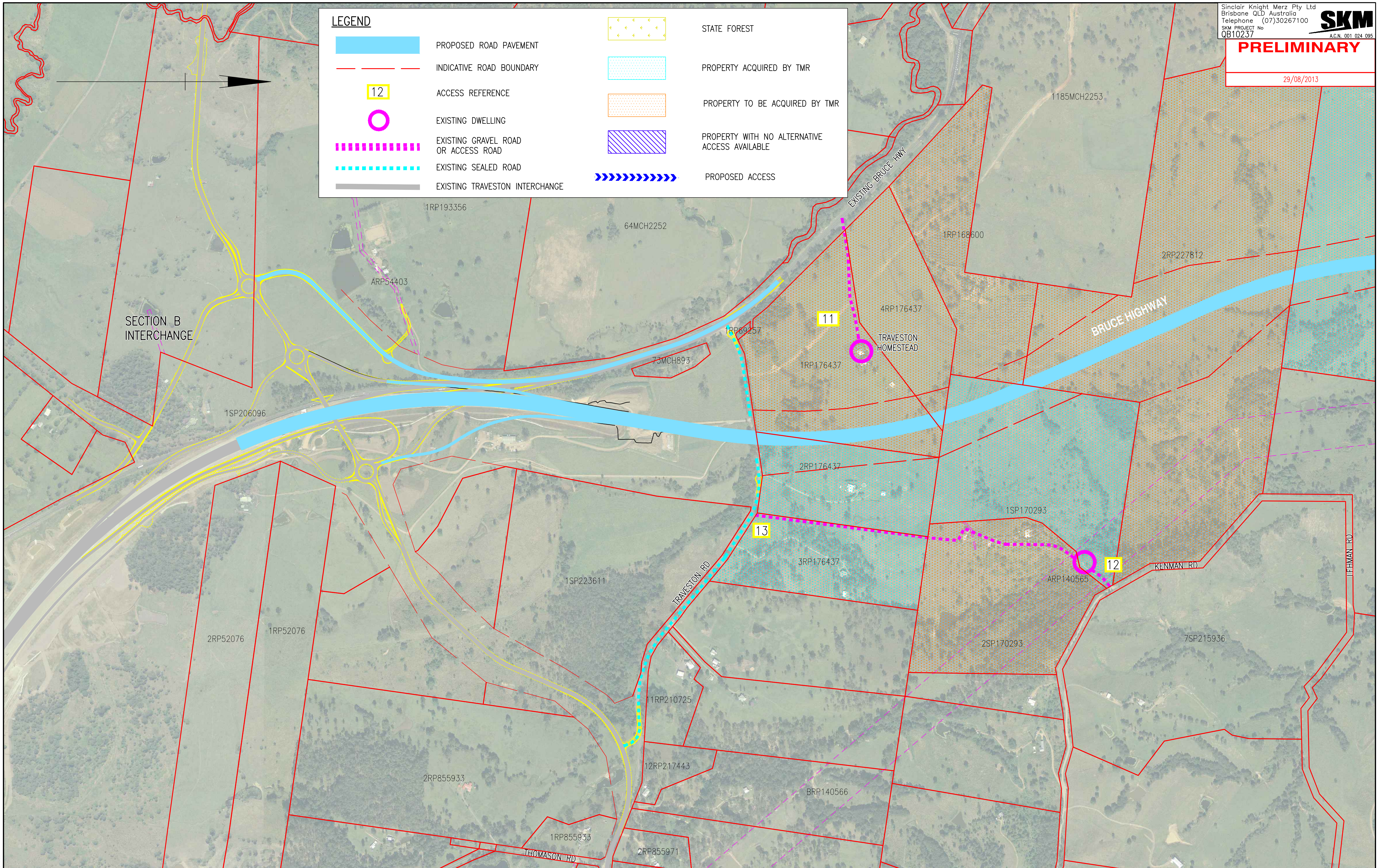
Ref No.	Property Address	Real Property Description	Property Use	Access Type	Comment
1	77 Tandur Road	Lot 4, RP139458	Rural residential	Gravel with gate	Property has been acquired by TMR and forms the proposed road corridor
2	Lot 6 Gresham Road	Lot 6, RP185500	Rural residential	Gravel with gate	Access to Gresham Road removed. Alternate access via proposed 800 m access road east to Burridge Road
3	-	Lot A, RP141994	Powerlink easement	Grassed with gate	Access from transmission tower to Gresham Road removed. Alternate access via proposed 800 m access road east to Burridge Road
4	-	Lot B, RP141971	Powerlink easement	Grassed with gate	Access from transmission tower to Gresham Road removed. Alternate access via proposed 800 m access road east to Burridge Road
5	39 Woondum Road	Lot 2, RP35056	Commercial "Pet Motel and Cemetery"	Gravel with grid	Access to Woondum Road removed. New access road provided to Woondum Road east of the proposed corridor
6	-	Lot A, RP141974	Powerlink easement Reference #5286	Grassed with gate	Access to Woondum Road removed. New access road provided to Woondum Road east of the proposed corridor
7	-	Lot A, RP141975	Powerlink easement Reference #5287	Grassed with gate	Access to Woondum Road removed. New access road provided to Woondum Road east of the proposed corridor
8/9	809 Bruce Highway	Lot 2, RP891751	Access to Powerlink and rural residential property	Grassed with gate	Existing access to the Bruce Highway to be maintained.
10	813 Bruce Highway	Lot 1, RP35055	Rural residential	Gravel with grid	Existing access to the existing Bruce Highway to be maintained with a minor realignment adjacent to the Woondum Interchange.

In addition to the severed property accesses, the Project will create residual land parcels with access changed. These properties are listed below in **Table 2-3**.

Table 2-3: Properties with access changes.

Ref No.	Property Address	Real Property Description	Property Use	Comment
11	1813 Bruce Highway "Traveston Homestead"	Lot 1, RP176437	Rural Homestead	Existing access to Bruce Highway to be maintained
12/13	44 Kenman Road	Lot 1, SP170293	Rural residential	Existing access to Traveston Road to be maintained
14	1627 Bruce Highway	Lot 2, RP110133	Rural pastoral land	Existing access to Bruce Highway to be maintained. Access from the residual area on the eastern side of the proposed corridor is removed. Alternative access to Tandur Road can be made available through the adjacent property 3RP208996
15	1435 Bruce Highway	Lot 2, RP124936	Rural residential	Existing access to Bruce Highway to be maintained
15	1435 Bruce Highway	Lot 1281, M37577	Rural residential	Existing access to Tandur Road to be maintained. Access from the residual area on the eastern side of the proposed corridor is removed. Access can be made available via the existing unnamed road
16	-	Lot 1459, M37678	Rural pastoral land	Access from the residual area on the western side of the proposed corridor is removed
17	-	Lot 1459, M37678	Rural pastoral land	Access from the residual area on the eastern side of the proposed corridor is removed. Access can be made available via the existing unnamed road
18	-	Lot 950, FTY1293	State forest	Access from the small residual area on the eastern side of the proposed corridor is removed. Access can be made available via the existing road easement
19	1235 Bruce Highway	Lot 416, CP882034	Rural residential	Existing access to Bruce Highway maintained. Access from the residual area on the eastern side of the proposed corridor is removed. Access can be made available via the existing unnamed road
20	Gresham Road	Lot 1382, M371313	Rural residential	Existing access to Gresham Road to be maintained
21	96 Woondum Road	Lot 1, RP173216	Commercial mulching business	Existing access to Woondum Road to be maintained. Access from the residual area on the western side of the proposed corridor is removed. Alternative access can be made available through the adjacent property 2RP840266
22	39 Woondum Road	Lot 3, RP213686	Rural residential	Access to Woondum Road removed. New access road provided to Woondum Road east of the proposed corridor
23	31 Woondum Road	Lot 2, RP157499	Rural residential	Existing access maintained to Woondum Road.

Existing and proposed property accesses are shown in **Figure 2-12A** to **Figure 2-12D**. This figure also shows where land parcels that will be severed by the road corridor will remain with no access from the road network.



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Associated Job Nos	SURVEY DATA		Scales
Auxiliary Drg Nos	Horiz. Grid	MGA94 ZONE 56	1:5000 (A1) 1:10000 (A3) 0 50 100 150 200m
	Height Origin	AHD (Derived)	
	Survey Books		Dimensions shown in metres except where shown otherwise

GYMPIE REGION

BRUCE HIGHWAY (BRISBANE – GYMPIE)

CTL CHGE

Reference Points				
Preceding RP	Dist. to start of job (km)	From start to end of job	From end to Following RP	Following RP

Through Chainage from Brisbane 125.24km to 137.20km

Drawn	RRL
Checked	
Designed	MRG
Verified	
Design Reviews (RPEQ)	
No.	Date. / /

FIGURE 2–12A: PROPERTY ACCESS ARRANGEMENTS

ENGINEERING CERTIFICATION (RPEQ)				
ENG. AREA	NAME	SIGNATURE	NO.	DATE
CIVIL				

For scheme approval status refer Drg. No. (of)

Queensland Government
Transport and Main Roads

Job No.	232/10A/2
Contract. No.	
Drawing No.	SK–0001 P1
Series Number	1 of 4

MRR_Detail (01/10)

P1	PRELIMINARY			
Revisions/Descriptions	Ref	Certification	Date	Microfiled

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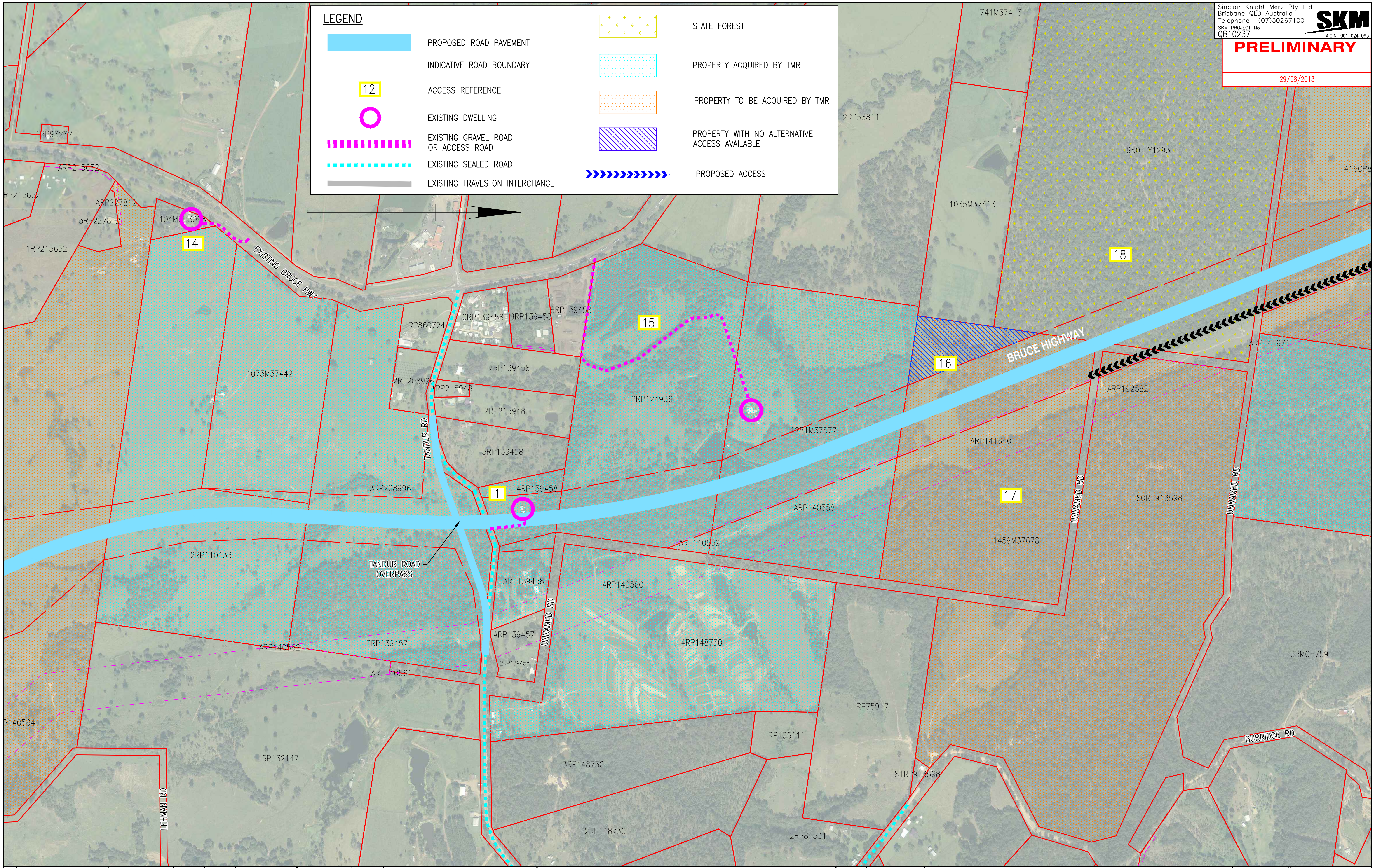

P1	PRELIMINARY				
	Revisions/Descriptions	Ref	Certification	Date	Microfiled

Associated Job Nos

Auxiliary Drg Nos

SURVEY DATA

Horiz. Grid	MGA94 ZONE 56
Height Origin	AHD (Derived)
Survey Books	

Scales

1:5000 (A1) 1:10000 (A3) 0 50 100 150 200m

Dimensions shown in metres except where shown otherwise

GYMPIE REGION

BRUCE HIGHWAY (BRISBANE – GYMPIE)

CTL CHGE

Reference Points

Preceding RP	Dist. to start of job (km)	From start to end of job	From end to Following RP	Following RP

Through Chainage from Brisbane 125.24km to 137.20km

Drawn	RRL
Checked	
Designed	MRG
Verified	

Design Reviews (RPEQ)

No. Date / /

FIGURE 2–12B: PROPERTY ACCESS ARRANGEMENTS

ENGINEERING CERTIFICATION (RPEQ)

ENG. AREA	NAME	SIGNATURE	NO.	DATE
CIVIL				

For scheme approval status refer Drg. No. (of)

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Job No.	232/10A/2
Contract. No.	
Drawing No.	SK-0002 P1
Series Number	2 of 4

MRR_Detail (01/10)

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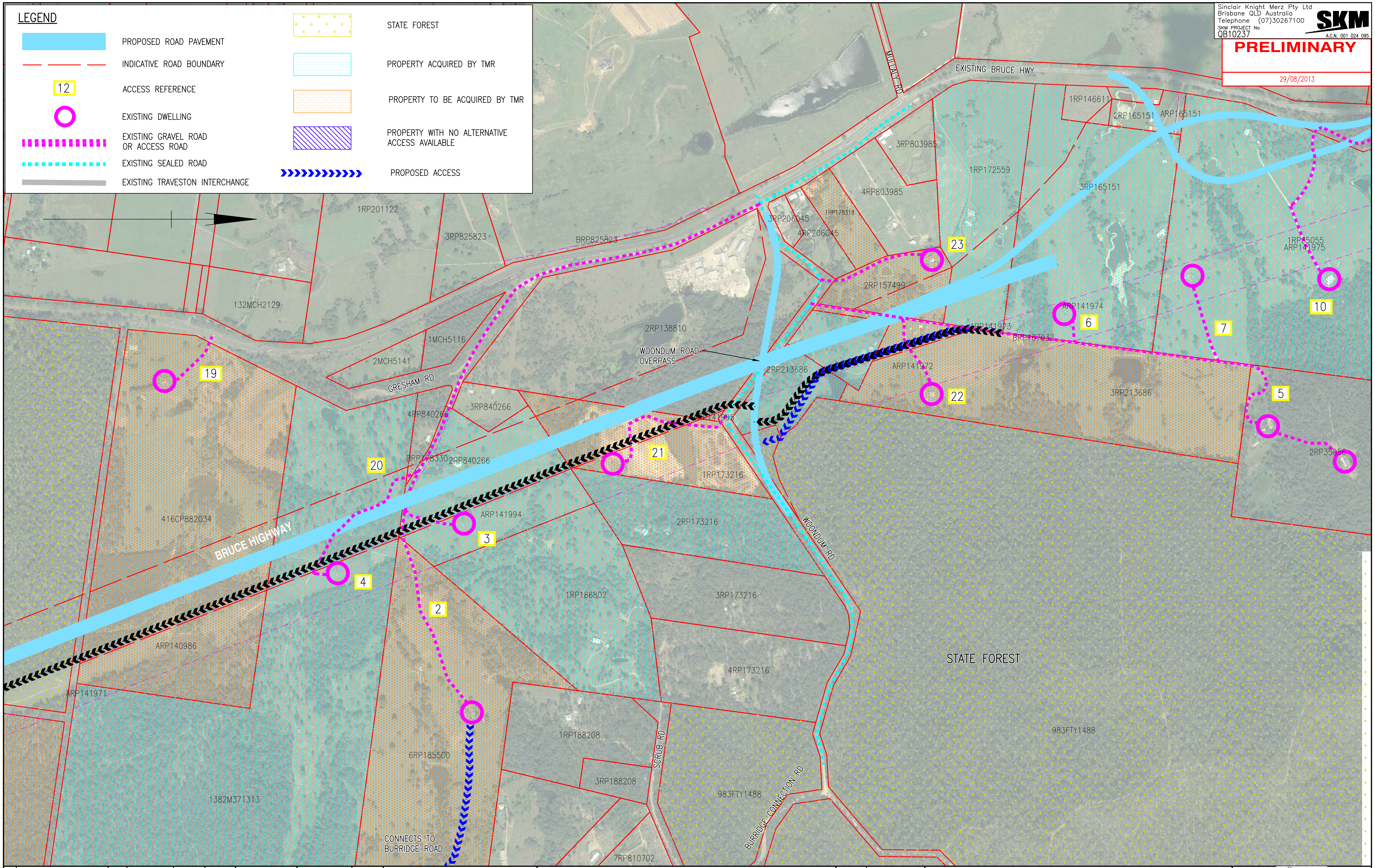

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	Revisions/Descriptions	Ref	Certification	Date	Microfiled

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Associated Job Nos

Auxiliary Drg Nos

SURVEY DATA

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Height Origin	AHD (Derived)
Survey Books	

Scales
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1:10000 (A3)
Dimensions shown in metres except where shown otherwise

GYMPIE REGION
BRUCE HIGHWAY (BRISBANE – GYMPIE)
CTL CHGE

Reference Points

Preceding RP	Dist. to start of job (km)	From start to end of job	From end to Following RP	Following RP

Through Chainage from Brisbane 125.24km to 137.20km

Drawn	RRL
Checked	
Designed	MRG
Verified	

Design Reviews (RPEQ)
No. Date. / /

FIGURE 2–12C: PROPERTY ACCESS ARRANGEMENTS

ENGINEERING CERTIFICATION (RPEQ)

ENG. AREA	NAME	SIGNATURE	NO.	DATE
CIVIL				

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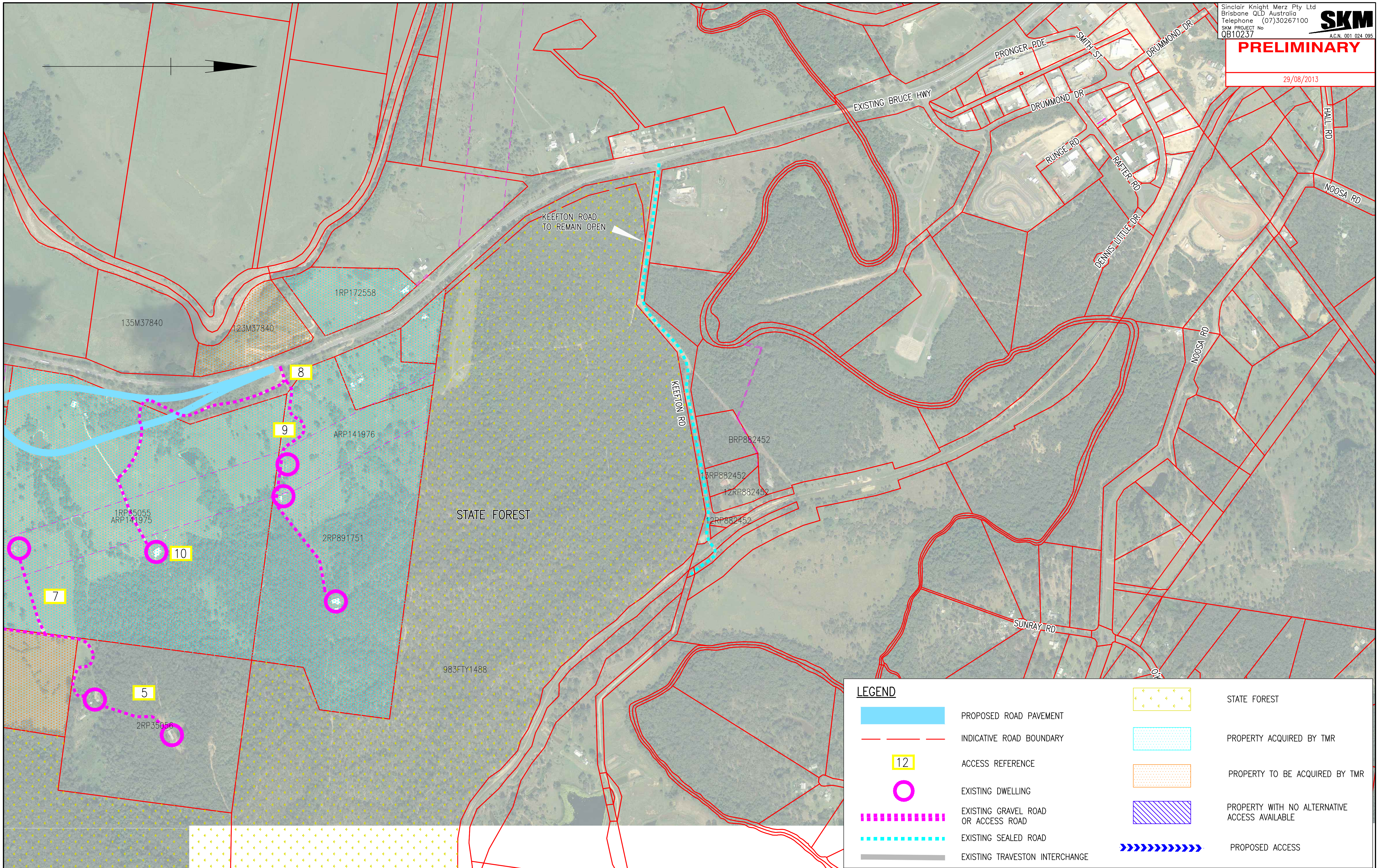
Queensland Government
Transport and Main Roads

Job No.	232/10A/2
Contract. No.	
Drawing No.	SK–0003 P1
Series Number	3 of 4

MRR_Detail (01/10)



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P1	PRELIMINARY			
Revisions/Descriptions	Ref	Certification	Date	Microfiled

Associated Job Nos

Auxiliary Drg Nos

SURVEY DATA	
Horiz. Grid	MGA94 ZONE 56
Height Origin	AHD (Derived)
Survey Books	

Scales
1:5000 (A1)
1:10000 (A3)
0 50 100 150 200m

Dimensions shown in metres except where shown otherwise

GYMPIE REGION
BRUCE HIGHWAY (BRISBANE – GYMPIE)
CTL CHGE

Reference Points

Preceding RP	Dist. to start of job (km)	From start to end of job	From end to Following RP	Following RP

Through Chainage from Brisbane 125.24km to 137.20km

Drawn	RRL
Checked	
Designed	MRG
Verified	
Design Reviews (RPEQ)	
No.	Date. / /

FIGURE 2–12D: PROPERTY ACCESS ARRANGEMENTS

ENGINEERING CERTIFICATION (RPEQ)

ENG. AREA	NAME	SIGNATURE	NO.	DATE
CIVIL				

For scheme approval status refer Drg. No. (of)

Queensland Government
Transport and Main Roads

Job No.	232/10A/2
Contract. No.	
Drawing No.	SK–0004 P1
Series Number	4 of 4

MRR_Detail (01/10)

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2.8.5 Easements

The main easement in the vicinity of the Project is the high voltage transmission line easement to the east of the proposed alignment (refer to **Figure 2-2A** to **Figure 2-2D)**. This easement is currently used for 275 kV electricity infrastructure, an example of which is shown in **Figure 2-13**. The Project will have minimal impact on this easement. The easement will continue to cross the existing Bruce Highway south of Keefton Road.

Figure 2-13: Example of 275 kV electrical infrastructure located in the easement adjacent to the Project alignment.

2.9 Project Construction

The majority of environmental impacts are likely to be associated with the construction phase of the project. This section describes the construction schedule, staging of construction works and the sequence of construction activities from clearing and topsoil stripping to pavement construction and revegetation.

2.9.1 Construction Timing

The Development Phase of the Project, comprising Preliminary and Detailed Design, is to commence in 2013 and continue until June 2016. Construction will commence shortly thereafter and will continue for approximately two years. The Project is due to open in late 2018.

Table 2-4: Project delivery schedule.

Project Activity	Schedule
Project Concept and Development Phases	December 2011 to June 2016
Contract Award	July 2016
Construction	July 2016 to May 2018
Finalisation	June 2018 to August 2018

2.9.2 Construction Staging

Construction staging refers to the order in which the major packages of work will be carried out. The Project may be constructed in two stages if required:

- Early works (**Section 2.9.2.1**) – comprising works on the local cross road network, particularly Tandur Road and Woondum Road.
- Main alignment (**Section 2.9.2.2**) – comprising all works along the main alignment, Woondum Interchange, upgrade to the existing Bruce Highway and minor road works.

The construction stages are likely to be completed in series with the early works package requiring four to six months to construct, which will be followed by the construction of the main alignment.

2.9.2.1 Early Works

The local cross-road network, including the Tandur Road (**Section 2.6.2**) and Woondum Road (**Section 2.6.3**) works, can be constructed as early works packages to provide cross corridor connectivity during the construction of the main alignment. This approach will allow uninterrupted haulage along the main corridor during the bulk earthworks exercise (**Section 2.9.3.4**). It would also reduce the requirement for access tracks adjacent to the construction corridor.

2.9.2.2 Main Alignment

The preferred construction staging for the project will be confirmed in the Business Case. However, the full works contract for the main corridor can be broken into either horizontal and/or vertical battery limits.

- A **horizontal battery limit** would split construction of the main alignment into horizontal zones along the main corridor.
- A **vertical battery limit** would split construction of the main alignment into sequential work items such as drainage, bulk earthworks, pavements and structures.

2.9.3 Construction Sequence

The construction sequence refers to a general set of activities that will be carried out at a particular location in order to construct the Project.

The construction sequence will generally entail the following activities:

- Progressive clearing of vegetation along the alignment as required to accommodate construction activities.
  - Timber / logs with high habitat value stockpiled for use in the rehabilitation works associated with the Project.
- Installation of erosion and sediment controls in accordance with the Project Erosion and Sediment Control Plans.
- Stripping of topsoil from the footprint of the earthworks formation as required.
  - Topsoil suitable for use in rehabilitation works will be stockpiled near the edge of the area cleared for construction.
- The vertical design formation will be achieved through bulk earthworks activities including:
  - Excavation and ripping of subsoil and weathered rock horizons as required in cut locations. Geotechnical investigations will verify whether blasting is required in areas identified as non-rippable during the Detailed Design phase.
  - Stockpiling and/or transportation of suitable material to fill locations.

  - Excess suitable material will be stockpiled in the vicinity of the Woondum Interchange at the northern end of the Project.
  - Unsuitable material will be placed in the core of zoned embankments, disposed of at suitable off site locations, or used as non-structural fill on site.
- The embankment will be constructed from suitable material likely to be sourced from the site.
- The subgrade will be constructed of suitable material likely to be sourced from offsite locations.
- The pavement will be constructed of asphalt which will be applied via mobile plant.
- Compaction of the embankment, subgrade and pavement will be required to achieve design specifications.
- Concrete components of the road, including barriers and kerbs, will be constructed where required.
- Rehabilitation works will be carried out to stabilised exposed batters utilising stockpiled topsoil described above.

At watercourse crossing locations, structures will generally be constructed as follows:

- Vegetation will be cleared as required to accommodate the construction activities.
- Suitable controls will be installed to minimise erosion within the bed and banks of watercourses.
- Piles will be drilled and concrete poured.
- Piers and/or slabs will be placed with consideration to the relevant regulatory requirements relating to working within a watercourse and the provision of fish passage.
- Bridge decks and culvert cells will be installed and paved as per design specifications.

2.9.3.1 Vegetation Clearing

Vegetation will be cleared in accordance with Technical Standard MRTS04 – General Earthworks. Estimates of vegetation clearing requirements for the purpose of the environmental assessment are consistent with Section 7.2.1 of MRTS04, and are the minimum width required to construct the works plus three metres.

The following general principles will be applied to clearing activities:

- Clearing will be restricted to the minimum width required to construct the works plus three metres.
  - Exclusion zones to be identified in the Environmental Management Plan (Planning) and contract documentation will be adhered to where additional clearing is required to accommodate construction activities.
- Trees to be left undisturbed will be clearly marked prior to the commencement of clearing activities.
- Clearing within streams and waterways shall not include the removal of stumps and roots below the ground surface.
- Hollow timber which is suitable for fauna habitat will be relocated to areas clear of construction activities.
- Marketable timber will be clearly marked prior to clearing and felled in a manner that reduces damage to trunks.
- Timber that is not considered marketable or suitable for use as fauna habitat may be mulched as required on site.
- Burning of cleared vegetation will not occur during the construction of the Project.

2.9.3.2 Topsoils Stripping

Preliminary geotechnical investigations suggest that the average topsoil depth is approximately 200 mm and with a maximum depth of approximately 800 mm.

Topsoil stripping will be carried out in accordance with MRTS04, with specific practices to be employed including:

- Topsoil suitable for use as planting media will be stripped with minimal contamination with subsoil material and stockpiled near the edge of the cleared area.
- Topsoil will not be removed within the drip lines of trees to be retained along the alignment.
- Topsoil will not be stockpiled within 50 metres of waterways or below the Q5 flood level.
- Topsoil stockpiles will be limited to three metres high by ten metres wide at the base. Length of stockpiles will be determined on site.
- Suitable erosion and sediment controls will be installed for topsoil stockpiles.

2.9.3.3 Unsuitable Material

Unsuitable material generally includes any excavated material that does not meet the required specifications for use in construction. Examples of unsuitable material likely to be encountered during construction of the Project include any of the following:

- Material from the bottom of dams and creeks.
- Material from the upper one metre of cuttings, which is likely to be dispersive and prone to erosion.
- Material from the lower part of cuttings, which may be too coarse for compaction
- Contaminated soil.

It is estimated that approximately 35,000 cubic metres of unsuitable material (not including contaminated material) will require management during the construction of the Project. Of this total volume, the majority is anticipated to be used on site where appropriate. It is anticipated that some material will require disposal at an off-site location and the determination will be made in accordance with the waste management hierarchy.

If required, disposal of contaminated material will be conducted in accordance with all regulatory requirements.

2.9.3.4 Bulk Earthworks

The proposed earthworks strategy for the Project minimises haul distances along the main alignment to less than two kilometres.

The Project design achieves an approximate cut/fill balance with the inclusion of an estimated 10% bulking factor. Any variance in this bulking factor experienced during construction will be managed through the following measures:

- Cut batters may be laid back to a flatter slope than 1:2 where additional material is required for embankment construction.
- Suitable material will be stockpiled in the vicinity of the Woondum Interchange at the northern end of the Project (refer to **Figure 2-2A** to **Figure 2-2D**) in the event that excess material is generated during earthworks.

Bulk earthworks will be conducted using the plant and equipment described in **Section 2.9.4.6**. In general, the following activities will be carried out:

- Open bowled scrapers or excavators will be used to remove subsoil down to the weathered rock horizon.
- If required, dozers with tynes will be used to rip the weathered rock zone.
- Excavators will be used to load moxys and dump trucks to transport material to embankment locations.
- Compactors will be used to compact the embankment material to the relevant design standard.

2.9.3.5 Blasting

Preliminary geotechnical investigations revealed sections of rock material classified as non-rippable in the cuttings shown in **Table 2-5**.

Table 2-5: Summary of non-rippable material quantities for the Project.

Section Chainage	Main Line Cut General Quantities	Non-Rippable	
	Total (m^3)	% volume	(m^3)
128000 to 128100	84,679	40%	33,872
131300 to 131400	45,248	17%	7,692
132800 to 132900	66,887	50%	33,444
132900 to 133000	84,105	25%	21,026
134000 to 134100	44,863	12%	5,384
Miscellaneous locations	329,743	NA	43,664
TOTAL	1,245,440 m^3	TOTAL	145,081 m^3

Non-rippable areas will require the use of blasting or rock breakers prior to excavating to the design surface level. All blasting will be carried out in accordance with MRTS55 - Use of Explosives in Roadworks and in compliance with relevant legislation and guidelines.

2.9.3.6 Waterway Diversions

Minor waterway diversions will be required at Traveston Creek and Kybong Creek to accommodate the preferred crossing structures at these locations.

Diversions of approximately 240 metres of Traveston Creek and 120 metres of Kybong Creek will be required to realign these waterways accommodate the proposed crossing structures (refer to **Figure 2-4** and **Figure 2-5**). These diversions will be constructed and stabilised prior to the construction of the bridge piles, deck and culvert respectively.

Designs will be developed to manage alterations to hydraulic gradients of these waterways and to mimic the natural form of the waterways where it is practical to do so. It is expected that the construction of the diversions will be completed ‘off line’ and additional diversion channels will not be required. However, the construction methodology has not yet been determined.

These activities will be carried out during low flow periods to reduce the likelihood of impacts.

2.9.3.7 Existing Farm Dams

A number of existing farm dams are located along the proposed alignment. All dams that have a direct conflict with the alignment will be required to be dewatered and have unsuitable material removed prior to the bulk earthworks exercise. This unsuitable material will be disposed of in accordance with **Section 2.9.3.3** prior to being filled with suitable material in accordance with design specifications.

Where practical, existing dams will be utilised as construction water sources to minimise water drawn from local waterways. Further detail on construction water sources is provided in **Section 2.9.4.9**.

2.9.3.8 Pavement Construction

The surface course for all sections of pavement will be open graded asphalt (OGA) with 14 mm aggregate. The main alignment will be designed and constructed with a pavement design life of forty years, while the side roads, ramps and overpasses will have a design life of twenty years. It is intended that these pavements will require minimal maintenance during the period of the stated design life. Details of the general pavement cross section are provided in the engineering drawings in **Appendix A**.

OGA is designed to have a noise level 2 dB(A) lower than dense graded asphalt when new.

2.9.3.9 Landscaping and Vegetation

Landscaping and revegetation activities will be conducted in accordance with the Landscape and Revegetation Works Technical Standard suite. Landscaping and revegetation activities will include:

- The application of soil ameliorants to meet the requirements for suitable planting media.
- Roughening of banks to at least 50 mm depth to form keys for planting media.
- Application of planting media at a depth necessary to support proposed revegetation species.
- Revegetation using grass to be applied by manual methods, hydromulching or the use of an organic blanket.
- Planting of trees as specified in the Landscape and Revegetation Plan to be developed for the Project.

The selection of tree species will be in accordance with safety requirements for the operation of the new road. Factors such as lines of sight and clear zones for errant vehicles will be considered in the location of areas to be revegetated and the selection of species.

Landscaping, revegetation and rehabilitation works may also be required on land acquired by TMR where the current land use will be discontinued, such as the wood chipping industry that fronts Woondum Road.

Landscaping and revegetation works will be completed as soon as practicable following the completion of construction works in each location.

2.9.4 Ancillary Activities

Several ancillary activities will be required during the early works and construction phase of the Project, including:

- The establishment of a site office (or offices).
- Clearing and stripping of access tracks.
- Establishment of stockpile and spoil areas.
- Establishment of laydown areas for construction materials.
- Establishment and operation of a motor vehicle workshop for repairing and maintaining construction plant.
- Crushing and screening of material sourced on site.
- Sourcing suitable construction materials for the embankments and pavement.
- Sourcing water for construction activities.

There is also a potential requirement for asphalt manufacturing and concrete batching to be carried out on site. However, it is likely that these activities will be conducted by a third party in an off-site location with the materials delivered to site as required.

Locations for ancillary activities will be selected in order to efficiently address construction requirements while minimising environmental impacts. Environmentally sensitive sites will be confirmed during the Detailed Design process and included in the contract documentation and Environmental Management Plan (Construction).

In general, locations for ancillary activities will be selected based on the following criteria:

- Located within the road corridor to minimise disturbance.

- Located away from environmentally sensitive zones.
- Located away from any watercourses and above the Q5 flood level.
- Located in places convenient to the construction activities.

The Contractor will be required to identify appropriate sites for ancillary activities that do not impact on environmentally sensitive sites and obtain any necessary permits required to carry out these activities.

Control measures consistent with the Main Roads Technical Standards and relevant Australian Standards will be implemented on the Project and are summarised in the relevant sections below.

2.9.4.1 Site Offices

All properties directly impacted by the proposed alignment will be wholly or partially acquired by TMR. Some of these properties with existing dwellings present an ideal opportunity for site office locations. The proposed site office (or offices) will ideally be located on a property adjacent to Tandur and/or Woondum Road to utilise the public utility services available at these sites and for ease of access.

Tandur Road is located adjacent to the southern and central zones of the project where a large amount of the bulk earthworks will be required. Woondum Road is located adjacent to the central zone and northern interchange zone of the project.

A detailed analysis of site office size and location will be conducted during the Preliminary Design phase of the project. Management of site facilities will be the responsibility of the Contractor and will be conducted in accordance with MRTS28 – Contractors Site Facilities and Camp.

2.9.4.2 Access Tracks

Access tracks will be required during the construction phase in order to transport materials along the alignment, and to minimise light and heavy vehicle interactions. Temporary drainage structures will be installed where access tracks cross waterways along the alignment.

The requirement for access tracks along the main alignment will be significantly reduced through the construction staging process described in **Section 2.9.2**, in which cross corridor connectivity can be maintained by completing the Woondum Road and Tandur Road overpasses prior to the construction of the main alignment.

2.9.4.3 Stockpile and Spoil Areas

Stockpiling of materials including topsoil, spoil, unsuitable material and subgrade materials will be required during construction. Consistent with **Section 2.9.4**, stockpile and spoil locations will be placed outside of environmentally sensitive zones.

Excess spoil may be stored in the vicinity of the Woondum Interchange at the northern end of the Project (refer to **Figure 2-2A** to **Figure 2-2D**) depending on the bulking factors of material excavated during construction. The proposed spoil stockpiles are located in the vicinity of the proposed alignment for the ultimate Woondum Interchange layout (**Section 2.10.2.4**) and the Section D main alignment. This location was selected to minimise the requirement move this material during future construction activities.

2.9.4.4 Laydown Areas

Laydown areas will be required at locations where construction effort is focussed such as the bridge structures and large drainage installations described in **Section 2.5**. Compacted road base material will be provided where required to provide a stable base for laydown areas, which will be of sufficient size to store materials required to carry out construction activities.

2.9.4.5 Motor Vehicle Workshop

It is likely that the Contractor will establish a motor vehicle workshop to repair and maintain plant and equipment during construction. The motor vehicle workshop will be established outside of environmentally sensitive areas, particularly and flood prone vegetated areas.

2.9.4.6 Plant and Equipment

Plant and equipment will be sufficient to carry out bulk earthworks, drainage structures, culvert installations and pavement construction. In general, plant used may include:

- Moxy articulated trucks.
- Open bowled scrapers.
- Excavators (up to 50 tonne capacity).
- Dump trucks (including truck and dogs).
- Graders.
- Dozers (up to D11 equivalent).
- Soil and vibratory compactors.
- Hydraulic cranes.
- Drill rigs for blast hole drilling.
- Bobcats.
- Pavement and asphalt plant.

The size and type of plant will be refined during the Preliminary and Detailed Design phases. However, the Contractor will ultimately determine the plant used during construction.

2.9.4.7 Crushing and Screening

Crushing and screening activities may be required on site to process material for erosion protection and site stabilisation structures, such as gabions and rock blankets. However, the majority of subgrade and pavement materials will be sourced from local suppliers, including the Moy Pocket quarry, minimising the requirement for onsite crushing and screening.

2.9.4.8 Construction Material Sources

Bulk earthworks activities required during project construction are summarised in **Section 2.9.3.4**. Embankment material will be sourced on site from cuttings along the main alignment. It is unlikely that borrow areas outside of the proposed cuttings will be required for embankment material.

As detailed in **Section 2.9.3.3**, unsuitable material may be used in the core of zoned embankments if deemed to be an appropriate approach during construction.

Subgrade and pavement materials are likely to be sourced from off-site locations and suppliers. Where possible, suppliers from within the local region will be engaged to minimise haul distances to the Project site.

2.9.4.9 Construction Water Sources

A significant amount of water will be required during the construction of the Project. Water for construction will be obtained from the following sources:

- Construction water supply dam (or dams) of up to a total of 40 ML capacity[1] which will be constructed during the early works phase.
- Purchased from a local supplier such as SunWater.
- Existing farm dams located on TMR owned properties.
- Sediment basins with pumps and standpipes installed.
- Local waterways and drainage features.

The identification and recommendation of a few preferred locations of construction water supply dams will be consistent with the approach identified in **Section 2.9.4**. If required, the final locations of these dams will be determined during the Preliminary Design phase.

2.9.4.10 Concrete Batching

Onsite concrete batching is not likely to be carried out on site for the Project. Potential concrete supply options include the Holcim plant in Gympie and Boral at Moy Pocket. Both supply points are within a suitable distance to the Project site to ensure the integrity of the supplied material.

2.9.4.11 Asphalt Manufacture

Asphalt manufacture is not likely to be carried out on site for the Project. Asphalt will be delivered to site by a local supplier as required.

2.9.5 Workforce

A workforce of approximately 400 personnel will be required during the peak of construction phase activities.

2.10 Project Alternatives

A number of alternatives were considered for the following Project components during the options analysis phase in order to address the project objectives. Multiple options were considered for the following:

- The main alignment[2].
- Crossing and drainage structures such as bridges, concrete arches and culverts for the four main waterways along the alignment[3].
- The Woondum Interchange[4].
- Road alignments for local road upgrades, including Tandur Road and Woondum Road[5].

Alternatives were assessed against a number of criteria, including engineering, cost and environmental impacts.

2.10.1 Sustainability

2.10.1.1 Sustainability by Design Framework

The workshop held on 21 February 2012 was designed and delivered so that the project team shown in **Table** 2-6 considered situations and specific challenges differently – reframing the challenge. The aim was to achieve a different and better outcome than would have been the case under a ‘business as usual’ regime. Action plans were developed to advance the ‘smart ideas’ from the workshops that went beyond ‘business as usual’ as part of the project development.

[1] Construction water for Section B was sourced from two dams of 20 ML and 15 ML capacity. It is likely that similar capacity storages will be required for the construction water on this Project.
[2] Refer to SKM Technical Note 7: East v West corridor assessment.
[3] Refer to SKM Technical Note 28: Major Watercourse Crossing Assessments.
[4] Refer to SKM Technical Note 10: Woondum interchange concept option.
[5] Refer to SKM Technical Note 11: Tandur Road and Woondum Road Options Analysis.

Table 2-6: Workshop attendees.

Name	Organisation	Project Role
Rod Tebbutt	TMR, Major Infrastructure Projects, Gympie Office	Program Manager, Cooroy to Curra project
Russell Lewis	TMR, Major Infrastructure Projects, Gympie Office	Project Manager, Cooroy to Curra project, Section C
Jim Martin	TMR, Pavement, Materials & Geotechnical, Engineering & Technology	Geotechnical Consultant, Cooroy to Curra project
John Artiach	TMR, Investment Analysis and Evaluation, Portfolio Investment Division	Project Manager, Preliminary Evaluation, Cooroy to Curra, Section C
Jeff Bess	TMR, Major Infrastructure Projects, Gympie Office	Consultant Project Advisor, Cooroy to Curra project
Kris Henrickson	TMR, Major Infrastructure Projects, Gympie Office	Principal Designer (Civil), Cooroy to Curra project
Ricky Cox	TMR, Road Planning and Design, Engineering & Technology	Director, (Special Projects) – Road Planning and Design
Norm Stevens	TMR, Major Infrastructure Projects, Metropolitan Office	Manager (Design and Technical)
Paramaswaran Suresh	TMR, Program Delivery and Operations, Gympie Office, (WBBR)	Principal Engineer, Civil
Juan Delgado	TMR, Road Planning and Design, Engineering & Technology	Principal Engineer, (Design and Processes)
Peter Black	SKM, Transport Infrastructure, Brisbane	SKM Project Manager
Simon Jones	SKM, Transport Infrastructure, Brisbane	SKM Design Manager
David Carson	SKM, Environmental Assessment & Management, Brisbane	SKM Environmental Lead
Daryl Davis	SKM, Transport Infrastructure, Maroochydore	SKM Project Director
Dr. Ian Thompson	SKM, Transport Infrastructure, Brisbane	SKM Pavements Lead
Brad Wolff	SKM, Transport Infrastructure, Brisbane	SKM Hydraulics Lead
Professor Rod Troutbeck	Troutbeck & Associates	Consulting Professor, Specialist Advisor
Darren Leeson	SKM, Structures, Brisbane	SKM Structures Lead
Keith Marr	SKM, Sustainability & Innovation, Brisbane	SKM, Value by Design facilitator

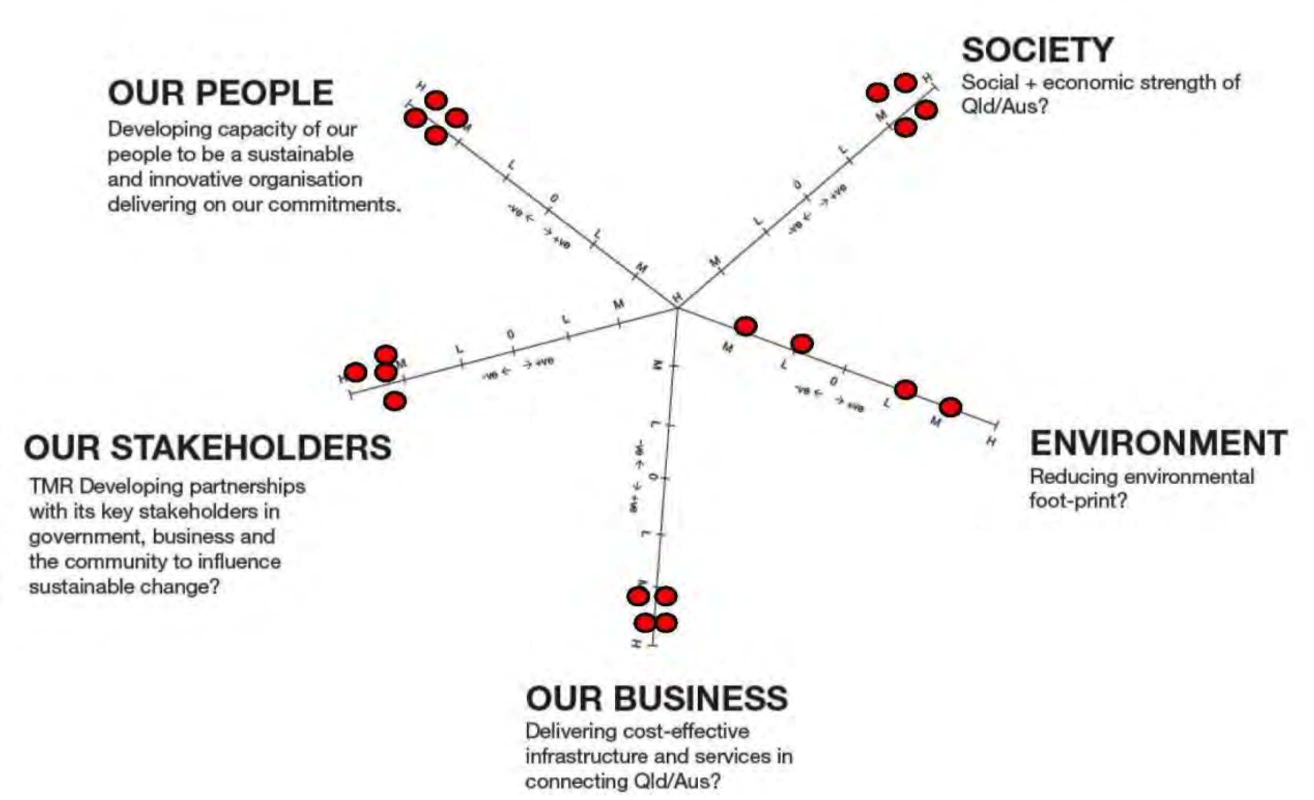
This workshop quantified the extent of alignment between the project objectives and the project service requirements. With the exception of one project objective, all other project objectives were found to strongly align with the project service requirements. The exception was the project objective; 'minimise disruption through closures and delay by adhering to acceptable flood immunity standards'. The project objective relating to this project service requirement did not include 'network resilience' so it was changed to 'minimise disruption through closures and delay by adhering to acceptable flood immunity standards to enhance network resilience'.

2.10.1.2 TMR Sustainability Framework

The TMR Sustainability Framework articulates its commitment to being sustainable in planning, delivering and managing a transport system that connects Queensland. This is guided by the value placed on its customers, people and reputation.

The first workshop assessed the project in relation to the existing infrastructure based on TMR's sustainability dimensions: our people, society, environment, our business and our stakeholders. The red dots shown in **Figure 2-14** provide the outcomes of the assessment of the Project against the TMR Sustainability Framework.

Figure 2-14: Assessment of the Project within the TMR Sustainability Framework.



The project was found to significantly contribute to four of TMR's sustainability dimensions: 'our people', 'our society', 'our business' and 'our stakeholders'. Variable scoring was recorded for the environment dimension. Based on expected environmental impacts from the project, it was found to contribute less favourably to 'our environment' on the basis that the project would have a negative impact on the environment primarily associated with the clearing footprint required.

However, the incorporation of mitigation measures during project development should reduce and the potential impacts on the environment and improve performance in this dimension of the TMR Sustainability Framework.

2.10.2 Main Alignment

2.10.2.1 Longitudinal Staging Scenarios

Potential longitudinal staging scenarios were investigated to improve Project affordability and therefore funding flexibility. The options were assessed against the following criteria:

- Road safety
- Flooding
- Freight efficiency
- Redundancy of infrastructure.

Two longitudinal staging scenarios were developed and are shown in **Figure 2-15A** and **Figure 2-15B.**

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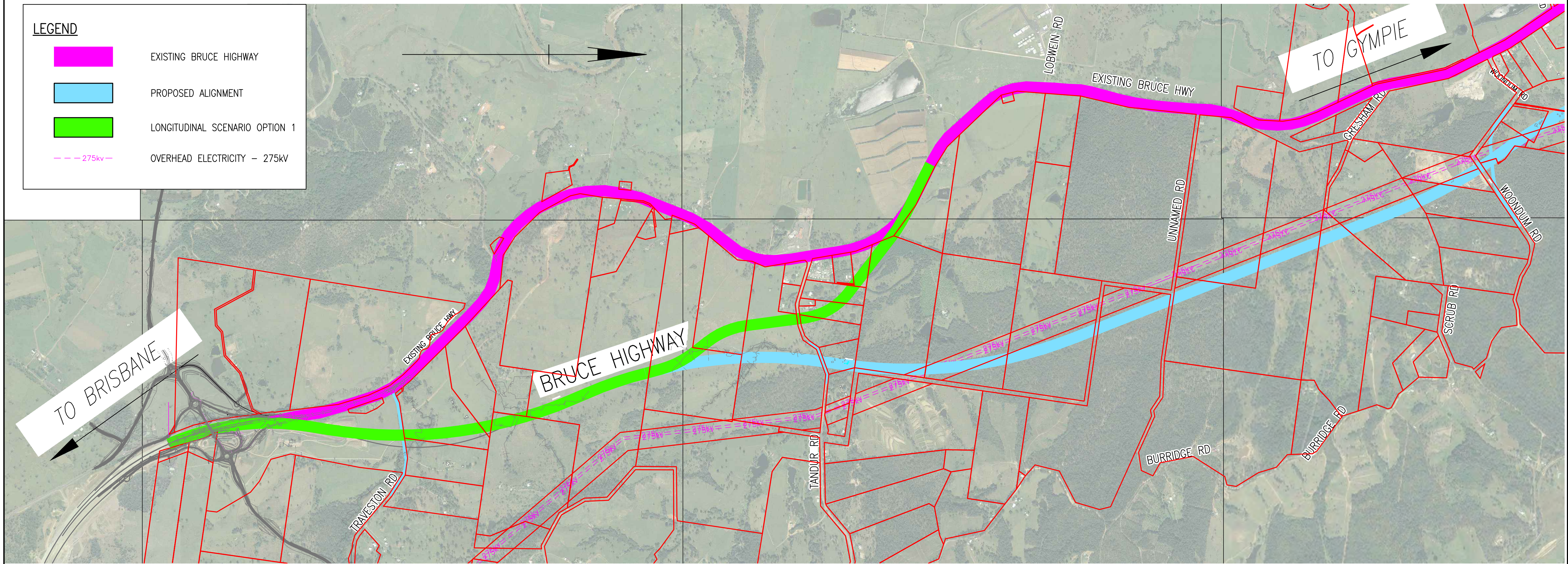

FIGURE 2–15A: LONGITUDINAL STAGING SCENARIOS – OPTION 1

GYMPIE REGION
BRUCE HIGHWAY (BRISBANE – GYMPIE)
CTL CHGE

Associated Job Nos	SURVEY DATA	
Auxiliary Drg Nos	Horiz. Grid	MGA94 ZONE 56
	Height Origin	AHD (Derived)
	Survey Books	

Scales

Dimensions shown in metres except where shown otherwise

Preceding RP	Dist. to start of job (km)	From start to end of job	From end to Following RP	Following RP

Reference Points

Through Chainage from Brisbane 125.24km to 137.20km

Drawn	RRL
Checked	
Designed	MRG
Verified	
Design Reviews (RPEQ)	
No.	Date. / /

ENGINEERING CERTIFICATION (RPEQ)

ENG. AREA	NAME	SIGNATURE	NO.	DATE
CIVIL				

For scheme approval status refer Drg. No. (of)

P1 PRELIMINARY				
Revisions/Descriptions	Ref	Certification	Date	Microfiled

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Queensland Government
Transport and Main Roads

Job No.	232/10A/2
Contract. No.	
Drawing No.	SK-0022 P1
Series Number	1 of 1

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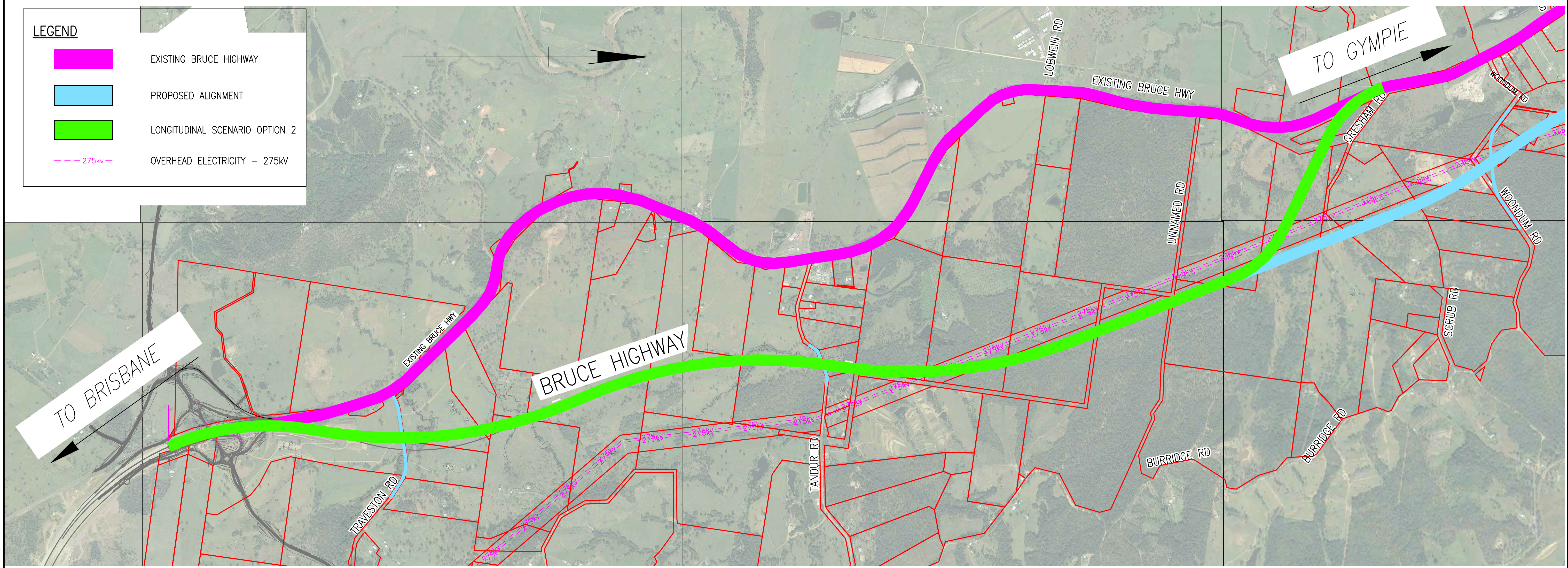

P1	PRELIMINARY			
Revisions/Descriptions	Ref	Certification	Date	Microfilmed

Associated Job Nos

Auxiliary Drg Nos

SURVEY DATA

Horiz. Grid	MGA94 ZONE 56
Height Origin	AHD (Derived)
Survey Books	

Scales

Dimensions shown in metres except where shown otherwise

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BRUCE HIGHWAY (BRISBANE – GYMPIE)

CTL CHGE

Reference Points

Preceding RP	Dist. to start of job (km)	From start to end of job	From end to Following RP	Following RP

Through Chainage from Brisbane 125.24km to 137.20km

Drawn	RRL
Checked	
Designed	MRG
Verified	

Design Reviews (RPEQ)

No. Date. / /

FIGURE 2–15B: LONGITUDINAL STAGING SCENARIOS – OPTION 2

ENGINEERING CERTIFICATION (RPEQ)

ENG. AREA	NAME	SIGNATURE	NO.	DATE
CIVIL				

For scheme approval status refer Drg. No. (of)

Queensland Government

Transport and Main Roads

Job No.	232/10A/2
Contract. No.	
Drawing No.	SK–0023 P1
Series Number	1 of 1

MRR_Detail (01/10)

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The comparison of the two longitudinal staging scenarios against delivery of the total project confirmed that each of these options represented an incremental achievement of the project objectives. However, the comparison confirmed that the project and technical objectives were best addressed through the construction of the total project shown in **Figure 2-2A** to **Figure 2-2D** and were not further developed.

2.10.2.2 Traveston Road to Tandur Road

The Strategic Planning alignment (refer to *Recommended Corridor Report Transport and Main Roads, July 2008)* adopted horizontal radius curves that required superelevation between Traveston Road Interchange and Tandur Road. The revised design criteria for the Project required more stringent water film depth and texture depth requirements for the aquaplaning criteria and a review of the alignment between Traveston interchange and Tandur Road was undertaken.

The horizontal alignment was refined to meet the aquaplaning requirements mentioned above and in consideration of the following:

- Maximising the horizontal offset to the heritage significant Traveston Homestead (consistent with the Strategic Planning alignment).
- Bisecting the existing saddle in the large hill which reduced long side slopes for the proposed cutting.
- The location of the horizontal curve approaching Tandur Road minimised the impact on the existing vegetation to the east which is an ‘Of Concern’ Regional Ecosystem (RE).

2.10.2.3 Tandur Road to Woondum Road

The Strategic Planning alignment crossed to the east of the high voltage power line easement north of Tandur Road, before crossing back to the west of this easement, north of Woondum Road. Crossing this easement and the associated high voltage power infrastructure imposed several engineering constraints on the horizontal and vertical alignment for the Project. As a result, a comparative assessment of an alignment option located entirely on the western side of the high voltage transmission line easement and the Strategic Planning alignment was completed. **Figure 2-16** shows the location of the two alignment options considered during this process.

FIGURE 2–16A: TANDUR ROAD TO WOONDUM ROAD ALIGNMENT

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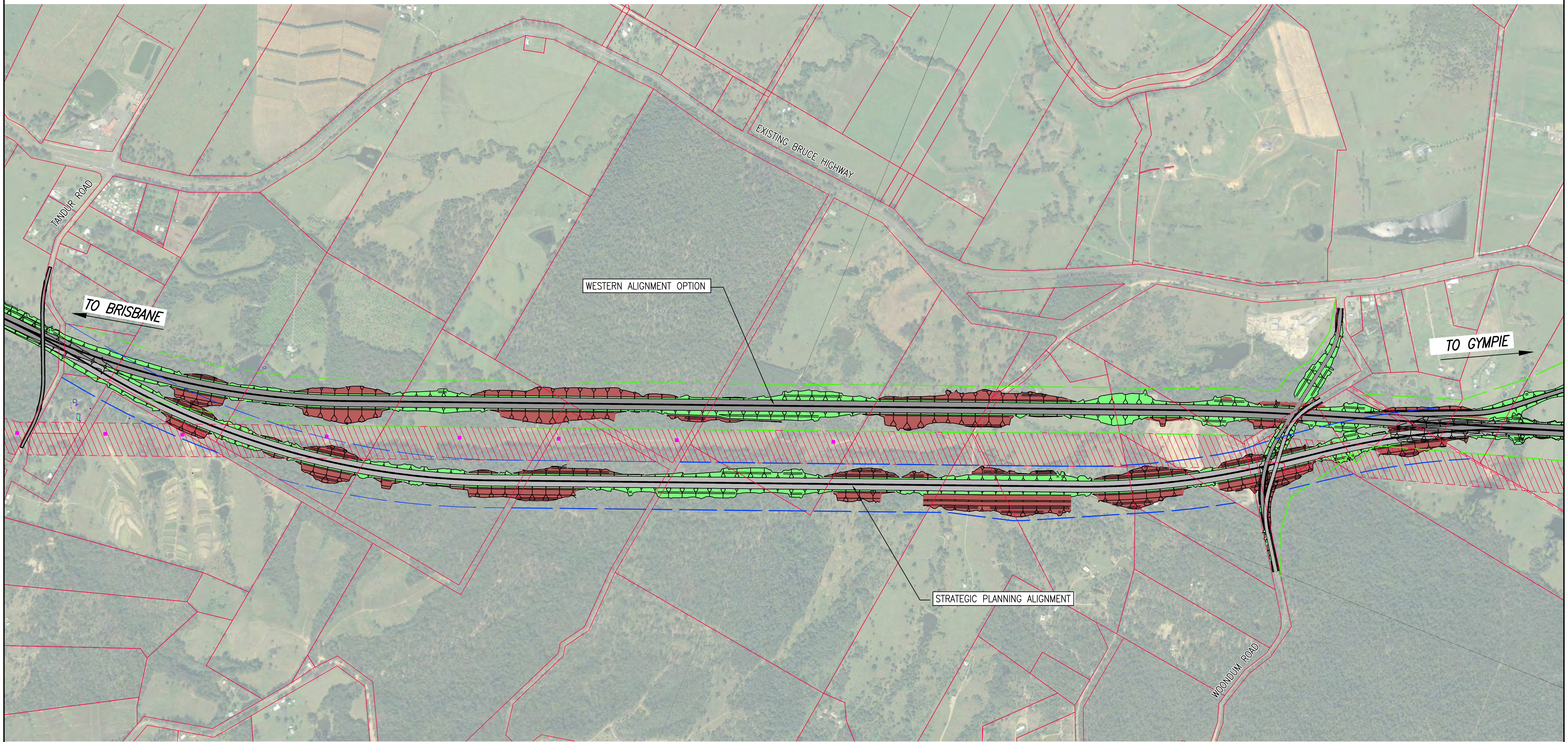
PRELIMINARY
15.08.2013

LEGEND

- WESTERN ALIGNMENT BOUNDARY
- STRATEGIC PLANNING ALIGNMENT BOUNDARY
- EASEMENT FOR 275 kv TRANSMISSION LINE
- TRANSMISSION LINE TOWERS



P1	PRELIMINARY			
	Revisions/Descriptions	Ref	Certification	Date	Microfiled

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Associated Job Nos

Auxiliary Drg Nos

SURVEY DATA	
Horiz. Grid	MGA94 ZONE 56
Height Origin	AHD (Derived)
Survey Books	

Scales

Dimensions shown in metres except where shown otherwise

GYMPIE REGION

BRUCE HIGHWAY (BRISBANE – GYMPIE)

CTL CHGE

Reference Points				
Preceding RP	Dist. to start of job (km)	From start to end of job	From end to Following RP	Following RP

Through Chainage from Brisbane 125.24km to 137.20km

Drawn	RRL
Checked	
Designed	MRG
Verified	

Design Reviews (RPEQ)

No. Date. / /

ENGINEERING CERTIFICATION (RPEQ)				
ENG. AREA	NAME	SIGNATURE	NO.	DATE
CIVIL				

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Job No.	232/10A/2
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The engineering and environmental investigations undertaken for the analysis of options found that the Project alignment option located to the west of the high voltage transmission line easement had lesser impacts than the Strategic Planning alignment.

The benefits of the Project alignment identified through the comparative assessment were:

- Reduced the impact on REs, areas of biodiversity value, high value regrowth (HVR) and mapped habitat for species listed under the *Native Conservation Act 1992* and *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).
- Eliminated the impacts from the diversion of approximately 1.2 kilometres of Jackass Creek.
- Eliminated the vertical and horizontal constraints of the high voltage power line infrastructure, reducing overall structure length and width of the Tandur Road overpass.
- Reduced excavation and therefore reduced project footprint.
- Reduced costs from reduced structures length, excavation and the elimination of watercourse diversions.
- Land requirements would be accommodated.
- Elimination of the impacts on the high voltage power line easement, the existing infrastructure and the potential future duplication of the transmission lines.

Further detail on the results of this comparative assessment is provided in **Appendix D**.

2.10.2.4 Woondum Interchange

The primary technical objective for determining a preferred option for the Woondum Interchange was *'to provide an interchange at Woondum south of Gympie that maintains network connectivity including north facing ramps and free flowing priority movements.'* Therefore, an ultimate interchange solution providing for all movements for future planning was considered in the options development.

The Sustainability by Design workshop also generated the following ideas for consideration for the Woondum Interchange.

- Addressed planning inputs
- Simplified configuration
- Provided versatility for expansion
- Incorporated a northbound U-turn facility at the Bruce Highway/Keefton Road intersection as part of the interchange function
- Considered speed management
- Managed driver behaviour
- Provided quality way finding through the interchange
- Considered freight access.

Interchange concepts were developed with consideration of the technical objectives and the Sustainability by Design outcomes included:

- Consideration of the staged delivery of the interchange from the northern Project connection to the ultimate Cooroy to Curra, Section D configuration.
- Identification of the lower demand movements that could be removed from the ultimate interchange in conjunction with the provision of a U-turn facility at the Bruce Highway – Keefton Road intersection under signalisation. The low demand movements identified were:
  - Existing Bruce Highway (south of the interchange) to/from the main alignment (south).
  - Existing Bruce Highway (south of the interchange) to/from the main alignment (north).

Five concept options for the Woondum Interchange were further developed to determine a preferred ultimate interchange option and are shown in **Figure 2-17**.

The five concept options were evaluated against the assessment criteria to confirm a preferred ultimate interchange option.

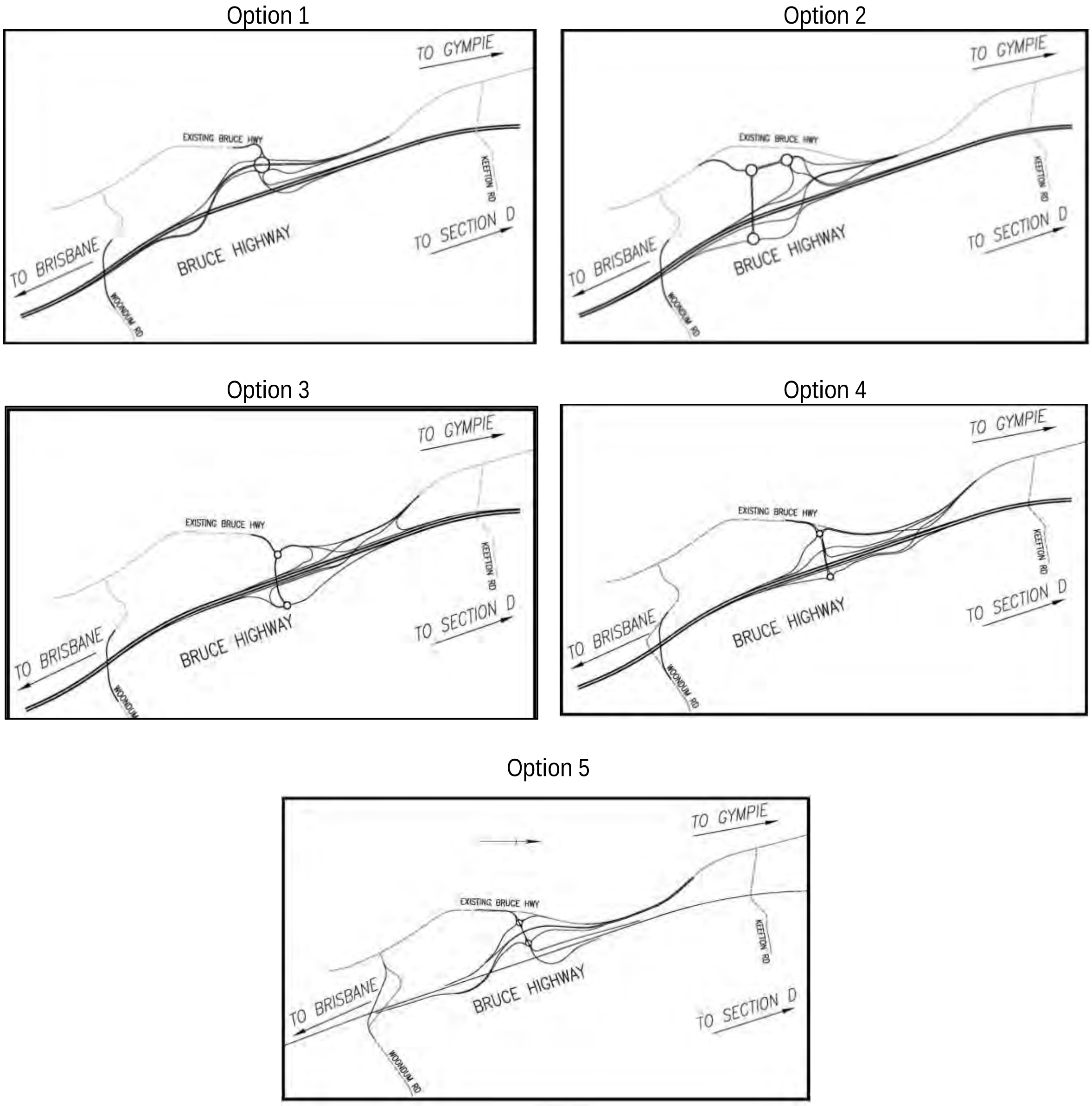
Options 1 and 5 were recommended as they met all assessment criteria to a medium or high level with no criteria being assessed to a minor level. They also addressed the outcomes generated at the Sustainability by Design workshop.

There were two differentiators in the comparison of Options 1 and 5:

- Option 1 was assessed as high for the provision of simple and legible movements (way finding) requiring negotiation of one large roundabout while Option 5 was assessed as medium requiring negotiation of two smaller roundabouts.
- Option 1 was assessed as medium for minimising complexity of structures requiring a large, multiple span bridge over the large radius roundabout while Option 5 was assessed as high requiring a smaller single span bridge over the connection between the two smaller roundabouts. This would provide a significant cost savings and reduction in complexity of the bridge for Option 5.

There were no other criteria assessed that provided a key differentiator for the comparison of Options 1 and 5. It was concluded that Option 5 provided the greatest benefits for the ultimate interchange.

Figure 2-17: Concept options for the Woondum Interchange.



2.10.2.5 Woondum Interchange Staged Delivery

Analysis was undertaken on Option 5 for an interim interchange option that would allow staged delivery for the future ultimate interchange if required, including the connection to Cooroy to Curra, Section D. Refer to **Figure** 2-18.

The interim interchange option can be provided by the main alignment connecting to the existing Bruce Highway and include a connection to/from the old Bruce Highway and Gympie. The ultimate connection can then be provided by the continuation of the main alignment to Section D and the interim connection provides the connection to/from Gympie as ramps. The southbound ramp to the main alignment will be realigned over the main alignment for Section D. The north and south facing ramps from the roundabout can be provided as required, and subject to, the future planning requirements for Cooroy to Curra, Section D.

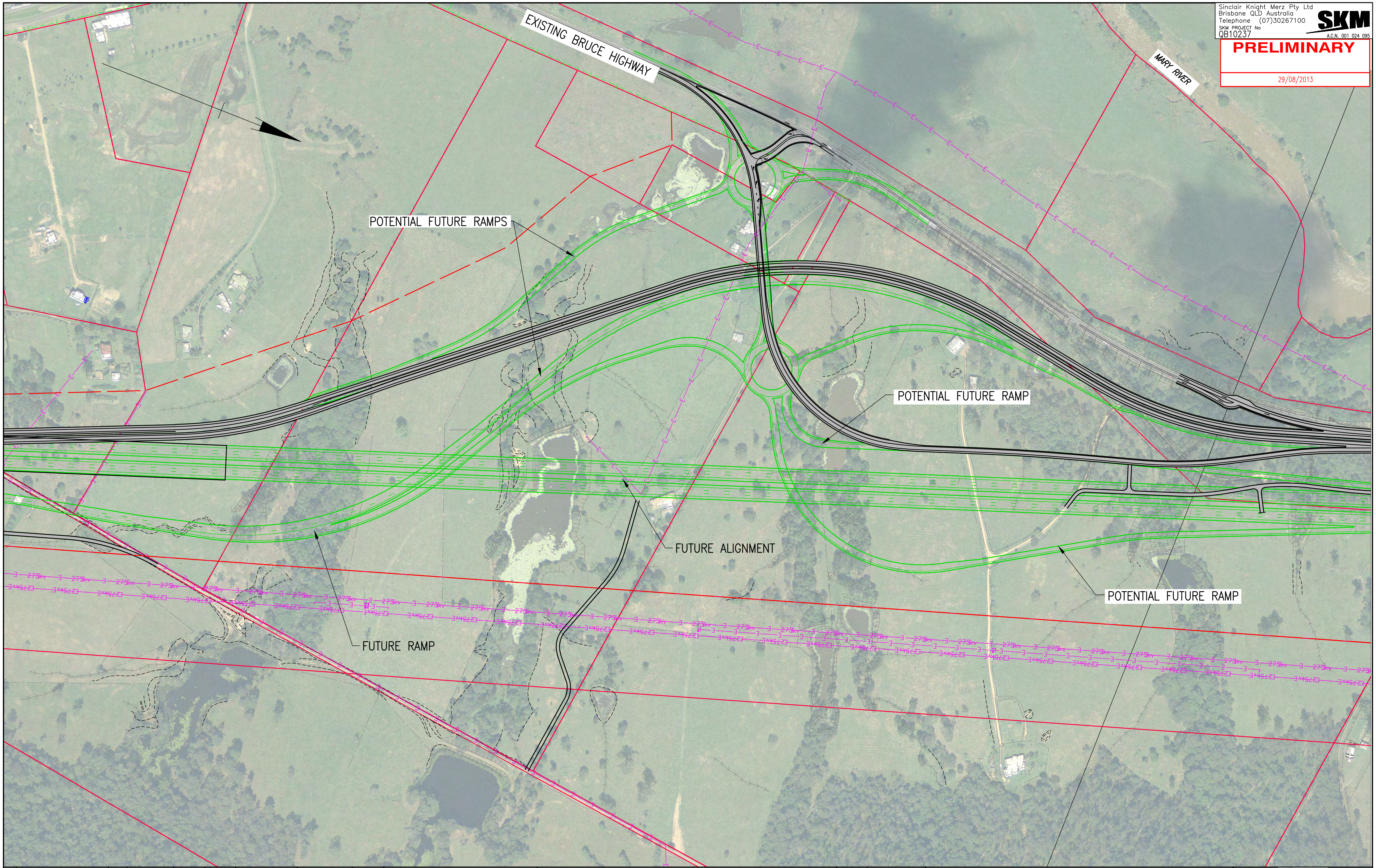


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FIGURE 2–18: WOONDUM INTERCHANGE STAGED DELIVERY

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Contract. No.	
Drawing No.	SK–0010 P1
Series Number	1 of 1

Drawn	RRL
Checked	
Designed	MRG
Verified	
Design Reviews (RPEQ)	

Scales: 1:2000 (A1) 1:4000 (A3) 0 20 40 60 80m

Dimensions shown in metres except where shown otherwise

SURVEY DATA	
Horiz. Grid	MGA94 ZONE 56
Height Origin	AHD (Derived)
Survey Books	

Associated Job Nos

Auxiliary Drg Nos

Reference Points

Preceding RP	Dist. to start of job (km)	From start to end of job	From end to Following RP	Following RP

Through Chainage from Brisbane 125.24km to 137.20km

No. Date. / /

ENGINEERING CERTIFICATION (RPEQ)

ENG. AREA	NAME	SIGNATURE	NO.	DATE
CIVIL				

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2.10.2.6 Transverse Staging Scenarios

The following transverse staging options were considered:

- Two-lane formation scenario – two-lane formation and two-lane pavement
- Three-lane formation scenario – three-lane formation and two-lane pavements with overtaking lanes
- Four-lane formation scenario – four-lane formation and four-lane pavement
- Six-lane formation scenario – six-lane formation and four-lane pavement.

The two and three-lane formation transverse delivery scenarios were eliminated as they did not meet the project and technical objectives with respect to:

- Operational and maintenance safety
- Required level of service at day of opening
- Significant works required to achieve a future four or six lane divided carriageway.

The six lane formation scenario was preferred based on the following:

- Construction for the four-lane formation scenario would initially involve significant construction constraints when upgrading to the six-lane option through large cuts and fill embankments
- A significant cost differential between constructing the six-lane formation compared to constructing the four lane formation and widening to six-lanes in the future.

2.10.3 Local Road Alignments

2.10.3.1 Tandur Road

Two alignment options were investigated for Tandur Road and are shown in **Figure 2-19A** and **Figure 2-19B**. Option 1 was preferred as it provided an improved alignment with construction clear of the existing Tandur Road. Option 1 also minimised property impacts and the risks associated with working around high voltage electricity infrastructure.

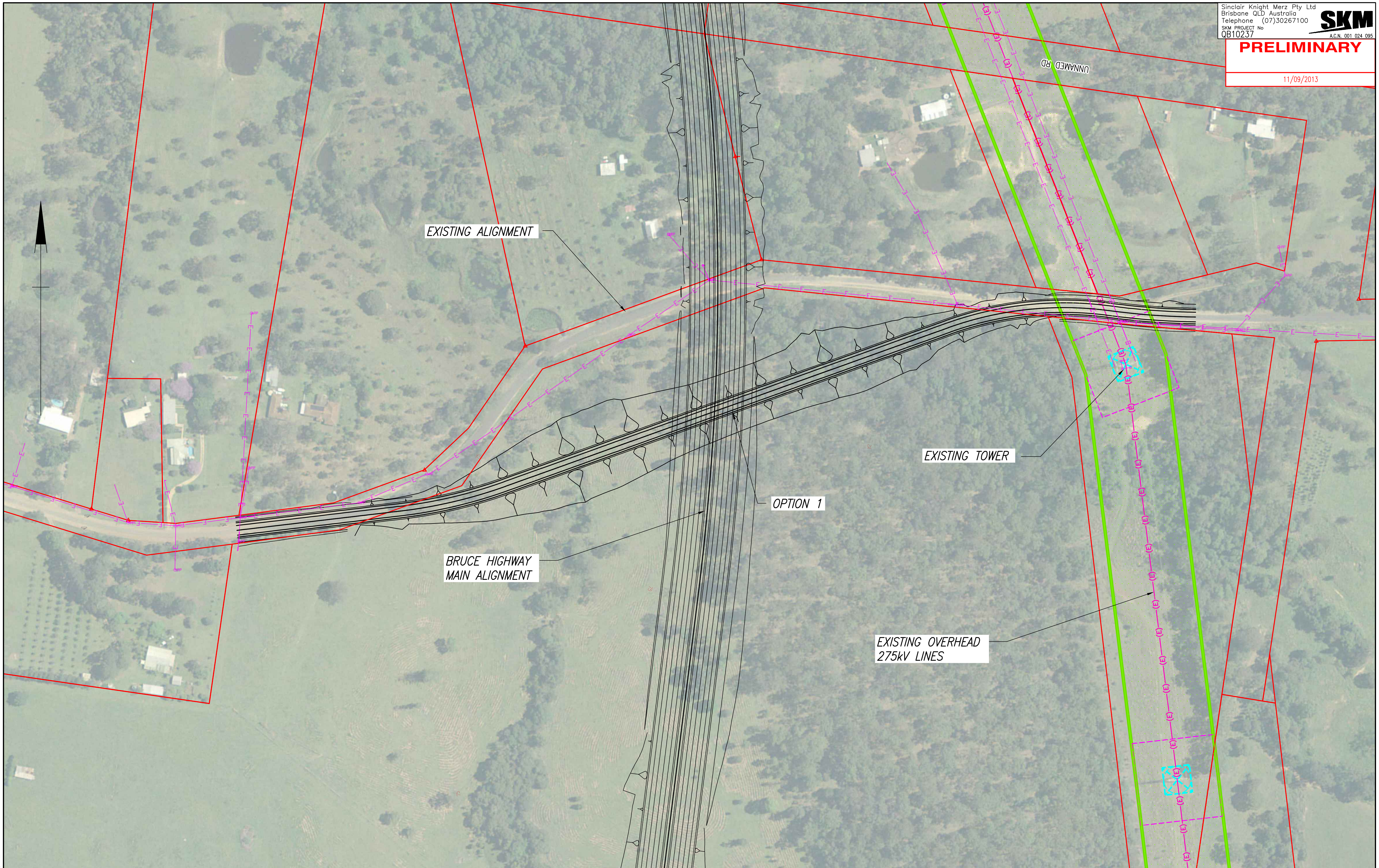

FIGURE 2–19A: TANDUR ROAD REALIGNMENT – ALTERNATIVE OPTION 1

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Revisions/Descriptions	Ref	Certification	Date	Microfiled
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Associated Job Nos

Auxiliary Drg Nos

SURVEY DATA

Horiz. Grid	MGA94 ZONE 56
Height Origin	AHD (Derived)
Survey Books	

Scales: 1:2000 (A1) 1:4000 (A3) 0 20 40 60 80m PLAN

Dimensions shown in metres except where shown otherwise

Reference Points

Preceding RP	Dist. to start of job (km)	From start to end of job	From end to Following RP	Following RP

Through Chainage from Brisbane 125.24km to 137.20km

Drawn	RRL
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Designed	MRG
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Design Reviews (RPEQ)

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Drawing No.	SK–0029 P1
Series Number	1 of 1

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FIGURE 2–19B: TANDUR ROAD REALIGNMENT – ALTERNATIVE OPTION 2

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Reference Points				
Preceding RP	Dist. to start of job (km)	From start to end of job	From end to Following RP	Following RP

Through Chainage from Brisbane 125.24km to 137.20km

Drawn	RRL
Checked	
Designed	MRG
Verified	
Design Reviews (RPEQ)	
No.	Date. / /

Scales
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1:4000 (A3) PLAN
Dimensions shown in metres except where shown otherwise

SURVEY DATA	
Horiz. Grid	MGA94 ZONE 56
Height Origin	AHD (Derived)
Survey Books	

Associated Job Nos
Auxiliary Drg Nos

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ENGINEERING CERTIFICATION (RPEQ)

ENG. AREA	NAME	SIGNATURE	NO.	DATE
CIVIL				

For scheme approval status refer Drg. No. (of)

Queensland Government
Transport and Main Roads

Job No.	232/10A/2
Contract. No.	
Drawing No.	SK–0030 P1
Series Number	1 of 1

MRR_Detail (01/10)

2.10.3.2 Woondum Road

Three alignment options were investigated for Woondum Road (**Figure 2-20A** to **Figure 2-20C**). Option 2 was preferred as it provided an improved alignment with a minor skew provided for the four by 16 metre span bridge over the main alignment. It also increased the operating speed from 65 km/h to 80 km/h.

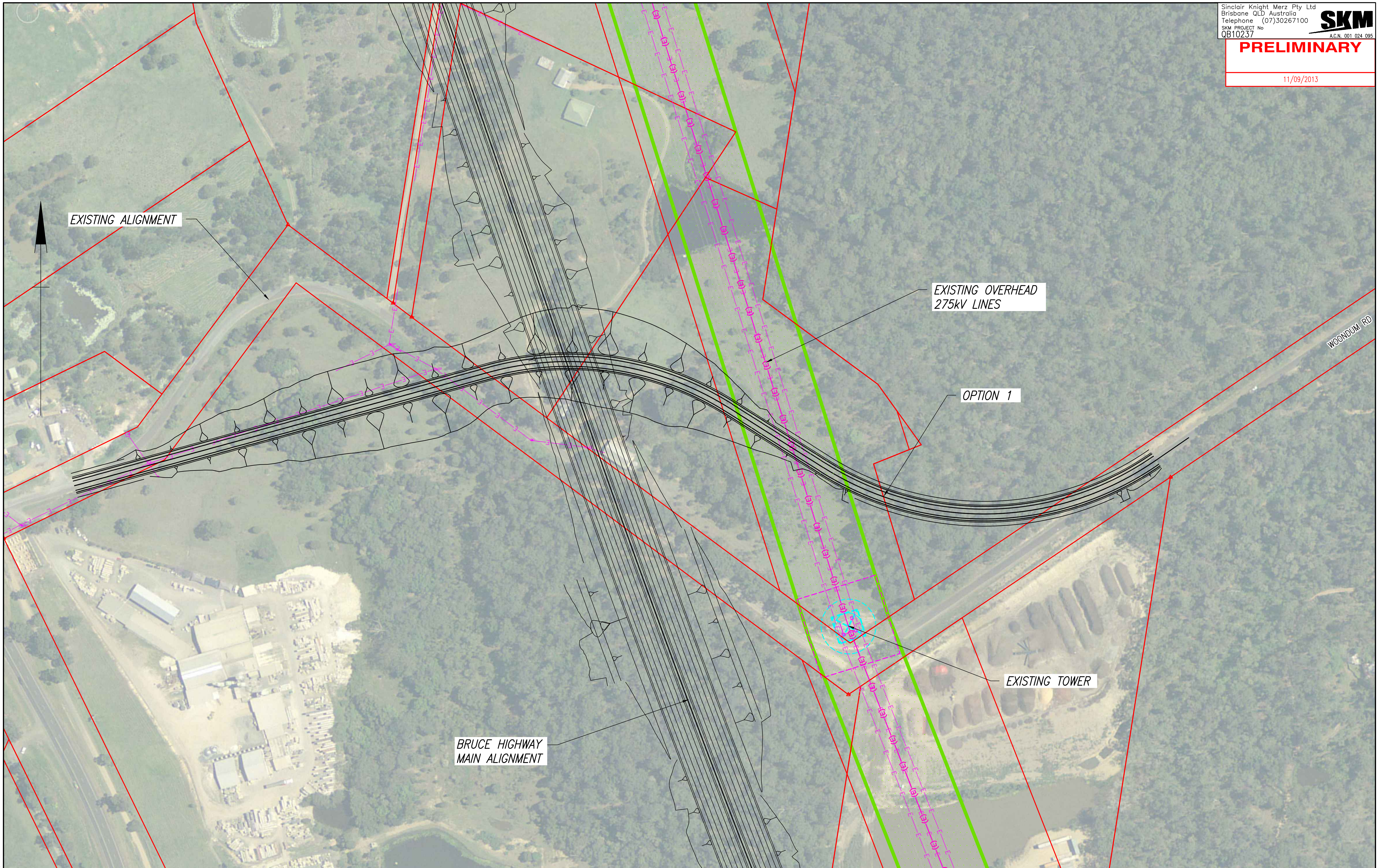

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FIGURE 2–20A: WOONDUM ROAD REALIGNMENT – ALTERNATIVE OPTION 1

GYMPIE REGION
BRUCE HIGHWAY (BRISBANE – GYMPIE)
CTL CHGE

Reference Points: Preceding RP | Dist. to start of job (km) | From start to end of job | From end to Following RP | Following RP

Through Chainage from Brisbane 125.24km to 137.20km

Drawn RRL
Checked
Designed MRG
Verified
Design Reviews (RPEQ)
No. Date. / /

SURVEY DATA
Horiz. Grid: MGA94 ZONE 56
Height Origin: AHD (Derived)
Survey Books

Associated Job Nos
Auxiliary Drg Nos

Scales
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PLAN
Dimensions shown in metres except where shown otherwise

ENGINEERING CERTIFICATION (RPEQ)
ENG. AREA | NAME | SIGNATURE | NO. | DATE
CIVIL

For scheme approval status refer Drg. No. (of)

Queensland Government
Transport and Main Roads
Job No. 232/10A/2
Contract. No.
Drawing No. SK–0031 P1
Series Number 1 of 1
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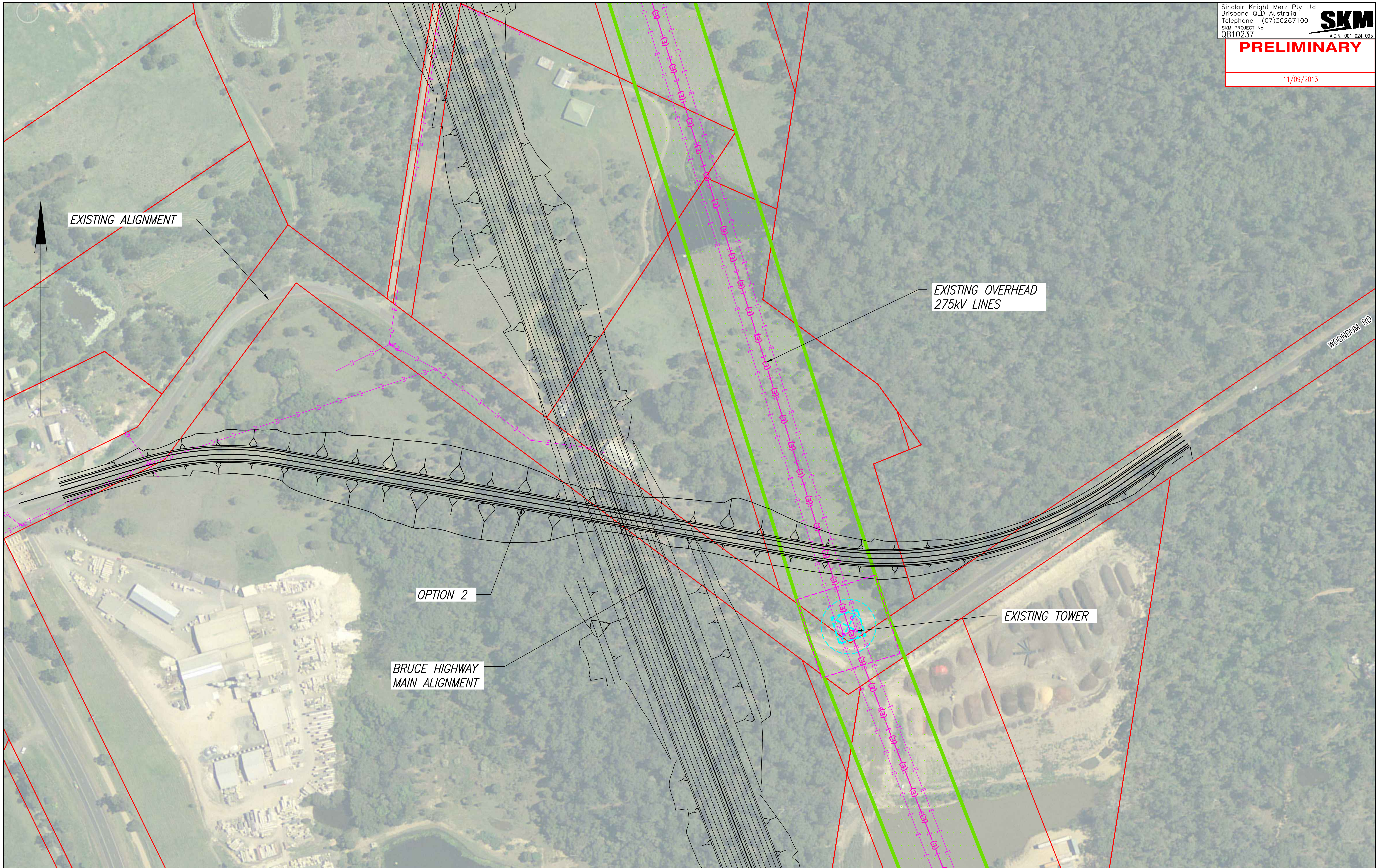

FIGURE 2–20B: WOONDUM ROAD REALIGNMENT – ALTERNATIVE OPTION 2

GYMPIE REGION

BRUCE HIGHWAY (BRISBANE – GYMPIE)

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Preceding RP	Dist. to start of job (km)	From start to end of job	From end to Following RP	Following RP

Through Chainage from Brisbane 125.24km to 137.20km

Drawn	RRL
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Designed	MRG
Verified	
Design Reviews (RPEQ)	
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ENGINEERING CERTIFICATION (RPEQ)

ENG. AREA	NAME	SIGNATURE	NO.	DATE
CIVIL				

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Transport and Main Roads

Job No.	232/10A/2
Contract. No.	
Drawing No.	SK-0032 P1
Series Number	1 of 1

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Associated Job Nos

Auxiliary Drg Nos

SURVEY DATA

Horiz. Grid	MGA94 ZONE 56
Height Origin	AHD (Derived)
Survey Books	

Scales

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1:2500 (A3)

0 10 20 30 40 50m

PLAN

Dimensions shown in metres except where shown otherwise

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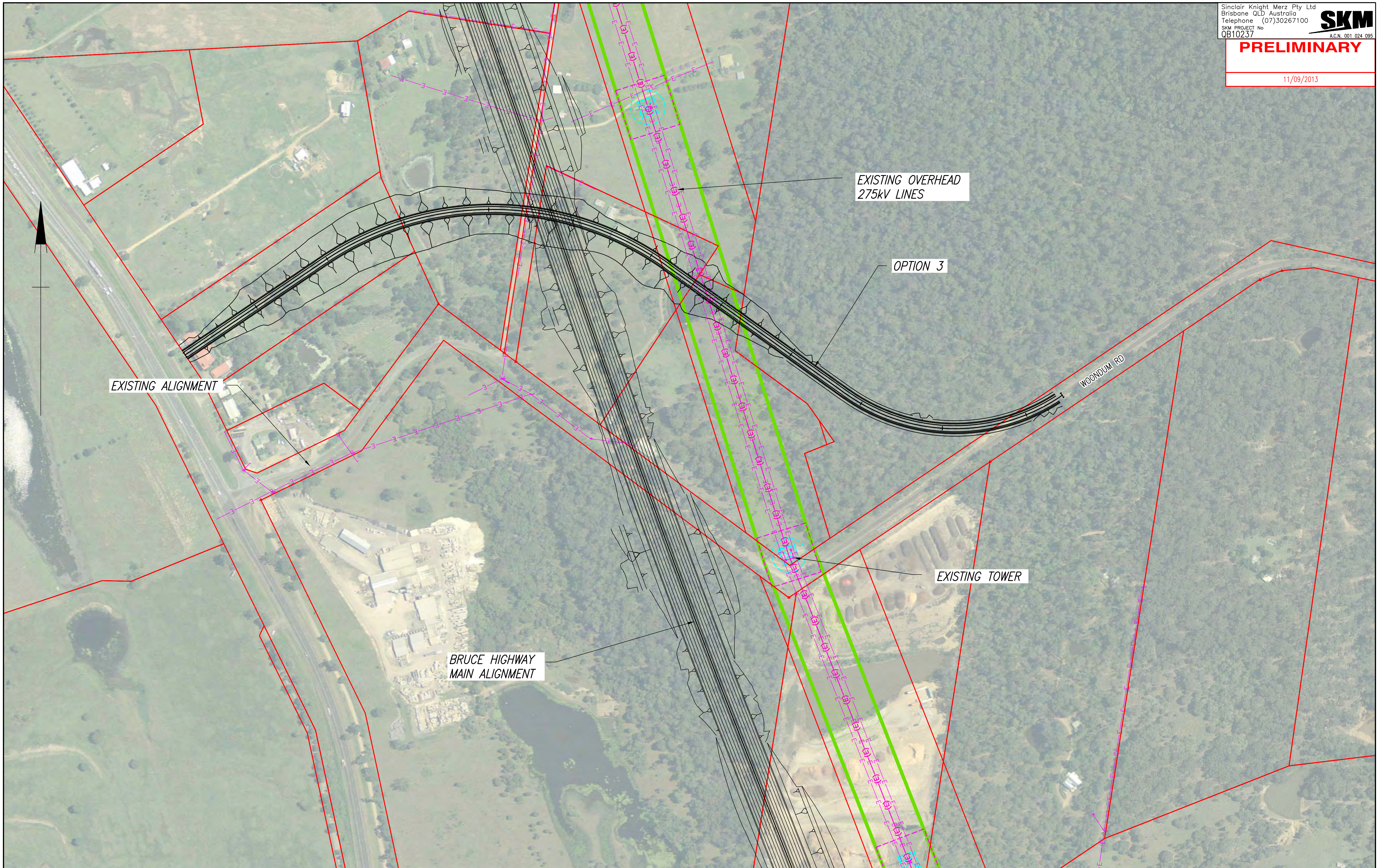

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FIGURE 2-20C: WOONDUM ROAD REALIGNMENT – ALTERNATIVE OPTION 3

GYMPIE REGION

BRUCE HIGHWAY (BRISBANE – GYMPIE)

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Job No.	232/10A/2
Contract. No.	
Drawing No.	SK-0033 P1
Series Number	1 of 1

Associated Job Nos

Auxiliary Drg Nos

SURVEY DATA	
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Height Origin	AHD (Derived)
Survey Books	

Scales
1:2000 (A1) 1:4000 (A3)
0 20 40 60 80m
PLAN

Dimensions shown in metres except where shown otherwise

Drawn	RRL
Checked	
Designed	MRG
Verified	

Design Reviews (RPEQ)
No. Date. / /

Reference Points

Preceding RP	Dist. to start of job (km)	From start to end of job	From end to Following RP	Following RP

Through Chainage from Brisbane 125.24km to 137.20km

ENGINEERING CERTIFICATION (RPEQ)

ENG. AREA	NAME	SIGNATURE	NO.	DATE
CIVIL				

For scheme approval status refer Drg. No. (of)

	Revisions/Descriptions	Ref	Certification	Date	Microfiled
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2.10.4 Structures

Analysis was undertaken for the structures options to span the major waterways along the main alignment at Traveston Creek, Kybong Creek, Cobbs Gully and Jackass Creek. The structures options considered were:

- Bridge
- Pre-cast concrete arch
- Reinforced Concrete Box Culverts (RCBC).

An assessment matrix was developed for evaluation of the crossing options (**Appendix E**). The non-price assessment criteria were divided into three categories.

- Environment – impact on flora, fauna and connectivity.
- Construction – construction risks/complexity.
- Hydraulics – flow, capacity and velocities.

Comparative estimates of costs were developed to allow a price comparison of the options.

2.10.4.1 Traveston Creek

Table 2-7 summarises the structures options investigated at Traveston Creek.

Table 2-7: Traveston Creek structures options.

	Bridge	Pre-Cast Concrete Arch	RCBC
Structure Details	3 x 30 m span	2 x 21m span x 7m height	13/2400 x 2400

The three span bridge option met the majority of the criteria to a high level and was recommended for Traveston Creek.

The concrete arch met the majority of the criteria to a medium level. Whilst it was a lower cost than the bridge, impacts within Traveston Creek and the potential additional costs for additional environmental mitigation measures were considered to be greater.

The RCBC met the majority of the criteria to a low level. It was the lowest cost option however had the highest impact on Traveston Creek and fish passage.

2.10.4.2 Kybong Creek

Table 2-8 summarises the structures options investigated at Kybong Creek.

Table 2-8: Kybong Creek structures options.

	Bridge	Pre-Cast Concrete Arch	RCBC
Structure Details	2 x 20 m spans	2 x 12 m span x 3 m height	8/3600 x 1200

The RCBC option was the lowest cost and met the majority of the criteria to a medium/low level. The RCBC was recommended for Kybong Creek primarily due to the limited cost to benefit ratio of constructing a bridge or pre-cast concrete arch with limited clearance above ground level at this location.

The RCBC had a higher impact within Kybong Creek. However, it was considered likely that the costs of additional environmental mitigation measures required would be offset by the high cost differential with the bridge option.

The concrete arch was eliminated on the basis of limited clearance available from the creek level to road level.

The two span bridge met the majority of criteria to a high level and was the highest cost.

2.10.4.3 Cobbs Gully

Table 2-9 summarises the structures options investigated at Cobbs Gully.

Table 2-9: Cobbs Gully structures options.

	Bridge	Pre-Cast Concrete Arch	RCBC
Structure Details	3 x 28 m span	1 x 21 m span x 7 m height	2/3000 x 3000

The concrete arch option met the majority of the criteria to a medium level at a significantly lower cost than the bridge option, and was recommended for Cobbs Gully. The concrete arch also provided fauna connectivity across the corridor at this location.

The concrete arch is likely to have a higher impact within the creek than the bridge. However, it was considered that the costs of additional environmental mitigation measures required would be offset by the cost differential with the bridge.

The bridge met the criteria to a high level in the majority of the assessment criteria and was the highest cost.

The RCBC met the majority of the criteria to a low level and a lower cost to the concrete arch. The RCBC was considered to have the highest impact within the creek. The height of fill required a non-standard design for the RCBC and introduced the risk of considerable lead time to manufacture and supply the units during construction.

2.10.4.4 Jackass Creek

Table 2-10 summarises the structures options investigated at Jackass Creek.

Table 2-10: Jackass Creek structures options.

	Bridge	Pre-Cast Concrete Arch	RCBC
Structure Details	4 x 30 m span	-	5/2400 x 2400

The bridge option met all the criteria to a high level and was also the highest cost. The bridge option was recommended for Jackass Creek on the basis of the construction risks associated with the concrete arch and RCBC options, and the environmental and flood mitigation benefits of the bridge option.

The RCBC met the criteria to a medium/low level in the majority of the assessment criteria and the lowest cost. The height of fill required a special design for the RCBC and introduced the risk of considerable lead time to manufacture and supply the units during construction.

A concrete arch option was eliminated as the height of fill exceeded the maximum requirements for the arch structure.

3. Legislative Requirements

3.1 Introduction

This chapter outlines the environmental and planning legislative requirements for the Project. It provides an overview of the relevant Commonwealth and state legislation, as well as state, regional and local planning instruments and its relevance to the Project. The environmental and planning statutory requirements are current as of the date of this REF version.

The objective of this chapter is to:

- Identify Commonwealth and state legislation, and state, regional and local planning instruments relevant to the Project.
- Provide detail of how each statutory instrument applies to the Project.
- Identify potential approvals, licences and permits that may be required in the construction and operation of the proposed new road.

3.2 Commonwealth Legislation

3.2.1 Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) regulates activities that impact on matters of national environmental significance (MNES). An action that will have, or is likely to have, significant impacts[6] on MNES is defined as a 'controlled action' and must be referred to the Commonwealth Department of the Environment (DotE).

3.2.1.1 Referral

If a Project is referred to DotE under the EPBC Act, a recommendation must be provided as to whether the proponent believes the Project to constitute a 'controlled action'. This recommendation may state:

- The proposed action is not a controlled action, or
- The proposed action is a controlled action, in which case the MNES likely to be impacted are nominated.

This section allows proponents to submit a referral to DotE even if they do not believe a project to be controlled action, thereby eliminating the risk of third party referrals to DotE which may impact on the Project schedule.

3.2.1.2 Decision

DotE will decide whether the proposed action is likely to have a significant impact on MNES and whether assessment and approval under the EPBC Act is required. This decision may state:

- The proposed action is not likely to have a significant impact and does not need approval, or
- The proposed action is not likely to have a significant impact if undertaken in a particular manner, or
- The proposed action is likely to have a significant impact and does need approval (i.e. it is a controlled action), or
- The proposed action would have unacceptable impacts and cannot proceed.

DotE will determine the level of assessment required if the proposed action will have significant impacts on MNES.

[6] As defined in the Significant Impact Guidelines – matters of national environmental significance (DEWHA, 2009).

3.2.1.3 MNES Relevant to the Project

A search of the Protected Matters Search Tool was used to identify MNES potentially relevant to the Project. The following MNES were identified as requiring further investigation to determine the significance of impacts as a result of the Project:

- Listed threatened species and ecological communities.
- Migratory species.

Database searches and field surveys have been conducted to determine the likely presence of these MNES in the vicinity of the Project that may be impacted by the construction and operation of the proposed road. **Chapter 6 – Terrestrial Ecology** and **Chapter 7 – Aquatic Ecology and Water Quality** provide details of the survey methodologies employed, the flora and fauna species identified during these surveys, and the potential impacts of the Project on these species.

A summary of the MNES potentially impacted by the Project is provided in **Table 3-1**.

Table 3-1: Summary of potential impacts on MNES as a result of the Project.

MNES	Protected Matters Search Tool	Field Survey
Threatened ecological communities	Two EPBC Act Threatened Ecological Communities may occur in the area	No threatened ecological communities were identified during field surveys. Refer to **Chapter 6 – Terrestrial Ecology** for further details.
Threatened species	35 EPBC Act threatened species potentially occur in the search area	No EPBC Act listed flora species were identified during field surveys. Evidence of the presence of the Koala (Vulnerable) and Black-breasted Button-quail (Vulnerable) were observed during field surveys. In addition, the Grey-headed Flying-fox (Vulnerable) is considered likely to occur in the vicinity of the Project. However, none of these species were directly observed during fauna surveys. Approximately 36.1 ha of Koala habitat and 37.1 ha of Grey-headed Flying Fox habitat, will be cleared to allow construction of the Project. There is also potential for indirect impacts on Black-breasted Button-quail habitat located in Woondum State Forest. Impacts on these species are not likely to be significant provided adequate mitigation measures are implemented. Refer to **Chapter 6 – Terrestrial Ecology** for further details. No aquatic MNES species were observed during field surveys. Direct impacts on these species as a result of the Project are unlikely. Refer to **Chapter 7 – Aquatic Ecology and Water Quality** for further details.
Migratory Species	14 EPBC Act migratory species potentially occur in the search area	Seven migratory species were observed during field surveys. An additional seven species were considered likely to occur in the vicinity of the Project.

The Protected Matters Search Tool indicates that the Project is upstream of the Great Sandy Strait Ramsar wetland of international importance. However, impacts on this wetland are unlikely due to the distance between the project site and the Great Sandy Strait Ramsar site, provided appropriate erosion and sediment control measures are incorporated into construction.

Impacts on listed threatened species, particularly the Koala and Grey-headed Flying Fox, are considered the greatest risk of triggering an environmental assessment under the EPBC Act. As noted in **Table 3-1**, results of field surveys confirmed that there are no threatened ecological communities within the Project area.

3.2.1.4 Environmental Assessment Process

If an action to be undertaken for the Project is declared as a ‘controlled action’, the Project will be subject to the assessment and approval process under the EPBC Act. An assessment can be carried out through the following processes:

- Accredited assessment
- Assessment on referral information (assessment done solely on the information provided in the referral form)
- Assessment on preliminary documentation (referral form and any other relevant material identified by the Minister as being necessary to adequately assess a proposed action)
- Assessment by environmental impact statement (EIS) or public environment report (PER)
- Assessment by public inquiry.

A bilateral agreement established between the Queensland Government and the Australian Government allows the Australian Government Minister for the Environment to rely on specified environmental impact assessment processes of the State of Queensland, such as an EIS required for the Project under the *State Development and Public Works Organisation Act 1971* (SDPWO Act), the *Sustainable Planning Act 2009* (SP Act), or the *Environmental Protection Act 1994* (EP Act) in assessing actions under the EPBC Act.

3.2.1.5 Offsets under the EPBC Act

If the Project is declared to be a controlled action, offsets may be required for any residual impacts on MNES that cannot be avoided or mitigated. Residual impacts area those that remain after avoidance and mitigation measures have been implemented.

Offsets may be in the form of direct offsets or other compensatory measures, however direct offsets must make up 90% of the total offset package. Direct offsets must result in a net biodiversity gain for the impacted MNES and may include enhancing habitat, creating new habitat, reducing threats or averting loss of an MNES or its habitat. Other compensatory measures include research, educational programs or other relevant actions that are described in an approved recovery plan for the impacted MNES.

3.2.1.6 Relevance to Project

The Project is to be referred DotE to determine if it has the potential to have a significant impact on MNES. In the event that the Project is declared to be a ‘controlled action’ it will require approval under the EPBC Act.

The requirement for additional environmental assessment under the EPBC Act is considered to be a low to moderate risk based on the findings of the field surveys completed. However, it is considered likely that the project will be approved subject to meeting certain conditions. It is recommended that a referral is submitted to DotE during the Detailed Design phase to confirm the environmental assessment requirements and eliminate the risk of a third party referral at a later date.

If required, completion of an EIS is likely to require 12 to 24 months; therefore early identification of this requirement will be necessary. As detailed in **Section 3.2.1.5**, an offset may be required for impacts on MNES and their habitat if the Project is declared a controlled action.

3.2.2 Aboriginal and Torres Strait Islander Heritage Protection Act 1984

The objective of the *Aboriginal and Torres Strait Islander Heritage Protection Act 1984* (ATSIHP Act) is to preserve and protect places, areas and objects that are of particular significance to Aboriginal people. Aboriginal people can request the Australian Government protect places or things of significance to Aboriginal people. These Commonwealth powers override the powers of the States and Territories. The Commonwealth would seek to exercise these powers only after the relevant Aboriginal party had exhausted all opportunities to protect the Aboriginal cultural heritage through the State or Territory legislative process.

3.2.2.1 Relevant to Project – Duty to Report

Personnel involved in the Project who discover anything he or she has reasonable grounds to suspect to be Aboriginal remains shall report the discovery to the Commonwealth Minister who is responsible for administering the ATSIHP Act, giving particulars of the remains and of their location.

In the event that an application is made for the declaration of a ‘significant Aboriginal area’ or ‘significant Aboriginal object’ within the Project area, there may be potential delays while the application is assessed. TMR would be consulted with during this application process.

All personnel involved with the Project have a responsibility to report any finds that are potentially Aboriginal remains.

Impact to cultural heritage items and sites is considered a medium risk for the Project. This will be managed through the duty of care provisions included in the Queensland *Aboriginal Cultural Heritage Act 2003* through the completion of site assessments and surveys.

An assessment of the Project area’s potential to contain places or things of significance to Aboriginal people should include a search of the Aboriginal and Torres Strait Islander Cultural Heritage Database. This search should be undertaken during future phases of environmental assessment for each land parcel impacted by the Project. The Project area’s Traditional Owners would be consulted with during this assessment.

3.2.3 Native Title Act 1993

The *Native Title Act 1993* (NT Act) provides for the recognition and protection of native title, establishes ways in which future dealings affecting native title may proceed, establishes a mechanism for determining native title claims and provides for the validation of past acts. The NT Act also obligates the State to ascertain whether native title exists on each parcel of land affected by the Project, issue notices for the suppression or extinguishment of native title if extant, and compensate native title holders for any loss, diminution or impairment of their rights.

Native title assessments have been conducted by TMR’s Native Title Unit in accordance with the ‘Queensland Government – Native Title Work Procedures’ for each land parcel to determine whether native title exists and if so, the appropriate native title parties and procedural rights.

Section 24KA of the NT Act would be applied to the Project, meaning native title rights and interests would continue to exist and would not be extinguished. Rights and interests would have no bearing on construction, operation, use, maintenance or repair of the Project.

Section 24JA of the NT Act would apply where the Project impacted on parcels of land designated as reserves. Native title rights and interests would be extinguished in this instance, as the construction or establishment of a public work (includes ‘road’) extinguishes native title in accordance with s24JB (2) of the NT Act.

3.2.3.1 Relevance to Project – Native Title Requirements

TMR is required to ensure that the necessary processes are conducted to achieve compliance with the Future Act requirements of the NT Act.

3.3 State Legislation and Policies

3.3.1 State Development and Public Works Organisation Act 1971

The purpose of the *State Development and Public Works Organisation Act 1971* (SDPWO Act) is to facilitate timely, coordinated and environmentally responsible infrastructure, planning and development to support Queensland’s economic and social progress.

Section 25 of the SDPWO Act requires that proper account is taken of the environmental effects of any development. Compliance with this requirement can be achieved by following TMR's assessment process.

Under section 26 of the SDPWO Act, the Coordinator-General may declare the Project to be a coordinated project for which an EIS is required. In this event, the assessment processes for an EIS under the SDPWO Act must be followed.

The Coordinator-General will consider a number of factors in determining whether a project is to be considered a coordinated project, including:

- If provided, the Project proponent's initial advice statement
- Complexity of local, state and federal government approval requirements
- Potential environmental impacts
- Potential impacts on existing infrastructure
- Level of capital investment
- Job opportunities
- Project's strategic significance to locality, region or state
- Relevant local, state and federal government planning schemes and policies.

The declaration of the Project as a coordinated project requiring an EIS does not exempt it from requiring necessary development approvals or compliance with relevant planning or environment laws and planning instruments.

3.3.1.1 Relevance to Project – Environmental Assessment Process

If the Project is declared to be a coordinated project by the Coordinator-General, TMR will be required to undertake an environmental assessment under section 26 of the SDPWO Act. This environmental assessment will generally require the preparation of an EIS, which may take 12 to 24 months to complete. This is considered to be a low risk as the Section A and B components of the Project were not considered to be coordinated projects requiring an EIS under the SDPWO Act.

If the Project is not declared to be a coordinated project requiring an EIS, TMR's standard internal assessment processes as detailed in the Road Projects Environmental Processes Manual will satisfy the requirements under section 25 of the SDPWO Act.

3.3.2 Sustainable Planning Act 2009

The *Sustainable Planning Act 2009* (SP Act) regulates and manages development in Queensland, providing a framework for the preparation and implementation of planning instruments. It requires the coordination and integration of State, regional and local planning outcomes. A development permit is required under the SP Act prior to commencing assessable development.

3.3.2.1 Potential Permit Requirements

Schedule 3 of the *Sustainable Planning Regulation 2009* (SP Reg) outlines assessable development and self-assessable development. **Table 3-2** outlines assessable development identified in schedule 3 that may be relevant to the Project along with the relevant legislative trigger. They are discussed further in the following sections.

Table 3-2: Schedule 3 of SP Reg - Assessable and Self-Assessable Development.

Type of Development	Relevant Section of Schedule 3 of SP Reg	Supporting Legislation	Further Information
Material Change of Use for concurrence Environmentally Relevant Activities	Table 2, Item 1	*Environmental Protection Act 1994*	Section 1.3.3.1
Operational Works for Clearing Vegetation	Table 4, Item 1	*Vegetation Management Act 1999*	Section 1.3.6.1
Operational Work for Interfering with Water	Table 4, Item 3	*Water Act 2000*	Section 1.3.4.1
Operational Works for Constructing a Waterway Barrier	Table 4, Item 6	*Fisheries Act 1994*	Section 1.3.5.3
All Aspects of Development for the Removal of Quarry Material	Table 5, Item 1	*Water Act 2000*	Section 1.3.4.1
All Aspects of Development on a Queensland Heritage Place	Table 5, Item 2	*Queensland Heritage Act 1992*	Section 1.3.2.3
All Aspects of Development on a Local Heritage Place	Table 5, Item 3	*Queensland Heritage Act 1992*	Section 1.3.2.3

3.3.2.2 State Assessment and Referral Agency

As of 1 July 2013, the State Assessment and Referral Agency (SARA) established within the Department of State Development, Infrastructure and Planning (DSDIP) a single point of lodgement, coordination and decision making on behalf of all state agencies (not including government-owned organisations such as Energex). Under the new arrangements, SARA is the assessment manager or concurrence agency for all development applications where a state agency has a jurisdiction.

The State Development Assessment Provisions (SDAP) set out the matters of interest to the state for development assessment, where the chief executive administering the SP Act (i.e. through SARA) is responsible for assessing or deciding development applications.

The SDAP is prescribed in the SP Reg, and contains the matters the chief executive may have regard to when assessing a development application. The chief executive may give these matters the weight he or she is satisfied is appropriate.

SDAP contains state codes that are specific to each matter of state interest.

3.3.2.3 Schedule 3 Exemptions

Schedule 3, table 4, item 1 of the SP Reg outlines that operational work for the clearing of native vegetation, as defined under the *Vegetation Management Act 1999* (VM Act), is assessable development unless the clearing is mentioned in schedule 24 of the SP Reg.

The clearing of native vegetation for road works carried out on a State-controlled road or future State-controlled road is exempt development under schedule 24, part 1, item 11 of the SP Regulation. Road works is defined under the TI Act as “constructing roads or things associated with roads”. As the Project involves undertaking works for State-controlled roads, all works for the Project within the State-controlled road corridor, including the removal of vegetation is exempt development. No permits for the clearing of vegetation or associated offsets will be required under the VM Act for road works within the State-controlled road corridor.

Schedule 24, part 1, item 16 of the SP Reg also exempts clearing for community infrastructure specified in schedule 2 of the SP Reg. State-controlled roads are defined in schedule 2 as community infrastructure. It is not clearly specified in schedule 24 or schedule 2 whether this exemption applies to clearing for ancillary activities associated with community infrastructure where these activities occur outside of the State-controlled road corridor (or future State-controlled road corridor).

Schedule 3, table 5, item 2 of the SP Reg states that development carried out by the State does not require a development permit for any aspect of development on a Queensland heritage place, provided TMR has sought and received permission from the Minister.

Schedule 3, table 5, item 3 of the SP Regulation states that development that is mentioned in schedule 4 of the SP Reg does not require a development permit for any aspect of development on a local heritage place. Consequently, a development permit would not be required if the works interfere with a local heritage place.

3.3.2.4 Schedule 4 Exemptions

Schedule 4 of the SP Reg outlines development that cannot be declared to be development of a particular type against a local planning instrument. **Table 3-3** outlines the types of development that could be relevant to the Project that would not be declared to be development of a particular type against a local government planning instrument.

Table 3-3: Schedule 4 exemptions relevant to TMR projects.

Type of Development	Relevant Section of Schedule 4 of SP Reg	Details
Operational Work	Table 4, Item 1	Operational work carried out by, or on behalf of, a public sector entity authorised under State law to carry out the work.
Operational Work	Table 4, Item 2	Operational work for ancillary works and encroachment done as required by a contract entered into under the Section 50 of the *Transport Infrastructure Act 1994*.
Operational Work	Table 4, Item 10	Operational work for removing quarry material from a State forest, timber reserve, forest entitlement area or Crown land as defined under the *Forestry Act 1959*.
All aspects of development	Table 5, Item 6	All aspects of development a person is directed to carry out under a notice, order or direction made under State law.
All aspects of development	Table 5, Item 7	All aspects of development: a) for the maintenance, repair, augmentation, upgrading, duplication or widening of State-controlled road infrastructure; or b) for ancillary works and encroachments carried out by the State; or c) adjacent to a State-controlled road and ancillary to the construction, maintenance, repair, augmentation, upgrading, duplication or widening of the road, such as excavating, crushing, screening, cutting, filling, preparing road construction material (including concrete), storing materials, removing vegetation, dam building, site offices and worker accommodation.

The Project corridor has been designated as a future State-controlled road. As the Project includes the duplication and upgrading of State-controlled roads, all works for the Project within the State-controlled road corridor are exempt from assessment against the planning scheme. However, the Project's compatibility with the planning scheme has been considered in **Section 4.3.4**.

3.3.2.5 Community Infrastructure Designation

Land may be designated by a Minister or a local government for community infrastructure under chapter 5 of the SP Act. The process is a mechanism for the forward identification of land for community infrastructure to facilitate the integration of land use and infrastructure planning and the efficient and cost effective provision of the infrastructure.

A Community Infrastructure Designation (CID) negates the need to undertake a development assessment under the relevant local government planning schemes and any reconfigurations of land (subdivisions) in relation to the Project are also exempt from assessment.

In order for the Project to be designated as community infrastructure it will need approval from a State Minister. Rather than the applicant applying directly to referral agencies, the State Minister will take advice on the decision making process from the relevant state agencies. This advice will be incorporated into the State Minister's overall response to the CID application. The State Minister will approve or refuse the CID based on an assessment of the following matters:

- A designation must show that there has been adequate environmental assessment and public consultation and that issues raised during public consultation have been taken into account.
- Designation must pass the public benefit test to ensure the designation is justified.
- Consideration of the approved development requirements for any relevant land approved as a State Development Area under the SDPWO Act.
- Any state planning regulatory provisions that may apply.
- Any regional plans that may apply.
- Any relevant state planning policies.
- Any relevant declared master plans.
- Any relevant local planning instruments.

A designation may include requirements about the use of land, such as plans showing the development height, shape or location of works on the land, or other requirements to lessen the impacts of works or use of the land.

In order to provide adequate environmental assessment and public consultation it has been identified that the EIS process under part 4, division 3 of the SDPWO Act is a sufficient means for conveying the necessary information.

It is understood that the proposed works are identified as a potential 'community infrastructure' use as described within schedule 2 of the SP Reg. Schedule 2 states that "State controlled roads" are considered as community infrastructure for transport.

Development under a CID becomes exempt from assessment against a local planning scheme. The CID process also clearly defines land intended to be developed for community infrastructure such that this purpose is considered in future planning instruments and decisions. Given that development for a State-controlled road is made exempt from assessment under a local planning scheme under schedule 4 of the SP Reg, and gazettal of a State-controlled road or future State-controlled road clearly defines land intended for this community purpose, the CID process is not considered appropriate for the Project. Currently, there are no State-controlled roads listed as having a CID on Department of State Development, Infrastructure and Planning CID database.

3.3.2.6 State Planning Policy

The State Planning Policy (SPP) came into effect on 2 December 2013. The SPP replaces all previous state planning policies and provides a clear, consolidated and comprehensive view of the state's interests in land use planning and development. The SPP applies to the preparation or amendment of local planning schemes and regional plans, designation of land for community infrastructure, and development assessment carried out by local government where the SPP has not been appropriately reflected in a local planning scheme.

The SPP specifies sixteen state interests arranged under five broad themes (liveable communities and housing, economic growth, environment and heritage, hazards and safety and infrastructure). Key themes and associated state interests relevant to this Project include:

- Environment and heritage.
  - Biodiversity.
  - Cultural heritage.
  - Water quality.

- Hazards and safety.
  - Natural hazards.
- Infrastructure.
  - State transport infrastructure.

3.3.2.7 Relevance to Project – Development Assessment

As the Project does not involve designating land for community infrastructure or development assessable under a local planning scheme, the SPP is not applicable to the Project. However, consideration has been given to the Project's consistency with relevant state interests as discussed in **Chapter 4 – Planning and Land Use**.

3.3.3 Environmental Protection Act 1994

The *Environmental Protection Act 1994* (EP Act) provides for the protection of Queensland's environment while allowing for development in accordance with the principles of ecologically sustainable development.

The following provisions of the EP Act are relevant to the Project:

- Carrying out Environmentally Relevant Activities (ERAs)
- Depositing prescribed water contaminants in waters
- The general environmental duty and duty to notify
- Disposal of contaminated soil
- Environmental Protection Policies subordinate to the EP Act.

3.3.3.1 Environmentally Relevant Activities

Schedule 2 of the *Environmental Protection Regulation 2009* (EP Reg) lists prescribed Environmentally Relevant Activities (ERAs). In order to operate an ERA, an environmental authority (EA) needs to be obtained under the EP Act.

Prescribed ERAs which listed in schedule 2 of the EP Reg may also trigger the requirement for a development permit to be obtained under schedule 3 of the SP Reg (refer **section 1.3.2.1**). Such ERAs are known as concurrence ERAs. In instances where a development permit is also required for a concurrence ERA under the SP Act, the development application for the development permit is also taken to be the application for the EA under the EP Act.

The EA application process has different levels of assessment according to the level of potential environmental risk. To take into account the level of risk, there are three types of EA applications:

- *Standard application* - if the ERA can meet the eligibility criteria and comply with the standard conditions.
- *Variation application* - if the ERA can meet the eligibility criteria, one or more of the standard conditions needs to be varied.
- *Site-specific application* - if the ERA does not have eligibility criteria or cannot meet the eligibility criteria.
- Standard applications for EAs for prescribed ERAs which comply with the eligibility criteria and standard conditions are very low risk and do not require the lodgement of detailed technical information with the application in order to obtain the EA.

3.3.3.2 Relevance to Project – ERAs

ERAs for the Project will primarily be carried out offsite under an existing EA by a suitable registered operator. The ERAs potentially required onsite for the Project include:

- ERA 8 - Chemical storage, including fuels

- ERA 53 – Composting and Soil Conditioner Manufacturing.

Licensing of ERAs under EAs is considered to be a relatively low risk for the Project, as this risk has effectively been passed onto the Contractor. The main risk for TMR relating to ERAs is likely to be Contractor compliance with EA conditions, which may be managed through an inspection and auditing regime during construction.

3.3.3.3 Depositing Contaminants in Waters

Section 440ZG of the EP Act states that a person must not unlawfully deposit a prescribed contaminant, including sediment or hydrocarbons, in a manner that it could be reasonably expected to enter a waterway. A breach of section 440ZG may be caused by:

- Inadequate erosion and sediment controls leading to offsite transport of sediment
- Sediment leaving a construction site on the tyres of vehicles and being deposited in a roadside gutter or similar
- Spills of chemicals or fuels resulting in contamination of waterways
- Accidental discharge of sewage to waterways.

The intent of section 440ZG is the protection of waters by placing broad responsibility for the management of all direct and indirect discharges to waters on individuals. Compliance with the general environmental duty (**Section 3.3.3.4**) is an adequate defence of a breach of section 440ZG, provided that it can be demonstrated that all reasonable and practical measures were taken to prevent the breach from occurring.

Deposition of sediment resulting from large exposed areas and inadequate erosion and sediment controls is a high risk for the Project. Controls identified to manage this risk include the development of ESCPs and an EMP(C). These plans should include the effective staging of works to minimise size and duration of disturbed areas as a requirement, and should be regularly audited during construction to determine compliance.

3.3.3.4 Relevance to Project – General Environmental Duty

Under the EP Act, activities that are likely to cause environmental harm are unlawful unless:

- The person carrying out the activity has discharged their general environmental duty, or
- The activity has been authorised under the EP Act.

The general environmental duty defined in section 319 of the EP Act states that "a person must not carry out any activity that causes, or is likely to cause, environmental harm unless the person takes all reasonable and practical measures to prevent or minimise the harm". TMR and its Contractor(s) must adhere to this requirement throughout the construction of the Project.

Section 320 of the EP Act specifies a duty to notify that applies if, "while carrying out an activity, a person becomes aware that an event has happened that causes or threatens serious or material environmental harm because of the person's or someone else's act or omission in carrying out the primary activity or another activity being carried out in association with the primary activity". TMR and its Contractor(s) must adhere to this requirement throughout the construction of the Project and must notify DEHP of any incidents or other unauthorised activities causing actual or potential serious or material environmental harm within 24 hours.

Section 371 of the EP Act specifies a duty to notify that applies if the owner or occupier of land (including TMR) who becomes aware the land has been, or is being, contaminated by a contaminant the owner or occupier knows is a hazardous contaminant, then the owner or occupier must, within 22 business days after becoming aware the land has been, or is being, contaminated, give notice to the administering authority in the approved form.

3.3.3.5 Relevance to Project – Disposal of Contaminated Soil

Searches of the Contaminated Land Register (CLR) and Environmental Management Register (EMR) are generally carried out during the transfer of ownership of land. These searches have been completed for all properties acquired for the Project. No parcels of land impacted by the Project were included on the CLR. Two parcels of land shown in **Table 3-4** were included on the EMR.

Table 3-4: Land parcels impacted by the Project listed on the EMR.

Site/Lot	EMR Result	Ownership
Lot 1073, M37442	The site has been subject to the following Notifiable Activity pursuant to section 374 of the *Environmental Protection Act 1994.* LIVESTOCK DIP OR SPRAY RACE - For the majority of rural properties only a small area may be affected by the chemicals used in livestock dips and spray races.	Department of Transport and Main Roads
Lot 3, RP208996	The site has been subject to the following Notifiable Activity pursuant to section 374 of the Environmental Protection Act 1994. LIVESTOCK DIP OR SPRAY RACE - For the majority of rural properties only a small area may be affected by the chemicals used in livestock dips and spray races.	Department of Transport and Main Roads

Both lots listed in **Table 3-4** were ground-truthed in February 2014 and confirmed the location of the cattle dips. The cattle dips were identified along the boundary of both lots at the western extent of the parcels of land, greater than 500 m from the extent of likely Project earthworks. **Figure 8-3** in **Chapter 8 – Geology and Soils** presents the location of the cattle dip in relation to the Project.

Contaminated land resulting from previous land uses may be encountered during the construction phase. If the geographical extent, concentration of contaminants and/or nature of contaminants represents the potential for serious environmental harm, the DEHP Contaminated Land Unit must be notified under section 371 of the EP Act and the land may be registered on the EMR or CLR. A Disposal Permit (section 424 of the EP Act) must be obtained if contaminated soil is to be removed from a site listed on the EMR or CLR. If there is evidence of minor contamination from previous activities or incidents during construction which does not represent a potential for environmental harm, the material may be disposed of as waste soil or fill.

Figure 3-1: Cattle dip located along the boundary of Lot 1073 on M37442 and Lot 3 on RP 208996.

3.3.3.6 Relevance to Project – Environmental Protection Policies

The EP Act enables subordinate legislation which defines environmental objectives and sets targets for achieving these objectives. The following subordinate legislation is applicable to the Project:

- *Environmental Protection (Air) Policy 2008 (EPP (Air))*
- *Environmental Protection (Noise) Policy 2008 (EPP (Noise))*
- *Environmental Protection (Water) Policy 2009 (EPP (Water))*
- *Environmental Protection (Waste Management) Regulation 2000*
- *Environmental Protection Regulation 2008*

Each of the EPPs identifies the environmental values and performance objectives required to protect these values. TMR will be required to adhere to the relevant performance objectives outlined in the EPPs.

3.3.3.7 Relevance to Project – Exemptions under the EP Act

Under the *Environmental Protection Regulation 2008* (EP Reg), TMR are currently exempt from the requirement to obtain development approval for:

- Extracting and screening material over a surface area less than 10,000 m^2 in an existing road corridor if the quarried material is to be used for road construction or maintenance in any year.
- Extracting, other than by dredging and screening less than 5, 000 tonnes of material in a year.
- Extracting material from a place for constructing a road (i.e. cut to fill construction).

In addition, schedule 1 of the EP Act provides a list of exclusions relating to environmental nuisance, including:

- Safety signal noise from a reversing vehicle.
- Noise from the ordinary use of a public road or State-controlled road.
- Maintaining a public road, State-controlled road, railway or other infrastructure for public transport.

3.3.4 Water Act 2000

The purpose of the *Water Act 2000* (Water Act) is to protect rivers, creeks or other streams in which water flows permanently or intermittently. A person must not take or interfere with the flow of water in a watercourse, lake or spring without an authorisation or entitlement under the Water Act.

3.3.4.1 Relevance to Project – Potential Permit Requirements

As a 'constructing authority', TMR has authority to take water to construct and maintain infrastructure under section 20C of the Water Act subject to compliance with the 'Protocol – authorised taking of water without an entitlement under the Water Regulation 2002'. However, this exemption does not include interfering with watercourses as required for diversions. Further information on this exemption is provided in **Section 3.3.4.2**.

The proposed construction methodology includes the diversion of Traveston Creek and Kybong Creek. These works, and any other works including the diversion or realignment of watercourses for the Project, will involve interfering with the flow of water in a watercourse for which a water licence is required under section 206 of the Water Act. Pursuant to schedule 3, part 1, table 4, item 3 of the SP Regulation, a development permit for operational work that involves taking or interfering with water from a watercourse, lake or spring will not be required where the interfering is authorised under a water licence and the work complies with the conditions of the licence.

In accordance with schedule 3, part 1, table 5, item 1 of the SP Reg, a development permit for operational works is required for works involving the removal of quarry material from a watercourse as defined under the Water Act. In addition to the development permit, a quarry material allocation notice would need to be obtained under the Water Act prior to any quarrying activities within the watercourse.

Permits required under the Water Act do not represent a significant risk to the Project.

3.3.4.2 Relevance to Project – Exemptions under the Water Act

From July 1, 2011 TMR and nominated construction contractors are exempt from the requirement to obtain a permit to take water for construction and maintenance of TMR infrastructure for projects with a foreseeable end date. This exemption does not include:

- The construction and installation of associated development such as bores or fixed water pumps.
- Destruction of vegetation, excavation or placing of fill in a watercourse.
- Installing structures that interfere with the flow of water.
- The take of water from a watercourse or lake within a water supply scheme area managed under an interim resource operations licence, resource operations licence or distribution operations licence unless prior written approval is obtained from the licensee.
- Diverting flow outside a watercourse.
- Regular watering of landscaping after the maintenance phase has been completed.

TMR will be required to comply with the requirements of the permit to take water, including obtaining written approval from the licensee of the resource operations licence at the time of construction.

A permit to excavate or place fill in a watercourse, lake or spring (riverine protection permit) will not be required under section 266 of provided the works comply with the "Riverine Protection Permit Exemption Requirements".

TMR and its contractors, subcontractors and other agents are approved entities authorised to use these exemption requirements. The exemption requirements only apply to the excavation or placement of fill in a watercourse, lake or spring in association with:

- The construction, installation, removal, maintenance or protection of approved infrastructure
- The establishment and maintenance of flow efficiency around approved structures
- Riverine restoration or rehabilitation, flood mitigation, erosion protection or weed control.

Suitable planning, notification and record keeping activities will be required for works carried out under these exemption requirements.

3.3.5 Fisheries Act 1994

The purpose of the *Fisheries Act 1994* (Fisheries Act) in relation to the Project is the management and protection of fish habitat, including the ongoing provision of fish passage in waterways. Permits may be required under the Fisheries Act for the construction of any temporary or permanent waterway barriers including culverts.

Authority to construct a waterway barrier may be obtained through two main pathways, including:

- Complying with the relevant self-assessable code for waterway barrier works, or
- Obtaining development approval for waterway barrier works.

A summary of each approach and recommendation for the Project is provided in the following sections.

3.3.5.1 Determination of Waterways

Approvals under the Fisheries Act only apply to waterways as defined in the Act. Determination of waterways for waterway barrier works can be made by referring to the *Guide for the determination of waterways using the spatial layer Queensland waterways for waterway barrier works* (DAFF, 2013). The location of DAFF waterways within the Project area are presented in **Appendix K.**

The project crosses:

- 12 x Green (Low Risk) Waterways
- 8 x Amber (Moderate Risk) Waterways, including Jackass Creek, Kybong Creek, Cobbs Gully
- 3 x Red (High Risk) Waterways, including Traveston Creek.

3.3.5.2 Self-Assessable Codes for Waterway Barrier Works

Waterway barrier works may be self-assessable if the works are compliant with either of the following:

- WWBW01: Code for self-assessable development – Minor waterway barrier works, Part 1: low impact dams and weirs (January 2013), Part 3: culvert crossings (April 2013) and Part 4: bed level crossings (April 2013), or
- WWBW02: Code for self-assessable development – Temporary waterway barrier works (April 2013).

Development approval is not required if works are carried out in accordance with the relevant code. However, there are planning, reporting and monitoring requirements associated with the self-assessable approach.

3.3.5.3 Development Approval for Waterway Barrier Works

Development approval for operational works that is the construction or raising of a waterway barrier will be required if the proposed works are not compliant with the relevant self-assessable codes. The approaches, timeframes and risks associated with these approvals are shown in **Table 3-5**.

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Table 3-5: Approaches, timeframes and risks associated with waterway barrier approvals.

Approach	Timeframe	Risks
Compliance with self-assessable code	Submission of pre-works notification to Department of Agriculture, Fisheries and Forestry (DAFF) at least 5 business days prior to commencement of works. Submission of post-works notification to DAFF within 15 business days of construction completion.	**Schedule** – failure to comply with code may lead to stop work order and/or the requirement for development approval.
Development approval	Generally 3-6 months, though can take up to 12 months.	**Schedule** – timeframe in the assessment of the application. Detailed design information required for application.

In order to provide greater certainty and manage the schedule risk associated with this process, it is recommended that TMR consult with SARA and DAFF (Fisheries) during the preliminary design phase to determine the optimal approach for managing these works. If a development approval is required, the application should be completed once detailed design information for these works is available.

3.3.6 Vegetation Management Act 1999

The *Vegetation Management Act 1999* (VM Act) regulates the clearing of native vegetation. A development permit for operational works is required to clear native vegetation as defined in the VM Act unless the clearing is exempt under schedule 24 of the SP Regulation.

3.3.6.1 Relevance to Project – Vegetation Clearing Permit

As detailed in **Section 3.3.2.3**, TMR are exempt from requiring a development permit to clear vegetation under the VM Act for road works in a State-controlled road or future State-controlled road. An exemption also exists for clearing vegetation for community infrastructure (which includes State-controlled roads). As such, no development permits to clear native vegetation are likely to be required.

3.3.7 Nature Conservation Act 1992

The purpose of the *Nature Conservation Act 1992* (NC Act) is for the conservation of nature and the protection of wildlife and its habitat. TMR currently have exemptions to requirements of the NC Act relating to protected plants and breeding places for certain least concern animals as described in **Sections 3.3.7.1** and **3.3.7.2**.

Field surveys have identified flora and fauna species listed under the NC Act. Details of these species are provided in **Chapter 6 – Terrestrial Ecology**.

3.3.7.1 Protected Plant Exemption

Under section 89(1) of the NC Act, it is an offence to take any plant that is indigenous to Australia other than under:

a) Conservation plan applicable to the plant; or

b) A license, permit or other authority issued or given under a regulation; or

c) An exemption under a regulation.

Works completed by TMR are currently exempt from the requirement to obtain a clearing permit under section 89(1)(c) of the NC Act following the granting of the protected plant exemption for taking a protected plant in the course of an activity under a roads implementation program. Qualification for the exemption is based on the following factors:

- Listing status of the protected plant (least concern, near threatened, vulnerable or endangered)
- Location of the plant (State managed land, protected area status)

- Previous clearing activities at the location of the protected plant.

The protected plant exemption remains in effect until 30 June 2014. Any works carried out after this date will be required to comply with the NC Act and any future exemptions relevant at the time of construction.

3.3.7.2 Species Management Program

The Species Management Program (SMP) prepared under section 332(5) of the *Nature Conservation (Wildlife Management) Regulation 2006* permits TMR to remove or otherwise tamper with the breeding place of certain animals listed as 'least concern' under the NC Act. This SMP does not apply to:

- Species defined as 'near threatened', 'vulnerable', 'endangered' or 'extinct in the wild'
- Breeding places located in forest reserves or other areas protected under the NC Act
- Breeding places (roosts) for flying-fox species, including the grey-headed flying fox
- Special least concern animals including koala, echidna, platypus and migratory bird species listed under selected international agreements
- Species classed as 'colonial breeders'.

A separate authority must be obtained from the DEHP prior to disturbing breeding places for animals falling into the categories listed above. Further information on the species for which a separate authority will be required will be provided in the Project Environmental Assessment.

The SMP remains in effect until 30 June 2016. Any works carried out after this date will be required to comply with the NC Act and any future exemptions relevant at the time of construction.

3.3.7.3 Relevance to Project – Permit Requirements

Any activities that are not subject to the exemptions described in **Sections 3.3.7.1** and **3.3.7.2** will require authorisation under the NC Act prior to construction. It is considered likely that species requiring authorisation under this Act will be encountered, therefore permits will most likely be required.

In addition to the requirement for permits under the NC Act, the Queensland Government Environmental Offsets Policy (QGEOP) provides for the conditioning of approvals to include environmental offsets. Offsets may be required for clearing protected plants under a clearing permit or clearing vegetation in a State forest.

The potential offset requirements represent a high risk for the Project as vegetation within the Traveston State Forest and Woondum State Forest will be cleared. In addition, field surveys identified protected plants may be adjacent to the proposed alignment. Opportunities to offset vegetation as required under the QGEOP should be investigated.

3.3.8 Forestry Act 1959

The *Forestry Act 1959* (Forestry Act) provides for forest reservations and their management, silvicultural treatment and protection of State forests, and the sale and disposal of forest products and quarry material, the property of the Crown on State forests, timber reserves and on other lands; and for other purposes.

A Memorandum of Understanding (MOU) between TMR and DAFF has been prepared that transfers the administrative responsibility of access to State-owned quarry material on State lands for the purpose of road works to TMR. Section 4 of the MOU, which took effect on 2 December 2011, states that where State-owned quarry material is being extracted by TMR for the purposes of road works governed under the TI Act, no quarry licence is required.

As it is intended that the land required for the Project would be acquired by TMR prior to the commencement of construction, no permits for works within existing State forest land would be required for the Project corridor.

Converting the tenure of land within the Woondum State Forest and Traveston State Forest for the Project will require the revocation of the State Forest declarations in these areas under the section 26 of the Forestry Act.

3.3.8.1 Relevance to Project – Authority

In the event that Project works are to be undertaken within Woondum State Forest land or Traveston State Forest land prior to the transfer of tenure to a State-controlled road corridor, an authority would be required under section 39 of the Forestry Act for interference with forest products within a State forest. As noted in **Section 3.3.8**, this requirement does not apply to quarry material extracted by TMR for the purposes of road works.

3.3.8.2 Relevance to Project – Revocation of State Forest

The Project is likely to impact on approximately 11.2 hectares of Traveston State Forest and 12.0 hectares of Woondum State Forest (including 8.9 hectares associated with the Section D main alignment). In addition, the proposed alignment for Cooroy to Curra Section D will impact on Woondum State Forest. In all cases, the tenure of the areas impacted will require conversion to a road corridor.

Under the Queensland Government's administrative arrangements, the Forestry Act is jointly administered in part by the Department of National Parks, Recreation, Sport and Racing (DNPRSR) and the DAFF.

Revocations of State Forest by the above state agencies may be considered where it can be demonstrated that there are no feasible alternatives, that it is in the public interest and that there will be no net loss for nature conservation.

TMR will need to commence negotiations with DNPRSR (Queensland Parks and Wildlife Service Operations Manager and/or the Regional Manager) and DAFF. Issues which will need to be negotiated and resolved as part of the revocation process include:

- Written agreement to an offset package as compensation for loss of land from the state forest
- Written confirmation that Native Title issues in relation to the area/s to be revoked have been, or are in the process of being, addressed and resolved
- Provision of an initial accurate sketch of the area sought for revocation, and the compensatory land, for inclusion with the request for Ministerial approval in principle
- Written agreement that TMR will bear all costs in the matter (i.e. survey, native title negotiations).

Once these issues have been resolved, and in principle support has been gained from the Minister, Cabinet approval to table the proposal in the Legislative Assembly must be obtained. The proposal for revocation will then need to be debated by the Minister, and if successful, amended subordinate legislation will need to be drafted and the gazettal of the revocation will need to be finalised.

The revocation process can take up to 12 months to reach gazettal. To remove the requirement for this process to be repeated as part of the Section D project, it is recommended that additional impacts on Woondum State Forest are incorporated into the revocation negotiations for this Project.

3.3.9 Aboriginal Cultural Heritage Act 2003

The purpose of the *Aboriginal Cultural Heritage Act 2003* (ACH Act) is to recognise, protect and conserve Aboriginal cultural heritage. The ACH Act defines Aboriginal cultural heritage as anything that is:

- A significant Aboriginal area in Queensland
- A significant Aboriginal object
- Evidence of archaeological or historic significance of Aboriginal occupation of an area of Queensland.

A significant Aboriginal area or object must be significant to Aboriginal people because of either or both of the following:

- Aboriginal tradition
- The history, including contemporary history, of any Aboriginal party for the area.

3.3.9.1 Relevance to Project – Duty of Care

Section 23 of the ACH Act establishes a duty of care requiring that all persons carrying out an activity must take all reasonable and practicable measures to ensure the activity does not harm Aboriginal cultural heritage.

Section 28 of the Act provides for the Minister to gazette duty of care guidelines outlining what constitutes reasonable and practicable measures for ensuring activities minimise harm to Aboriginal cultural heritage. The duty of care guidelines identify reasonable and practicable measures for ensuring activities are managed to avoid or minimise harm to aboriginal cultural heritage.

There is no offence for not complying with the duty of care guidelines, provided the action does not result in damage to Aboriginal cultural heritage. Complying with the guidelines affords strict compliance with the cultural heritage duty of care, thus affording some protection for the proponent.

All personnel involved in the construction of the Project must take all reasonable and practicable measures to ensure that an activity they are involved in does not harm Aboriginal cultural heritage.

Impacts to Aboriginal cultural heritage are considered a medium risk for the Project. The Contractor will be required to establish guidelines to be followed onsite to ensure that the duty of care is adhered to. These guidelines should be included in the EMP(C) for the site.

3.3.10 Queensland Heritage Act 1992

The *Queensland Heritage Act 1992* (Heritage Act) provides for the conservation of Queensland's cultural heritage for the benefit of the community and future generations. The Heritage Act imposes obligations on everyone discovering potential archaeological artefacts to protect said artefacts and to notify the DEHP. Indigenous and non-Indigenous places and things can be protected under this Act.

3.3.10.1 Relevance to Project - Permit Requirements

This is considered a low risk for the Project. As stated in **Section 3.3.2.3**, a development permit would not be required for development undertaken on either a Queensland or local heritage place, provided permission was obtained from the Minister prior to commencement of works.

3.3.10.2 Relevance to Project – Duty to Notify

Section 89 of the Heritage Act places a duty on a person who discovers a thing the person knows or ought reasonably to know is an archaeological artefact that is an important source of information about an aspect of Queensland's history must give the chief executive a notice under this section.

All personnel involved in the Project have a duty to notify of any discovery of anything that could potentially be considered to be an archaeological artefact.

3.3.11 Strategic Cropping Land Act 2011

The *Strategic Cropping Land Act 2011* (SCL Act) commenced on 30 January 2012 with the objectives to:

- Protect land that is highly suitable for cropping;
- Manage the impacts of development on that land; and
- Preserve the productive capacity of that land for future generations.

To support the SCL Act, DNRM have prepared ‘Trigger Maps for Strategic Cropping Land in Queensland’ (Trigger Map) to illustrate areas considered to be SCL and potential SCL. Trigger Map C3 identifies that the Project affects Potential SCL.

3.3.11.1 Relevance to Project – Exemptions

State-controlled roads are defined as community infrastructure in Schedule 2 of the SP Reg, and as such the Project is an excluded matter for SCL or potential SCL under schedule 13A of the SP Reg. Therefore, the SCL Act does not apply to the Project.

3.3.12 Land Protection (Pest and Stock Route Management) Act 2002

The purpose of the *Land Protection (Pest and Stock Route Management) Act 2002* (the LP Act) is to provide for pest management for land and stock route network management. Plant species declared to be pests in Queensland are managed under the LP Act.

Under section 77 of the LP Act, landowners must take all reasonable steps to keep land free of class 1 and class 2 pests.

Section 78 of the LP Act allows for the issuing of a pest control notice if a landowner is not complying with the requirements of section 77, or if a class 3 pest on the owner’s land is causing, or has the potential to cause, an adverse economic, environmental or social impact.

3.3.12.1 Relevance to Project – Obligations

All personnel involved in the Project have a duty to ensure that all reasonable steps have been taken to ensure that land is kept free of class 1 and class 2 pests.

3.3.13 Transport Infrastructure Act 1994

The overall objective of the *Transport Infrastructure Act 1994* (TI Act) is, consistent with the objectives of the *Transport Planning and Coordination Act 1994* (TPC Act), to provide a regime that allows for and encourages effective integrated planning and efficient management of a system of transport infrastructure.

Section 24 of the TI Act enables the Minister to declare a road or route to be a State-controlled road. Unless specified otherwise in a declaration, the width of a State-controlled road through a State reserve, State forest, timber reserve, vacant State land or pastoral holding is 30 metres each side of the centre line of the trafficked route.

Relevant to the Project, in order to construct, maintain and operate the State-controlled road, the TI Act enables TMR to enter into contracts for the State with other persons (including local governments, State government bodies and agencies of the Government of some other State or of a Territory) for the carrying out of:

- Road works on a State-controlled road or on land that is intended to become a State-controlled road
- Other works that contribute to the effectiveness and efficiency of the road network
- The operation of a State-controlled road
- Carry out road works on a local government road in accordance with an agreement between the chief executive and the local government
- Temporarily occupy and use land, including roads, and do anything on the land that is necessary or convenient to be done
- Divert a watercourse or construct a watercourse, whether permanent or temporary, to carry out road works.

3.3.14 Transport Planning and Coordination Act 1994

The *Transport Planning and Coordination Act 1994* (TPC Act) provides for the planning and coordination of transport. Relevant to the Project, under the TPC Act, general powers are provided that enable TMR to:

- Acquire, hold, dispose of or otherwise deal with property for the purposes of transport, for an incidental purpose, for the purpose of a transport associated development or for a combination of these purposes
- Acquire land that will be required at some future time for transport purposes.

3.3.15 Fire and Rescue Service Act 1990

The *Fire and Rescue Service Act 1990* (FRS Act) provides for the prevention of, and response to, fires and certain other incidents endangering persons, property or the environment.

3.3.15.1 Relevance to Project – Obligation

Fires are not to be lit in areas protected under the NC Act and Forestry Act. Burning is restricted and controlled by the Rural Fires Board.

3.3.15.2 Relevance to Project – Potential Permit Requirement

Under the FRS Act, the Queensland Fire and Rescue Service may declare a Fire Danger Period to prevent uncontrolled fires potentially putting property at risk. During this period a ‘Permit to Light Fires’ must be obtained prior to the lighting of any fires.

3.3.16 Explosives Act 1999

The *Explosives Act 1999* (Explosives Act) provides for the safe possession, use, transport and storage of explosives. The Explosives Act requires that reasonable precautions and reasonable care must be taken to avoid endangering any person’s safety, health or property, in any acts involving explosives.

3.3.16.1 Relevance to Project – Permit Requirement

In the event that explosives are to be used, transported or stored for the Project, a permit must be obtained by the person responsible for the explosives.

3.3.17 Waste Reduction and Recycling Act 2011

The purpose of the *Waste Reduction and Recycling Act 2011* (Waste Act) is to reduce the amount of waste generated through the implementation of the waste management hierarchy (avoid, reduce, reuse, recycle, recover, treat, dispose). The Waste Act also requires state and local governments to prepare strategic waste management plans.

3.3.17.1 Relevance to Project – Waste Management

The Contractor will be required to manage waste in accordance with the Waste Act and the *Environmental Protection (Waste Management) Regulation 2000*.

3.3.18 Acquisition of Land Act 1967

The *Acquisition of Land Act 1967* (LA Act) provides for the taking and purchasing of land for public works or other public purposes. The provisions of the LA Act enable the compulsory acquisition of land in the event that negotiated acquisitions are unsuccessful.

Under the provisions of the LA Act, land required for the Project must be acquired and/or access permitted prior to carrying out works.

Written notice of intention to take land must be given to those entitled to claim compensation under the LA Act, in respect of the land concerned. This notice must state the date (being a date not less than 30 days after the date of the notice) that the person served with the notice may issue an objection in the taking of the land.

3.3.18.1 Relevance to Project

TMR intend on acquiring whole or partial parcels of land impacted by the Project. All access to properties not acquired by TMR at the time of access will be required to follow the TMR Permit to enter process under the provisions of the LA Act.

3.3.19 Queensland Biodiversity Offsets Policy

The purpose of the Queensland Biodiversity Offsets Policy (the Policy) is to increase the long-term protection and viability of the State's biodiversity where residual impacts from a development, on an area possessing State significant biodiversity values, cannot be avoided. The policy provides the framework to ensure that there is no net loss of biodiversity. Relevant to the Project, the Policy applies to:

- Development that is an ERA with an aggregate environment score.
- The taking of plants that are identified as endangered, vulnerable, or near threatened under the NC Act.
- Construction of a State-controlled road, except construction to which this policy does not apply.

However, relevant to the Project, the Policy does not apply to:

- Development that is a coordinated project declared under section 26(1)(a) of the SDPWO Act.
- Development that is a government supported transport infrastructure project:
  - That is being undertaken because the project location has been identified as one where there is an immediate or high risk to public safety (for example, road locations with a high number of fatal or serious injury crashes or high risk of head on or run-off road crashes) and the project has partial or complete funding under the Commonwealth's Government's Black Spot Program or State Government's Safer Roads Sooner Program.

3.3.19.1 Relevance to Project – Offset Requirements

The requirement for offsets for impacts on State significant biodiversity values during the construction of State-controlled roads is determined at the time the funding and construction arrangements are approved by the State or Commonwealth. The requirement for offsetting, and the assessment of offsets provided under the Policy will be undertaken by TMR.

The provision of offsets for State significant biodiversity values under Appendix 1 of the Policy is self-assessable by TMR. Where self-assessment reveals an impact on State significant biodiversity values, TMR must notify DEHP of the project impacts, offset requirements (values and extent), offset delivery method and offset outcome upon either legally securing the land-based offset or making an offset payment to the Balance the Earth trust.

The current Queensland Biodiversity Offsets Policy will be replaced by the Queensland Biodiversity Offsets framework in mid-2014, which will require offsets for impacts on matters of state environmental significance as defined in the State Planning Policy. The Project will require assessment against this framework to determine the offsets required.

3.4 Local Laws

3.4.1 Local Government Planning Scheme

As stated in **Section 3.3.2.4** the Project is exempt from requiring assessment against a local government planning scheme.

3.4.2 Local Laws

As identified in the TMR document *TMR Exemptions from Environmental Legislation* (July 2011), local laws made by local governments under the *Local Government Act 2009* do not apply to TMR, or Contractors carrying out work on behalf of TMR. However, the relevant local government must be consulted to understand any potential concerns.

3.4.3 Water Access

The use of potable water for construction activities (with some exceptions) is prohibited. Approval may be granted from the local authority for taking water from mains in some areas where the use of other water types are not acceptable for public health reasons.

3.5 Permits and Approvals

The potential permits and approvals relevant to the construction of the Project are shown in **Table 3-6**. These suggested permits and approvals are subject to further investigation and confirmation on the basis of the Project design.

Table 3-6: Potential permits relevant to the Project.

Legislation/ Policy	Approval Type	Assessing Authority	Relevance/Trigger	Location	Timeframe	Responsibility
Environment Protection and Biodiversity Conservation Act 1999	Referral of an action	DotE	Where any aspect of the project is likely to significantly impact on a MNES.	Project footprint, particularly habitat for threatened species.	Dependent on DotE	TMR
Forestry Act 1959	Revocation of State Forest	DNPRSR/ DAFF	Where a road corridor will be declared in a State Forest.	Traveston State Forest and Woondum State Forest. Additional impacts to Woondum State Forest will occur as a result of Section D.	12 months+	TMR
Nature Conservation Act 1992, s89(1)	Permit to take a protected plant	DEHP	Clearing or damage to a protected plant that is not authorised under the existing protected plant exemption available to TMR.	Throughout alignment where protected plants will be cleared.	2-4 months	TMR
Nature Conservation (Wildlife Management) Regulation 2006, s.332	Permit to tamper with an animal breeding place	DEHP	Authorisation required for tampering with the breeding place of an animal not subject to the TMR SMP.	Habitat areas for protected species.	2-4 months	TMR
Water Act 2000	Water Licence	DNRM	Interfering with the flow of water in a watercourse (diversion)	Traveston Creek, Kybong Creek	4-6 months	TMR
Sustainable Planning Act 2009 *Water Act 2000*	Removing quarry material from a watercourse Quarry Material Allocation Notice	SARA / DNRM	Taking quarry material from a watercourse	Traveston Creek, Kybong Creek, Cobbs Gully, Jackass Creek, unnamed tributaries of Jackass Creek at the location of the Woondum Interchange (refer to amber waterways in **Appendix K**).	4-6 months	TMR
Sustainable Planning Act 2009 *Fisheries Act 1994*	Permit for Constructing or Raising a Waterway Barrier	SARA	Constructing or raising a barrier that would impede the movement of fish species, if not carried out in compliance with relevant self-assessable code.	Traveston Creek, Kybong Creek, Cobbs Gully, Jackass Creek, unnamed tributaries of Jackass Creek at the location of the Woondum Interchange (refer to amber waterways in **Appendix K**).	4-6 months	TMR

Legislation/ Policy	Approval Type	Assessing Authority	Relevance/Trigger	Location	Timeframe	Responsibility
Sustainable Planning Act 2009 *Vegetation Management Act 2009*	Permit to Clear Native Vegetation	SARA	Clearing native vegetation where not located within a State-controlled road and not for a community purpose	Not determined	4-6 months	TMR
Sustainable Planning Act 2009 *Environmental Protection Act 1994, s.115*	Material change of use for a concurrence Environmentally Relevant Activity	SARA / DEHP	ERA 6, ERA 8, ERA 16, ERA 19, ERA 41, ERA 53, ERA 56, ERA 57	For environmentally relevant activities directly or indirectly triggered by the project.	4-6 months	Contractor
Environmental Protection Act 1994	Environmental Authority	DEHP	ERA 6, ERA 8, ERA 16, ERA 19, ERA 41, ERA 53, ERA 56, ERA 57	For environmentally relevant activities directly or indirectly triggered by the project.	4-6 months	Contractor
Sustainable Planning Act 2009 *Environmental Protection Act 1994, s.424*	Permit to dispose of contaminated soil	DEHP	Discovery of contaminated soil requiring disposal.	Potentially contaminated soil located on Lot 1073, M37442. Contamination may also occur in the vicinity of service stations.	2 months	Contractor

4. Planning and Land Use

4.1 Introduction

This chapter provides an assessment of the planning and land use elements of the Project. The objectives of the planning and land use assessment for the Project include:

- Describe the existing land uses within and surrounding the Project, using figures where necessary.
- Describe the relevant planning scheme and regional plan zones within and surrounding the Project, using figures where necessary.
- Assess the compatibility of the Project with the relevant local, regional and state planning instruments.
- Assess the potential impact of the Project on current and future land uses within and adjacent to the Project during both construction and operation phases.
- Provide recommendations and mitigation measures based on identified impacts to planning and land uses.

4.2 Methodology

The methodology of the planning and land use assessment involved:

- Review of documentation and background information for the Project, including design drawings.
- Review of the local planning scheme and associated documents.
- Review of relevant legislation and State and regional planning instruments.
- Review of maps and aerial photographs to identify existing land uses within, adjacent and surrounding the Project.
- Site visit to confirm land uses within, adjacent and surrounding the Project.
- Review of existing background documentation.

4.3 Relevant Planning Instruments

This section discusses current planning frameworks relevant to the Project. The planning policies considered in the assessment of the Project include:

State planning:

- State Planning Policy
- Queensland Transport and Roads Investment Program 2011-2012 to 2014-2015

Regional planning:

- Wide Bay Burnett Regional Plan

Local government:

- Gympie Regional Planning Scheme 2013.

4.3.1 State Planning Policy

4.3.1.1 Environment and Heritage

Biodiversity

The biodiversity state interest seeks to ensure that "matters of environmental significance are valued and protected, and the health and resilience of biodiversity is maintained or enhanced to support ecological integrity". The Project will traverse areas potentially containing matters of national environmental significance and matters of state environmental significance. Ecological surveys as part of this study have been undertaken to identify environmental factors that exist within the Project. Recommendations have been provided to avoid, mitigate and offset impacts where necessary, including inputs into the design of structures and crossings as well as appropriately locating fauna crossing structures to assist in minimisation impacts of habitat fragmentation.

Cultural Heritage

The cultural heritage state interest aims to ensure that "the cultural heritage significance of heritage places and heritage areas, including places of indigenous cultural heritage is conserved for the benefit of the community and future generations". A cultural heritage assessment has been prepared by TMR as part of this study. It involved the search of the relevant databases encompassing both indigenous and European heritage. Further detail on cultural heritage values, including recommended measures to avoid or minimise impacts on these values are provided in **Chapter 15 – Cultural Heritage**.

Water Quality

This state interest seeks to ensure that "the environmental values and quality of Queensland waters are protected and enhanced". The Project will have the greatest potential impact to water quality during the construction phase. Erosion and Sediment Control Plans and an Environmental Management Plan (Construction) will be prepared in accordance with the Best Practice Erosion and Sediment Control document (IECA, 2008) and to help protect the environmental values specified in the *Environmental Protection (Water) Policy 2009.* Further details on environmental values relating to water quality are provided in **Chapter 7 – Aquatic Ecology and Water Quality**.

4.3.1.2 Hazards and Safety

Natural Hazards

This state interest aims to ensure that "the risks associated with natural hazards are avoided or mitigated to protect people and property and enhance the community's resilience to natural hazards". The Queensland Government's objective to 'Fix the Bruce Highway' is in response to community alarm over the condition and operation of the Bruce Highway. This objective focuses on three priority areas, which include improvements to safety, flooding and capacity. The Project aims to minimise disruption through closures and delay by adhering to acceptable flood immunity standards to enhance network resilience.

4.3.1.3 Infrastructure

State Transport Infrastructure

Economic and social development in Queensland depends on a system of transport infrastructure that is safe, structurally sound and reliable. This state interest seeks to ensure that "planning enables the safe and efficient movement of people and goods across Queensland and encourages land use patterns that support sustainable transport".

The overall Cooroy to Curra Project is one of Queensland's highest priority road projects and will significantly improve safety and transport efficiency. Further detail is provided in **Section 4.3.2** below.

4.3.2 Queensland Transport and Roads Investment Program 2011-2012 to 2014-2015

The *Queensland Transport and Roads Investment Program 2011-2012 to 2014-2015* (QTRIP) sets out the Queensland Government's plan to deliver transport and road projects to meet the infrastructure needs of Queensland over the next four years. The delivery of these projects is the responsibility of TMR. The delivery of QTRIP is divided into 12 regions with the Project located within the Wide Bay/Burnett Region.

The regional profile for the Wide Bay/Burnett Region identifies that TMR will continue construction and planning of the Bruce Highway Upgrade between Cooroy and Curra. It outlines that the Project is one of Queensland's highest priority road projects and will significantly improve safety and transport efficiency.

4.3.3 Wide Bay Burnett Regional Plan

The Regional Plan is a statutory instrument and provides a vision and direction for six local government areas over the next twenty years, one of which being Gympie Regional Council. The purpose of the Regional Plan is to manage regional growth and change in the most sustainable way to protect and enhance the quality of life. This purpose is achieved through a regional framework made up of a regional vision, strategic directions and a regional settlement pattern.

The Regional Plan is supported by a regional land use map identifying preferred development areas. The Project is predominantly located within the 'regional landscape and rural production area' with a small section north of Keefton Road encroaching into the 'urban footprint'.

Regarding the regional settlement pattern, the Regional Plan identifies that there is existing capacity in the Gympie region to accommodate growth in the residential, commercial and industrial sectors and especially potential in regionally significant industrial expansion. It states that to fulfil this potential, investment in upgrading the Bruce Highway between Cooroy and Curra is crucial. The Regional Plan also recognises that this upgrade will provide a more efficient link to South East Queensland.

The Regional Plan also contains ten Desired Regional Outcomes (DRO) to articulate the preferred direction for development and land use in the region. The most relevant DROs to the Project include:

- Sustainability, climate change and natural hazards;
- Environment;
- Natural resource management;
- Managing growth;
- Urban form;
- Strong economy; and
- Infrastructure.

Table 4-1 outlines the overall objective for each of the abovementioned DROs and the Project's compatibility.

Table 4-1: Assessment of the Project's compatibility with the DROs of the Regional Plan.

Desired Regional Outcome (DRO)	DRO Objective	Project Compatibility
Environment	A healthy and resilient natural environment supports the region's rich biodiversity and ecosystem services which contribute to the economic development and social and cultural identity of the region.	The Project will require the clearing of vegetation, including part of the Woondum State Forest, and traverses numerous watercourses. Although the Project will result in the clearance of vegetation, the Project alignment generally follows adjacent the existing cleared Powerlink easement to minimise vegetation fragmentation. Further discussion on the impacts of the Project on terrestrial and aquatic flora and fauna is provided in **Chapter 6 – Terrestrial Ecology** and **Chapter 7 – Aquatic Ecology and Water Quality** respectively.
Natural resource management	Regional natural resources and primary production areas continue to provide cultural, social, economic and environmental values to the region, while being protected, managed, enhanced and used sustainably.	The Project will impact on rural uses for much of its alignment. The properties impacted by the Project are used for small agricultural operations and it is considered that their fragmentation may result in agricultural uses to no longer be viable.
Managing growth	An efficient and sustainable settlement pattern that supports the efficient use of land and infrastructure, supports housing choice and affordability and provides opportunities for well-planned growth now and in the future.	The Regional Plan identifies that the Project will support the increased growth of Gympie by providing improved accessibility. The industrial areas in the southern parts of Gympie will benefit from the Project through improved freight accessibility to major centres in South East Queensland.
Urban form	The towns and cities of the region are accessible and build on their heritage, character and liveability through designs that respond to the environment and the provision of high quality urban green space.	The Regional Plan identifies that the urban footprint of the Gympie Region has capacity to accommodate growth in the industrial sector, particularly in the Victory Heights and East Deep Creek areas. The Project is considered necessary to support the long-term industrial expansion sought for the region.
Strong economy	A thriving regional economy that is sustainable, resilient and robust, and advances the prosperity and liveability of communities within the region.	The Regional Plan identifies that the Gympie region represents an affordable option for relocating and expanding enterprises. The Project is considered to support the development of industrial land uses by providing an improved freight route. However, it is expected that existing retail land uses fronting the existing Bruce Highway would experience a loss of business. The Project may also result in negative impacts to some retail activities within Gympie as the new Bruce Highway alignment will bypass the centre. Impacts to the local economy are discussed in **Chapter 14 – Socio-Economic**.
Infrastructure	The region's communities have access to well-planned, coordinated, accessible, sustainable and reliable infrastructure.	The Project will improve accessibility not just within the Gympie Region, but also major centres in South East Queensland. The Project is required to improve safety for motorists travelling between South East Queensland and the Gympie Region and to meet future population growth forecasts.

4.3.4 Gympie Regional Council Planning Scheme 2013

The Project is situated within the Gympie Regional Council Local Government Area and is located within the jurisdictional boundaries of *Gympie Regional Council Planning Scheme 2013* (Planning Scheme). Although the Project is exempt from assessment against the Planning Scheme (discussed in **Section 3.3.2**), the Project's compatibility with the strategic outcomes and the purpose of zones and overlays have been considered for the purposes of this assessment.

4.3.4.1 Strategic Outcomes

The strategic outcomes establish the foundation of a planning scheme, expressing the purpose and what the scheme is intended to achieve. Planning schemes cover a broad range of issues including community need, economic activity and nature conservation. The detailed planning requirements and standards included in planning schemes support the achievement of the strategic outcomes and development must not compromise their achievement.

An evaluation of the Project against the relevant strategic outcomes of the Planning Scheme has been provided in **Table 4-2**.

Table 4-2: Assessment of the Project against the Gympie Regional Council Planning Scheme strategic outcomes.

Strategic Outcomes	Comment
Settlement Pattern	
Gympie will accommodate the majority of the estimated 22,000-person population growth in the Region for the next 20 years at Southside and Victory Heights, providing access to commercial and community services, major employment opportunities and urban infrastructure. Opportunities for urban expansion of Imbil, Kilkivan and Goomeri are anticipated within the capacity of urban infrastructure.	The Project will improve accessibility within and to the Gympie region by providing additional road capacity to accommodate increased vehicular demand due to population growth and urban expansion. The Regional Plan identifies that the Project will provide additional opportunities for industrial activities in Gympie by facilitating safe and quick access to South East Queensland, presenting opportunities for logistics and transport operations in proximity to the highway. The Project is also likely to facilitate improved connectivity between Gympie and Imbil, an area identified for urban expansion.
Rural towns and settlements continue to provide alternative lifestyle options, access to services, opportunities for employment and economic activity at a local level.	The Project will provide better access to services and opportunities for employment in nearby localities.
Strong Economy	
Economic development is enhanced by infrastructure that strengthens and develops linkages with the rest of Queensland, particularly the South East.	The Project will provide improved accessibility in the Gympie region and improves linkages with South East Queensland. Impacts to the local economy as a result of the Project are discussed in Chapter 14 – Socio-Economic. Large footprint and hard to locate industries will also benefit from the Project, which will ensure safe access is available without prohibitive costs.
Natural Systems and Sustainability	
The condition, extent, diversity and connectivity of important natural features are protected from inappropriate development to maintain and enhance their biodiversity areas.	The Project traverses Conservation Significant Areas in the overlay mapping under the Planning Scheme. Impacts of the Project on the natural environment are discussed further in the relevant chapters of this REF. Construction of the Project will be undertaken in accordance with an approved construction environmental management plan (EMP(C)) to ensure impacts to these natural features are minimal. It is likely that the Conservation Significant Areas overlay map under the Planning Scheme would be amended to reflect the Project passing through these areas.

Strategic Outcomes	Comment
New development demonstrates a commitment to the reduction in reliance on non-renewable resources and the generation of greenhouse gas emissions.	Construction of the Project will be undertaken in accordance with an approved environmental management plan to ensure impacts on the natural environment are minimised. The Project's impacts on the natural environment are discussed further in the relevant chapters of this REF. Mitigation measures for specific impacts are also provided.
Strong Communities	
Development occurs in a manner that provides access to a range of employment, commercial, cultural, recreational and community opportunities in serviceable locations that respond to community needs.	The Regional Plan identifies that the Project will provide additional opportunities for industrial activities in Gympie. Accessibility will also be improved in the surrounding region to community uses in Gympie. However, it is expected that existing retail land uses fronting the existing Bruce Highway would experience a loss of business. The Project may also result in negative impacts to some retail activities within Gympie as the new Bruce Highway alignment will bypass the centre. Impacts to the local economy are discussed in Chapter 14 – Socio-Economic.
Infrastructure and Servicing	
The relationship between land uses and transport infrastructure optimises opportunities to improve the efficiency of the transport system and contributes to its smooth operation.	The Project will provide an improved and more efficient link within and to the Gympie region.
The investment in the provision of major infrastructure is protected from the implications of incompatible development.	The design of the Project is consistent with existing highway designs in Queensland and is considered to meet community expectations. The Project is reflected in both the Planning Scheme and the Regional Plan and as such will be taken into account by future development.

4.3.4.2 Zone Intent

The preferred land use pattern within Local Government Areas is controlled through the inclusion of land in zones and associated development controls, including levels of assessment for particular uses.

Under the Planning Scheme the following zones are traversed by the Project:

- Open Space
- Environmental Management and Conservation
- Rural
- Industry Investigation.

Table 4-3 provides an evaluation of the Project against the purpose of these zones.

Table 4-3: Purposes of Zones.

Relevant Overall Outcomes	Comment
Open Space Zone	
The purpose of the zone provides for informal recreation where the built form is not essential to the enjoyment of the space. The zone provides for local, district and regional scale parks which serve the recreational needs of a wide range of residents and visitors. Where required to meet community needs, development may include shelters, amenity facilities, picnic tables and playgrounds and infrastructure to support safe access and essential management.	The Project is considered to be essential community infrastructure in improving the State-controlled road network in the Gympie region. It is required to support the anticipated growth of Gympie and meet the transport and access needs of the community and will facilitate improved access to recreational space within the locality.
Environmental Management and Conservation Zone	
The purpose of the zone is to provide for areas identified as supporting significant biological diversity and ecological integrity.	Construction of the Project will be undertaken in accordance with an approved EMP(C) to manage impacts on the environment and particularly the Traveston and Woondum State Forests are minimal. Impacts on the natural environment and mitigation measures are discussed further in the relevant chapters of this REF.
Rural Zone	
The purpose of the zone is to: (a) provide for a wide range of rural uses including cropping, intensive horticulture, intensive animal industries, animal husbandry, animal keeping and other primary production activities; (b) provide opportunities for non-rural uses that are compatible with agriculture, the environment, and the landscape character of the rural area where they do not compromise the long-term use of the land for rural purposes; and (c) protect or manage significant natural features, resources, and processes, including the capacity for primary production.	The Project will impact on rural uses for much of its alignment. The properties impacted by the Project are used for small agricultural operations and it is considered that their fragmentation may result in agricultural uses to no longer be viable.
Industry Investigation Zone	
The purpose of the zone is to identify and protect land that is suitable for industrial activities where further detailed planning, investigations and studies are required to determine the suitability of the industry investigation zone for use as an industry zone.	The Regional Plan identifies that there is significant potential for industrial expansion in the Gympie region and to fulfil this potential, upgrading the Bruce Highway between Cooroy and Curra is crucial. It states that the Project will provide additional opportunities to attract growth in industry to Gympie.

4.3.4.3 Overlay Codes

The Overlay Codes considered as part of the assessment of the Project are identified in **Table 4-4** and the trigger explained.

Table 4-4: Planning Scheme Overlays.

Overlay Code	Trigger	Comment
Bushfire Hazard Areas	The Project passes through Bushfire Hazard areas identified on Bushfire Hazard Overlay Maps 17 and 23.	Construction activities for the Project will be undertaken in accordance with an EMP(C) to ensure the likelihood of causing bushfire is minimised.
Conservation Significant Areas	The Project passes through conservation significant areas identified on Conservation Significant Areas Overlap Maps 17 and 23.	Construction of the Project will be undertaken in accordance with an approved EMP(C) to ensure impacts to the environment and the Traveston and Woondum State Forests are minimal. Impacts on the natural environment and mitigation measures are discussed further in the relevant chapters of this REF.
Flood Hazard Areas	The Project passes through floodplain areas identified in the GRC ARI 100 year Flood Study 2012 as shown on Flood Hazard Overlay Maps 41 and 44.	The Project has been designed to withstand a 1 in 100 year flood event to maintain safety and access in emergency situations. Potential localised flooding from construction of the Project is addressed in Chapter 9 – Hydrology and Hydraulics.
Good Quality Agricultural Land	The Project traverses both Class A and B GQAL identified on GQAL Overlay Maps 16 and 21.	The Project will impact on Class A and B GQAL resulting in its fragmentation. The properties impacted by the Project are used for small agricultural operations and it is considered that their fragmentation may result in agricultural uses no longer being viable. Portions of remaining lots may be amalgamated in accordance with the Planning Scheme to allow for agricultural land uses to continue.

4.4 Description of Existing Land Uses

The description of existing land uses affected by the Project has been divided into land uses within the Project alignment (refer to **Section 4.5**) and surrounding land uses (refer to **Section 4.5.4**). Land uses within and surrounding the Project study area are shown in **Figure 4-1A** to **Figure 4-1C**.

Beef cattle grazing is the predominant land use impacted by the Project. These grazing uses are generally small scale operations supported by homesteads and sheds. Land uses also impacted include State Forests, rural residential and industry.

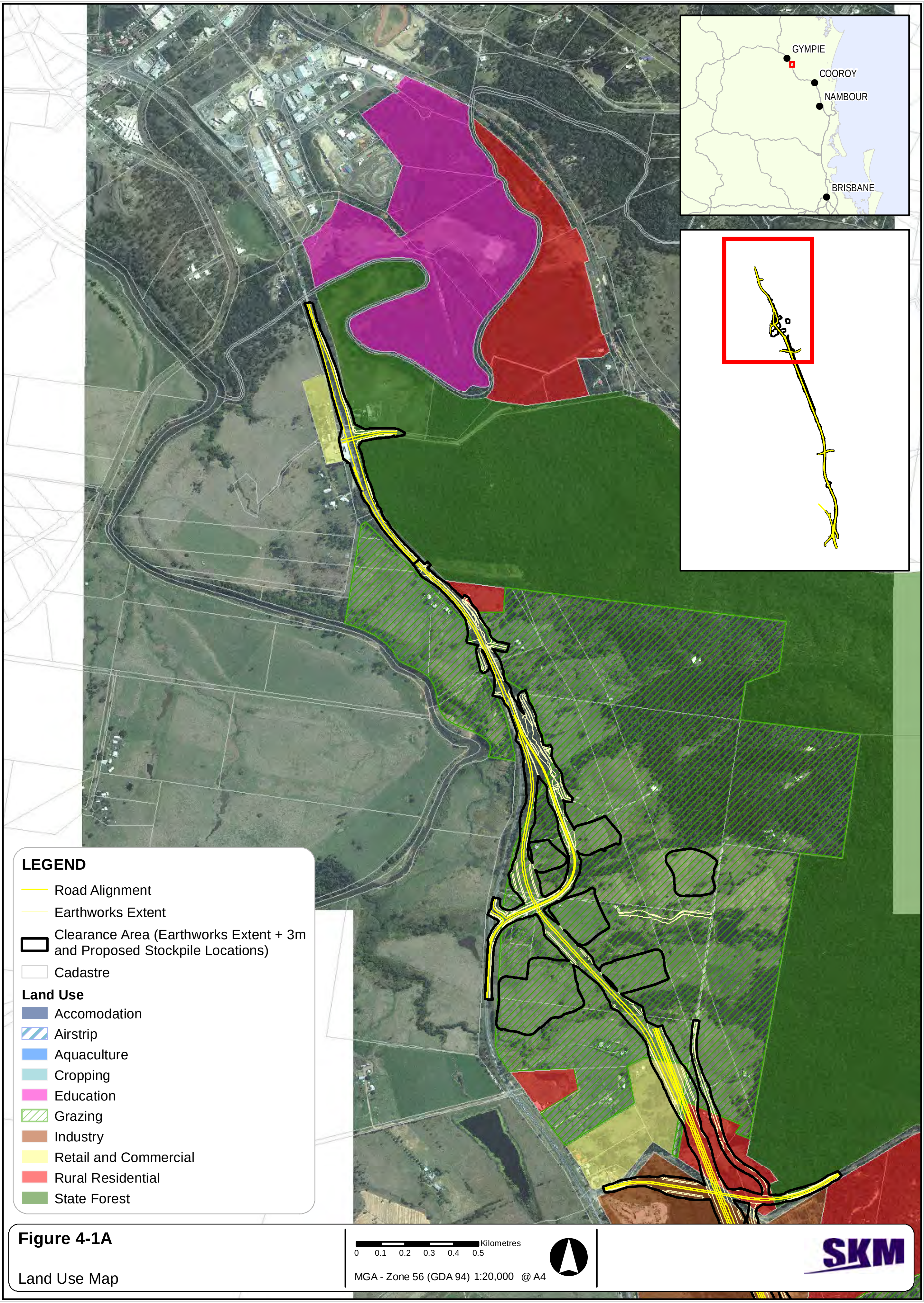

Figure 4-1A

Land Use Map

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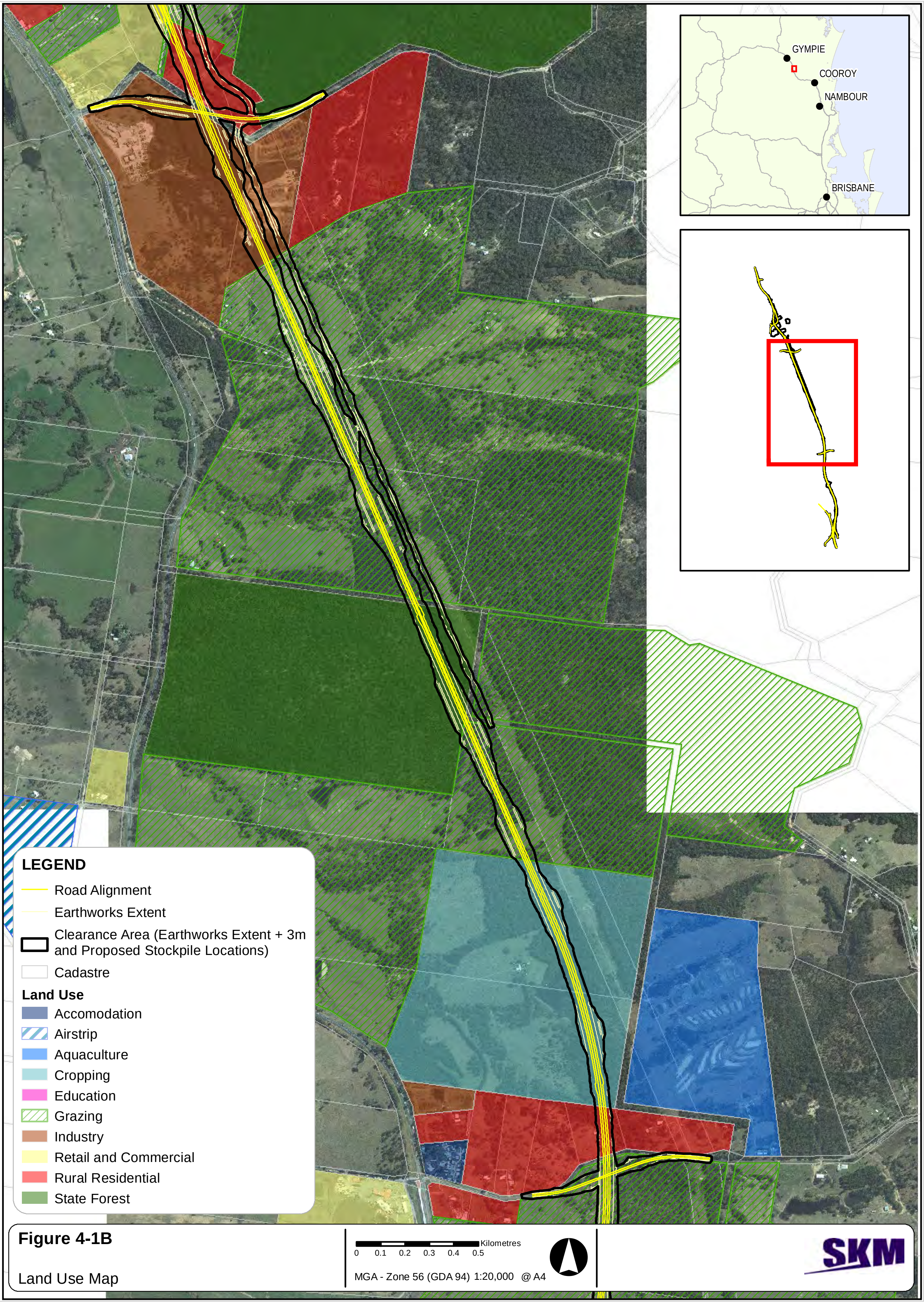

Figure 4-1B

Land Use Map

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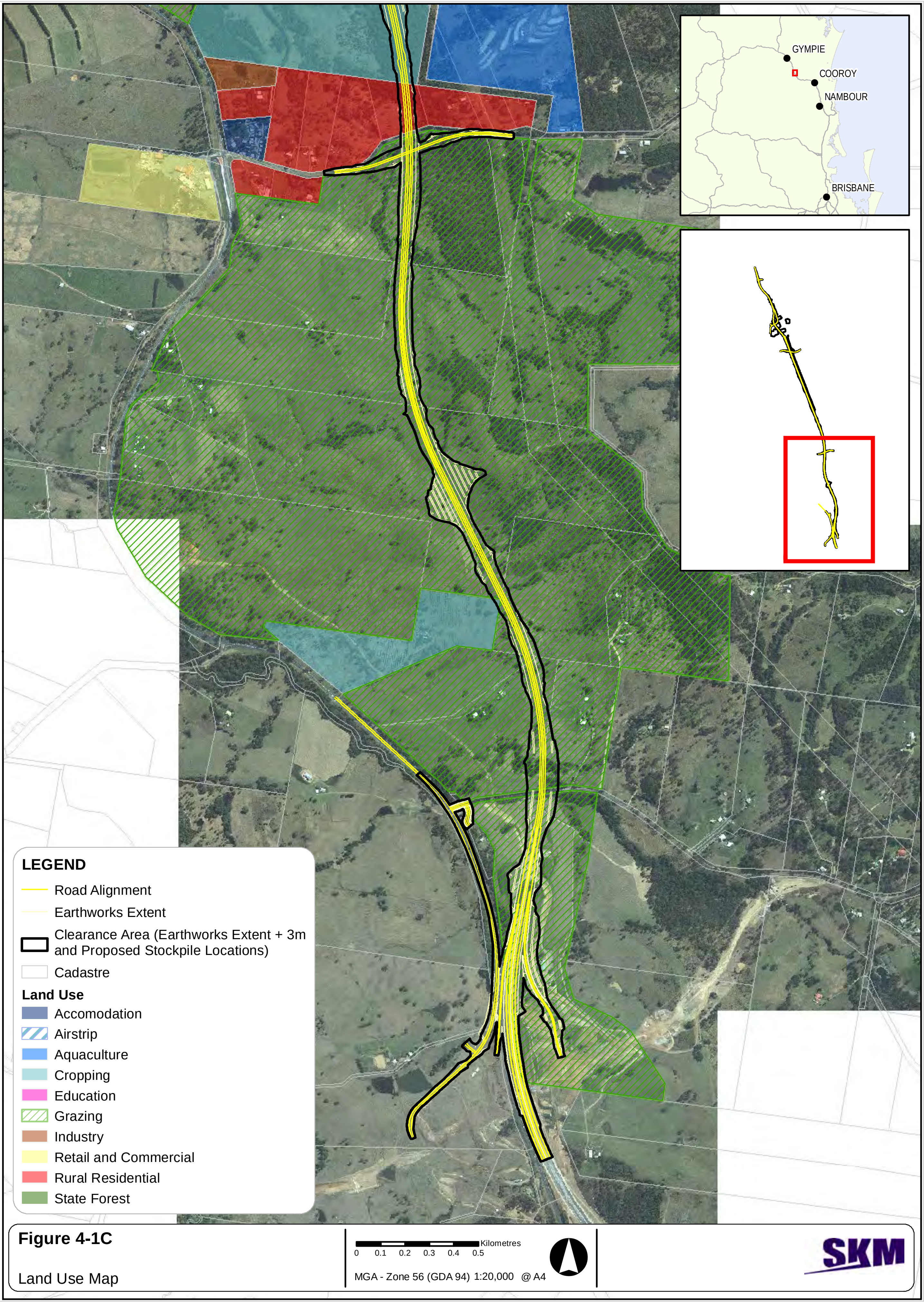

Figure 4-1C

Land Use Map

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4.5 Land Use

4.5.1 Traveston Road to Tandur Road

The predominant land use traversed between Traveston Road and Tandur Road is beef cattle grazing. There is a small olive tree plantation impacted by the Project approximately 650 metres north of Traveston Road near the Traveston Homestead (refer to **Figure 4-2**).

Figure 4-2: Olive tree plantation near the Traveston Homestead.

4.5.2 Tandur Road to Woondum Road

North of Tandur Road to Woondum Road, the Project passes through heavily vegetated areas as it adjoins an existing high voltage transmission line easement. Much of the easement is not fenced and as such, beef cattle graze the easement (refer to **Figure 4-3**).

Just south of Woondum Road, the Project traverses a wood chipping industry that fronts Woondum Road (refer to **Figure 4-4**) as well as a small part of the Gympie Cooloola Pet Resort. South of Woondum Road, the Project traverses the Woondum State Forest.

Figure 4-3: Powerlink transmission line easement used for beef cattle grazing.

Figure 4-4: Wood chipping industry on Woondum Road.

4.5.3 Woondum Road to Keefton Road

North of Woondum Road, the Project traverses part of the Gympie Cooloola Pet Resort.

Between Woondum Road and Keefton Road, the Project traverses some grazing land and rural residential land uses. In this section of the alignment, five residential premises are impacted directly.

Approximately 800 metres north of Keefton Road, the Project traverses part of a driver training facility "Roadcraft" (refer to **Figure 4-5**).

Figure 4-5: Driver training facility 'Roadcraft'.

The roads crossed by the Project include:

- Traveston Road
- Tandur Kybong Road
- Gresham Road
- Woondum Road
- Keefton Road.

Numerous local access routes and driveways to residential premises and homesteads are also crossed by the Project (refer to **Figure 2-12A** to **2-12D**).

4.5.4 General Project Setting

The predominant land use surrounding the Project is small scale beef cattle grazing with associated residential homesteads, sheds and dams. There are some areas of cropping and plantations on the western side of the Project, particularly on properties bordered by the Mary River. Some rural residential properties are located along the ridgeline to the east of the Project. These properties are accessed from Burridge Road. There is also fish breeding ponds no longer in use approximately 250 metres north of Tandur Kybong Road on the eastern side of the Project.

The Project impacts numerous local access routes to rural properties surrounding the Project.

The Traveston Homestead, of local heritage significance under the Gympie Regional Council heritage register, is located approximately 100 metres from the Project (refer to **Figure 4-2**). There is a graveyard located on the property in the vicinity of the homestead. Another heritage listed property, the Kybong Hall, is located on the eastern side of the Bruce Highway about 1.6 kilometres from the Project.

The Kybong Tandur Pioneer Park memorial is located approximately 250 metres east of the Bruce Highway and Tandur Road intersection (refer to **Figure 4-6**).

The Traveston State Forest is located to the west of the Project approximately 1.65 kilometres north of Tandur Kybong Road and the Woondum State Forest is located on the southern side of Woondum Road. Both State Forests are traversed by the Project.

Some retail land uses, local businesses and accommodation are located along the existing Bruce Highway, mainly concentrated on the intersections of the highway with Tandur Kybong Road, Lobwein Road, Woondum Road and Keefton Road. Local businesses and retail land uses surrounding the Project include:

- A service station, caravan park and a landscaping business at the intersection of Tandur Kybong Road and the Bruce Highway (refer to **Figure 4-7**).
- A retail outlet selling rocks and minerals located on the northern corner of the Bruce Highway and Lobwein Road.
- A masonry outlet (refer to **Figure 4-8**) and an antiques store at the intersection of the Bruce Highway and Woondum Road.
- A service station and industrial use located at the intersection of Keefton Street and the Bruce Highway. Just south of the intersection is an equestrian centre.

The Gympie Airport is located on Lobwein Road on the western side of the Bruce Highway (refer to **Figure 4-9**). Approximately 800 metres north of Keefton Road is Gympie's main industrial area on the eastern side of the Bruce Highway. The Gympie Australian Rules Football Club is located near to the industrial area on the western side of the Bruce Highway (refer to **Figure 4-10**).

Figure 4-6: Kybong Tandur Pioneer Park on Tandur Road.

Figure 4-7: Matilda service station located at the intersection of the Bruce Highway and Tandur Road.

Figure 4-8: Masonry outlet at the intersection of the existing Bruce Highway and Woondum Road.

Figure 4-9: The Gympie Airport on Lobwein Road.

Figure 4-10: Gympie Australian Rules Football Club.

4.6 Land Tenure

Table 4-5 provides a percentage breakdown of the different land tenure affected by the Project. Of the 52 properties impacted, TMR currently owns 20 of these. **Appendix C** provides a full list of the properties affected by the Project and their ownership.

Table 4-5: Breakdown of land tenure affected by the Project.

Land tenure	Percentage overall
Freehold	82.69%
Leasehold	11.54%
Reserve for State Forest	3.85%
Reserve for local Government	1.92%

4.7 Potential Impacts and Mitigation Measures

This section describes the potential impacts the Project will have on existing land uses and planning scheme designations. The Project's influence on future land uses is also discussed.

4.7.1 Impacts to existing land use

South of Tandur Kybong Road, the Project will impact grazing land uses. The Project will result in fragmentation of these uses and as these are small scale operations, their continuation may not be viable. The Project would impact on part of the olive tree plantation near the Traveston Homestead. Impacts to agricultural land uses are discussed further in **Chapter 8 – Geology and Soils**.

Impacts to grazing land uses would be less where the Project adjoins the existing power line easement. However, some properties span across this easement, allowing cattle to pass freely beneath the power lines and graze within the easement. The Project will no longer allow this to occur.

The Project will require the removal of established vegetation protected in the Traveston and Woondum State Forests. The Project will result in a loss of vegetation overall, particularly where the alignment adjoins the existing Powerlink easement north of Tandur Kybong Road. Impacts to vegetation communities are discussed in **Chapter 6 – Terrestrial Ecology**. The removal of vegetation would also result in a change to visual values and the character of the area. Impacts to visual amenity are discussed further in **Chapter 13 – Landscape and Visual Amenity**.

Residential premises directly impacted by the Project would be acquired by TMR. Approximately 40% of land parcels impacted by the Project have already been acquired by TMR.

The Project passes directly through the wood chipping industry and this land use would cease as a result. The Project traverses part of the Gympie Cooloola Pet Resort, including the access route to this property. However, it is expected that the continuation of this use would be viable.

Many of the existing local business and retail land uses fronting the Bruce Highway are expected to experience a loss of business. These land uses rely on travellers, such as service stations, and will suffer as traffic will shift to the new alignment. The Project may also result in negative impacts to some retail activities within Gympie as the new Bruce Highway alignment will bypass the centre. Impacts to the local economy are discussed in **Chapter 14 – Socio-Economic**.

It is expected that industry in the south of Gympie will benefit from increased freight efficiency as a result of the Project. This is reflected in the Regional Plan and the planning scheme.

4.7.2 Future Land Use

The Project will improve freight efficiency and capacity in the Gympie region and it is expected that industrial land uses would benefit. Both the Regional Plan and the planning scheme identify capacity for industrial growth in the southern parts of Gympie in which the Project will provide a direct link.

It is expected that the Project will cause changes in retail land uses along the existing Bruce Highway alignment as a result of the reduction in traffic. Existing retail uses along the Bruce Highway are zoned as rural and this may guide the change in these land uses. The reduction in traffic and importantly, freight traffic, along the existing Bruce Highway may also encourage more sensitive land uses to locate here.

As the Project requires land outside of the road corridor designation under the planning scheme, Council may consider amending zone boundaries. Council may also consider amending zones to capture potential land use opportunities as a result of the Project. This would be carried out through the development of a new consolidated planning scheme for Gympie Regional Council.

4.7.3 Land Tenure

The Project will be gazetted as a road corridor prior to the commencement of construction, including 7.6 hectares of Traveston State Forest and 4.2 hectares of Woondum State Forest. Properties directly impacted by the Project will be reconfigured to accommodate the proposed road corridor.

4.7.4 Mitigation Measures

As discussed, the Project impacts predominantly on grazing land uses. Given the nature of the Project, it would be difficult to mitigate the loss of grazing land. To avoid the sterilisation of some grazing parcels, it may be possible for access to be provided specifically for cattle movement alongside watercourses crossed by the Project.

Table 4-6 outlines the mitigation measures that are recommended to minimise land use impacts associated with the Project.

Table 4-6: Potential impacts and mitigation measures relating to land use.

Potential Impact	Mitigation Measure
Construction	
Construction phase impacts on property access	Provide alternative access routes and notify landowners/stakeholders affected by the Project of changes to access. Stage construction works to allow ongoing access to all affected properties.
Property acquisition	Acquisition of properties to be included as road corridor would be carried out in accordance with TMRs land acquisition process.
Removal of vegetation during construction	Minimise clearing of vegetation near residential properties and locate alignment adjacent existing Powerlink transmission easement to minimise fragmentation of vegetation patches. Locate construction sites and site offices on existing cleared land.
Disruption to the Meadvale KRA transport route on Woondum Road	Establish an alternative access arrangement during construction activities, potentially using Kybong Tandur Road while construction activities are occurring on Woondum Road.
Operation	
Reduction in vegetation screening following construction activities	Rehabilitation and revegetation of construction work-sites and road corridor. This is discussed further in Chapter 13 – Landscape and Visual Amenity.
New access arrangements during operation	Notify and consult with landowners/stakeholders affected by the Project of new arrangements.
Sterilisation and fragmentation of grazing land	Provide access for cattle movement alongside watercourses crossed by the Project.
Direct impact to local businesses (wood chipping industry, Gympie Cooloola Pet Resort)	Acquisition of local businesses would be carried out in accordance with TMRs land acquisition process.
Resumption of residential properties	Acquisition and resumption of properties would be carried out in accordance with TMRs land acquisition process.
Planning Scheme impacts	The Planning Scheme maps currently reflect the indicative location of the Project as 'proposed highway'. As the Project requires land outside the road corridor designation under the Planning Scheme, Council should consider amending zone boundaries, particularly for State Forest areas in future updates to the Planning Scheme to accurately reflect the ultimate location of the Project once constructed.

4.8 Conclusion

The Project is consistent with relevant regional and local planning instruments. The Project is exempt from assessment against the Planning Scheme as it includes the duplication and upgrading of a State-controlled road and similarly, the provisions of the SCL Act do not apply to development relating to transport infrastructure or ancillary works or encroachments under the TI Act.

Grazing land uses is the predominant land use impacted by the Project. Impacts to grazing and agricultural land uses, local businesses and residential premises, including property access, outlined throughout this chapter should be mitigated in accordance with the measures identified in **Section 4.7.4**.

5. Climate

5.1 Introduction

This section provides a summary of the existing climate data for the Project area. It also provides an interpretation of the climatic data, and the potential implications for the Project during construction and operation.

5.2 Existing Environment

5.2.1 Local Setting

The Project is a linear infrastructure corridor in the Gympie Regional Council local government area in Queensland. The Project area is dominated by an undulating landscape containing mainly grazing land uses with some areas of cropping with associated homesteads and farming infrastructure.

5.2.2 Regional Climate

The Bureau of Meteorology (BoM) collects climate information from Gympie (site number 040093) approximately 20 kilometres west of the Project. **Table 5-1** provides a summary of the temperature, humidity and rainfall data for the surrounding area from 1870 to 2012.

Table 5-1: Climate Data for Gympie.

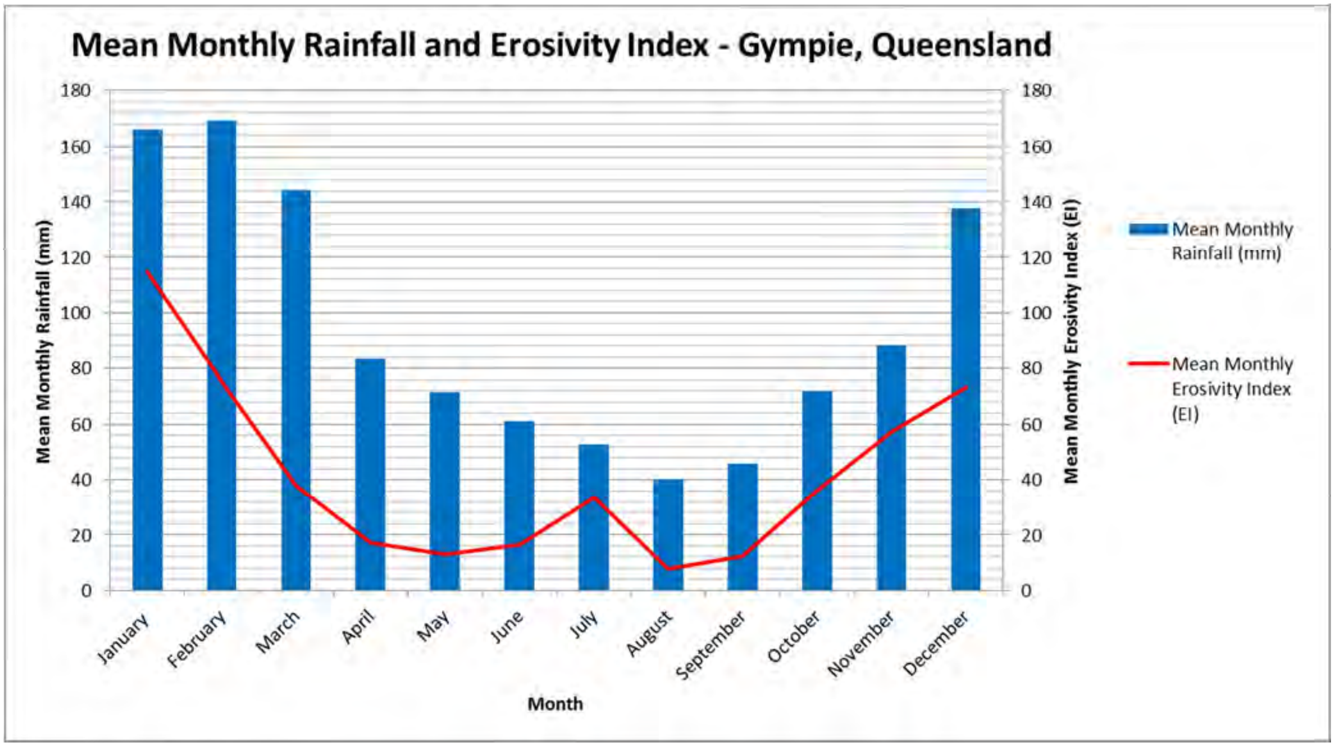
Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
Mean maximum temperature (°C)	31	30	29	27	25	22	22	23	26	28	30	31	27
Mean minimum temperature (°C)	20	20	18	15	11	8	6	7	10	14	16	19	14
Mean rainfall (mm)	166	169	144	83	71	61	53	40	46	72	88	138	1133
Mean number of rain days (≥1 mm)	9	9	10	7	6	5	4	4	4	6	7	8	79
Mean 9am temperature (°C)	26	25	24	21	17	14	12	14	19	22	24	26	20
Mean 9am relative humidity (%)	71	76	77	78	81	81	80	74	67	64	64	67	73
Mean 3pm temperature (°C)	30	29	28	26	23	21	21	22	25	27	28	29	26
Mean 3pm relative humidity (%)	56	60	58	57	56	52	47	42	41	46	50	52	51

Gympie typically has warm days during summer with average maximum daytime temperatures around 30°C falling to 22°C during the winter months. Overnight temperatures are generally cool to mild all year round and cold during the winter months with average minimum daily temperatures of 6°C in July, rising to greater than 18°C between December and March.

Mean 9 am relative humidity is generally greatest from April to July and least during the spring months. Mean 3 pm relative humidity is much lower than 9 am through the year, ranging from 21% in June up to 30% in January.

Highest rainfall is generally recorded during summer months with monthly rain averages above 135 mm/month from December to March. Mean monthly rainfall generally drops off in late autumn and winter with average monthly rainfalls less than 72 mm from May until October. Mean monthly rainfall and Erosivity Index are shown in **Figure 5-1**.

Figure 5-1: Mean monthly rainfall and Erosivity Index for Gympie.

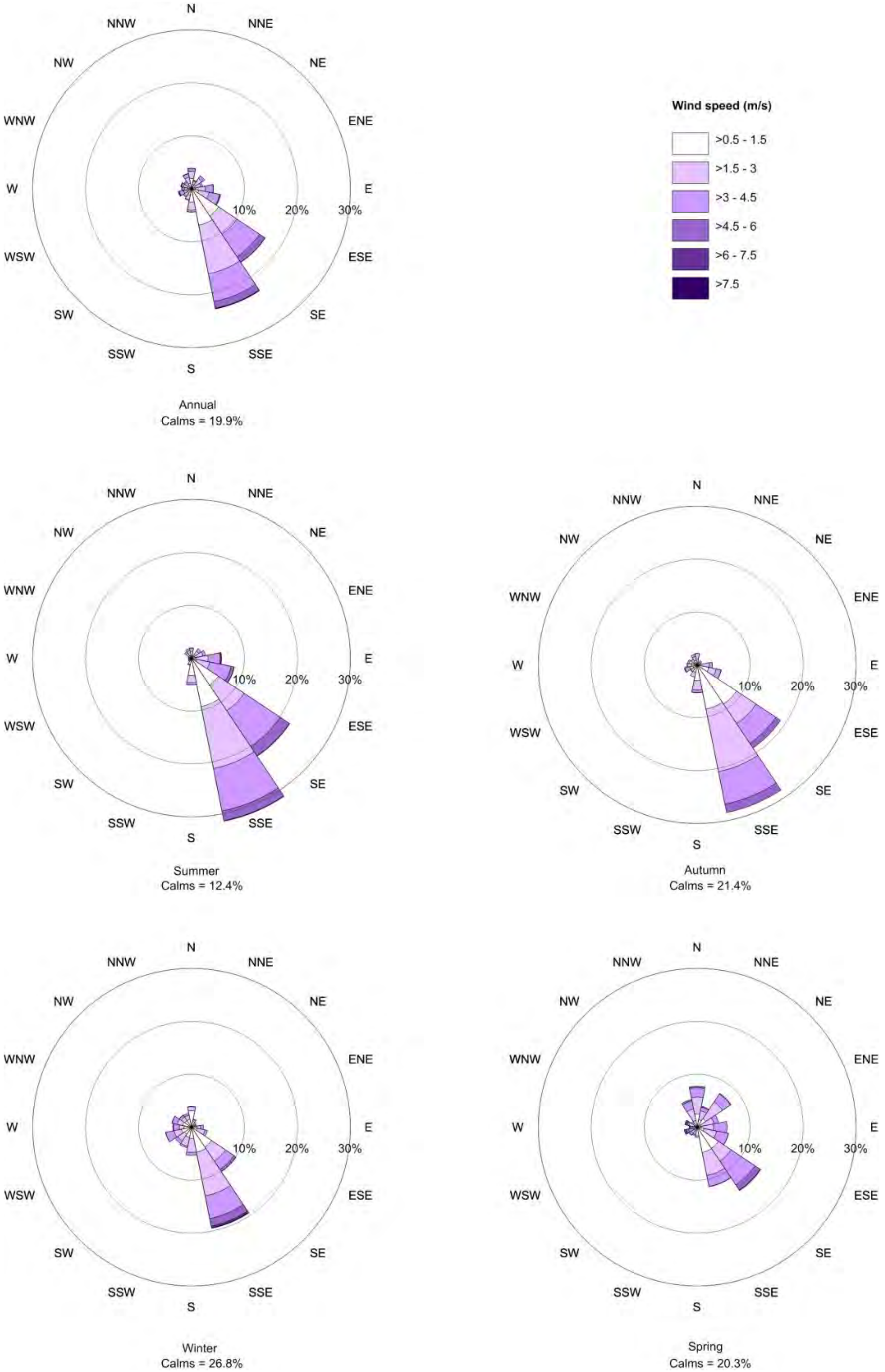


Rainfall and erosivity are contributing factors to the degree of erosion and associated water quality impacts experienced during construction. As shown in **Figure 5-1**, lowest mean rainfall and erosivity are generally experienced between April and September.

The BoM site at Gympie has recently upgraded their site to collect one minute data for wind speed and direction (presented in one hour averages). The data for 2011 contains a significant number of blank data points (approximately 20%) and therefore have been excluded from the analysis.

Wind roses have been presented excluding these blank data points and are provided in **Figure 5-2**. The wind roses show the frequency of occurrence of winds by direction and strength. The wind roses indicate that there are dominant winds from the south to southeast in summer, autumn and spring. The winter months also contain a high frequency of south easterly winds with a small percentage of winds from north to northeast. The wind pattern is consistent with the location of the meteorology station and the influence of valley winds along the Mary River.

Figure 5-2: Seasonal and annual wind roses for Gympie BoM station.



5.3 Potential Impacts

Intense rainfall and associated soil erosion and deposition in local waterways represent the greatest environmental risk to the Project in relation to the local climate. Construction works may also be impacted by localised flooding during significant rain events.

Construction activities should be conducted with consideration of the potential impacts associated with the local climate, including:

- Programming of the majority of bulk earthworks to occur in drier months
- Completion of construction works in and near waterways, particularly in Traveston Creek and Kybong Creek where diversions are required, between April and September
- Stabilisation of exposed batters should be reviewed prior to wetter months to determine if additional protection is required
- Vegetation ground works including the application of grass seed or hydro mulch should be conducted no later than September to provide greatest opportunity to achieve stabilisation success.

Other impacts of local climate and seasonal changes during the construction of the project include:

- Dry conditions are likely to increase the amount of dust generated from construction activities
- Increased wind speeds may increase the impact of dust-generating activities
- Wet weather can hamper construction activities and vehicle access to construction sites
- High temperatures and humidity can potentially affect construction workers, resulting in sunburn and/or sunstroke
- A cyclonic event or severe storm has the potential to cause flooding of construction areas and halt works for periods of time.

5.3.1 Vulnerability to Climate Change Impacts

The Project area does not suffer from any particular vulnerability to climate change in relation to rainfall, hydrology, temperature or extreme weather, beyond that of any other inland location.

It is noted that more intense storm events may occur over time resulting in potential increases in regional flood frequency and magnitude. However, the proposed design for crossing structures at the four major creek crossings, Traveston Creek, Kybong Creek, Cobbs Gully and Jackass Creek are higher than the regional 100 year flood level. The design height of these structures is expected to provide significant flood immunity for all drainage structures associated with the Project.

For the local area flooding event the minimum road levels will provide enhanced network resilience for the local events given the regional 100 year flood level is at least two metres higher than the local 100 year flood level.

The effects of a storm surge event are generally limited to tidal rivers and areas within one kilometre of the ocean foreshore. Impacts from storm surge are not expected as this section of the Mary River is not tidal and the site is approximately 42 kilometres inland.

6. Terrestrial Ecology

6.1 Introduction

This section provides an assessment of the terrestrial ecology impacts of the Project. This assessment has been carried out in accordance with relevant State and Commonwealth legislation.

The objectives of the terrestrial ecology assessment were to:

- Review background information including relevant databases, mapping and literature
- Identify gaps in the background information
- Complete a flora field survey to identify the terrestrial flora and regional ecosystems (REs) occurring within the study area, including an evaluation of the presence or absence of any conservation significant flora species
- Complete a fauna field survey to identify the terrestrial vertebrate fauna, significant faunal habitats and faunal movement corridors occurring within the study area, including an evaluation of the presence or absence of any conservation significant fauna species
- Describe the existing terrestrial flora and fauna values within and surrounding the study area
- Assess the potential impacts of the Project on terrestrial flora and fauna values in the context of relevant State and Commonwealth legislation, including an evaluation of the significance of impacts on matters of national environmental significance (MNES) protected under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)
- Propose measures to mitigate or offset adverse impacts on terrestrial flora and fauna at the design, construction and operational phases.

The structure of this chapter is as follows:

Section 6.2: Description of the relevant legislative framework

Section 6.3: Methodology of the flora and fauna studies

Section 6.4: Description of the existing environment

Section 6.5: Assessment of potential impacts and mitigation

Section 6.6: Evaluation of significance of impacts on MNES

Section 6.7: Offsets strategy

Section 6.8: Summary and conclusions

Since completion of the baseline flora and fauna study in December 2011 and January 2012, additional works have been proposed including Woondum Interchange and location of stockpile areas, and the Koala (*Phascolarctos cinereus*) was listed under the EPBC Act.

Additional ecological assessments have been undertaken to address information gaps and include:

- An assessment of the impact of the project on regional landscape connectivity
- An assessment of Woondum Interchange on ecological values
- Additional survey data for the Koala and Black-breasted Button-quail (*Turnix melanogaster*) to confirm its presence in the regional landscape.

6.2 Legislative Framework

6.2.1 Environment Protection and Biodiversity Conservation Act 1999

The EPBC Act prescribes the Commonwealth's role in environmental assessment, biodiversity conservation and the management of MNES. Under the provisions of the EPBC Act, an action that is likely to have a significant impact on a MNES requires the approval of the Australian Government Minister for DotE. Nine MNES are protected under the EPBC Act:

1. World Heritage properties.
2. National Heritage places.
3. Wetlands of international importance (listed under the Ramsar Convention).
4. Listed threatened species and ecological communities.
5. Listed migratory species protected under international agreements.
6. Commonwealth marine areas.
7. The Great Barrier Reef Marine Park.
8. Nuclear actions (including uranium mines).
9. A water resource, in relation to coal seam gas development and large coal mining development.

TMR plans to submit an EPBC Act referral for the Project to DotE in the second quarter of 2014 to determine whether the Project is a controlled action. The MNES that are considered potentially relevant to the Project are:

- Listed threatened species and ecological communities
- Listed migratory species.

The EPBC Act lists threatened species under the following categories; extinct in the wild, endangered and vulnerable. Furthermore, the EPBC Act provides protection for migratory species, including those listed under International Agreements such as the Japan-Australia Migratory Bird Agreement (JAMBA), the China-Australia Migratory Bird Agreement (CAMBA) or the Convention on the Conservation of Migratory Species of Wild Animals (i.e. the Bonn Convention).

6.2.2 Queensland Legislation

6.2.2.1 Vegetation Management Act 1999

Amendments to the Queensland Vegetation Management Framework, introduced by the *Vegetation Management Framework Amendment Act 2013* took effect on 2 December 2013. Key reforms include three new clearing purposes, a range of self-assessable vegetation clearing codes, simplified mapping and the removal of high value regrowth (HVR) regulations from freehold and Indigenous land.

The *Vegetation Management Act 1999* (VM Act) regulates clearing of certain native vegetation on a regulated vegetation management map. HVR vegetation (mature native vegetation that hasn't been cleared since 31 December 1989) is also regulated on leasehold land for agriculture and grazing and within 50 metres of identified watercourses in the priority Great Barrier Reef catchments of Burdekin, Mackay Whitsunday and Wet Tropics on freehold land, Indigenous land and leasehold land for agriculture and grazing.

The Project is not located within a priority reef catchment, and there is no leasehold land for agriculture or grazing impacted by the Project. Therefore, no regulated HVR vegetation exists in the corridor. However, field surveys have identified mature regrowth for the purpose of assessing the overall ecological value of the project area.

The VM Act is not likely to apply to the Project, due to the vegetation clearing exemptions for State-controlled road works as described below.

6.2.2.1.1 Vegetation Clearing Exemption

The clearing of native vegetation for road works carried out on a State-controlled road or future State-controlled road is exempt development under schedule 24, part 1, item 11 of the SP Regulation. Road works is defined under the TI Act as "constructing roads or things associated with roads". As the Project involves undertaking works for State-controlled roads, all works for the Project within the State-controlled road corridor, including the removal of vegetation is exempt development. No permits for the clearing of vegetation or associated offsets will be required under the VM Act for road works within the State-controlled road corridor.

6.2.2.2 Nature Conservation Act 1992

The *Nature Conservation Act 1992* (NC Act) provides for the conservation and management of Queensland's native flora and fauna. The Act prohibits the taking or destruction of listed flora and fauna species without authorisation.

The *Nature Conservation (Wildlife) Regulation 2006* lists the flora and fauna species considered extinct in the wild, endangered, vulnerable, near threatened, least concern, international and prohibited. It states the declared management intent and the principles to be observed in any taking of or destruction for each group.

The NC Act will apply to the Project. TMR currently has exemptions to certain requirements of the NC Act relating to protected plants and breeding places for certain least concern animals as described below.

6.2.2.2.1 Protected Plant Exemption

Under section 89(1) of the NC Act, it is an offence to take any plant that is indigenous to Australia other than under:

- Conservation plan applicable to the plant, or
- A license, permit or other authority issued or given under a regulation, or
- An exemption under a regulation.

Works completed by TMR are currently exempt from the requirement to obtain a clearing permit under section 89(1)(c) of the NC Act following the granting of the protected plant exemption for taking a protected plant in the course of an activity under a Roads Implementation Program. Qualification for the exemption is based on the following factors:

- Listing status of the protected plant (least concern, near threatened, vulnerable or endangered)
- Location of the plant (State managed land, protected area status)
- Previous clearing activities at the location of the protected plant.

The current protected plant exemption remains in effect until 30 June 2014. Any works carried out after this date will be required to comply with the NC Act and any future exemptions relevant at the time of construction.

The protected plants legislation is currently under review. The *Nature Conservation (Protected Plants) and Other Legislation amendment Bill 2013* has been passed to make the necessary changes for a new simplified protected plants legislative framework. The Project will need to consider these legislative changes.

6.2.2.2.2 Species Management Program

TMR has an approved, generic Species Management Program (SMP) prepared under section 332 of the *Nature Conservation (Wildlife Management) Regulation 2006* that permits TMR to remove or otherwise tamper with the breeding place of certain animals listed as 'least concern' under the NC Act. This SMP does not apply to:

- Species defined as near threatened, vulnerable, endangered or extinct in the wild
- Breeding places located in forest reserves or protected areas prescribed under the NC Act

- Breeding places (roosts) for flying-fox species, including the Grey-headed Flying-fox
- Special least concern animals including Koala, Echidna, Platypus and migratory bird species listed under selected international agreements
- Species classed as colonial breeders.

TMR must obtain a separate authority from the DEHP prior to disturbing breeding places for animals falling into the categories listed above.

The current SMP remains in effect until 30 June 2016. Any works carried out after this date will be required to comply with the NC Act and any future exemptions relevant at the time of construction.

6.2.2.2.3 Koala Conservation

The Project is located outside the South East Queensland Koala Protection Area (SEQKPA), and is therefore not subject to the requirements of the State Government Supported Community Infrastructure Koala Conservation Policy.

Differentiated levels of provisions apply to the three Koala districts that have been mapped across Queensland. The Project is located with Koala District B, which comprises 18 local government areas in the northern portion of South East Queensland Bioregion, where Koalas are listed as vulnerable under the NC Act. Koala District B supports Koala densities generally lower than 0.2 Koalas/hectare and characteristically contains habitat in areas zoned for rural purposes.

Elements of earlier regulatory instruments, such as policies relating to sequential clearing, the use of a Koala spotter, the rehabilitation of injured or sick Koalas and translocation remain in place.

6.2.2.3 Land Protection (Stock and Pest Route Management) Act 2002

The *Land Protection (Stock and Pest Route Management) Act 2002* (LP Act) and the *Land Protection (Pest and Stock Route Management) Regulation 2003* provides for improved management of weeds, pest animals and stock route network in Queensland. There are three classes of Declared Pest that are enforced under the LP Act and the management intent varies between each class. The Department of Agriculture, Fisheries and Forestry (DAFF) administers the LP Act.

6.2.3 Offset Policies

The Queensland and Commonwealth Governments have established frameworks for using environmental offsets to compensate the loss of environmental values where impacts from development are unavoidable.

Offset policies give guidance and set standards for what would constitute an acceptable offset under relevant legislation. Offsets must be legally secured by a legally binding mechanism associated with the land title such as a “covenant on title” or nature refuge and must also have an associated management or offset area implementation plan.

The Queensland Government environmental offset framework including the Queensland Government Environmental Offset Policy (QCEOP) and the Queensland Biodiversity Offset Policy (QBOP) is currently being reviewed. The QBOP is due to be replaced in mid-2014 with the revised Queensland environmental offset framework. It is likely that this policy will apply to the Project.

Should the project be declared a controlled action, the Australian Government EPBC Act Environmental Offsets Policy (EOP) will be applicable.

The EPBC Act EOP sets out the use of environmental offsets under the EPBC Act to compensate unavoidable impacts on MNES, including listed threatened species and threatened ecological communities. The policy applies to projects that have been referred to the DotE and declared a controlled action for assessment under the EPBC Act. The offsets policy does not apply to actions that have been declared as not a controlled action (i.e. significant impacts on MNES unlikely).

6.3 Methodology of flora and fauna surveys

6.3.1 Overview

Flora and fauna surveys have been completed for Section C in two stages. These are:

- **Stage 1** – baseline flora and fauna survey in December 2011 and January 2012, undertaken by Biodiversity Assessment and Management (BAAM)
- **Stage 2** – surveys of expanded project footprint to accommodate Woondum Interchange, Koala surveys and surveys to identify regional landscape connections in the vicinity of Section C.

Site locations for all terrestrial ecology surveys completed for the Project are shown in **Figure 6-2**.

6.3.1.1 Stage 1 – Baseline Flora and Fauna Survey

BAAM completed a baseline flora and fauna study for the Project in December 2011 and January 2012 (BAAM, 2012). The methodology employed by BAAM to investigate the terrestrial flora and fauna values and threats of the study area for the Project is summarised in **Section 0**. For more detail see **Appendix F**.

6.3.1.2 Stage 2 – Additional Surveys

Since completion of the baseline flora and fauna study, additional works outside the study area surveyed by BAAM in December 2011 and January 2012 have been proposed including Woondum Interchange and location of stockpile areas. In addition, the Koala has been listed as a vulnerable species under the EPBC Act.

Additional ecological assessments have been undertaken to describe the regional landscape connectivity in the vicinity of the project area, survey additional works not included in the original study area and gather further Koala survey data. The purposes of the additional ecological assessments are to provide:

- An additional fauna survey of the study area to understand the usage of ecological connectivity (particularly at Traveston and Woondum State Forests) potentially impacted by the road alignment by terrestrial vertebrate species (including species of conservation significance) and inform the design/placement of connectivity structures (i.e. culverts/bridges)
- Ecological surveys at the Woondum interchange (outside of the original surveyed study area), identifying vegetation communities, habitat values and significant features
- A targeted survey for the Black-breasted Button-quail in Woondum State Forest in accordance with the Survey guidelines for Australia's threatened birds (DEWHA, 2010) to confirm its presence and extent of suitable habitat
- Additional Koala survey data using the Spot Assessment Technique (SAT) developed by Phillips and Callaghan (2011) in accordance with the Draft EPBC Act referral guidelines for the vulnerable koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) (DotE, 2013), to confirm the presence of the species in the landscape.

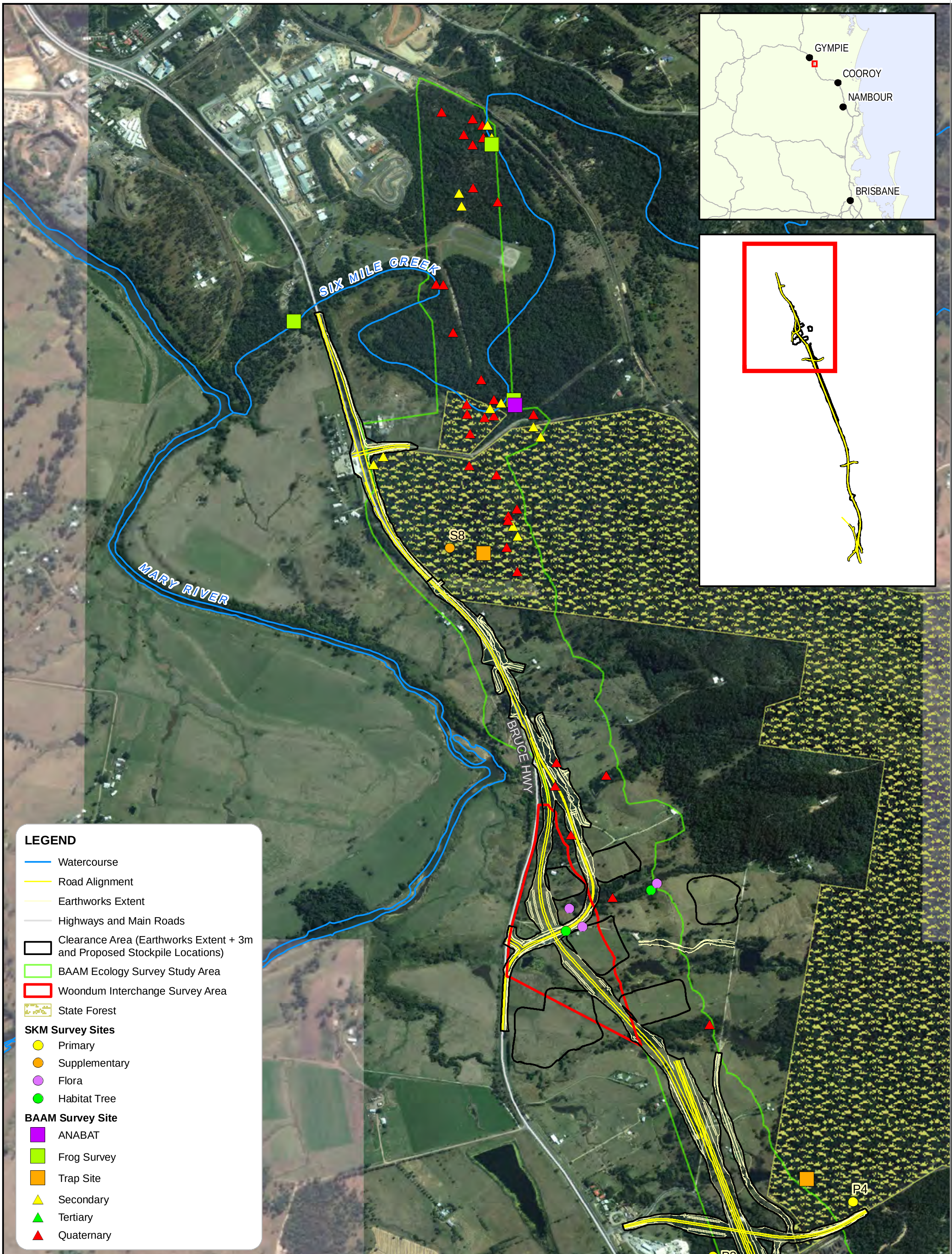


Figure 6-1A

Ecology Survey Sites

Kilometres
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Data Source: DEHP, BAAM (2012)

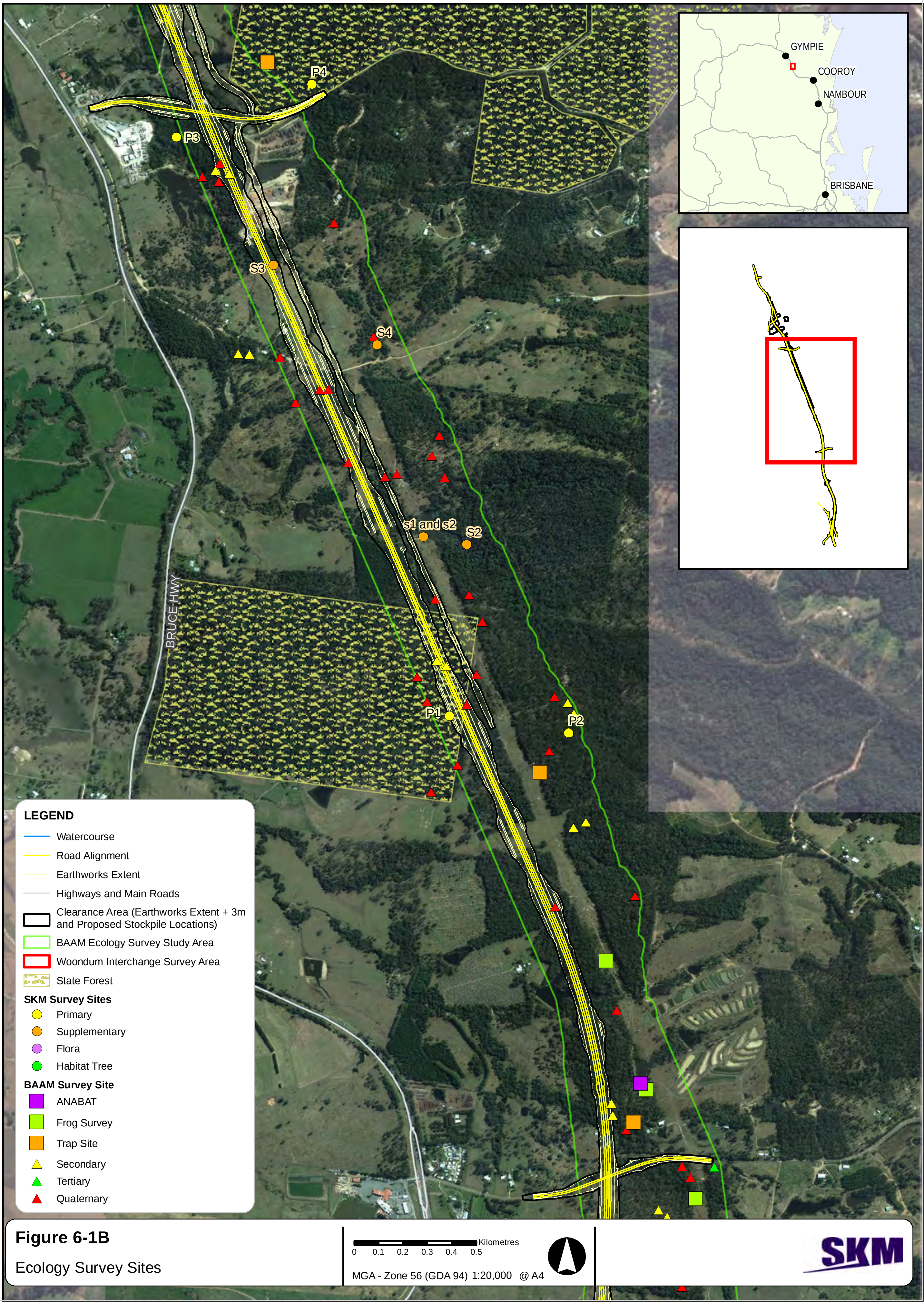

Figure 6-1B

Ecology Survey Sites

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Data Source: DEHP, BAAM (2012)

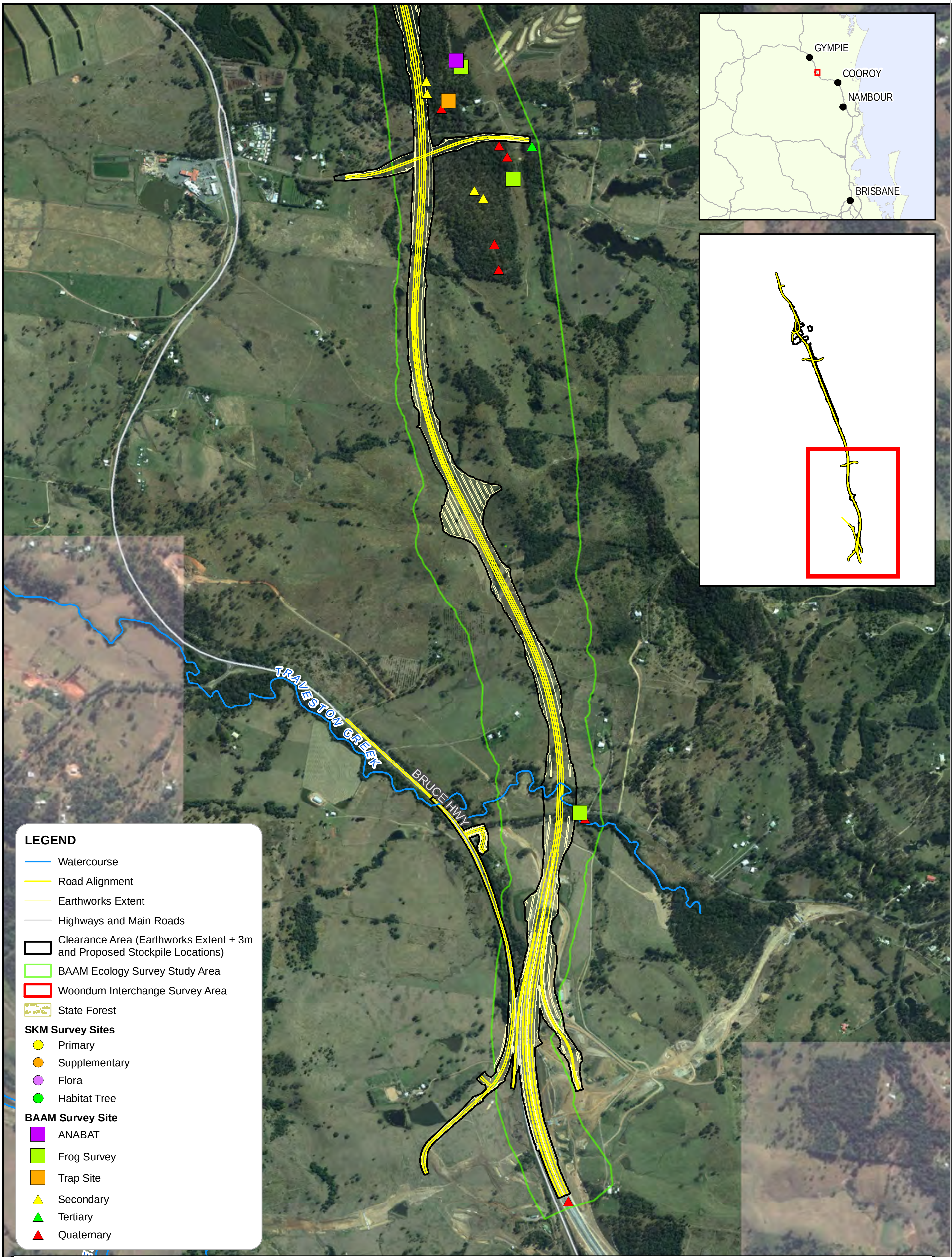

Figure 6-1C

Ecology Survey Sites

Kilometres 0 0.1 0.2 0.3 0.4 0.5

MGA - Zone 56 (GDA 94) 1:20,000 @ A4

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Data Source: DEHP, BAAM (2012)

6.3.2 Baseline Flora and Fauna Survey

6.3.2.1 Study Area

The study area defined by BAAM is located between the township of Tuchekoi and the southern outskirts of Gympie. The proposed alignment extends approximately 11 kilometres in a north-south direction running roughly parallel to the existing highway. The study area traverses a low range with land use including Woondum State Forest and rural activities (largely cattle grazing). The study area has been largely cleared of vegetation in the south but passes through forested areas between Kybong and Gympie.

The topography is undulating and includes many gullies incorporating ephemeral wetlands/creek lines and farm dams. Several creeks run through the study area including Traveston Creek, Kybong Creek, Cobbs Gully, Jackass Creek and Six Mile Creek. A 50 to 70 metre wide high voltage power line easement (largely cleared) passes through much of the study area.

6.3.2.2 Desktop Review

A desktop review of known and likely terrestrial flora and fauna values was undertaken within a five kilometre buffer of the study area. The desktop review included an inspection of environmental and wildlife databases, consisting of:

- EPBC Act Online Protected Matters Search Tool
- DEHP Regional Ecosystem Mapping Database and associated Regional Ecosystem Description Database (REDD) (Version 6.0b). Note current versions of the RE (Version 8.0) and the regrowth vegetation (version 2.1) have been reviewed for the REF
- DEHP Essential Habitat mapping (Version 6.0b)
- DEHP Biodiversity Planning Assessment
- Queensland Herbarium's HERBRECS database
- Queensland Museum's fauna database
- DEHP's WildNet (Wildlife Online) database
- Birds Australia's New Atlas database.

The results of database and mapping searches were used to inform the field investigation and target terrestrial species listed under the EPBC Act and NC Act. Information gained from this phase of the study was used to:

- Identify communities and species of significance known from the region
- Determine which species of significance are most likely to occur if suitable habitat was located within the study area. Those species that are known from recent, nearby records and State mapping were considered more likely to occur if suitable habitat was located
- Identify significant areas and associated development constraints within the study area from the statutory mapping.

6.3.2.3 Flora Survey

The flora field survey was undertaken over six days from the 5 to 10 December 2011.

High resolution colour aerial photography captured in 2011 and DEHP certified RE mapping were viewed to delineate vegetation boundaries prior to field survey. During the field survey, all flora species encountered were recorded. Searches for flora species, including threatened flora, were conducted continuously while traversing the study area during the survey period.

The flora survey consisted of 13 secondary survey sites and 63 quaternary survey sites. Data gathered during the secondary and quaternary field surveys were used to produce a vegetation map of the study area. The GPS points from the quaternary sites assisted with vegetation pattern interpretation and subsequent mapping.

6.3.2.4 Fauna Survey

A field survey program was conducted within and adjacent to the study area to ascertain the terrestrial vertebrate species present within the study area and to gain an understanding of the fauna habitat values of existing vegetation. The general field survey methodologies used for this survey are provided in **Appendix F**.

The terrestrial vertebrate field investigation involved a trapping program, targeted searches and site traverses over a period of nine days and seven nights over two periods from 5 to 10 December 2011 and 4 to 6 January 2012. Targeted searches were carried out for the Giant Barred Frog (*Mixophyes iterates*, Endangered under EPBC Act and NC Act) which was recorded in the area from database searches. The fauna methodologies followed DotE survey guidelines for EPBC Act threatened fauna where practicable and appropriate at the time, however specific survey guidelines for the Black-breasted Button-quail were not met during this survey.

The fauna survey was undertaken prior to the listing of the Koala under the EPBC Act. Although the fauna survey methodology included nocturnal spotlight surveys and habitat assessments, which surveyed for the presence of Koalas, no targeted Koala surveys using the SAT (developed by Phillips and Callaghan, 2011) was undertaken in accordance with the draft Koala referral guidelines (DotE, 2013).

6.3.3 Additional Ecological Assessments

6.3.3.1 Study Area

The study area for the additional ecological assessments is wider than the original BAAM study area and includes:

- **Traveston State Forest**: Remnant vegetation/habitat either side of the transmission line, including Traveston State Forest on Lot 950 FTY1293 (west) and private property on Lot 80 RP913598 (east).
- **Cobbs Gully**: Remnant and regrowth vegetation/habitat either side of the transmission line, including Lot 416 CP882034 (west) and Lot 1382 M371313 (east).
- **Jackass Creek**: Regrowth vegetation/habitat either side of the transmission line, including Lots 2 RP138810 and 1 RP173216 (west) and Lots 1 RP868802 and 2 RP840266 (east).
- **Woondum State Forest**: Remnant vegetation/habitat either side of Woondum Road and the proposed alignment, including private property along Jackass Creek on Lot 2 RP138810 (west) and Woondum State Forest on Lot 983 FTY1488 (east).
- **Woondum Interchange**: Non-remnant and regrowth vegetation/habitat on Lots 2 RP165151, 3 RP165151 and 1 RP35055.
- **Black-breasted Button-quail habitat**: Remnant vegetation/habitat between Keefton Road and the transmission line in Woondum State Forest (Lot 983 FTY1488).

6.3.3.2 Survey Site Locations

An analysis of the following spatial layers was undertaken to determine survey site locations:

- Aerial imagery
- Proposed alignment, additional road works and clearance areas including Woondum Interchange
- BAAM study area and fauna survey sites
- Watercourses
- Traveston and Woondum State Forests

- Field verified RE and HVR mapping within BAAM study area
- DEHP RE and HVR mapping around the BAAM study area
- Endangered, Vulnerable or Near Threatened (EVNT) fauna locations.

Survey sites focussed on habitat (remnant or regrowth vegetation) at:

- Traveston State Forest and Woondum State Forest either side of the alignment
- Cobbs Gully and Jackass Creek on either side of the alignment
- Woondum State Forest in the vicinity of Black-breasted Button-quail platelets recorded by BAAM
- Woondum Interchange.

6.3.4 Fauna Connectivity Survey

A fauna survey involving trapping (Elliot, cage, pitfall, reptile funnel, hair funnel, camera), Anabat bat call detection, bird surveys, active diurnal searches, nocturnal spotlighting, call playback, Koala SAT surveys and habitat assessments was conducted in the wider study area to ascertain the terrestrial vertebrate species usage of landscape ecological connectivity dissected by the proposed alignment.

The focus of the fauna connectivity survey was to understand the usage of fauna connectivity potentially impacted by the Project at Woondum State Forest and Traveston State Forest, as these are the largest tracts of contiguous forest in the landscape. Primary sites involving all survey techniques were established at either side of the proposed alignment at Traveston State Forest and Woondum State Forest.

Narrow strips of vegetation retained along watercourses (Jackass Creek, Cobbs Gully and Kybong Creek) are also likely to provide fauna connectivity and these sites were surveyed opportunistically. Supplementary sites involving the use of selected techniques were established at either side of the proposed alignment at Cobbs Gully and Jackass Creek.

6.3.4.1 Survey Timing

SKM's ecologist conducted the fauna survey over a period of five days and four nights from 17 to 21 February 2014. The weather during the survey was dry and sunny with relatively warm temperatures for the time of year (maximum daily temperatures of 35.1-38.1°C and minimum daily temperatures of 19.2-24.1°C).

6.3.4.2 Survey Effort

The survey consisted of four primary (trapping) sites and four supplementary sites. Details of the survey techniques conducted at each site are described in **Appendix G**. All survey techniques were employed at the primary sites, with surveys/searches at supplementary sites.

Table 6-1: Survey effort by site.

Survey technique	P1	P2	P3	P4	S1	S2	S3	S4
2 or 3 pitfall traps	4 nights	4 nights	3 nights	4 nights				
3 reptile funnel traps	4 nights	4 nights	3 nights	4 nights				
10 hair funnel traps	4 nights	4 nights	3 nights	4 nights				
1 infrared camera trap	4 nights	4 nights	3 nights	4 nights				
25 Elliot trap A	4 nights	4 nights	3 nights	4 nights				
5 Elliot trap B	4 nights	4 nights	3 nights	4 nights				
1 cage trap	4 nights	4 nights	3 nights	4 nights				
1 Anabat SD2 bat call detection	1 night	1 night	1 night	1 night		1 night		
20 min morning bird survey	1 survey	1 survey	1 survey	1 survey	1 survey	1 survey		
20 min active diurnal search	1 search	1 search	1 search	1 search				
60 min nocturnal spotlighting survey	2 man hours	2 man hours	2 man hours	2 man hours	2 man hours	2 man hours		
Call playback survey	1 survey	1 survey	1 survey	1 survey		1 survey		
Koala SAT survey	1 survey	1 survey	1 survey	1 survey				
Habitat assessment	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

P = Primary site; S = Supplementary site

6.3.5 Woondum Interchange ecological survey

A survey of the Woondum Interchange footprint was undertaken to survey terrestrial flora, vegetation communities and fauna habitats, and confirm the presence of any threatened flora species. The following methods were used:

- Ground-truthing of regional ecosystems and regrowth vegetation in accordance with the Queensland Herbarium methodology (Neldner *et al*. 2012) using formalised quaternary level sampling procedures, as well as informal site observations
- Random meander searches for threatened flora species
- Fauna habitat assessments to assess fauna habitats, fauna movement corridors and potential occurrence of threatened fauna species
- Identification of significant habitat features, including locations of mature, hollow-bearing trees
- Identification of weed species with a focus on declared weeds.

6.3.6 Black-breasted Button-quail survey

A targeted survey for the Black-breasted Button-Quail in Woondum State Forest was conducted to confirm the presence of this species and refine habitat mapping. BAAM had recorded platelets attributable to the species in Woondum State Forest during their surveys in 2011/2012. The SKM survey involved habitat mapping and area searches of suitable habitat with detection of flushing birds or hearing of foraging scratching or identification of platelets. Whenever platelets were identified, their location was recorded with a GPS and 20 minute call playback session was undertaken to listen for foraging scratching.

A total of 15 hours of land-based area searches of habitat was undertaken over three days, as follows:

- 18 February 2014 – 2 hours
- 3 March 2014 – 6.5 hours
- 4 March 2014 – 6.5 hours.

The survey effort for this species was in accordance with the Australian Government's Survey guidelines for Australia's threatened birds (DEWHA, 2010). Although the guideline states that detection of platelets is not conclusive unless birds are also sighted.

6.4 Existing Environment

6.4.1 Desktop Results

6.4.1.1 Certified Regional Ecosystem Mapping

Regional ecosystems (RE) mapped within the study area are described in **Table 6-2**. Certified RE mapping indicates 31% of the study area is remnant vegetation comprising seven RE types. A number of these are mosaic polygons, in which more than one RE type is identified. The majority (67%) of the certified remnant vegetation in the study area is mapped as RE 12.11.3 which is designated as Least Concern for its VM Act status. Substantial areas are also mapped as RE 12.11.14 and 12.3.11 (15% and 13%, respectively), both of which have Of Concern statuses. Only very small parts of the study area are mapped as Endangered remnant vegetation (REs 12.5.2 and 12.11.16), comprising less than 1% of mapped remnant vegetation. The remaining 4% of remnant vegetation is mapped as Least Concern vegetation (REs 12.9-10.17 and 12.3.7).

Table 6-2: Certified Regional Ecosystem (RE) remnant vegetation in the study area.

RE	Short Description (REDD)	Status	
		VM Act	EPBC Act
12.3.7	*Eucalyptus tereticornis*, *Callistemon viminalis, Casuarina cunninghamiana* fringing forest	LC	-
12.3.11	*Eucalyptus siderophloia*, *E. tereticornis*, *Corymbia intermedia* open forest on alluvial plains usually near coast	OC	-
12.5.2	*Eucalyptus tereticornis*, *Corymbia intermedia* on remnant Tertiary surfaces, usually near coast. Usually deep red soils	E	-
12.9-10.17	Open forest complex often with *Eucalyptus acmenoides*, *E. major*, *E. siderophloia* +/- *Corymbia citriodora* on sedimentary rocks	LC	-
12.11.3	Open forest generally with *Eucalyptus siderophloia*, *E. propinqua* on metamorphics +/- interbedded volcanics	LC	-
12.11.14	*Eucalyptus crebra*, *E. tereticornis* woodland on metamorphics +/- interbedded volcanics	OC	-
12.11.16	Tall open forest with *Eucalyptus cloeziana* on metamorphics +/- interbedded volcanics	E	-

RE = regional ecosystem; REDD = Regional Ecosystem Description Database; VM Act = vegetation management status under the *Vegetation Management Act 1999*; EPBC Act = listed threatened ecological community under the *Environment Protection and Biodiversity Conservation Act 1999*; LC = Least Concern; OC = Of Concern; E = Endangered; - = not listed.

Certified RE mapping (version 8.0) is provided in **Figure 6-2**.

6.4.1.2 Certified regrowth mapping

The certified regrowth mapping (version 2.1) is provided in **Figure 6-2**. Since completion of the baseline flora and fauna study in 2011/2012, VM Act amendments took effect removing High Value Regrowth regulations from freehold and Indigenous land. However, as noted in **Section 6.2.2.1**, the assessment of regrowth vegetation remains relevant for the purpose of assessing the overall ecological value of the project area.

6.4.1.3 Certified Essential Habitat mapping

Certified Essential Habitat mapping indicates the study area contains Essential Habitat for Koala and Black-breasted Button-quail.

Remnant vegetation mapped as Essential Habitat for Koala is located along watercourses in the study area (Six Mile Creek, Jackass Creek, Cobbs Gully and Kybong Creek). The area mapped as Essential Habitat for Black-breasted Button-quail is based on a buffered record for the species along Six Mile Creek in the north of the study area.

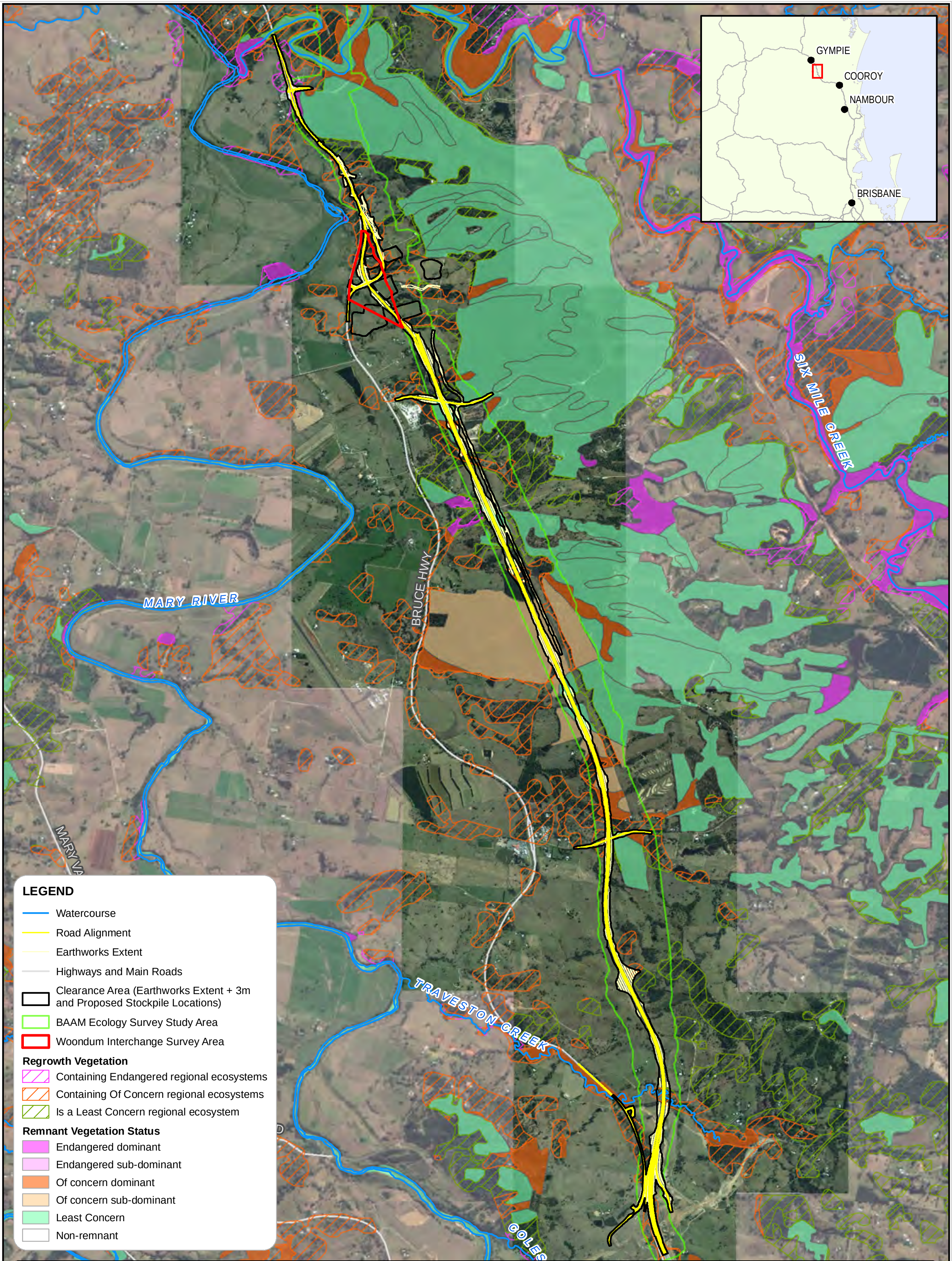

Figure 6-2
Certified Regional Ecosystem and Regrowth Vegetation Mapping

Sinclair Knight Merz does not warrant that this document is definitive nor free of error and does not accept liability for any loss caused or arising from reliance upon information provided herein.
Data Source: DEHP

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6.4.1.4 Threatened Ecological Communities

The EPBC Act Protected Matters report did not return any threatened ecological communities listed under the EPBC Act. Nonetheless, one threatened ecological community (TEC) was considered likely to occur within the study area based on the EPBC Act listing advice - Lowland Rainforest of Subtropical Australia TEC listed as critically endangered under the EPBC Act.

6.4.1.5 Threatened Species

Database search results indicate that several flora and fauna species (including one invertebrate) listed as Endangered, Vulnerable or Near Threatened (EVNT) under the NC Act and/or EPBC Act may occur within a five kilometre radius of the study area. An assessment of the likelihood of these species occurring within the study area is provided in **Appendix H** for threatened flora and **Appendix I** for threatened fauna.

6.4.1.6 Migratory Species

Database search results indicate that 15 fauna species listed as Migratory under the EPBC Act may occur within a five kilometre radius of the study area. An assessment of the likelihood of these species occurring within the study area is provided in **Section 6.4.2.6** and **Appendix I**.

6.4.1.7 Pest Animals

Database search results indicate that 13 fauna species listed as introduced species under the NC Act are known to be present in the local area. These include two species (Fox *Vulpes vulpes* and Dog *Canis familiaris*) listed as Class 2 declared pest species under the LP Act.

6.4.1.8 Biodiversity Planning Assessment - Corridors

Within the study area there are several locations where regionally significant vegetation corridors cross the Project. The corridors from the Biodiversity Planning Assessment are mapped in the baseline terrestrial ecology report located in **Appendix F**.

At the northern end of the study area (either side of Keefton Road) a regionally significant corridor associated with Six Mile Creek and Woondum State Forest crosses the alignment. Six Mile Creek and associated riparian vegetation is the central component of this corridor. Approximately three kilometres to the south of this crossing at Woondum Road, the same regionally significant corridor (associated with Woondum State Forest) extends across the alignment.

In the central section of the study area (north of Tandur Road), a regionally significant corridor crosses the alignment at Traveston State Forest and Cobbs Gully. This includes a large block within Traveston State Forest and adjacent remnant vegetation in private property to the east. The southern edge of this section is bordered by a large farm dam.

6.4.2 Field Survey Results

This section describes the terrestrial flora and fauna values of the study area identified from the field survey. The likely presence or absence of conservation significant species identified from the desktop review has been evaluated on the basis of a habitat assessment, and species considered likely or to have potential to occur within the study area have also been described in this section.

6.4.2.1 Field-Verified Regional Ecosystems

Table 6-3 describes the REs identified in the study area and their conservation status, while **Appendix F** provides a detailed description of the ecological features of each RE. Field verified mapping shows that remnant vegetation constitutes 31.4% of the study area. The majority (57.5%) of the study area is RE 12.11.3. A total of

5.6 ha of remnant Endangered RE 12.3.1 and less than a hectare of Endangered RE 12.11.6 are present in the study area.

Table 6-3: Field-verified Regional Ecosystem (RE) remnant vegetation in the study area.

RE	Short Description (REDD)	Status	
		VM Act	EPBC Act
12.3.1	Gallery rainforest (notophyll vine forest) on alluvial plains	E	CE*
12.3.2	*Eucalyptus grandis* tall open forest on alluvial plains	OC	-
12.3.11	*Eucalyptus siderophloia, E. tereticornis, Corymbia intermedia* open forest on alluvial plains usually near coast	OC	-
12.9-10.17	Open forest complex often *with Eucalyptus acmenoides, E. major, E. siderophloia* +/- *Corymbia citriodora* on sedimentary rocks	LC	-
12.11.3	Open forest generally with *Eucalyptus siderophloia, E. propinqua on metamorphics* +/- interbedded volcanics	LC	-
12.11.9	*Eucalyptus tereticornis* open forest on metamorphics +/- interbedded volcanics. Usually higher altitudes	OC	-
12.11.14	*Eucalyptus crebra, E. tereticornis* woodland on metamorphics +/- interbedded volcanics	OC	-
12.11.16	Tall open forest with *Eucalyptus cloeziana* on metamorphics +/- interbedded volcanics	E	-

RE = regional ecosystem; REDD = Regional Ecosystem Description Database; VM Act = Vegetation Management Status under the *Vegetation Management Act 1999*; EPBC Act = listed threatened ecological community under the *Environment Protection and Biodiversity Conservation Act 1999*; LC = Least Concern; OC = Of Concern; E = Endangered; CE = Critically Endangered; - = not listed.

Field-verified RE mapping for the study area is presented in **Figure 6-3A** to **6-3C**.

6.4.2.2 Field-Verified Regrowth vegetation

Field-verified regrowth vegetation mapping is also presented in **Figure6-3A** to **Figure 6-3C**. Regrowth vegetation within the study area consisted of the same REs as remnant vegetation (refer to **Table 6-3**) comprising REs 12.3.11, 12.11.3 and 12.11.14. In addition, REs 12.3.7 and 12.11.10 were field-verified as occurring within the study area in regrowth form (**Table 6-4**).

Table 6-4: Field-verified regrowth vegetation in the study area (in addition to REs identified in Table 6-3).

RE	Short Description (REDD)	Status	
		VM Act	EPBC Act
12.3.7	*Eucalyptus tereticornis*, *Callistemon viminalis*, *Casuarina cunninghamiana* fringing forest	LC	-
12.11.10	Notophyll vine forest +/- *Araucaria cunninghamii* on metamorphics +/- interbedded volcanics	LC	CE*

* regional ecosystem does not meet EPBC Act threatened ecological community description, key diagnostic characteristics and condition thresholds for Lowland Rainforest of Subtropical Australia, therefore is not a listed threatened ecological community. Refer to **Section 6.4.2.3** for further detail.

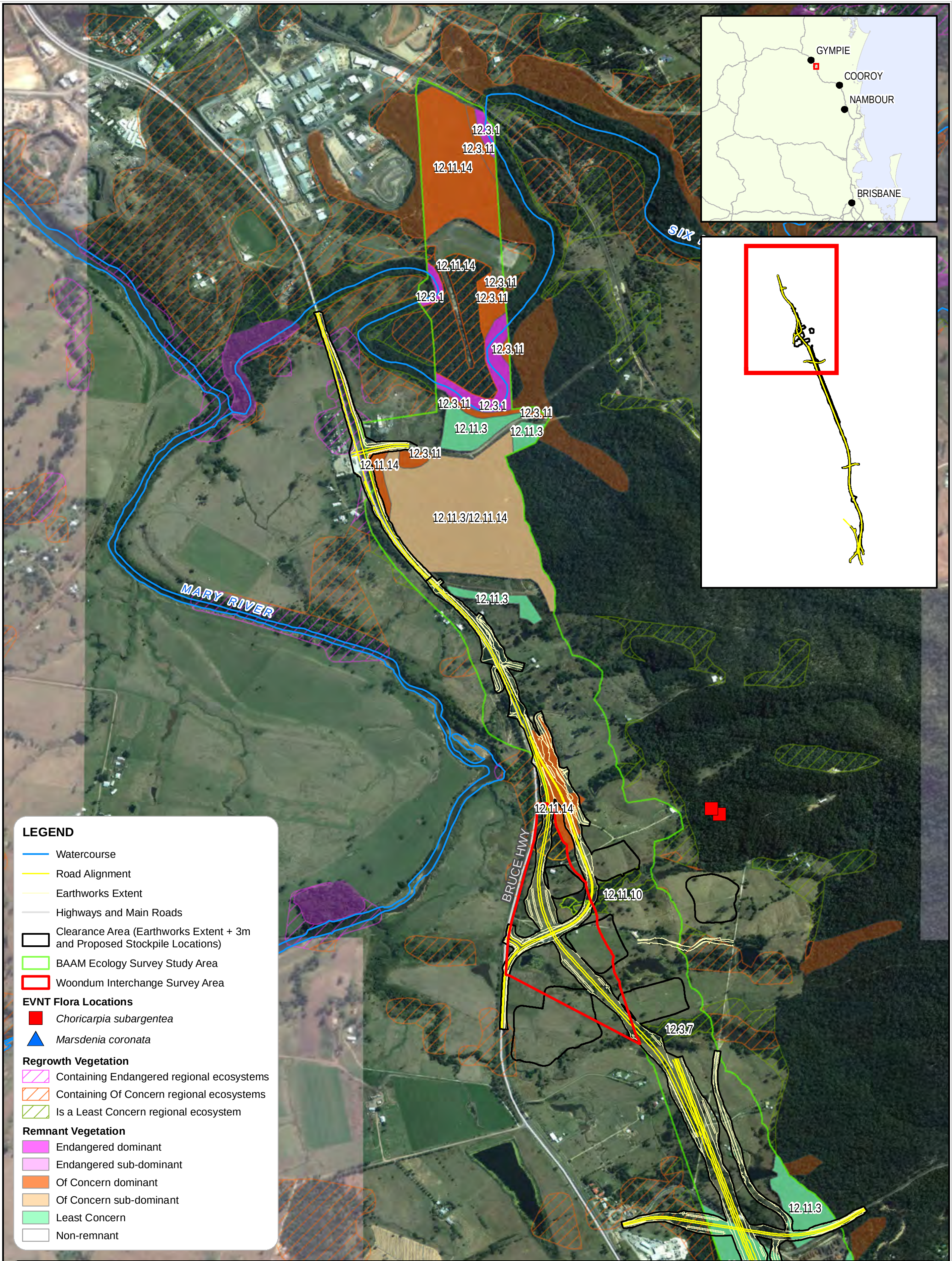

Figure 6-3A

Field-verified Regional Ecosystem and Regrowth Vegetation Mapping

Kilometres 0 0.1 0.2 0.3 0.4 0.5

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Data Source: DEHP, BAAM (2012).

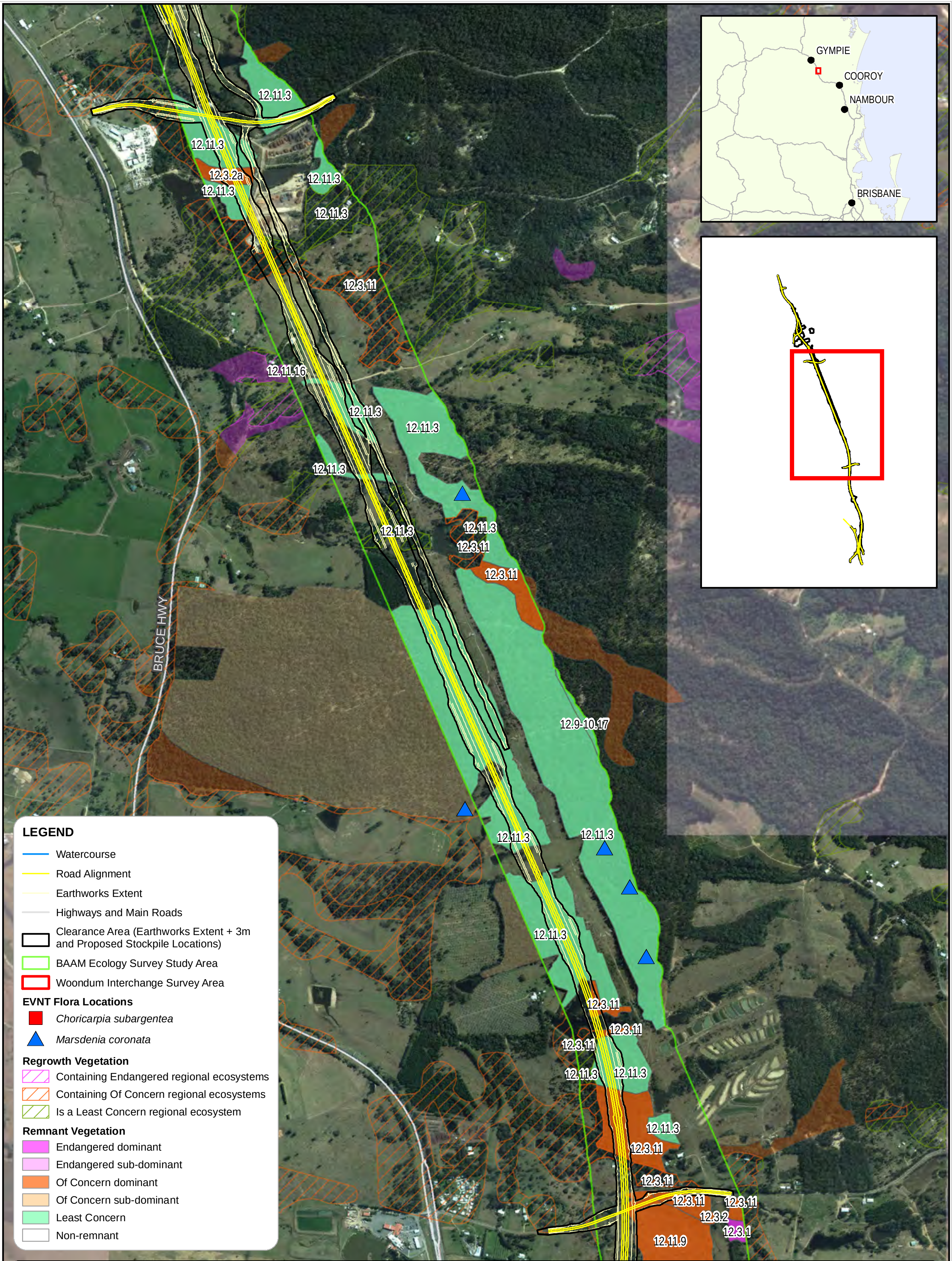

Figure 6-3B
Field-verified Regional Ecosystem and Regrowth Vegetation Mapping

Kilometres 0 0.1 0.2 0.3 0.4 0.5

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Data Source: DEHP, BAAM (2012).

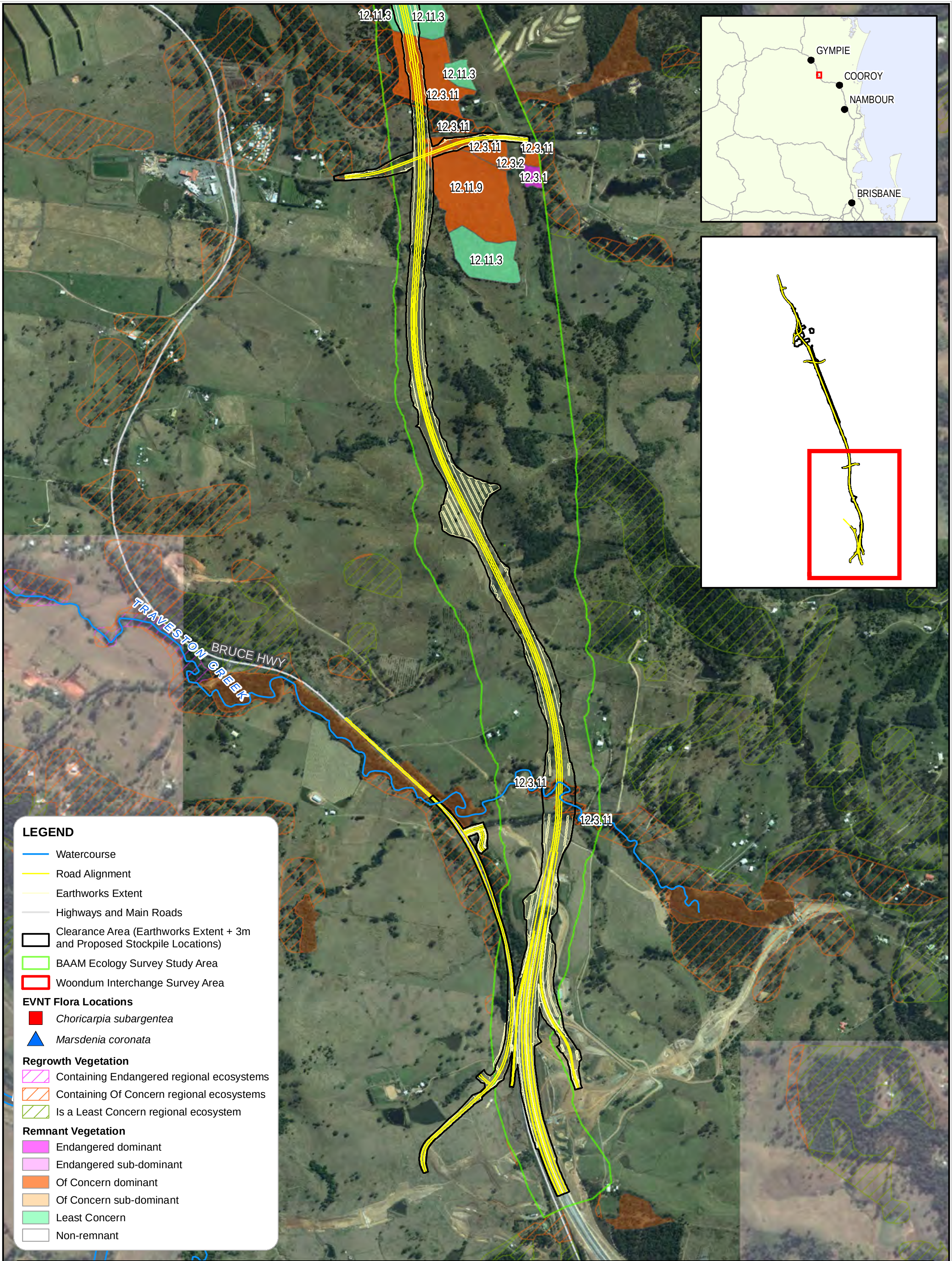

Figure 6-3C
Field-verified Regional Ecosystem and Regrowth Vegetation Mapping

Kilometres
0 0.1 0.2 0.3 0.4 0.5
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Data Source: DEHP, BAAM (2012).

6.4.2.3 Threatened Ecological Communities

No threatened ecological communities (TECs) were observed in the study area.

The DotE listing advice for the Lowland Rainforest of Subtropical Australia TEC lists remnant or regrowth examples of REs 12.3.1 and 12.11.10 as potentially meeting the criteria for this TEC providing the vegetation meets key diagnostic characteristics and condition thresholds. No regrowth or remnant examples of these rainforest REs within the study area met the condition thresholds as all areas failed to meet the species richness and/or patch size criteria required to meet the TEC listing advice.

The key diagnostic characteristics of the TEC are:

- Distribution of the ecological community is primarily in the NSW North Coast and South Eastern Queensland bioregions, according to Interim Biogeographic Regionalisation for Australia (IBRA) version 6.1 (2004)
- The ecological community occurs on: soils derived from basalt or alluvium; or enriched rhyolitic soils; or basaltically enriched metasediments
- The ecological community generally occurs at an altitude less than 300 m above sea level
- The ecological community typically occurs in areas with high annual rainfall (>1300mm)
- The ecological community is typically more than 2 km inland from the coast
- The structure of the ecological community is typically a tall (20 – 30 m) closed forest, often with multiple canopy layers.

Patches of the ecological community typically have high species richness (at least 30 woody species from Appendix A of the TEC listing advice)

The condition thresholds of the TEC and comparison against the observed conditions are provided in **Table 6-5**.

Table 6-5: Lowland Rainforest of Subtropical Australia Threatened Ecological Community (TEC) Condition Thresholds and Observed Conditions.

Condition Thresholds				Observed Conditions	
				12.3.1	**12.11.10**
Patch Type (evidence of remnant vegetation & regeneration status)	A Natural remnant evident by the persistence of mature residual tress from Appendix B. AND	B Some residual trees from Appendix B are present plus evidence of either natural regeneration[1] AND/OR regeneration with active management[2] AND	C A non-remnant patch that has recovered through a) natural regeneration1 AND/OR b) supplementary planting that has stature and quality that is reflective of the 'Description'[3] AND	A – remnant vegetation	C – non remnant vegetation
Patch Size	≥ 0.1 ha AND	≥ 1 ha AND	≥ 2 ha AND	≥ 0.1 ha	≤ 2 ha (patch is only 1.4 ha)
Canopy Cover (over entire patch4)	Emergent / canopy / subcanopy[4] cover is ≥ 70% AND			Emergent / canopy / subcanopy[4] cover is ≥ 70%	Emergent / canopy / subcanopy[4] cover is ≥ 70%
Species Richness (over entire patch)	Contains ≥ 40 native woody species[5] from Appendix A AND	Contains ≥ 30 native woody species[5] from Appendix A AND		Contained ≤ 40 native woody species from Appendix A	Contained ≤ 30 native woody species from Appendix A
Percent of total cover that is native[6]	≥ 70% of vegetation[6] is native	≥ 50% of vegetation[6] is native		≥ 70% of vegetation[6] is native	≥ 60% of vegetation[6] is native

Notes:

[1] Evidence of natural regeneration is shown by the presence of seedlings of a range of native species that did not originate through deliberate plantings.

[2] A patch that is actively managed has regular (e.g. every 1–2 years) on the ground human regenerative activity such as weed control or supplementary plantings.

[3] Closed canopy, 20–30 m tall, of representative species (e.g. white booyong, hoop pine, figs, brush box, yellow carabeen, red cedar, rosewood, white beech)

[4] Canopy cover (projective foliage cover) is estimated over the entire patch. When assessing the ecological community, the canopy includes the emergents and subcanopy (everything above 10 m tall). Canopy/sub-canopy includes all trees and vines (native and non-native).

[5] Woody species are trees, shrubs or vines that contain wood or wood fibres that consist mainly of hard lignified tissues. Excluded from woody species are graminoids, other herbs and non-woody vines.

[6] Total vegetation cover includes emergents/canopy/subcanopy and understory and ground layers.

6.4.2.4 Threatened Flora Species

The field survey located one threatened flora species within the study area, Slender Milkvine (*Marsdenia coronata*) which is listed as Vulnerable under the NC Act. No EPBC Act listed flora species were recorded in the study area

Slender Milkvine was recorded at five locations within RE 12.11.3 (refer to **Figure 6-3A** to **Figure 6-3C**). It is estimated that 19 individuals of Slender Milkvine occur at four locations within the study area with a further two plants occurring at one location adjacent to the study area.

Giant Ironwood (*Choricarpia subargentea*) was recorded outside the study area in RE 12.11.10 (refer to **Figure 6-3A** to **Figure 6-3C**). Suitable habitat for this species occurs within the study area, though no individuals were observed within this study area.

On the basis of habitat assessment throughout the study area, a further 13 threatened flora species listed under the EPBC Act and/or NC Act were assessed as having potential to occur. The likelihood of occurrence of each of these species is outlined in **Appendix H**.

Species profiles for the threatened flora species known or with potential to occur in the study area are outlined in **Appendix F**.

6.4.2.5 Threatened Fauna Species

Three threatened fauna species listed under the NC Act were observed during the field survey, these were:

- Tusked Frog (*Adelotus brevis*) – Vulnerable.
- Elf Skink (*Eroticoscincus graciloides*) – Near Threatened.
- Grey Goshawk (*Accipiter novaehollandiae*) – Near Threatened.

No EPBC Act listed threatened fauna species were actually observed during field survey activities.

Evidence of the presence of Black-breasted Button-quail, listed as Vulnerable under the NC Act and EPBC Act, was found within the study area during the BAAM fauna survey. Current feeding signs (platelets) in suitable habitat located in Woondum State Forest (eucalypt canopy with vine forest/shrubby understorey including *Lantana camara*) were attributed to the Black-breasted Button-quail. Current feeding evidence of button-quail (platelets) was abundant in this area.

Based on habitat (vine thicket), published descriptions of Black-breasted Button-quail platelets (Marchant and Higgins 1993) and BAAM and SKM's ecologist personal experience with the species, the feeding signs are considered likely to be that of Black-breasted Button-quail. The Painted Button-quail (*Turnix varius*), a species that feeds in a similar fashion, occurs in different habitat types (scrubland, open woodland, heathlands) and not vine thicket habitat.

Several searches for Black-breasted Button-quail were carried out without success despite fresh platelets (within the previous 24 hours) being observed. A WildNet database search centred on this area with a one kilometre radius (**Appendix F**) indicates one record of Black-breasted Button-quail, and five records within a five kilometre radius of the study area. There are also two Queensland Museum Records of this species from the Gympie locality. Consideration of this evidence suggests that the species is expected to occur within the study area in vine forest in Woondum State Forest.

The Black-breasted Button-quail was not observed during the SKM targeted survey, however an abundance of recent feeding activity (platelets) attributed to this species was observed. All platelet locations are shown on **Figure 6-7A**. The extent of primary habitat for the Black-breasted Button-quail was mapped. This is restricted to eucalypt forest (RE 12.11.3) with a vine/shrubby understorey and dense layer of leaf litter. Although RE 12.11.3 occurs consistently across Woondum State Forest, it is the understorey which defines the primary habitat.

Primary habitat appears to occur on east and south facing slopes, which is restricted to the southern boundary of Woondum State Forest (adjacent to the proposed alignment). This is probably a factor of microclimate arising from the slope aspect.

Figure 6-4: Black-breasted Button quail platelets.

Evidence of the presence of Koala (*Phascolarctos cinereus*), listed as Vulnerable under the EPBC Act, was also found within the study area. Koala habitat was associated with REs 12.3.11, 12.11.14, 12.11.3, 12.3.2 and 12.11.9. Distinctive claw marks of the Koala were found on trees in the study area, and the species is expected to occur in eucalypt forest throughout much of the study area. Records of the Koalas in the vicinity of the alignment are found in the WildNet database search results.

Koala SAT surveys found Koala claw marks (**Figure 6-5**) and scats at sites P1, P2, P3 and P4 adjacent to the study area and Koala claw marks within regrowth RE 12.3.2 along Jackass Creek (adjacent to P3). Koala scats were sent to Barbara Triggs for identification who confirmed Koala scats at sites P1, P2, P3 and P4).

Figure 6-5: Koala claw marks on trees.

Locations of threatened mammal, frog and reptile records and potential habitat are shown in **Figure 6-6A** to **Figure 6-6C** and for threatened birds on **Figure 6-7A** to **Figure 6-7C**.

On the basis of habitat assessment throughout the study area, a further 21 fauna species of conservation significance listed under the NC Act and/or EPBC Act were assessed as having potential to occur. The likelihood of occurrence of each of these species is outlined in **Appendix I**. Species profiles for the threatened fauna species known or with potential to occur in the study area are provided in **Appendix F**.

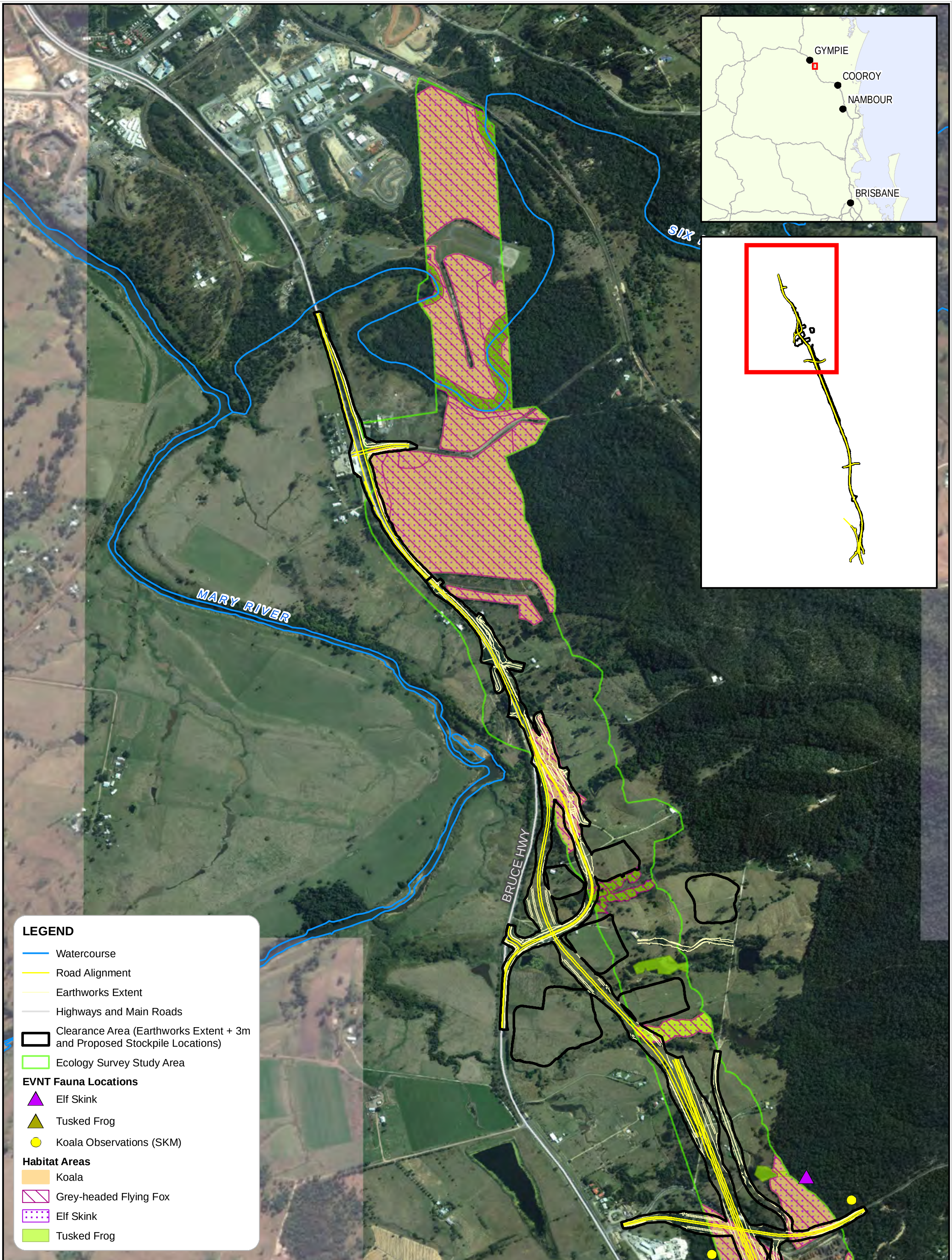

Figure 6-6A
Threatened mammals, frogs and reptiles observations and habitat

Kilometres 0 0.1 0.2 0.3 0.4 0.5
MGA - Zone 56 (GDA 94) 1:20,000 @ A4

SKM

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Data Source: DEHP, BAAM (2012).

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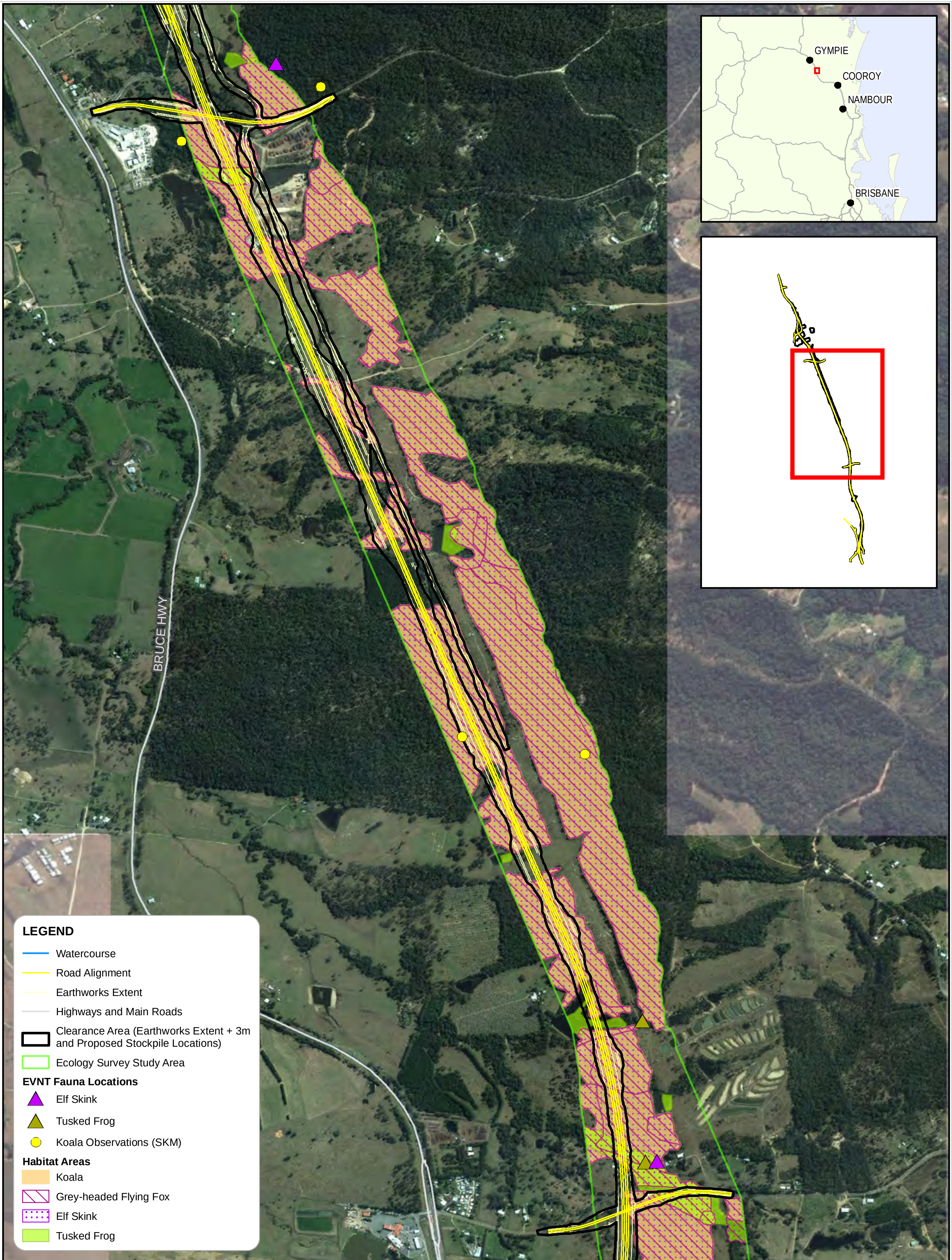

Figure 6-6B
Threatened mammals, frogs and reptiles observations and habitat

Kilometres
0 0.1 0.2 0.3 0.4 0.5
MGA - Zone 56 (GDA 94) 1:20,000 @ A4

SKM

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Data Source: DEHP, BAAM (2012).

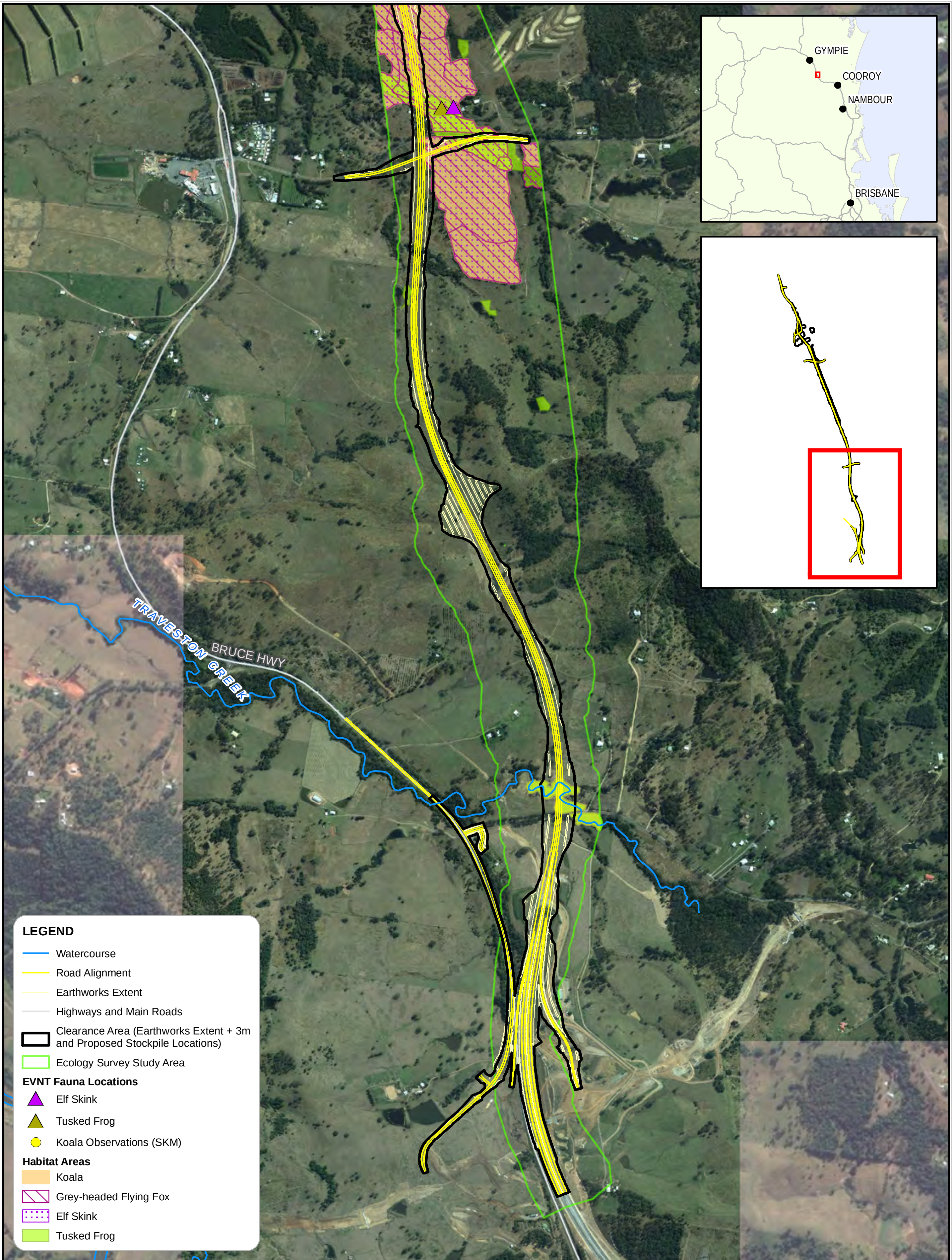

Figure 6-6C
Threatened mammals, frogs and reptiles observations and habitat

Kilometres
0 0.1 0.2 0.3 0.4 0.5
MGA - Zone 56 (GDA 94) 1:20,000 @ A4

SKM

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Data Source: DEHP, BAAM (2012).

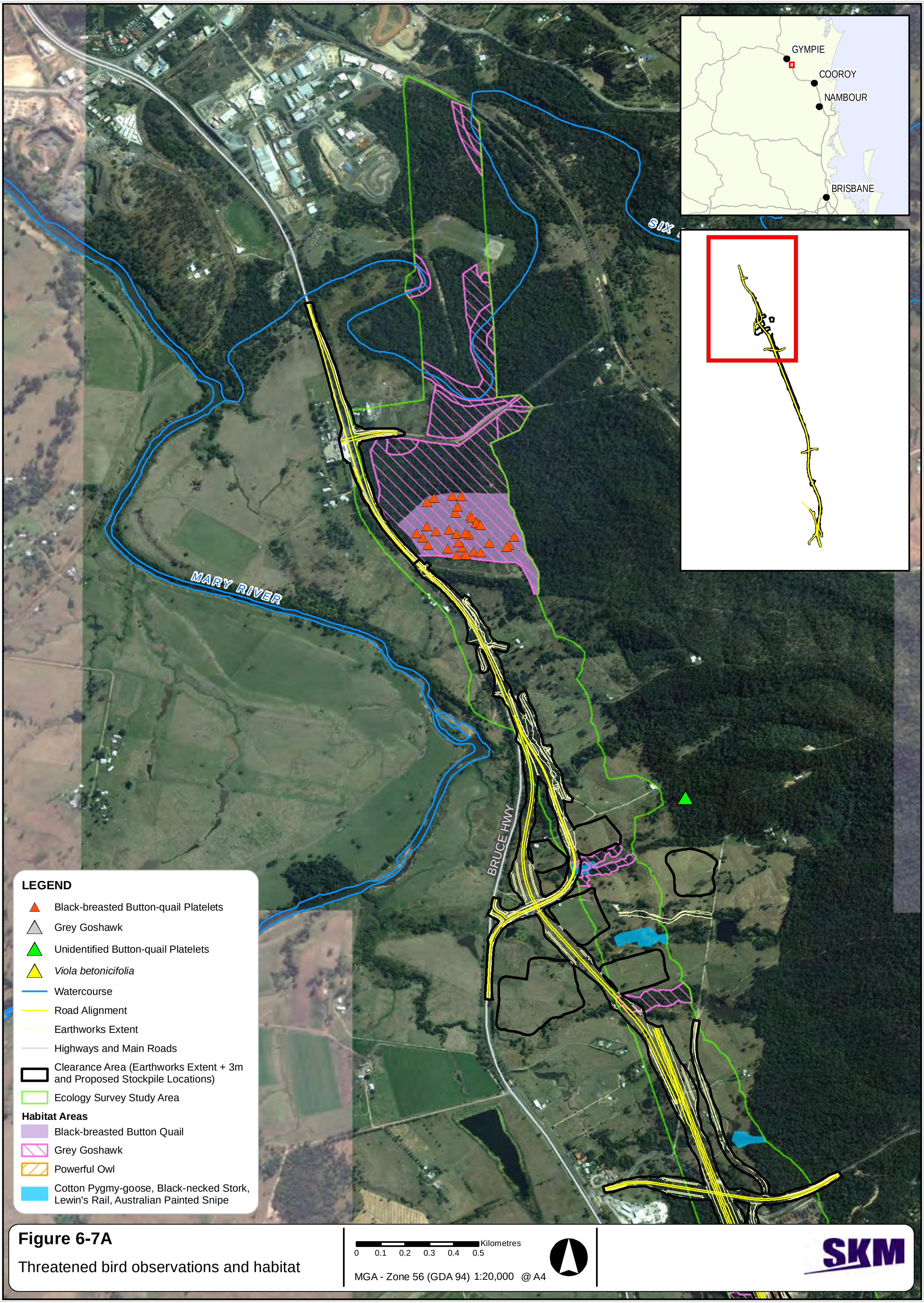

Figure 6-7A

Threatened bird observations and habitat

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Data Source: DEHP, BAAM (2012).

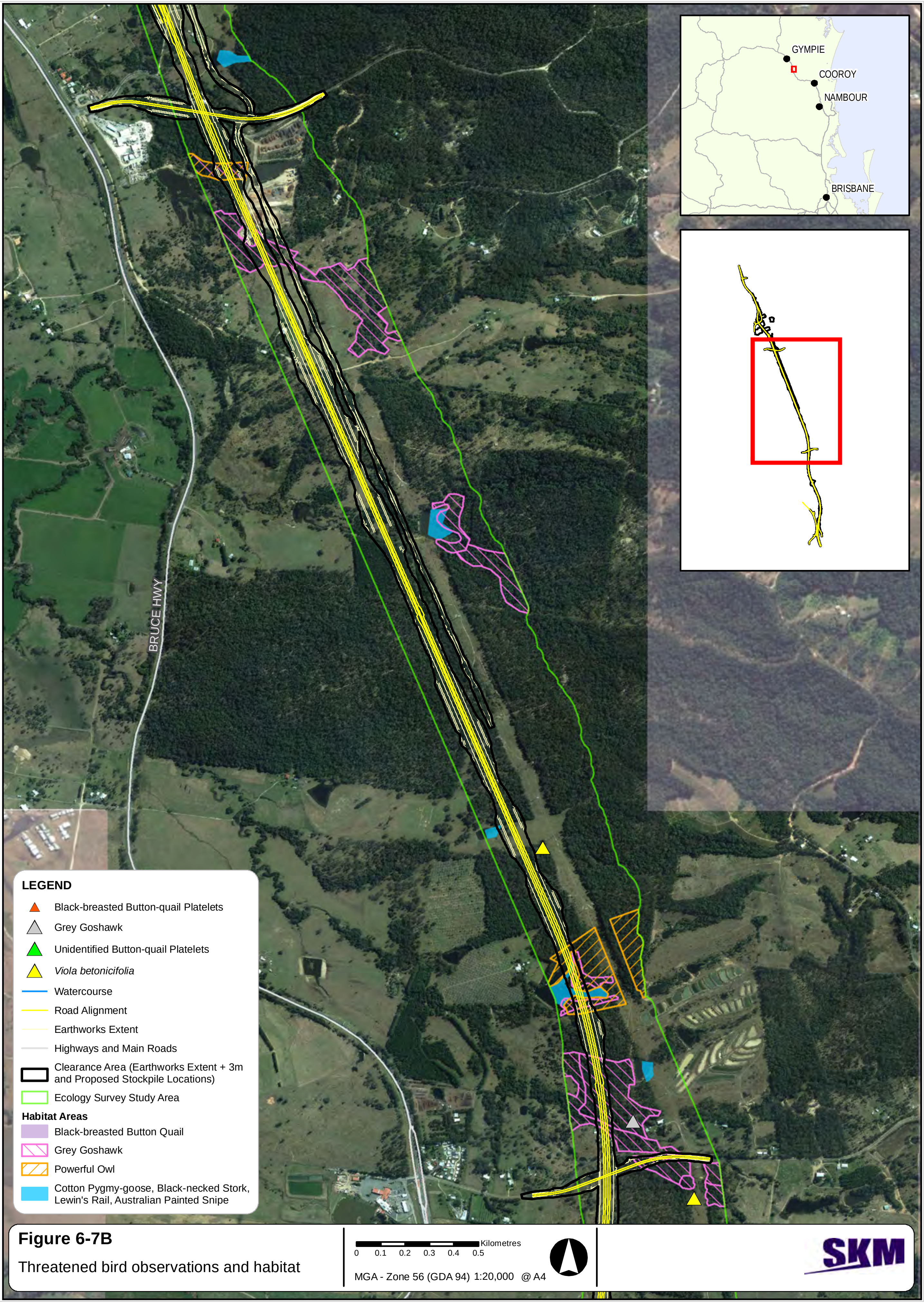

Figure 6-7B

Threatened bird observations and habitat

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Data Source: DEHP, BAAM (2012).

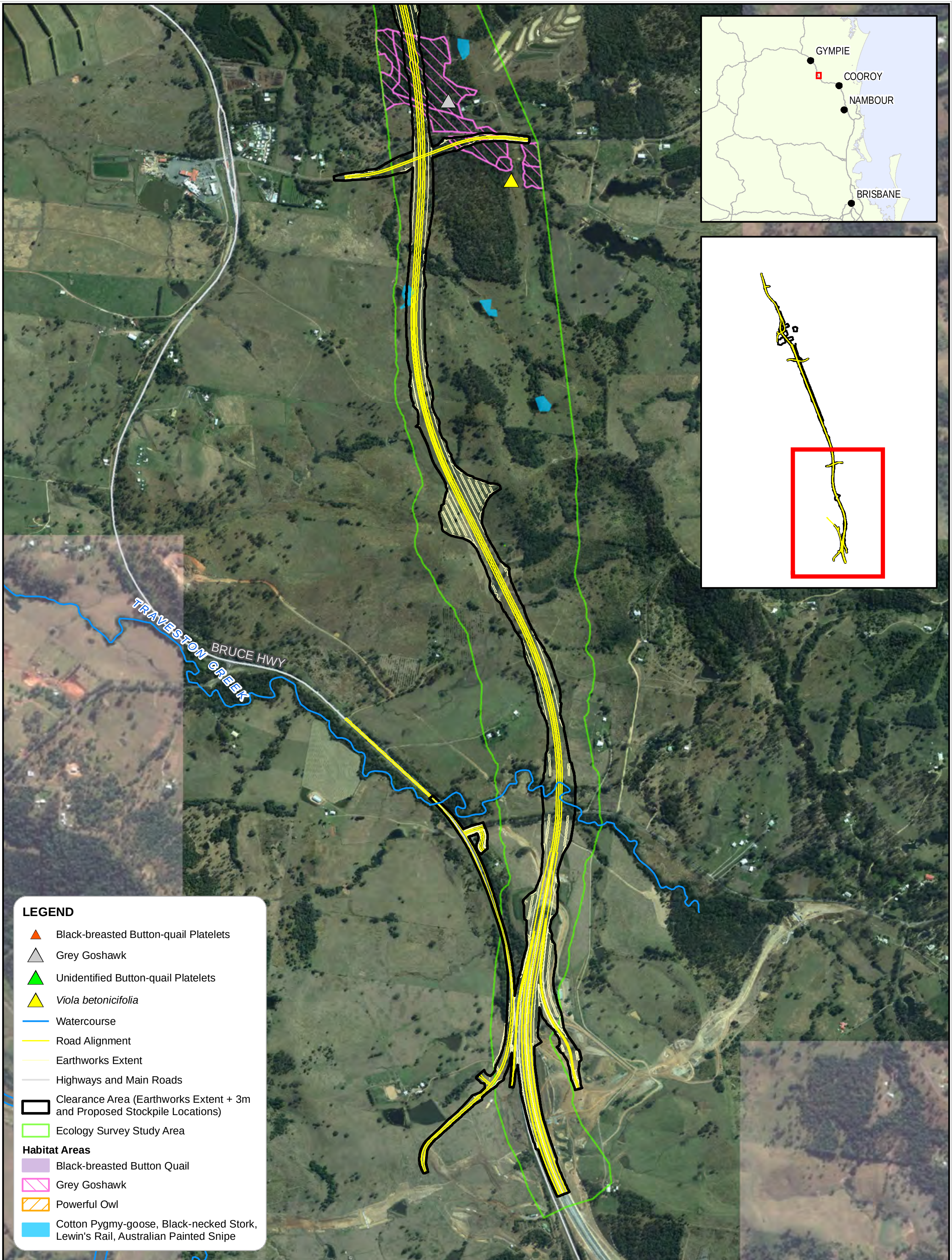

Figure 6-7C

Threatened bird observations and habitat

Kilometres 0 0.1 0.2 0.3 0.4 0.5

MGA - Zone 56 (GDA 94) 1:20,000 @ A4

SKM

I:\QBIF\Projects\QB10237\Technical\Spatial\ArcGIS\Figures\Ecology\140328_Ecology_Figure06-7_ThreatenedBirdRecordsAndHabitat.mxd Produced: 28/03/2014

Data Source: DEHP, BAAM (2012).

6.4.2.6 Migratory Species

The field survey located seven fauna species listed as Migratory under the EPBC Act within the study area, and a further eight species were assessed as likely to occur (**Appendix I**). The seven migratory species observed during field surveys are:

- Eastern Great Egret (*Ardea modesta*).
- Cattle Egret (*Ardea ibis*).
- White-bellied Sea-eagle (*Haliaeetus leucogaster*).
- White-throated Needletail (*Hirundapus caudacutus*).
- Rainbow Bee-eater (*Merops ornatus*).
- Rufous Fantail (*Rhipidura rufifrons*).
- Spectacled Monarch (*Symposiachrus trivirgatus*).

6.4.2.7 Flora Species Richness

In total, 342 flora species were observed within the study area. Of these species 305 (89%) are native and 37 (11%) are exotic. The full list of observed flora species is provided in **Appendix F**. Well-represented families included Myrtaceae (37 species), Poaceae (21 species), Fabaceae (18 species), Rutaceae (15 species), Rubiaceae and Sapindaceae (each with 13 species). This diversity reflects the vegetation characteristics of the study area, with the first three families being representative of drier habitats and the last three being largely rainforest families.

A number of regionally significant flora species were recorded during the field survey (**Appendix F**). A ground fern, *Christella hispidula*, was recorded in an unnamed tributary of Jackass Creek near Keefton Road. The Census of the Queensland Flora 2013 shows that this record represents the third specimen collected in the Wide Bay region (Bostock and Holland, 2010).

A number of species are at or near their southern distribution limit including *Vitex melicopea* and *Ventilago pubescens*, while other species reach their northern limit in the Gympie area including *Rhodamnia rubescens*.

Arrowhead Violet, *Viola betonicifolia*, was recorded in two locations within moist low lying areas of grassy non-remnant vegetation and is the larval host plant for the endangered Australian Fritillary Butterfly, *Argyreus hyperbius inconstans* (refer to **Figure 6-7A** to **Figure 6-7C**).

6.4.2.8 Fauna Species Richness

A total of 191 terrestrial vertebrate species were recorded during the field component of the baseline fauna survey and fauna connectivity survey. These included 122 birds, 30 mammals, 19 reptiles and 20 amphibians (see **Appendix F** for baseline survey fauna species list and **Appendix J** for connectivity survey fauna species list). Comments on fauna diversity within habitat types are provided in **Section 6.4.2.9**.

6.4.2.9 Fauna Habitat Values

Habitat within the study area can be divided into four broad categories, including:

- Open eucalypt forest.
- Vine forest/scrub.
- Wetlands (including dams, creeks and ephemeral waterways).
- Open pasture.

Descriptions of fauna habitat types are provided in the following sections.

6.4.2.9.1 Open Eucalypt Forest

The majority of the forested habitat within the study area can be classified as open eucalypt forest. Much of the extant habitat has been subject to disturbance in the past (largely by logging and cattle grazing) and condition varies greatly across the study area. In some areas the understorey and grass layer have been severely affected by cattle grazing, limiting the range of fauna able to use this habitat. In more intact areas such as State Forests the density of understorey vegetation and grasses varies with topography, with higher densities occurring in lower, wetter areas.

Canopy cover is also variable with some patches subject to relatively recent logging having a relatively open canopy. Large, woody debris is common in this habitat. Large tree hollows are not common as much of the older timber within the study area has been removed. However, a few habitat patches were noted for retaining large hollows. These were generally along lower slopes approaching gullies and creek lines including along Kybong Creek and Six Mile Creek and along several gully lines between Tandur Road and Woondum Road.

The most consistent habitat feature for the fauna is the eucalypt canopy. Flowering eucalypts provide seasonal resources for honeyeaters, flying-foxes and gliders. The leaves provide foraging resources for possums and Koala (Vulnerable in south-east Queensland – NC Act), as well as insects for a variety of insectivorous birds. Species such as White-throated Treecreeper (*Cormobates leucophaea*) and Varied Sittella (*Daphoenositta chrysoptera*) utilise bark for catching insects.

Large tree hollows provide shelter and breeding sites for a variety of species including possums, Powerful Owl (*Ninox strenua*) (Vulnerable – NC Act) and Cockatoos. Smaller hollows provide shelter for gliders and microbats. Intact mid and understorey vegetation provides habitat for a variety of small woodland bird species including fairywrens, finches, Eastern Yellow Robin (*Eopsaltria australis*), cuckoos and thornbills. The ground layer provides foraging habitat for pigeons and Painted Button-quail and daytime shelter for White-throated Nightjar (*Eurostopodus mystacalis*).

Frogs will generally be concentrated around damper areas, although species such as Green Tree Frog (*Litoria caerulea*) may be found away from water. Common species found in this habitat may include Copper-backed Broodfrog (*Pseudophryne raveni*), Graceful tree Frog (*Litoria gracilenta*) and Northern Banjo Frog (*Limnodynastes terraereginae*). The Green-thighed Frog (*Litoria brevipalmata*) (Near Threatened – NC Act) may be found in this habitat and will concentrate around ephemeral pools after heavy summer rains.

Open forest generally provides good habitat for a variety of reptiles due to woody debris and abundant ground cover. A variety of skink species occur including the Elf Skink (Near Threatened – NC Act) which is restricted to the region and was detected during the field survey. Other common reptile species such as Lace Monitor (*Varanus varius*), Yellow-faced Whipsnake (*Demansia psammophis*), and pythons are likely to occur.

Mammals likely to utilise the ground layer include the macropods and Yellow-footed Antechinus (*Antechinus flavipes*) is likely to occur where suitable woody debris exists. Where suitable cover is provided by a dense grassy and/or herbaceous layer, species such as Eastern Chestnut Mouse (*Pseudomys gracilicaudatus*), Northern Brown Bandicoot (*Isoodon macrourus*) and Rufous Bettong (*Aepyprymnus rufescens*) are likely to be present.

6.4.2.9.2 Vine Forest/Scrub

Vine forest/scrub features a greater diversity of tree species generally with a well-developed understorey (featuring abundant vines) and leaf litter layer. This habitat has been heavily impacted in the study area due to past land use and is often infested with weed species such as Lantana (*Lantana camara*) and Cat's Claw Creeper (*Dolichandra unguis-cati*), Six Mile Creek in particular. Within the study area vine forest occurs along some creek and gully lines such as Six Mile Creek. It also occurs as understorey vegetation in open eucalypt forest in the northern end of the study area (including Trap Site 1 within Woondum State Forest) and along part of Kybong Creek.

The bird fauna will include much of that found in open eucalypt forest as well as a range of species associated with denser vegetation including monarchs, Rufous Fantail (*Rhipidura rufifrons*), Eastern Whipbird (*Psophodes olivaceus*), Fairy Gerygone (*Gerygone palpebrosa*) and Largebilled Scrubwren (*Sericornis magnirostris*). Grey Goshawk (*Accipiter novaehollandiae*) (Near Threatened – NC Act) will utilise this habitat. Of note is the recorded presence of Black-breasted Button-quail (Vulnerable – EPBC and NC Acts) in Woondum State Forest in the north of the study area. This is a very shy species and although no individuals were observed, abundant feeding evidence in the form of fresh platelets was recorded indicating the presence of the species.

The frog fauna will largely be similar to that which occurs in open forest, however species such as Great Barred Frog (*Mixophyes fasciolatus*) and Giant Barred Frog (*Mixophyes iterates*) (Endangered – EPBC and NC Acts) may be found in vine forest habitat adjacent to creek lines. Within the study area vine forest along Six Mile Creek provides the most likely habitat for Giant Barred Frog, although the habitat is degraded and the species was not recorded despite good conditions for its detectability. Some reptile species such as Golden Crowned-snake (*Cacophis squamulosus*), Pink-tongued Lizard (*Cyclodomorphus gerrardii*) and Yolk-bellied Snake-skink are more likely to be found in these areas. Elf Skink will also be found in this habitat. Although it can occur in a range of habitats, the Common Death Adder (*Acanthophis antarcticus*) (Near Threatened – NC Act) may be more likely to occur in this habitat due to the well-developed litter layer present on which this species is dependent.

Several rainforest-associated mammals are more likely to be recorded in vine forest/scrub in the area including Mountain Brushtail Possum (*Trichosurus caninus*), Long-nosed Bandicoot (*Perameles nasutal*), Subtropical Antechinus (*Antechinus subtropicus*) and Fawn-footed Melomys (*Melomys cervinipes*).

6.4.2.9.3 Wetlands

Wetland habitat within the study area includes creek lines, ephemeral ponds along gullies and several well vegetated farm dams. These provide important habitat for a variety of water birds including ducks, Magpie Goose (*Anseranas semipalmata*), herons, cormorants and egrets. Well vegetated farm dams provide habitat for rail species including Purple Swamphen (*Porphyrio porphyria*) and Pale-vented Bush-hen (*Amaurornis moluccana*) as well as conservation significant species such as Lewin's Rail (*Lewinia pectoralis*; Near Threatened – NC Act) and Australian Painted Snipe (*Rostatula australis*; Vulnerable – EPBC and NC Acts). Dams with abundant floating vegetation provide suitable habitat for Cotton Pygmy-goose (*Nettapus coromandelianus*; Near Threatened – NC Act).

A range of common frog species will use these wetland habitats for breeding including Peron's Tree Frog (*Litoria peronii*), Striped Marsh Frog (*Limnodynastes peronii*) and Rocket Frog (*Litoria nasuta*). Tusked Frog (*Adelotus brevis*) (Vulnerable – NC Act) may also be present. Some species will be restricted to creek lines such as Eastern Stony-creek Frog (*Litoria wilcoxii*) and Giant Barred Frog may occur where the riparian cover is largely intact and groundcover conditions are suitable.

Reptiles utilising these habitats are those associated with water such as Water Dragon (*Physignathus leseuerii*) and turtle species. The Mary River Turtle (*Elusor macrurus*; Endangered – EPBC and NC Acts) may occur in Six Mile Creek, though detailed surveys including electrofishing and fyke netting did not detect this species in the main creeks directly impacted by the Project (Traveston, Kybong and Jackass Creeks, and Cobbs Gully).

Snake species such as Freshwater Snake (*Tropidonophis mairii*) and Red-bellied Black Snake (*Pseudechis porphyriacus*) will hunt for frogs around wetlands.

A range of mammals will utilise wetland areas. Species such as Large-footed Myotis (*Myotis macropus*) and Platypus (*Ornithorhynchus anatinus*) which has been recorded in database searches for the study area will largely be restricted to creeks. Water Rat (*Hydromys chrysogaster*) will forage along creeks and dams and several microbat species forage over these areas. Macropod species will utilise farm dams as watering points and as daytime refuges in densely vegetated dam areas.

6.4.2.9.4 Open Pasture

The remaining habitat is cleared grazing lands. Pasture provides habitat largely limited to a range of widespread and common fauna species. Bird species associated with open areas will forage in cleared include Australian Pipit (*Anthus australis*), Laughing Kookaburra (*Dacelo novaeguineae*), butcherbirds and Australian Magpie (*Gymnorhina tibicen*). As there is generally little cover (fallen timber and low shrubs) in this habitat the reptile fauna is likely to be restricted to small skinks and species such as Bearded Dragon (*Pogona barbata*) and Eastern Brown Snake (*Pseudonaja textilis*). Frog species will be restricted to areas that remain damp after significant rainfall such as Eastern Sign-bearing Froglet (*Crinia parinsignifera*) and Ornate Burrowing Frog (*Limnodynastes ornatus*).

A notable exception is the conservation significant Green-thighed Frog which may utilise temporary ponds after heavy summer rains. Pasture provides poor habitat for most mammals except macropod species.

Within the study area cleared areas in gullies and shallow seasonal swamps may also provide habitat for the larval food plant of the Australian Fritillary Butterfly (*Argyreus hyperbius inconstans*) (Endangered – NC Act). The food plant *Viola betonicifolia* was recorded in two areas along the existing powerline easement during the onsite surveys (refer to **Figure 6-7**). Historically, this species is known from the region; however there are no verified records from the last 20 years. The larvae feed on the plant during the caterpillar stage. Evidence of feeding was observed on some plants however no caterpillars were observed.

6.4.2.10 Important Habitat for Threatened Fauna Species

Five threatened fauna species were observed or evidence of their presence found in the study area during the field surveys. These include Tusked Frog, Elf Skink, Grey Goshawk, Black-breasted Button-quail and Koala (refer to **Section 6.4.2.5**). A further 15 species could potentially occur, based on habitat assessment and previous database records from the area, although several of these are considered to have a low potential of occurrence (refer to **Appendix I**).

The most important habitats for threatened fauna species within the study area are located in the northern section, encompassing Woondum State Forest and vine forest habitat adjacent to Six Mile Creek. The presence of Black-breasted Button-quail and Koala was detected within Woondum State Forest. This also provides suitable habitat for Elf Skink. The Koala was also recorded in open eucalypt forest (RE 12.11.3) in Traveston State Forest and adjoining private property to the east of the powerline easement, and within riparian eucalypt forest (HVR 12.3.2) along Jackass Creek and open eucalypt forest (RE 12.11.3) on adjoining private property to the east of the creek.

Several species listed as Migratory under the EPBC Act such as monarchs, Satin Flycatcher (*Myiagra cyanoleuca*) and Rufous Fantail are also likely to prefer vine forest habitat over surrounding eucalypt forests. Vine forest habitat along Six Mile Creek provides riparian nesting habitat for Mary River Turtle, Grey Goshawk and Giant Barred Frog. Giant Barred Frog, however, was not detected despite repeated night surveys in suitable habitat and weather conditions.

Other important habitats include wetlands/dams that provide suitable habitat for a range of conservation significant waterfowl including Lewin’s Rail, Australian Painted Snipe and Cotton Pygmy-goose as well as Tusked Frog. Additional important areas are those where the larval food plant (*Viola betonicifolia*) for the Australian Fritillary Butterfly were located. No larvae or adults were observed during the summer field surveys; however adults are more likely to be observed in winter (Sands and New 2002).

Appendix F provides maps showing the spatial distribution of threatened fauna species as determined from database searches, survey and habitat assessment.

6.4.2.11 Fauna Movement Corridors

All native vegetation, regardless of age, structure and floristic composition, may facilitate fauna movement even when it doesn’t provide adequate shelter and food resources to support those species permanently.

There is currently a high degree of habitat fragmentation across much of the study area. This is due to the clearing of native vegetation for agriculture and development including construction of the existing Bruce Highway and network of roads, and a transmission line corridor east of the proposed alignment. Contiguous areas of forest are generally associated with state forests (Traveston and Woondum State Forests). Thin strips of riparian vegetation have been retained along watercourses in the study area (Traveston Creek, Kybong Creek, Cobbs Gully and Jackass Creek). Terrestrial and riparian ecological corridors are shown on **Figure 6-8**.

Vegetation associated with Six Mile Creek (including forest to the north and south of the creek) and patches of forest between Woondum and Tandur Roads have been designated as part of a terrestrial bioregional corridor of regional significance under BPA mapping (**Appendix F**). This corridor links Six Mile Creek, Woondum State Forest, Jackass Creek, Cobbs Gully, Traveston State Forest and Kybong Creek.

At present, many species are relatively free to move between habitat patches within the study area and to/from larger patches associated with Woondum State Forest to the north-east, private property to the east and Traveston State Forest to the west. Habitat to the west of the proposed alignment has been substantially cleared (with the exception of Traveston State Forest), with movement of many species likely to be restricted to thin strips of vegetation along creek lines.

Further details on the fauna usage of landscape connectivity in the wider study area to/from Woondum State Forest and Traveston State Forest, and along Cobbs Gully and Jackass Creek are described below.

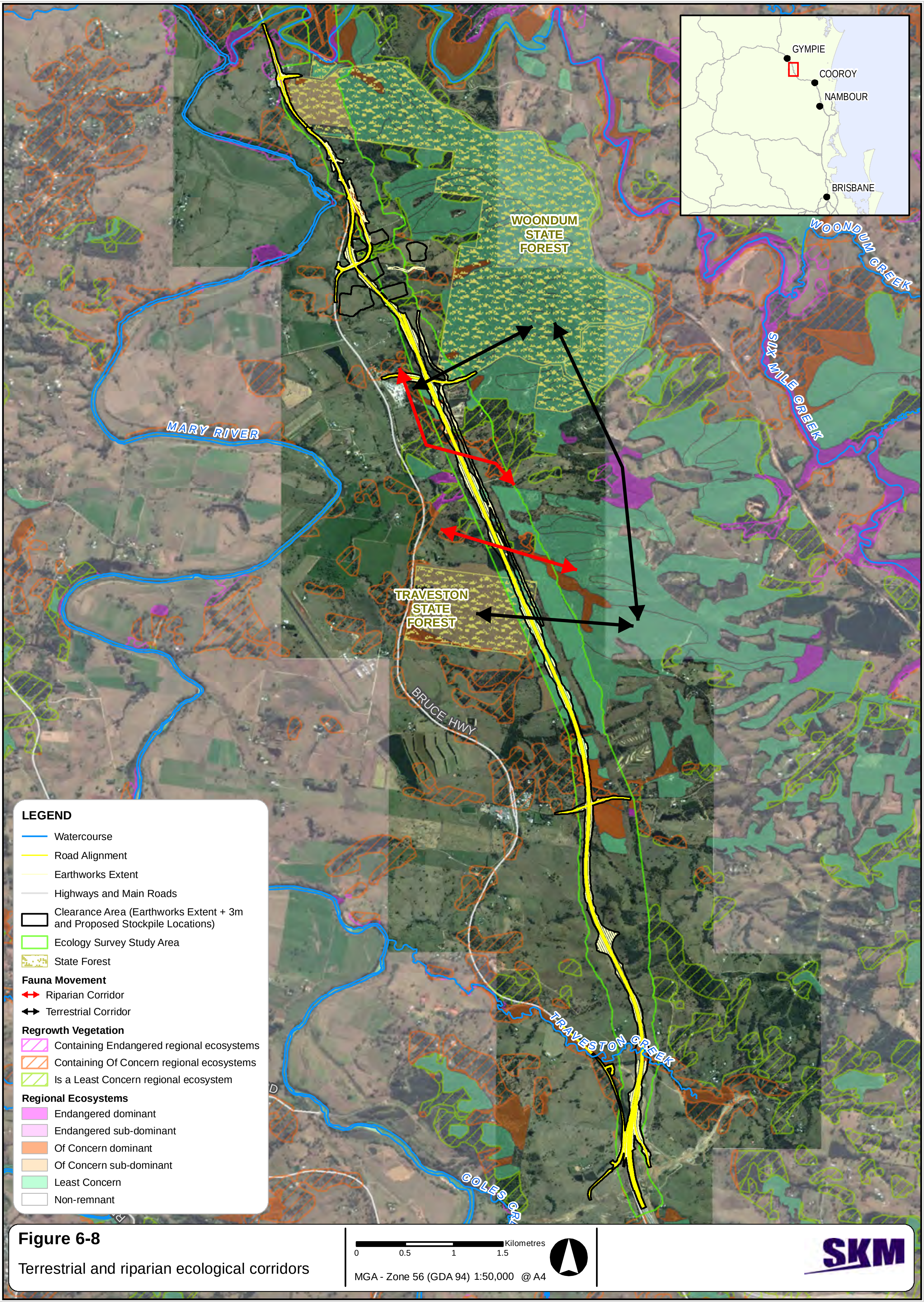

Figure 6-8

Terrestrial and riparian ecological corridors

Data Source: DEHP, BAAM (2012).

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6.4.2.11.1 Woondum State Forest

Woondum State Forest is a 455 ha tract of open eucalypt forest comprising RE 12.11.3 (Open forest generally with *Eucalyptus siderophloia*, *E. propinqua* on metamorphics +/- interbedded volcanics) east of both the existing Bruce Highway and proposed alignment. It is known to support the threatened fauna species Black-breasted Button-quail and Koala and is considered likely to support the Elf Skink.

Connectivity west of Woondum State Forest across the proposed alignment and existing Bruce Highway is limited due to existing clearing for rural and industrial land uses, however there is a small patch of open eucalypt forest (RE 12.11.3) associated with private property adjoining Jackass Creek which provides some connectivity although this is dissected by Woondum Road. Fauna surveys detected many of the same fauna species in both habitat patches, including the Koala. Other mammal fauna detected include Common Brushtail Possum (*Trichosurus vulpecula*), Yellow-footed Antechinus and Bush Rat (*Rattus fuscipes*). Smaller hollows provide roosting habitat for microbat species.

Species positively recorded on both sides of the proposed alignment include Gould's Wattled Bat (*Chalinolobus gouldii*), South-eastern Long-eared Bat (*Nyctophilus* species), *Scotorepens* sp., Eastern Forest Bat (*Vespadelus pumilus*), Little Bentwing Bat (*Miniopterus australis*), White-striped Freetail Bat (*Austronomus australis*), Beccari's Freetail Bat (*Mormopterus beccarii*) and Eastern Freetail Bat (*Moropterus ridei*). Yellow-bellied Sheathtail Bat (*Saccolaimus flaviventris*) was only recorded on one side of the proposed alignment; however it is considered that these species would occur on both sides.

Reptile fauna included Pink-tongued Skink (*Cyclodomorphus gerrardii*), Eastern Blue-tongue (*Tiliqua scincoides*), Lace Monitor and *Carlia vivax*. Bird fauna included White-throated Nightjar, Peaceful Dove (*Geophelia striata*), Laughing Kookaburra (*Dacelo novaeguineae*), White-throated Treecreeper, Superb Fairy-wren (*Malurus cyaneus*), Grey Shrike-thrush (*Colluricincla harmonica*), Rufous Whistler (*Pachycephala rufiventris*) and Cicadabird (*Coracina tenuirostris*).

The open eucalypt forest within Woondum State Forest, and on private property south of Woondum Road has been disturbed by logging. As a result, the canopy cover is relatively open, the ground layer is grassy, and large, woody debris is common. However this is still consistent with RE 12.11.3. Large tree hollows only occur occasionally as much of the older timber has been removed. There is also evidence of grazing on the private property. The Class 3 declared pest plant, Lantana, is also present, with dense thickets forming in Woondum State Forest.

Habitat for the Black-breasted Button-quail is restricted to eucalypt forest with vine/Lantana understorey in the northern sections of Woondum State Forest.

6.4.2.11.2 Traveston State Forest

Traveston State Forest is an 85 ha tract of open eucalypt forest (RE 12.11.3) east of the existing Bruce Highway and west of the proposed alignment. The state forest is dissected by a 50-70 m wide cleared powerline easement along its eastern border. Contiguous areas of open eucalypt forest (RE 12.11.3) continue across private property to the east of the powerline easement. Although these two habitat patches are fragmented by the powerline easement, fauna are able to traverse cleared areas if they are relatively narrow and free of threats, in particular at night so this is unlikely to represent a significant barrier to the movement of fauna. Furthermore, strips of riparian vegetation along Cobbs Gully connected to Traveston State Forest to the north would also be facilitating the movement of species between these habitat patches.

The open eucalypt forest within Traveston State Forest and adjoining private property has been disturbed by logging. As a result, the canopy cover is relatively open, the ground layer is grassy, and large, woody debris is common. Large tree hollows only occur occasionally as much of the older timber has been removed. There is evidence of fire, as well as grazing on the private property.

Fauna surveys detected many of the same fauna species in both Traveston State Forest and forest on private property on the opposite side of the powerline easement, indicating that fauna usage across the two habitat patches is likely to be continuous.

The eucalypts provide foraging resources for Koala and Common Brushtail Possum. Tree stumps and large, woody debris provide habitat for Yellow-footed Antechinus which was observed in abundance across the habitat patches. The grassy open forest provides foraging resources and shelter for Eastern Grey Kangaroo (*Macropus giganteus*) and Red-necked Wallaby (*Macropus rufogriseus*). Tree hollows provide shelter and breeding sites for Common Brushtail Possum, nocturnal birds (White-throated Nightjar and Australian Owlet Nightjar) and birds (Pale-headed Rosella *Platycercus adscitus*, Rainbow Lorikeet *Trichoglossus haematodus* and Laughing Kookaburra).

Smaller hollows provide roosting habitat for microbat species. Species positively recorded on both sides of the proposed alignment include *Scotorepens* sp., Eastern Forest Bat (*Vespadelus pumilus*), Little Bentwing Bat (*Miniopterus australis*), South-eastern Long-eared Bat (*Nyctophilus species*) and White-striped Freetail Bat (*Austronomus australis*). Species recorded on only one side of the proposed alignment include Eastern Horseshoe Bat (*Rhinolopus megacarpus*), Gould's Wattled Bat (*Chalinolobus gouldii*) and Yellow-bellied Sheathtail Bat (*Saccolaimus flaviventris*); however it is considered that these species would occur on both sides.

Abundant ground cover provides habitat for a variety of reptiles, including skink species (*Carlia pectoralis*, *Carlia vivax* and *Cryptopherlarus virgatus*) and Lace Monitor. A number of woodland bird species were also observed including Peaceful Dove, White-throated Gerygone (*Gerygone albogularis*), White-throated Honeyeater (*Melithreptus albogularis*), Grey Shrike-thrush and Rufous Whistler.

6.4.2.11.3 Cobbs Gully

Cobbs Gully is an ephemeral creek commencing east of the proposed alignment in contiguous open forest on private property, fringed by RE 12.3.11 (*Eucalyptus siderophloia*, *E. tereticornis*, *Corymbia intermedia* open forest on alluvial plains usually near coast). The creek flows to the west towards the Mary River, through a powerline easement. There is a small dam (fringed by regrowth vegetation) within the easement supporting water birds including Pacific Black Duck (*Anas superciliosa*) and Eurasian Coot (*Fulica atra*). West of the dam (and proposed alignment) the surrounding landscape has been cleared and the creek supports thin strips of regrowth riparian vegetation, including scattered Forest Red Gum (*Eucalyptus tereticornis*) and Swamp Box (*Lophostemon suaveolens*) and an understorey tree layer dominated by *Melaleuca* spp. Fauna connectivity to/from contiguous forest in the east and the Mary River in the west is provided along this regrowth riparian habitat.

This riparian / wetland habitat provides connectivity across the study area for a number of amphibian species including Striped Marsh Frog (*Limnodynastes peronii*), Spotted Grass Frog (*Limnodynastes tasmaniensis*), Eastern Dwarf Tree Frog (*Litoria fallax*), Broad-palmed Frog (*Litoria latopalmata*), Rocket Frog (*Litoria nasuta*) and Peter's Frog (*Litoria inermis*), as well as snakes species including Carpet Python (*Morelia spilota*) and likely Freshwater Snake and Red-bellied Black-snake.

The more intact riparian vegetation to the east also supports a number of bird species associated with denser vegetation including White-throated Treecreeper, Yellow-faced Honeyeater (*Lichenostomus chrysops*), Eastern Yellow Robin and Rufous Fantail. It is also likely that Koalas, Eastern Grey Kangaroos and Red-necked Wallabies utilise this riparian corridor. The dam provides a water source for microbats inhabiting the surrounding forest. Species positively recorded include *Scotorepens* sp. and Eastern Freetail Bat (*Moropterus ridei*).These species roost in tree hollows and are likely to roost in riparian forest along Cobbs Gully on either side of the proposed alignment.

6.4.2.11.4 Jackass Creek

Jackass Creek is an ephemeral creek commencing east of the proposed alignment at the border of contiguous forest on private property. The creek flows to the west towards the Mary River, through a powerline easement and around the back of industrial works (brick works and soil supplies). The surrounding landscape has been cleared and the creek supports thin strips of regrowth riparian vegetation. There is a large dam west of the proposed alignment behind the brickworks supporting water birds including Pacific Black Duck, Black Swan (*Cygnus atratus*), Little Black Cormorant (*Phalacrocorax sulcirostris*), Pied Cormorant, Cattle Egret (*Phalacrocorax varius*), Eurasian Coot and Dusky Moorhen (*Gallinula tenebrosa*).

Historically Jackass Creek is likely to have supported RE 12.3.11 and 12.3.2 (*Eucalyptus grandis* tall open forest on alluvial plains). The most intact riparian vegetation is located north of the dam (west of the proposed alignment) behind the brickworks. Mature Flooded Gum (*Eucalyptus grandis*) with koala scratches was observed. Fauna connectivity to/from Woondum State Forest in the north east and the Mary River is provided along this regrowth riparian habitat and open eucalypt forest on private property south of Woondum Road.

6.4.2.12 Weeds

The field survey identified nine weed species listed under the LP Act.

Two class 2 declared pest plants were identified during the survey; Drooping Prickly Pear (*Opuntia monacantha)* was located as an infestation beside Gresham Road while Groundsel Bush (*Baccharis halimifolia*) was scattered in disturbed moist areas including farm dam margins in the south of the study area North of Tandur Road. Of the class 3 declared pest plants the *Asparagus* spp. were each recorded in a single location; *A. aethiopicus* just south of Keefton Road (site 4) and *A. africanus* in RE 12.11.16 between Woondum and Gresham Roads (site 12). The woody declared class 3 pest plants Camphor Laurel (*Cinnamomum camphora*), Chinese Elm (*Celtis sinensis*) and Small Leaf Privet (*Ligustrum sinense*) were mainly concentrated in riparian areas particularly within RE 12.3.1 along Six Mile Creek.

Dense infestations of Cat's Claw Creeper a Class 3 declared weed were also present in this area and represent a threat to the long term survival and regeneration of gallery rainforest RE 12.3.1 along Six Mile Creek. Lantana a Class 3 declared weed was scattered throughout the study area.

6.4.2.13 Pest Animals

Based on the desktop and field survey results, 17 pest animal species are known or are likely to occur within the study area and surrounds. Five of these species are declared Class 2 pests under the LP Act:

- Red Fox (*Vulpes vulpes*) - Class 2
- Dingo/Dog (*Canis lupus dingo/familaris*) - Class 2
- Cat (feral) (*Felis catus*) - Class 2
- Rabbit (*Oryctolagus cuniculus*) - Class 2
- Pig (feral) (*Sus scrofa*) - Class 2
- Cane Toad (*Rhinella marina)* was abundant on the site during the field surveys, and evidence of Fox, Dingo and/or Dog was also encountered.

6.4.2.14 Woondum Interchange

6.4.2.14.1 Vegetation Communities

The Woondum Interchange study area extends over several rural properties comprising predominantly cleared paddocks and several farm dams. There are no remnant REs. Regrowth vegetation was observed along a watercourse, with dams on either end, comprising RE 12.11.10 Notophyll vine forest +/- *Araucaria cunninghamii* on metamorphics +/- interbedded volcanics. Regrowth vegetation is mapped in **Figure 6-3A** to **Figure 6-3C** and described below.

Regrowth vine forest along a gully comprising emergent Hoop Pine (*Araucaria cunninghamii*) with an understorey tree layer of *Melaleuca linearifolia*, Red Ash (*Alphitonia excelsa*) and the introduced species, Camphor Laurel (*Cinnamomum camphora*) and Chinese Elm (*Celtis sinensis*). The canopy tree layer is sparse and comprises occasional Forest Red Gum (*Eucalyptus tereticornis*) on the banks and scattered Grey Gum (*Eucalyptus propinqua*) on the upper slopes of the gully. Shrub layer dominated by Acacia sp. and introduced species, Lantana and Easter Cassia (*Senna pendula* var. *glabrata*).

6.4.2.14.2 Threatened Ecological Communities

No threatened ecological communities were observed in the Woondum Interchange study area.

6.4.2.14.3 Fauna Habitat

Habitat within the Woondum Interchange study area includes:

- Regrowth vine forest
- Wetlands (dams and ephemeral waterways)
- Open pasture.

Regrowth vine forest is heavily impacted by weed species such as Lantana, Easter Cassia, Camphor Laurel and Chinese Elm, however denser vegetation within the gully provides habitat for bird species. Due to the lack of eucalypts and hollow-bearing trees it is unlikely to provide habitat for arboreal mammal species.

Wetland habitat included vegetated farm dams and ephemeral waterways along gullies. These provide habitat for a variety of water birds including ducks, cormorants and egrets, common frog species and reptiles and mammals associated with water including Water Dragon (*Physignathus leseuerii*). The landholder reported sightings of the threatened species Black-necked Stork (*Ephippiorhynchus asiaticus*) and Mary River Turtle and the special least concern species Platypus (*Ornithorhynchus anatinus*) on the farm dam on the floodplain. This is possible as major flooding of the Mary River occurs across this floodplain.

Two mature habitat trees were observed within the Woondum Interchange study area. These are shown on **Figure 6-3A** to **Figure 6-3C** and comprise Moreton Bay Fig (*Ficus macrophylla*) and Bennett's Ash (*Flindersia bennettiana*). These trees provide food resources for bird and fruit bat species, including the threatened species Grey-headed Flying-Fox (*Pteropus Poliocephalus*).

6.4.2.14.4 Threatened Species

No threatened flora or fauna species were observed on the Woondum Interchange study area. The landholder reported sightings of Black-necked Stork (Near Threatened under the NC Act) and Mary River Turtle (Endangered under the NC Act and EPBC Act) on the farm dam on the floodplain.

6.5 Potential Impacts and Mitigation

This section describes the potential impacts of construction and operation of the Project and mitigation measures to avoid or minimise these impacts on terrestrial flora and fauna values. Where measures to mitigate impacts are insufficient, offsets have been proposed.

6.5.1 Identification of Potential Impacts

As a summary, potential terrestrial flora and fauna impacts that may result from the Project are:

- Loss of native vegetation (including remnant REs, regrowth vegetation, threatened flora and their habitats) from clearing associated with road construction
- Loss of terrestrial and riparian habitat for native and threatened fauna (including food resources, shelter and refuge areas during non-breeding and breeding life-cycle events) from clearing associated with road construction
- Mortality of native and threatened fauna from clearing associated with road construction.

- Reduced connectivity for native and threatened flora and fauna species and populations with the degradation of wildlife and habitat corridors (including links to state forests) from clearing associated with road construction
- Fragmentation of terrestrial and riparian habitat and edge effects from road operation (traffic noise, light and wind turbulence)
- Impacts to ground water dependent ecosystems and wetlands from any significant road cuttings through low-lying area
- Invasion and spread of weeds and pest animal species from road construction activities
- Spread of disease pathogens from road construction activities
- Introduction or increased exposure to key threatening processes that may affect native and threatened flora and fauna species, populations and their habitat and significant REs
- Regional cumulative impacts affecting long term viability and survival of native and threatened flora and fauna species, populations and their habitats and significant REs.

These identified potential impacts are described in detail in the following sections.

6.5.2 Design

The Project alignment has sought to minimise the impact on terrestrial flora and fauna through route selection. Engineering and environmental investigations were undertaken for a comparative analysis of the alignment options (eastern corridor alignment option verse western corridor alignment option). Note that the impact area employed for this assessment was a broader corridor than the assessment for the overall alignment. Therefore the impact areas are indicative and for use in the comparative assessment only.

The western corridor alignment option (Project alignment) was found to have reduced impacts on REs, areas of biodiversity value, regrowth vegetation and essential habitat for species listed under the NC Act and/or EPBC Act (SKM, 2012).

Table 6-6 summarises the key environmental constraints of the eastern and western corridor alignment options.

Table 6-6: Comparative assessment of ecological constraints of the eastern and western corridor alignments.

Regional ecosystem	Eastern corridor alignment [7]	Western corridor alignment[7]	Difference
Remnant Vegetation Status			
Of Concern	6.6 ha within corridor	5.7 ha within corridor	Reduction of 0.9 ha (13.6%)
Least concern	42.2 ha within corridor	36.2 ha within corridor	Reduction of 6 ha (14.2%)
Regrowth Vegetation Status			
Of Concern	6.7 ha within corridor	4.6 ha within corridor	Reduction of 2.1 ha (31.3%)
Least concern	3.8 ha within corridor	3.6 ha within corridor	Reduction of 0.2 ha (5.3%)
Biodiversity Planning Assessment Mapping			
State significance	No impact	0.2 ha within corridor	Increase of 0.2 ha
Regional significance	55.3 ha within corridor	41.7 ha within corridor	Reduction of 13.6 ha (24.6%)
Mapped Fauna Habitat			
Koala (*Phascolarctos cinerus*)	59.5 ha within corridor	50.0 ha within corridor	Reduction of 9.5 ha (16.0%)
Grey-headed Flying-fox (*Pteropus poliocephalus*)	59.5 ha within corridor	50.0 ha within corridor	Reduction of 9.5 ha (16.0%)
Tusked Frog (*Adelotus brevis*)	2.8 ha within corridor	4.6 ha within corridor	Increase of 1.8 ha (64.3%)
Grey Goshawk (*Accipiter novaehollandiae*)	13.4 ha within corridor	10.4 ha within corridor	Reduction of 3.0 ha (22.4%)
Powerful Owl (*Ninox strenua*)	6.2 ha within corridor	4.1 ha within corridor	Reduction of 2.1 ha (33.9%)
Known EVNT Flora Locations			
Slender Milk Vine (*Marsdenia coronata*)	Four individuals impacted	No individuals impacted	Four fewer individuals impacted
Known EVNT Fauna Locations			
Tusked Frog (*Adelotus brevis*)	Two known locations impacted	No known locations impacted	Two fewer locations impacted
Grey Goshawk (*Accipiter novaehollandiae*)	One known location impacted	No known locations impacted	One less location impacted
Arrowhead Violet (*Violo betonicifolia*)	No known locations impacted	One known location impacted	One additional location impacted

6.5.3 Ancillary activities

Ancillary activities, such as establishment of stockpile and spoil areas, laydown areas, site office and workshops, will be located in existing cleared areas as a priority. Where this is not possible they will be located outside environmentally sensitive areas, such as remnant REs, habitat for threatened flora and fauna species and fauna movement corridors, to minimise environmental impacts. Environmentally sensitive areas will be identified on design drawings and refined during the Preliminary and Detailed Design processes. Environmentally sensitive sites will be included as exclusion zones in Detailed Design documentation which will form the contract for the construction of the Project.

In general, locations for ancillary activities will be selected based on the following criteria:

- Located within the road corridor to minimise disturbance
- Located away from environmentally sensitive zones
- Located away from any watercourses and above the Q5 flood level

[7] The comparative assessment was based on a broader impact area than the overall project impact assessment and is for indicative purposes only.

- Located in places convenient to the mass haul operations during the bulk earthworks phase.

The construction contractor will be required to identify appropriate sites for ancillary activities that do not impact on environmentally sensitive sites and obtain any necessary permits required to carry out these activities.

6.5.4 Loss of vegetation communities

The data generated during the field surveys from the study areas (and supplemented with desktop data for areas outside the study area) were compared to the clearing area in order to calculate the impact of the Project on flora and fauna values.

The Project will clear about 27.5 hectares of remnant vegetation, affecting a number of Endangered, Of Concern and Least Concern REs and 15.5 hectares of regrowth vegetation. The extent and class of remnant and regrowth REs impacted are listed in **Table 6-7** and **Table 6-8** respectively and illustrated in **Figure 6-3A** to **Figure 6-3C**. These clearing estimates have been calculated based on the construction footprint (the road construction footprint plus an additional three metre allowance either side).

Impact areas have been calculated by overlaying the Project clearance footprint onto BAAM's ground-truthed vegetation mapping, updated with SKM's vegetation mapping for Woondum Interchange. Where the Project alignment was refined since BAAM's field surveys, a portion of the clearance footprint extends further than the study area that was investigated during field surveys.

For these areas DEHP RE mapping (version 8.0) and regrowth mapping (version 2.1) has been used. This does not include clearing that may be required for potential ancillary activities beyond this construction footprint, as ancillary facilities location have not yet been determined and will be located in existing cleared areas as a priority to avoid additional impacts on vegetation communities.

No threatened ecological communities listed under the EPBC Act will be impacted.

Table 6-7: Areas of remnant vegetation impacted by the Project.

Remnant Regional Ecosystem	VM Act status	Impact area (ha)
By Regional Ecosystem		
12.3.11	Of Concern	2.5
12.3.2a	Of Concern	0.7
12.5.2a	Endangered	0.1
12.11.14	Of Concern	3.5
12.11.3	Least Concern	19.9
12.11.3/12.11.14	Least Concern	0.1
12.11.9	Of Concern	0.8
	TOTAL	**27.5**
By Regional Ecosystem Status		
Endangered REs		0.1
Of Concern REs		7.4
Least Concern REs		20.0
	TOTAL	**27.5**

Table 6-8: Areas of regrowth vegetation impacted by the Project.

Regrowth Vegetation	Impact area (ha)
12.3.11	5.1
12.11.10	0.3
12.3.7	0.8
12.11.3	3.6
Containing Endangered Regional Ecosystems[8]	1.7
Containing Of Concern Regional Ecosystems[8]	4.0
Containing Least Concern Regional Ecosystems[8]	0.1
TOTAL	**15.5**

Disturbance and clearing of vegetation as a result of the Project is unavoidable due to road construction, however opportunities to minimise the loss of native vegetation and fauna habitat in the design will be refined during the Detailed Design processes, including:

- Reducing the clearing width of the road corridor where it passes through environmentally sensitive areas including watercourses, significant REs and habitat for threatened species giving consideration to road design and safety criteria
- Selection of location of ancillary activities away from environmentally sensitive areas
- Implementation of the vegetation clearing process to minimise vegetation removal wherever possible.

6.5.5 Vegetation clearing process

A vegetation clearing process will be implemented during construction to minimise impacts on flora and fauna. This vegetation clearing process will include:

Pre-clearing:

- Implement a minimum disturbance policy consistent with MRTS04 – General Earthworks, which stipulates a maximum clearing area of the construction footprint plus three metres
- Visibly mark the extent of the areas to be cleared prior to clearing. Flagging shall remain in place until the works are completed
- No disturbance shall occur outside the clearance zone or within exclusion zones without appropriate approvals and/or further environmental assessments
- To maintain connectivity along watercourses and wetlands, and minimise erosion and deposition of sediment into watercourses, where possible clearing of vegetation shall not occur within 100m of watercourses and wetlands
- Where clearing within streams and waterways cannot be avoided then stumps and roots shall not be removed
- Pre-clearing surveys of potential habitat to be undertaken by a suitably qualified ecologist to search for threatened flora species and identify significant faunal habitat
- Where outside or adjacent to the road construction footprint, large trees with hollows should not be removed as these trees provide safe haven as dens, nesting and roosting sites for birds, bats and mammals and a buffer area should be established around these trees. The buffer should be at least equivalent to the diameter of the canopy to reduce the risk of root damage
- Implement a pest and weed management plan for the construction and operational phases of the project

[8] Regional ecosystem not defined in DEHP mapping.

- Implement a pathogen management plan for the construction phase of the project for myrtle rust and chytrid fungus
- Implement DEHP approved SMP for least concern wildlife, and specific species management plan for special least concern and threatened wildlife
- Pre-determine appropriate translocation/relocation sites for flora/fauna, and contacts for wildlife rehabilitator/carer or veterinarian.

Clearing:

- During clearing activities, all contractors are to be reminded during a site specific induction and toolbox meetings of their responsibilities in complying with the protection of fauna and flora within exclusion zones
- Vegetation clearing operations are to occur as in accordance with TMR Standard Specifications and contract annexures
- Additional investigations will be conducted and additional permits obtained if clear zones are required in accordance with the TMR Landscape and Revegetation Works Technical Standard suite
- Sequential clearing in a direction away from disturbed/cleared areas but towards vegetation to be retained so that any less mobile, non-volant fauna are able to move to other areas of suitable habitat (i.e. where possible start clearing from an existing cleared site and do not disconnect patches of habitat)
- An experienced and licensed fauna spotter-catcher to actively search habitat and breeding places (i.e. nests, hollows, burrows) immediately prior to clearing
- The fauna spotter-catcher to possibly relocate any fauna unable to safely move away from the disturbance into predetermined sites (if possible fauna should be encouraged to move on their own volition)
- The fauna spotter-catcher to remove and relocate inactive breeding places into adjacent habitat. Where possible avoid tampering with active breeding places by allowing the breeding cycle to complete, i.e. buffer zones to allow young to vacate the breeding place. Where clearing is unavoidable within this timeframe, the eggs/young from the breeding place will be removed by the fauna spotter-catcher and given to a wildlife carer
- The fauna spotter-catcher to facilitate clearing activities to ensure methods used are appropriate with minimal risk of injury or death to animals in accordance with the Draft Queensland Code of Practice for the welfare and management of wild animals affected by land-clearing and the modification or destruction of wildlife habitats and wildlife spotter/catchers (Hanger, 2006)
- Any animals injured by the activities on site should be referred to an appropriate wildlife rehabilitator/carer or veterinarian (to be predetermined prior to clearance works) and records of injured or killed animals should be referred to the appropriate authority
- Hollow timber, woody debris and bush rock which is suitable for fauna habitat will be relocated to retained habitat areas adjacent to the road corridor
- Marketable timber will be clearly marked prior to clearing and felled in a manner that reduces damage to trunks to allow collection of timber resources in accordance with the MRTS04
- Timber that is not considered marketable or suitable for use as fauna habitat may be mulched as required on site
- Burning of cleared vegetation will not occur during the construction of the Project
- Locating ancillary facilities in existing cleared areas as a priority
- Setting up exclusion areas in consultation with an ecologist; no works should be carried out in these sections including the storage of materials or track construction.

6.5.6 Impact on threatened flora species

The Project is not anticipated to impact on any threatened flora species recorded in the study area. Slender Milkvine, listed as Vulnerable under the NC Act (recently delisted under the EPBC Act), and Giant Ironwood, listed as Near Threatened under the NC Act, were both recorded in the study area, however outside the clearance footprints. The Project will still impact on 23.5 ha of potential habitat for Slender Milkvine and 0.3 ha of potential habitat for Giant Ironwood. Potential impacts and mitigation measures on these species are summarised in **Table 6-9**.

Table 6-9: Potential impacts on threatened flora species.

Species	Status	Presence in study area	Impact assessment
Slender Milk Vine (*Marsdenia coronata*)	V (NC Act)	Known	The Project will impact on 23.5 ha of potential habitat for this species (Remnant and regrowth RE 12.11.3). 21 individuals were recorded in five locations in RE 12.11.3 outside the clearance footprint. An exclusion zone will be defined around this location to ensure there are no impacts to this species. Pre-clearance surveys will be undertaken in potential habitat areas prior to construction. Translocation, rehabilitation and/or offsets will be implemented if the species is found within the clearance area.
Giant Ironwood (*Choricarpia subargentea*)	NT (NC Act)	Possible	This species was recorded outside the study area in RE 12.11.10 and will not be impacted by the Project. An exclusion zone will be defined around this location to ensure that impacts to this species are minimised. The project will impact on 0.3 ha of potential habitat (regrowth RE 12.11.10) for this species. Pre-clearance surveys would be undertaken in potential habitat areas prior to construction. Translocation (if practical), rehabilitation and/or offsets would be implemented if the species is found within the clearance area.

Status = Vulnerable, NT = Near Threatened.

An additional 13 State and Commonwealth listed threatened flora species were assessed as having potential to occur in the study area and could be impacted by the Project. These include:

- Hairy-joint Grass (*Arthraxon hispidus*)
- Jointed Baloghia (*Baloghia marmorata*)
- Three Leaved Bosistoa (*Bosistoa transversa* [includes *B. selwynii*])
- Ball Nut (*Floydia praealta*)
- Deep Creek (*Fontainea rostrata*)
- Macadamia Nut (*Macadamia integrifolia*)
- Maroochy Nut (*Macadamia ternifolia*)
- Fleabane Hawkweed (*Picris conyzoides*)
- Brush Sophora (*Sophora fraseri*)
- Hairy Hazelwood (*Symplocos harroldii*)
- Minute Orchid (*Taeniophyllum muelleri*)
- Glossy Spicebush (*Triunia robusta*)
- Southern Penda (*Xanthostemon oppositifolius*).

To minimise impacts on threatened flora species, a qualified botanist will undertake pre-clearance surveys of potential habitat areas to confirm the presence of the species listed above and assess the size/condition/structure of populations if found. These will occur during detail design so that potential management measures can feasibly be implemented.

For any confirmed populations, management measures will be implemented as follows:

1. Include them in the environmentally sensitive areas and where possible avoid in the road construction footprint and the location of ancillary facilities.
2. Determine if the age and condition of individuals present will allow successful translocation.
3. Determine if seed collection and nursery propagation is feasible.
4. If 2 and/or 3 are possible, design rehabilitation plans to incorporate the species.
5. If 2 and/or 3 are not possible, incorporate suitable habitats for the species within the offset package.

6.5.7 Impacts to groundwater dependent ecosystems

There are several vegetation communities within the study area which are considered to be a form of groundwater dependent ecosystem. They comprise vegetation occurring on waterways and floodplains which are likely to be reliant on groundwater, particularly during drought periods. In the study area, there are four vegetation communities and habitats that have the potential to be affected by impacts to groundwater:

- RE 12.3.1: Gallery rainforest (notophyll vine forest) on alluvial plains
- RE 12.3.2: *Eucalyptus grandis* tall open forest on alluvial plains
- RE 12.3.7: *Eucalyptus tereticornis*, *Callistemon viminalis*, *Casuarina cunninghamiana* fringing forest
- RE 12.3.11: *Eucalyptus siderophloia*, *E. tereticornis*, *Corymbia intermedia* open forest on alluvial plains usually near coast.

Road crossings through and adjacent to these communities can impact on groundwater levels by blocking drainage passages and groundwater flows. Potential impacts to groundwater dependent ecosystems may occur within vegetation communities located in low lying floodplain areas which are intersected by road cuttings. This occurs at RE 12.3.11 and 12.3.2 around Jackass Creek, Cobbs Gully and Kybong Creek. Impacts on these communities require further consideration in accordance with groundwater assessment of the road cuttings.

6.5.8 Loss of fauna habitat

Clearance of the construction footprint will result in the loss of approximately 43.0 ha of remnant and regrowth vegetation which serves as habitat for a diversity of fauna species. The impact on areas of fauna habitat is summarised in **Table 6-10**. This habitat also support several microhabitat types such as bush rocks, leaf litter, dead wood and hollow logs and branches. Fauna populations will be impacted by the removal of habitat that provides shelter, food and/or nesting resources (such as hollow-bearing trees, stag trees and ground logs), and interruption of movement corridors which can lead to reduced viability of fauna populations.

Table 6-10: Broad fauna habitat types.

Habitat type	Regional Ecosystems	Direct loss (hectares)
Open eucalypt forest	12.3.11, 12.5.2a.,12.11.13, 12.11.14, 12.11.13/12.11.14, 12.11.9	35.5
Vine forest/scrub	12.11.10	0.3
Wetlands (including dams, creeks and ephemeral waterways)	12.3.2a, 12.3.7	1.4
Other regrowth	Containing Endangered, Of Concern and Least Concern REs	5.8
Total fauna habitat cleared		*43.0*
Open pasture	Non-remnant	76.0

The vegetation clearance procedure includes measures to minimise impacts on fauna due to the loss of habitat (refer **Section 6.5.5**) including sequential clearing and presence of an experienced and licensed fauna spotter-catcher.

Impacts of loss of habitat on threatened fauna species are discussed in **Section 6.5.10**.

6.5.9 Habitat Fragmentation and Reduced Connectivity

The Project will create isolated habitat patches and create barriers to the movement of small ground-dwelling mammals and birds, birds associated with denser vegetation, reptiles and amphibians, arboreal and larger mammals on both a local and regional population level.

The width of the Project will vary according to the location and proximity of service roads and interchanges. Typically, the Project will comprise 8.4 kilometres of six lane formation with a three metre cleared either side to accommodate four lanes of pavement with a central concrete barrier. The clearing width will be up to 100 metres in some locations. The Project deviates substantially from the existing highway and will create a new barrier to the movement of wildlife. Large sections of the Project will also occur adjacent to the existing transmission line easement, such that the existing fragmentation effect of the transmission line would be increased.

The Project occurs along the boundary of Woondum State Forest which will avoid fragmentation of this habitat. However, the Project may reduce connectivity along the following fauna movement corridors represented in **Figure 6-8**.

- East-west terrestrial corridor from Jackass Creek and adjoining eucalypt forest on private property to/from Woondum State Forest. Although this corridor is currently fragmented by Woondum Road, this is unlikely to be creating a barrier to mobile fauna species and the Project will increase the isolation of Jackass Creek and adjoining habitat. Alternative connectivity exists along the Jackass Creek riparian corridor
- East-west terrestrial corridor from Traveston State Forest to/from open eucalypt forest on private property to the east of the powerline easement – although this corridor is currently fragmented by the cleared powerline easement, this is unlikely to be creating a barrier to mobile fauna species and the Project will increase the isolation of Traveston State Forest. Alternative connectivity exists along the Cobbs Gully riparian corridor
- East-west riparian corridors along Jackass Creek, Cobbs Gully and Kybong Creek – although riparian vegetation along these creek lines is currently patchy, this is unlikely to be creating a barrier to the movement of mobile fauna species and the Project will increase the fragmentation along these riparian corridors.

The Project will create a barrier effect for ground-dwelling and arboreal mammals and ground-dwelling birds, but more mobile species such as birds and bats may not be affected.

To minimise the impact to fauna movement as a result of the Project, fauna sensitive design mechanisms should be used to allow for fauna passage.

There is considerable existing data on the use of connectivity structures by fauna in Australia, including arboreal mammals (Goldingay *et al*. 2011 and Goldingay *et al*. 2012), small to medium sized terrestrial mammals, amphibians and reptiles (SMEC, 2007), Koalas (Moon, 1998) and small mammals (Hayes and Goldingay, 2009, Veage and Jones, 2007), however there is a lack of evidence on some specific species and taxa. Fauna crossing structures are particularly effective when used with fauna exclusion fencing that direct fauna away from the road and towards the structure (Taylor and Goldingay, 2003, SMEC 2007, Goldingay *et al.* 2011).

The 'Fauna Sensitive Road Design Manual Volume 2: Preferred Practices' (DMR, 2010) provides design guidelines for managing fauna movement. A number of environmental guidelines and mitigation measures are recommended in this Manual, including maximising connectivity between vegetated areas either side of the crossing, and providing for fauna pathways with adequate light penetration, revegetation, and avoidance of concrete or rocky based surfaces. A number of requirements for construction activities are also recommended, including a water quality monitoring program, rehabilitation monitoring program and maintenance program.

It is recommended that the design of the proposed crossing structures (underpasses – bridges and culverts) at Traveston Creek, Kybong Creek, Cobbs Gully, Jackass Creek are reviewed during the Preliminary and Detailed Design processes to maximise the opportunity to function as fauna crossings. The following should be considered in the design:

- Design of the underpass is targeted for use by fauna recorded in the study area.
- Three metre by three metre box culverts are generally considered suitable to accommodate a wide variety of terrestrial fauna species (including macropods, Koalas and flightless birds).
- A minimum vertical clearance of three to five metres is considered necessary to encourage the passage of a variety of small to large fauna species.
- The substrate should be as natural as possible (i.e. gravel, mulch, rocks) and provide dry passage for fauna.
- Either end of the underpass must be visible and lead directly to natural habitat.
- Underpass entrances should be vegetated with native species.
- Inclusion of fauna furniture (i.e. refuge pools and ground logs/rocks) in the underpasses to provide refuge for fauna from predators and floodwaters.
- At least 200 m of fauna exclusion fencing should be installed either side of a fauna passage culvert or bridge to encourage fauna to use the structure and to limit the opportunity for fauna to cross the highway and be exposed to vehicle strike.

The height of fill above the proposed reinforced concrete box culvert (RCBC) structure at Kybong Creek is insufficient to accommodate a three metre high box culvert. Therefore, a dedicated fauna crossing structure (or structures) is recommended in the vicinity of Kybong Creek to maintain connectivity along these waterways.

No changes are recommended for Traveston Creek (a three by 30 metre span bridge), Cobbs Gully (a 21 metre span, seven metre high reinforced concrete arch) or Jackass Creek (a four by 30 metre span bridge) as the proposed design of these structures is likely to provide adequate fauna passage.

Due to isolation of Traveston State Forest and the presence of Koalas on both sides of the proposed alignment, it is also recommended that a dedicated crossing structure is installed here to maintain fauna connectivity.

An ecological monitoring program should be developed and implemented to monitor the success of the fauna crossing structures.

6.5.10 Impact on Threatened Fauna Species

The Project has the potential to impact on five threatened fauna species confirmed or likely in the study area: Tusked Frog, Elf Skink, Grey Goshawk, Black-breasted Button-quail, Grey-headed Flying Fox and Koala. Habitat mapping is shown in **Figure 6-6A** to **Figure 6-6C** for threatened mammals, frogs and reptiles, and in **Figure 6-7A** to **Figure 6-7C** for threatened birds. Potential impacts on species known or likely to occur in the study area are assessed in **Table 6-11**.

Impact areas have been calculated by overlaying the Project clearance footprint onto fauna habitat mapping, updated with SKM's revised habitat mapping for Black-breasted Button-quail. Where the Project alignment was refined since BAAM's field surveys, a portion of the clearance footprint extends further than the study area that was investigated during field surveys. For these areas DEHP RE mapping (version 8.0) and regrowth mapping (version 2.1) has been used. This does not include clearing that may be required for potential ancillary activities beyond this construction footprint, as ancillary facilities location have not yet been determined and will be located in existing cleared areas as a priority to avoid additional impacts on fauna habitat.

Table 6-11: Potential impacts on threatened fauna species.

Species	Status	Presence in study area	Impact assessment
Amphibian			
Tusked Frog *(Adelotus brevis)*	V (NC Act)	Known	This species prefers areas that that are seasonally flooded, water bodies or area of ephemeral inundation. The project is anticipated to impact on 9.3 ha of suitable habitat for the Tusked Frog. Another likely impact from the project on this species includes the changes to the environment of the populations within the road reserve and those populations downstream caused by pollution from runoff from the road and the changes is hydrological regimes of the area. The Project has the potential to facilitate the movement of pest species such as feral pigs that destroy the preferred habitat and breeding places of this species. There is also the potential that the project may contribute to the spread of amphibian chytrid fungus that has been attributed to the decline in the species throughout its known range.
Reptiles			
Elf Skink *(Eroticoscincus graciloides)*	NT (NC Act)	Known	This species prefers areas that have a variety of habitat features including logs, leaf litter and rocks. The project is anticipated to impact on 37.1 ha of suitable habitat for the Elf Skink. The Elf Skink is intolerant to sunlight and therefore a decline in canopy cover can impact of the species by making the habitat unsuitable. Changes to surface and groundwater flows may also impact on downstream populations by drying out habitat. Elf Skinks are known to be associated with damp depressions in some of the drier habitats in which they occur. The project has the potential to facilitate the movement of pest species such as feral cat and feral pigs. Feral cats will predate on this species, whereas the feral pig are known to destroy habitat for this species through their foraging behaviour.
Birds			
Grey Goshawk *(Accipiter novaehollandiae)*	NT (NC Act)	Known	This species prefers wooded areas with tree branches and forks that are used for hunting and breeding purposes. The project is anticipated to impact on 37.1 ha of suitable habitat for the Grey Goshawk. Impacts on the general fauna assemblages in the area will impact on the Grey Goshawk by limiting the availability of prey for the species within the area. The project has the potential to facilitate the movement of pest species such as feral cat that may predate upon nestlings and fledglings.

Species	Status	Presence in study area	Impact assessment
Black-breasted Button-quail *(Turnix melanogaster)*	V (NC Act and EPBC Act)	Likely	Black-breasted Button-quails occurs in dry rainforest and vine thickets with an abundance of leaf litter for foraging. Suitable habitat for Black-breasted Button-quail was mapped during targeted surveys and includes eucalypt forest with a vine/shrubby understorey and dense layer of leaf litter. This is restricted to the southern boundary of Woondum State Forest. The Project will not directly impact on suitable habitat. However, the Project will create edge effects (noise, light, weeds) which are likely to extend into this habitat. Suitable habitat appears to be connected to Araucarian notophyll vine forest (12.11.10) occurring along Six Mile Creek in Woondum State Forest, which provides further habitat for this species so this will not have a significant impact on the species. The project has the potential to facilitate the movement of pest species such as feral cat, wild dogs and feral pigs. Feral cats and dogs will predate on both the adults and young, whereas the feral pig has potential to feed on eggs and newly hatched young. Feral pigs are also known to destroy habitat for this species through the pig's own foraging behaviour. Introduction of weed species from construction of the project may also degrade the habitat of the Black-breasted Button-quail. Lantana however is already widespread across the habitat and does not appear to be affecting the presence of Black-breasted Button-quail.
Mammals			
Koala *(Phascolarctos cinereus)*	V (NC Act and EPBC Act)	Known	The Koala prefers habitats that are dominated by its main food resource, which is a variety of eucalypt species. The project is anticipated to impact on 36.1 ha of suitable habitat for the Koala. The Project will also increase habitat fragmentation that is a key threatening process to the survival of Koala populations. Koala evidence was detected on both sides of the proposed alignment at Traveston State Forest, Woondum State Forest/Jackass Creek and is likely to also occur along Cobbs Gully. Habitat fragmentation increases the level of mortality of Koalas particularly during the breeding season. As Koalas move through fragmented habitats they have high chances of being hit by cars and encountering predators such as domestic and wild dogs. Furthermore, the six lane formation with central concrete barrier will provide a barrier to movement without dedicated fauna crossing structures. It has also been recorded that Koalas in fragmented habitat have a high prevalence of disease within their populations (Higgins 2009). This could be potentially linked to additional stress on the animals from competition for resources and home ranges and from the likelihood of inbreeding within populations due to the lack of connectivity (Higgins 2009). The project has the potential to facilitate the movement of pest species such as wild dogs. Wild dogs will predate on both the adults and young, which come to the ground to move from tree to tree. Introduction of weed species from construction of the project may also degrade the habitat of the Koala through the suppression of sapling growth.

Species	Status	Presence in study area	Impact assessment
Grey-headed Flying-fox (*Pteropus poliocephalus*)	V (EPBC Act)	Likely	The Grey-headed Flying-fox is considered likely to forage across the study area in eucalypt and riparian forests. Although no flying-fox camps have been observed in the study area, the study area supports foraging habitat that is productive during winter and spring (when food shortages have been identified) and therefore provides an essential foraging resource for this species. Construction of the project will result in the loss of 37.1 ha of foraging habitat for the Grey-headed Flying-fox. However, the surrounding landscape, in particular eucalypt forest in Woondum State Forest, Traveston State Forest and on private property to the east of the study area will continue to provide a foraging resource, in particular during food shortages.

Status: E = Endangered, V = Vulnerable, NT = Near Threatened.

An additional 21 state and commonwealth listed threatened fauna species were assessed as having potential to occur in the study area and could be impacted by the Project. These include:

Invertebrates:

- Australian Fritillary Butterfly (*Argyreus hyperbius inconstans*)

Amphibians:

- Giant Barred Frog (*Mixophyes iteratus*)

Reptiles:

- Common Death Adder (*Acanthophis antarcticus*)
- Mary River Turtle (*Elusor macrurus*)

Birds:

- Fork-tailed Swift (*Apus pacificus*)
- Double-eyed Fig-parrot (Coxen's) (*Cyclopsitta diophthalma coxeni*)
- Black-necked Stork (*Ephippiorhynchus asiaticus*)
- Red Goshawk (*Erythrotriorchis radiates*)
- Latham's Snipe (*Gallinago hardwickii*)
- Lewin's Rail (*Lewinia pectoralis*)
- Australian Cotton Pygmy-goose (*Nettapus coromandelianus albipennis*)
- Powerful Owl (*Ninox strenua*)
- Australian Painted Snipe (*Rostratula australis*)

Mammals:

- Northern Quoll (*Dasyurus hallucatus*)
- Spotted-tailed Quoll (south-east mainland) (*Dasyurus maculatus maculatus*)
- Platypus (*Ornithorhynchus anatinus*)
- Grey-headed Flying-fox (*Pteropus poliocephalus*)
- Short-beaked Echidna (*Tachyglossus aculeatus*)

A species management plan will be developed during detailed design to minimise impacts on threatened fauna species during construction of the Project. The vegetation clearance procedure includes measures to minimise impacts on fauna due to the loss of habitat (refer to **Section 6.5.5**) including sequential clearing and presence of an experienced and licensed fauna spotter-catcher.

In accordance with MRTS16B – Vegetation Ground Works, sites will be in a weed free condition prior to the commencement of works. A Weed and Pest Management Plan will be implemented for construction of the Project which will assist in controlling weeds and pest animals which may degraded habitat and/or predate on threatened species. Where significant weed outbreaks are identified on adjoining properties, Gympie Regional Council should be advised and appropriate action recommended.

6.5.11 Impact on Migratory Species

The Project will impact on seven migratory fauna species recorded in the study area listed under the NC Act or EPBC Act. The Project will impact on up to 43.0 ha of habitat for the migratory species. Potential impacts on known species are assessed in **Table 6-12**.

Table 6-12: Potential impacts on migratory species.

Species	Status	Presence in study area	Impact assessment
Birds			
Eastern Great Egret *(Ardea modesta)*	SLC (NC Act) M (EPBC Act)	Known	This species prefers wetlands and vegetation associated with water courses and bodies. The Project is anticipated to impact on 1.4 ha of preferred habitat for the Eastern Great Egret. The Project has the potential to facilitate the movement of pest species such as feral cat, wild dogs and feral pigs. Feral cats and dogs will predate on both the adults and young, whereas the feral pig are known to destroy habitat for this species through the pig's own foraging behaviour. Introduction of weed species from construction of the Project may also degrade the habitat of the Eastern Great Egret. Populations of the Eastern Great Egret both within the project footprint and downstream have the potential to be impacted by pollution run-off and changes in hydrological regimes of the area.
Cattle Egret *(Ardea ibis)*	SLC (NC Act) M (EPBC Act)	Known	This species prefers wetlands and vegetation associated with water courses and bodies. The Project is anticipated to impact on 1.4 ha preferred habitat for the Cattle Egret. The Project has the potential to facilitate the movement of pest species such as feral cat, wild dogs and feral pigs. Feral cats and dogs will predate on both the adults and young, whereas the feral pig are known to destroy habitat for this species through the pig's own foraging behaviour. Introduction of weed species may also be facilitate by the project and this can also degrade the habitat of the Cattle Egret. Populations of the Cattle Egret both within the project footprint and downstream have the potential to be impacted by pollution run-off and changes in hydrological regimes of the area.

Species	Status	Presence in study area	Impact assessment
White-bellied Sea-eagle *(Haliaeetus leucogaster)*	SLC (NC Act) M (EPBC Act)	Known	This species prefers wetlands and vegetation associated with water courses and bodies. The Project is anticipated to impact on 1.4 ha of wetlands and 35.5 ha of Open Eucalypt Forest, the preferred habitat for the White-bellied Sea-eagle. The Project can facilitate the movement and spread of a variety of pests and weeds that impact on the food sources for the White-bellied Sea-eagle. If the decline is suitable food sources and foraging area declines then the area may be abandoned by the species due to the lack of resource. Populations of the White-bellied Sea-eagle both within the project footprint and downstream have the potential to be impacted by pollution run-off and changes in hydrological regimes of the area.
White-throated Needletail *(Hirundapus caudacutus)*	SLC (NC Act) M (EPBC Act)	Known	This species is almost exclusively an aerial species and therefore the Project is unlikely to have any direct impacts. It is possible that the project may impact on the White-throated Needletail through the destruction of habitat for its prey species which are largely insects. The Project will impact on 43.0 ha of habitat for a variety of insect species.
Rainbow Bee-eater *(Merops ornatus)*	SLC (NC Act) M (EPBC Act)	Known	This species forages in woodlands and open forests and breeds by digging burrows into the banks of watercourses and steep cliffs and escarpments. The Project is anticipated to impact on 35.5 ha of Open Eucalypt Forest which is suitable foraging habitat and 1.4 ha of wetland that is suitable breeding habitat for the Rainbow Bee-eater. The Project has the potential to facilitate the movement of pest species such as feral cats and feral pigs. Feral cats will predate on both the adults and young. Feral pigs may feed on the eggs and nest young if they dig up the nest. However they are more likely to degrade suitable breeding locations through the pigs own foraging habits.
Rufous Fantail *(Rhipidura rufifrons)*	SLC (NC Act) M (EPBC Act)	Known	This species forages in thick forest and woodlands with plenty of foliage cover to protect it from predators. The Project is anticipated to impact on 0.3 ha of Vine Forest/Scrub, the preferred habitat for the Rufous Fantail. The Project has the potential to facilitate the movement of pest species such as feral cats. Feral cats will predate on both the adults and young.
Spectacled Monarch *(Symposiachrus trivirgatus)*	SLC (NC Act) M (EPBC Act)	Known	This species forages in thick forest and woodlands with plenty of foliage cover to protect it from predators. The Project is anticipated to impact on 0.3 ha of Vine Forest/Scrub, the preferred habitat for the Spectacled Monarch. The project has the potential to facilitate the movement of pest species such as feral cats. Feral cats will predate on both the adults and young.

Status: SLC = Special Least Concern, M = Migratory.

A species management plan will be developed during detailed design to minimise impacts on migratory species during construction of the Project. The vegetation clearance procedure includes measures to minimise impacts on fauna due to the loss of habitat (refer **Section 6.5.5**) including sequential clearing and presence of an experienced and licensed fauna spotter-catcher.

A Weed and Pest Management Plan will be implemented for construction of the Project which will assist in controlling weeds and pest animals which may degraded habitat and/or predate on migratory species, in particular wetland species.

6.5.12 Fauna Mortality

Fauna injury or death can occur during the clearing phase of construction during the removal of habitat (i.e. shelter and hollow-bearing trees) and from collision with vehicles during the operation of the new section of highway.

6.5.12.1 Construction

While some diurnal and mobile species, such as birds and large reptiles, may be able to move away from the path of construction tree-clearing, other species that are less mobile, those that are nocturnal, or those that have smaller home ranges, are less inclined to move rapidly or disperse large distances away from such activity. This includes roosting microchiropteran bats and the threatened species, Koala, Black-breasted Button-quail, Tusked Frog and Elf Skink.

The DEHP approved generic SMP will be followed to minimise impacts on least concern species during construction of the Project. The vegetation clearing process will be implemented to minimise impacts on native fauna due to the loss of habitat (refer **Section 6.5.5**) including sequential clearing and presence of an experienced and licensed fauna spotter-catcher.

6.5.12.2 Operation

Mortality due to vehicle strike has the potential to affect fauna species at the sub-population level. In general, mortality rates from vehicle strike are likely to be directly proportional to the distance of native vegetation/fauna habitat crossed by the project (Forman, 2000). However, other factors such as the design of the road (e.g. through road cutting or road embankment, presence of adjacent stock fences, presence of fauna exclusion fencing or fauna crossing structures) also influence vehicle strike mortality.

Road mortality can have further impacts, including reduced breeding success. Isolated populations where growth relies on breeding rather than the influx of individuals from adjacent populations, can be more greatly impacted from road mortality.

Threatened fauna that have the greatest potential to be negatively affected by vehicle strike over the length of the project include Koala. Other common fauna that may be affected include possums, gliders, bandicoots, wallabies and woodland bird species.

Fauna crossing structures and fauna exclusion fencing will be implemented to minimise fauna mortality by vehicle strike.

6.5.13 Edge effects

Edge effects are zones of changed environmental conditions (e.g. altered light levels, wind speed, temperature and noise) occurring along the edges of habitat fragments. These new environmental conditions can promote the growth of different plants (including weeds) and altered vegetation community structure. A change in the structure of vegetation communities can allow invasion by pest animals conducive to edge habitats or change the behaviour of resident animals (Moenting & Morris, 2006). Edge zones can be subject to higher levels of predation by introduced mammalian predators and native avian predators having a long-term impact on sensitive species.

Edge effects will occur where the project creates a new edge through contiguous forest. This will be greatest through RE 12.11.3 comprising Traveston State Forest. This includes potential habitat for the vulnerable Slender Milkvine, and a range of threatened fauna species that are susceptible to edge effects including Black-breasted Button-quail, Powerful Owl, Elf Skink, Koala and Grey-headed Flying-fox. The effects of creating a new edge will increase the risk of predation for resident fauna including threatened species. It may also reduce the health of important habitat trees and hollow bearing trees as an indirect result.

6.5.14 Noise and light impacts

There are two sources of potential impacts on habitat edges from noise and light. Firstly, construction noise (e.g. construction vehicles and machinery) and artificial night lighting associated with road construction, some night-time construction work will be required as part of the construction program. This will require lighting at ancillary facility locations and at the construction site.

Secondly, general traffic noise, vehicle lighting and roadside lighting associated with road operation. Roadside lighting will be limited to interchange roundabouts, major bridges, and merge and diverge traffic lanes.

Negative effects of traffic noise have been recorded mainly in species that frequently vocalise, including birds and amphibians (van der Zande et al 1980, Reijnen *et al.* 1997) and species that rely on hearing for hunting such as forest owls. Whether noise could cause road avoidance and other barrier effects in isolation from other factors such as vehicle movements, presence of humans or edge effects remains to be ascertained (Kaseloo, 2006). There is some evidence to support less vocal mammal species altering normal movement pattern to avoid traffic noise (Byrnes *et al*, 2012).

However, it is important to consider that no multi-species study has found all species to be sensitive to road traffic noise. In several studies that cover a wide range of habitat types it has been shown that while some species become less common near the road, others show the opposite effect, and the importance of these (ecotonal) species may also need to be considered in evaluating the impact of roads (Ferris, 1979; Adams and Geis, 1981).

Some nocturnal birds and even diurnal raptors are attracted to street lights as a source of increased prey activity; however the Powerful Owl is dependent on hearing for capturing medium-sized arboreal mammals.

The potential impacts from the project may be greatest on a range of threatened amphibian, bird and mammal species in terms of altering vocalisations and interrupting breeding cycles (e.g. Tusked Frog, Black-breasted Button-quail, Powerful Owl and Koala) and also a range of small and medium sized mammal species in terms of negatively affecting movement patterns and habitat connectivity.

6.5.15 Weeds, pest animals and pathogens

The construction and operation of the project has the potential to increase invasion by weed species, invasion by pest animals or spread of pathogens.

6.5.15.1 Weed invasion

Nine weed species listed under the LP Act were confirmed from field surveys along the project, including one weed of national significance (Lantana) and two Class 2 declared pest plants (Groundsel Bush and Drooping Prickly Pear).

During construction there is potential to disperse weed seeds and plant material into adjoining areas of remnant vegetation where weed species do not currently occur. The most likely causes of weed dispersal will be through the movement of soil and attachment of seed (and other propagules) to construction vehicles and machinery involved with clearing of vegetation and stockpiling mulch and topsoil during earthworks.

To minimise the potential for the spread and introduction of weeds from the outset of construction, a weed management plan will be developed for construction of the Project. As part of the weed management plan a site assessment by an ecologist or person trained in weed identification and management will be required to assess the extent and severity of weed species in the construction footprint with particular emphasis on noxious weed species.

The weed management plan will include descriptions and mapping of major weed infestations during pre-clearing surveys and appropriate management actions to be undertaken for each infestation. The details of the weed management plan will vary for each site but should include:

- Taxa and potential sources of the weed species
- Weed management priorities and objectives
- Sensitive environmental areas within or adjacent to the site
- Location of weed infested areas
- Treatment and removal methods for all Class 2 weed species listed in the LP Act
- Mechanical weed control methods such as slashing or mowing, as well as a range of herbicides to avoid the development of herbicide resistance
- Measures to prevent the spread of weeds
- A monitoring program to measure the success of weed management
- Strategic management with adjacent landowners
- Appropriate disposal of weed infested materials and soils
- Communication strategies to improve contractor awareness of weeds and weed management.

Management methods for declared weeds must be consistent with recommendations in Pest Fact sheets produced by Department of Agriculture, Fisheries and Forestry.

6.5.15.2 Pest animals

Pest animal species can impact on native fauna through predation and competition for feeding or habitat resources. These species could also impact on vegetation through grazing. Five pest animal species listed under the LP Act are known or likely to occur along the project (Red Fox, Dingo/Dog, Cat, Rabbit and Pig).

It is considered unlikely that construction of the Project will result in an increase in the numbers or distribution of pest animals in the region because they readily access all areas now. However, wild dogs may be attracted to work sites if food scraps are available. Measures will be implemented to minimise this, such as disposal of food scraps in refuse bins with lids. Waste should be collected on a regular basis and disposed of at a local waste facility.

Fauna sensitive design mechanisms (fauna crossing structures and fauna exclusion fencing) will be incorporated in the Project to allow for fauna passage. It is important to note that predators can exploit the channelling function of the fence by hunting near the entrance to the underpass or overpass (Harris et al. 2010). Monitoring of the effectiveness of fauna crossing structures, including the presence/absence of feral predators in recommended once the Project is operational. Predator control should be investigated if this is demonstrated to be an issue for safe fauna passage.

The Project is located outside of mapped Fire Ant zones. However, fire ant may be introduced to the area through the importing of plant and materials from restricted areas. Appropriate inspections and controls will be required to prevent the introduction of Fire Ants as a result of Project activities.

6.5.15.3 Spread of pathogens

Pathogens cause disease in flora and fauna and are usually living organisms such as bacterium, virus or fungus. Several pathogens known in South East Queensland have potential to impact on biodiversity as a result their movement and infection during construction of the project and include:

- **Myrtle rust (*Uredo rangelli*):** An introduced fungus that attacks the young leaves, short tips and stems of Myrtaceous plants eventually killing the plant. Introduction and establishment of exotic Rust Fungi of the order Pucciniales on plants of the family Myrtaceae.

- **Chytrid fungus (*Batrachocytrium dendrobatidis*):** Infection by chytrid fungus resulting in an infectious disease (chytridiomycosis) that affects amphibian's worldwide causing death. This is identified as a key threatening process under the EPBC Act.

The potential for pathogens to occur should be considered a high likelihood across the whole project and treated as a potential risk during construction. This is particularly a risk for the project at waterway crossings where the risk of transmission is higher. Pathogen management should therefore be implemented throughout all stages of construction.

6.6 Significance of impacts on MNES

6.6.1 Methodology

The potential for significant impacts on EPBC Act listed threatened species known or likely to occur in the study area (Black-breasted Button-quail, Koala and Grey-headed Flying-fox) have been assessed against the significant impact criteria for vulnerable species outlined in the EPBC Act Significant Impact Guidelines 1.1 (DEWHA, 2009).

The Draft EPBC Act referral guidelines for the vulnerable koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) (DotE, 2013), herein referred to as Draft Koala Referral Guidelines have been used to assess the importance of the koala habitat impacted by the Project and to support the requirement for a referral under the EPBC Act. Habitat 'critical to the survival of the Koala' has been determined in accordance with the Koala habitat assessment tool contained in the Draft Koala Referral Guidelines.

6.6.2 Threatened species

Table 6-13, and **Table 6-16** assess the potential impacts on the Black-breasted Button-quail, Koala and Grey-head Flying-fox, respectively. **Table 6-15** provides results of the Koala habitat assessment tool as applicable to the Project.

Table 6-13: Significant impact assessment for the Black-breasted Button-quail.

Criteria	Impacts	Mitigation and offsets
Lead to a long-term decrease in the size of an important population of a species	Black-breasted Button-quails occurs in dry rainforest and vine thickets with an abundance of leaf litter. This species was not directly observed however a high density of platelets likely to be made by this species were observed in the vine scrub habitat in Woondum State Forest and a lesser density observed on a private property further to the east. These platelets were observed outside the Project clearance footprint. The Black-breasted Button-Quail has 14 known populations within its range with two main populations occurring in the Yarraman-Blackbutt region and the second in the Great Sandy region (Curtis et al. 2012). The project is located within vicinity of the Great Sandy region population. The population in Woondum State Forest is considered to comprise an important population as it is necessary for the species long term survival and recovery. Construction of the Project will not impact on suitable habitat for the Black-breasted Button-quail. Furthermore the Project is not impacting on habitat where feeding signs have been detected (platelets). However the Project will create edge effects (noise, light, weeds) which are likely to extend into suitable habitat. Suitable habitat appears to be connected to Araucarian notophyll vine forest (12.11.10) occurring along Six Mile Creek in Woondum State Forest to the east, which provides further habitat for this species. The Project will be constructed on the western edge of the Woondum State Forest and therefore will not fragment habitat or connectivity with the wider landscape. This allows for the species to disperse through the landscape and also allows for genetic flow through the population. These factors increase the survival of the species within this area. In conclusion, no, the Project will not lead to a long-term decrease in the size of an important population.	Avoid any unnecessary impacts or further works in the suitable habitat and known feeding locations of this species. Sequential clearing from the western side of the Project clearance footprint towards Woondum State Forest to allow Black-breasted Button-quails to safely move on their own volition away from the disturbance. Fauna spotter-catcher to actively search vine scrub habitat prior to clearing activities and safely relocate any Black-breasted Button-quails found to adjacent habitat within Woondum State Forest. Offset impacts to the habitat of the Black-breasted Button-quail. Implement weed and pest management and monitoring during construction and operational phases.
Reduce the area of occupancy of an important population	Although the Project will not clear any suitable habitat for this species, edge effects are likely to degrade the quality of habitat for this species within a few hundred metres of the clearance footprint which may reduce the area of occupancy of an important population. Commonly edge effects are known to alter the structure and species diversity of the outer edges of larger patches and can completely overtake small isolated patches. These changes are linked to a number of factors such as pollution, weeds, changes in hydrological regimes, changes in fire regimes and loss of canopy cover. However, the Project is impacting on the edge of the suitable habitat as opposed to traversing through the central of the habitat and therefore edge impacts will not be as great as if the Project was to traverse the habitat.	As above.
Fragment an existing important population into two or more populations	The Project will not fragment an existing important population, as the Project will be constructed on the edge of Woondum State Forest, and will not fragment habitat or connectivity with the wider landscape.	No impact.

Criteria	Impacts	Mitigation and offsets
Adversely affect habitat critical to the survival of a species	The Project will not impact on habitat critical for the survival of the Black-breasted Button-quail, nor will it impact on known feeding locations (platelets) for this species.	As above.
Disrupt the breeding cycle of an important population	This species is considered to potentially breed throughout the year (DotE 2013). They nest on the ground with the nest usually situated between buttress roots. The females can have two clutches within 8-10 days of the first as it is the males that incubate the eggs. The eggs are incubated for 18-21 days after which the young follow the male on foot (DotE 2013). Therefore the nest is only used for incubation purposes.	A fauna spotter/catcher will actively search suitable habitat immediately prior to clearing activities to identify any nests within clearing areas. Any active nests should be marked and a buffer zone established. Works will be delayed until the nest is no longer active. Once the male and young have moved on another search will be done to ensure no additional nesting has taken place.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The Project will not impact on suitable habitat or known feeding locations (platelets) and will be constructed on the edge of Woondum State Forest. Therefore it is not considered likely that the species will decline in the area.	As above.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	The project has the potential to facilitate the movements of feral species such as feral cats and wild dogs which have been known to predate on the adults and young of the migratory species. Feral pigs have been known to be opportunistic and prey on the eggs and nestlings of ground dwelling birds. Feral pigs are also known to cause degradation the habitat utilised by the Black-breasted Button-quail. The Project also has the potential to increase the invasion of weeds. These invasive weed species can lead to area of habitat no longer being suitable, particularly those weeds that can alter the structure of ecosystems, i.e. Lantana. Lantana however is already widespread across the habitat and does not appear to be affecting the presence of Black-breasted Button-quail.	All vehicles and machinery should be washed down a weed certified prior to entering the project during the construction phase. All material being brought onto site such as soils, mulch and the like should have a weed hygiene certificate. Implement weed and pest management and monitoring during construction and operational phases.
Introduce disease that may cause the species to decline	The Project will not introduce any diseases that are known to affect the Black-breasted Button-quail.	No impact.
Interfere substantially with the recovery of the species	The recovery plan highlights fragmentation by roads as a major threat to the recovery of the Black-breasted Button-quail. Construction of the Project will not impact on, or fragment suitable habitat for the Black-breasted Button-quail.	As above.
In conclusion, the Project is unlikely to have a significant impact on the Black-breasted Button-quail. Construction of the Project will not impact on, or fragment suitable habitat for the Black-breasted Button-quail. However the Project will create edge effects (noise, light, weeds) which are likely to extend into suitable habitat.		

Table 6-14: Significant impact assessment for the Koala.

Criteria	Impacts	Mitigation and offsets
Lead to a long-term decrease in the size of an important population of a species	Field surveys conducted for the Project did not observe any Koalas, however evidence of Koala (claw marks on trees and scats) were found at Jackass Creek and adjacent eucalypt forest on private property to the east (P3), Woondum State Forest (P4), and Traveston State Forest (P1) and adjacent eucalypt forest on private property to the east (P2). Koala is also likely to occur along Cobbs Gully. Large tracts of forest (Woondum State Forest and Traveston State Forest) are therefore assumed to support populations of the Koala. The Koala prefers habitats that are dominated by its main food resource, a variety of Eucalypts species. Construction of the Project will impact on 36.1 ha of critical Koala habitat, as defined by the Koala habitat assessment tool in the Draft Koala Referral Guidelines (refer Table 6-15). The Project is also expected to increase fragmentation of habitat at Traveston State Forest and along riparian corridors (Jackass Creek, Cobbs Gully and Kybong Creek), within an already heavily fragmented environment. Without appropriate mitigation measures, it is possible that the Project could lead to a long-term decline in the population.	Avoid any unnecessary impacts to Koala habitat. Avoid further works in Koala habitat. Establish fauna friendly crossing into the design including crossing structures suitable for Koalas and exclusion fencing, in particular at Traveston State Forest and riparian corridors (Traveston Creek, Kybong Creek and Cobbs Gully). Offset impacts to the habitat of the Koala.
Reduce the area of occupancy of an important population	Yes, the Project will reduce the area of occupancy of a Koala population by 36.1 ha of critical Koala habitat.	As above
Fragment an existing important population into two or more populations	The population already exists in a heavily fragmented landscape; however the Project will increase fragmentation of habitat at Traveston State Forest and along riparian corridors (Jackass Creek, Cobbs Gully and Kybong Creek). Without appropriate mitigation measures, it is possible that the Project could fragment the population.	Establish fauna friendly crossing into the design including crossing structures suitable for Koalas and exclusion fencing, in particular at Traveston State Forest and riparian corridors (Traveston Creek, Kybong Creek and Cobbs Gully).

Criteria	Impacts	Mitigation and offsets
Adversely affect habitat critical to the survival of a species	The study area has been assessed as containing habitat critical to the survival of the Koala in accordance with the Koala habitat assessment tool contained in the Draft Koala Referral Guidelines (refer Table 6-15). Habitat received a total score of 8, as it is remnant or regrowth open forest containing more than 2 koala food trees. The Project is anticipated to impact on 36.1 ha of critical Koala habitat. This area provides important food and shelter resources for the Koala, however the surrounding landscape, in particular Woondum State Forest, Traveston State Forest and eucalypt forest to the east of the study area, will continue to provide these resources after the project has been implemented.	An experienced and licensed fauna spotter-catcher will actively search suitable habitat (in particular food and shelter trees) immediately prior to clearing to check for presence of Koalas All clearing will be carried out in accordance with the sequential clearing procedures outlined in the *Nature Conservation (Koala) Conservation Plan 2005 and Management Program 2006-2016* to encourage Koalas to relocate on their own accord into adjacent habitat. A fauna spotter-catcher is not to physically move Koalas from a tree in which they are residing to another location. Should a Koala be found, each tree identified by the fauna spotter-catcher as being a risk to a Koala if felled, should not be felled, damaged or interfered with until the Koala has moved from the felling site of its own volition. The fauna spotter-catcher would monitor the animal to ensure that works in the wider area do not cause any stress to the animal. Once the animal has moved out of the area on its own accord then works may commence in the area. Koalas cannot be relocated unless the animal is in direct mortal danger or requires vet assistance.
Disrupt the breeding cycle of an important population	The Koala's breeding season is roughly between August and February, with females giving birth to a single young between October through to May. The impact the Project may have on the Koala's breeding cycle is the increase to fragmentation of the landscape. Male Koalas will actively seek out female Koalas. The increase in fragmentation may lead to Koalas having a higher risk of encountering vehicles, and domestic and wild dogs as they will be forced to come to ground to move across the road corridor.	Establish fauna friendly crossing into the design including crossing structures and exclusion fencing suitable for Koalas, in particular at Traveston State Forest and riparian corridors (Traveston Creek, Kybong Creek and Cobbs Gully). Incorporate Koala refuge poles into the fauna crossing structures. Implement pest management and monitoring for the construction and operational phases of the project.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The Project is anticipated to impact on 36.1 ha of critical Koala habitat. This area provides important food and shelter resources for the Koala, however the surrounding landscape, in particular Woondum State Forest, Traveston State Forest and eucalypt forest on private property to the east of the study area, will continue to provide these resources after the project has been implemented. Should fauna crossing structures suitable for the Koala be incorporated into the design, the species is unlikely to decline in the area.	As above

Criteria	Impacts	Mitigation and offsets
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	The project has the potential to facilitate the movement of pest species such as wild dogs. Wild dogs will predate on both the adults and young, which come to the ground to move from tree to tree. Introduction of weed species may also be facilitate by the project and this can also degrade the habitat of the Koala through the suppression of sapling growth.	All vehicles and machinery should be washed down a weed certified prior to entering the project during the construction phase. All material being brought onto site such as soils, mulch and the like should have a weed hygiene certificate. Implement weed and pest management and monitoring during construction and operational phases.
Introduce disease that may cause the species to decline	The project is not likely to introduce any diseases that may lead to decline in the Koala population. However Koalas within the wider region are known to suffer from Chlamydia and even though the project is unlikely to introduce the disease, there are elements that can attribute to the presence of the disease. The elements include habitat clearing and fragmentation that leads to increased stress and potential inbreeding of populations that are known to increase the potential of a disease outbreak within the population.	As above.
Interfere substantially with the recovery of the species	The project will impact on 36.1 ha of critical Koala habitat in an already fragmented landscape. This area provides important food and shelter resources for the Koala, however the surrounding landscape, in particular Woondum State Forest, Traveston State Forest and eucalypt forest on private property to the east of the study area, will continue to provide these resources after the project has been implemented. Should fauna crossing structures suitable for the Koala be incorporated into the design (recommended at Jackass Creek, Cobbs Gully, Traveston State Forest and Kybong Creek), the Project is unlikely to interfere with the recovery of this species.	As above.
In conclusion, with implementation of appropriate mitigation measures including Koala friendly crossings and exclusion fencing at Jackass Creek, Cobbs Gully, Traveston State Forest and Kybong Creek, construction and operation of the Project is not expected to significantly impact on the Koala, as although there will be a loss of 36.1 ha of habitat critical to the survival of the Koala, with maintained connectivity, Koalas will continue to utilise habitat across the landscape in Woondum State Forest, Traveston State Forest and patches of forest on private property. The Draft Koala Referral Guidelines recommend referring the action where the impact is more than two hectares and the habitat score is five or greater.		

Table 6-15: Koala habitat assessment tool (DotE, 2013, pp. 12).

Attribute	Score	Justification
Koala occurrence	+2 (high)	Evidence of Koalas at sites P1, P2, P3 and P4, and Flooded Gum riparian forest along Jackass Creek (regrowth RE 12.3.2) adjacent to P3.
Vegetation composition	+2 (high)	The project clearance area contains patches of open eucalypt forest with Koala food trees in the canopy: **Primary food trees:** Forest Red Gum (*Eucalyptus tereticornis*) Small-fruited Grey Gum (*Eucalyptus propinqua*) **Secondary food trees:** Lemon-scented Gum (*Corymbia citriodora)* Grey Ironbark (*Eucalyptus siderophloia*) Pink Bloodwood (*Corymbia intermedia*) Narrow-leaved ironbark (*Eucalyptus crebra*) Flooded Gum (*Eucalyptus grandis*) Brush Box (*Lophestemon confertus*)
Habitat connectivity	+2 (high)	The study area has connections with Traveston State Forest and Woondum State Forest, which alone total ≥ 500 ha.
Key existing threats	+1 (medium)	Unknown, but likely to be evidence of infrequent or irregular koala mortality from vehicle strike on the existing Bruce Highway in TMR fauna incident register.
Recovery value	+1 (medium)	Uncertainty exists as to whether the habitat is important for achieving the interim recovery objectives for the Koala.
Total Score	**8**	

In accordance with the Draft EPBC Act referral guidelines for the vulnerable koala (DotE, 2013), the Project should be referred to the DotE as the habitat score of 8 and likely clearing area of 36.1 hectares represent an action defined in this guideline that is likely to 'adversely affect habitat critical to the survival of the koala'.

A referral is being prepared by TMR for submission to DotE in Q2 2014.

Table 6-16: Significant impact assessment for the Grey-headed Flying-fox.

Criteria	Impacts	Mitigation and offsets
Lead to a long-term decrease in the size of an important population of a species	The Grey-headed Flying-fox is considered likely to forage across the study area in eucalypt and riparian forests. Although no flying-fox camps have been observed in the study area, the study area is likely to support an important population necessary for the species' long-term survival and recovery, as it is near the northern extent of the species range (see criteria for an important population in the EPBC Act Significant Impact Guidelines). Construction of the project will result in the loss of 37.1 ha of foraging habitat for Grey-headed Flying-fox. However, the surrounding landscape, in particular eucalypt forest in Woondum State Forest, Traveston State Forest and on private property to the east of the study area will continue to provide suitable foraging habitat. This is therefore not expected to lead to a decrease in the size of a population.	Avoid any unnecessary impacts or further works in foraging habitat for Grey-headed Flying-fox. An experienced and licensed fauna spotter-catcher will actively search suitable habitat immediately prior to clearing to check for any individual roosting flying-foxes (not in camps) and will facilitate the safe rehabilitation of any animals found into adjacent habitat. Offset impacts to the foraging habitat of Grey-headed Flying-fox.
Reduce the area of occupancy of an important population	The Grey-headed Flying-fox is a highly mobile species and will be able to fly over the road corridor to access foraging habitat on either side of the proposed alignment, therefore the Project will not reduce the area of occupancy of a population.	No specific measures proposed.
Fragment an existing important population into two or more populations	The Grey-headed Flying-fox is a highly mobile species and will be able to fly over the road corridor to access foraging habitat on either side of the proposed alignment, to avoid impacts from fragmentation.	No specific measures proposed.
Adversely affect habitat critical to the survival of a species	Foraging habitat that is productive during winter and spring (when food bottlenecks have been identified) is defined as "habitat critical to the survival of the Grey-headed Flying-fox" in the Draft National Recovery Plan for the Grey-headed Flying-fox (DECC, 2009). Note that this is not an approved national recovery plan. Open eucalypt and riparian forest in the study area contains eucalypts which flower during winter and spring (i.e. Flooded Gum *Eucalyptus grandis*, Forest Red Gum *Eucalyptus tereticornis* and Spotted Gum *Corymbia citriodora*). The study area therefore supports foraging habitat that is productive during food shortages. Construction of the project will result in the loss of 37.1 ha of foraging habitat that is productive during winter and spring (defined as critical foraging habitat in the draft recovery plan). However, the surrounding landscape, in particular eucalypt forest in Woondum State Forest, Traveston State Forest and on private property to the east of the study area will continue to provide this critical foraging habitat during food shortages.	An experienced and licensed fauna spotter-catcher will actively search suitable habitat immediately prior to clearing to check for any individual roosting flying-foxes (not in camps) and will facilitate the safe rehabilitation of any animals found into adjacent habitat.
Disrupt the breeding cycle of an important population	The mating of the Grey-headed Flying fox is from early autumn, after which time the larger camps begin to break up, reforming in late spring/early summer. Females usually give birth in October. Lactation continues for three to four months or sometimes longer. For a period of four to five weeks after giving birth, the mother carries her single young with her to feeding sites. Once the young are completely furred, they are left in maternal camps and continue to be nursed until they are independent after around 12 weeks (DotE, 2014). No flying-fox camps have been observed in the study area; therefore disruption to the breeding cycle is not anticipated.	An experienced and licensed fauna spotter-catcher will actively search suitable habitat immediately prior to clearing to check for flying-fox camps. Prepare flying-fox management plan should any camps be found.

Criteria	Impacts	Mitigation and offsets
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	Construction of the project will result in the loss of 37.1 ha of foraging habitat that is productive during winter and spring. However, the surrounding landscape, in particular eucalypt forest in Woondum State Forest, Traveston State Forest and on private property to the east of the study area will continue to provide a foraging resource during food shortages. This is therefore not expected to lead to the species decline.	Avoid any unnecessary impacts or further works in foraging habitat for Grey-headed Flying-fox. An experienced and licensed fauna spotter-catcher will actively search suitable habitat immediately prior to clearing to check for any individual roosting flying-foxes (not in camps) and will facilitate the safe rehabilitation of any animals found into adjacent habitat. Offset impacts to the foraging habitat of Grey-headed Flying-fox.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	Habitat disturbance has the potential to increase the invasion of weeds which can degrade Grey-headed Flying-fox habitat through the suppression of sapling growth of flowering eucalypts. Numerous weed species, including Lantana, are already an issue in the study area.	All vehicles and machinery should be washed down a weed certified prior to entering the project during the construction phase. All material being brought onto site such as soils, mulch and the like should have a weed hygiene certificate. Implement weed management and monitoring during construction.
Introduce disease that may cause the species to decline	The project is not likely to introduce any diseases that may lead to decline in the Grey-headed Flying-fox.	No specific measures proposed.
Interfere substantially with the recovery of the species	Construction of the project will result in the loss of 37.1 ha of foraging habitat that is productive during winter and spring. The surrounding landscape, in particular eucalypt forest in Woondum State Forest, Traveston State Forest and on private property to the east of the study area will continue to provide a foraging resource during food shortages, therefore this is not expected to interfere with the recovery of the species.	As above
In conclusion, the Project is not expected to significantly impact on the Grey-headed Flying-fox. No flying-fox camps have been observed and although construction of the project will result in the loss of 37.1 ha of foraging habitat that is productive during winter and spring, the surrounding landscape, in particular eucalypt forest in Woondum State Forest, Traveston State Forest and on private property to the east of the study area will continue to provide a foraging resource during food shortages		

6.6.2.1 Migratory species

Table 6-17 provides an assessment of the potential impact on EPBC Act listed migratory species known to occur within the project area. The species and impacts are assessed in regards to the Significant Impact Guidelines for species listed as migratory.

Table 6-17: Impact and mitigations for migratory species.

Criteria	Impacts	Mitigation and offsets
Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycle), destroy or isolate an area of important habitat for a migratory species	The study area is not known to support important habitat for any migratory species. Dams and wetlands throughout the study area support numerous species, including the migratory wetland birds Great Egret, Cattle Egret and White-bellied Sea-eagle. Open eucalypt forest habitats also support migratory terrestrial birds, including White-throated Needle tail, Rainbow Bee-eater, Spectacled Monarch and Rufous Fantail. It is unlikely that habitats will be substantially modified, destroyed or isolated given their migratory habits, the ephemeral nature of important food and habitat resources. Further the encroachment of urbanisation throughout the project has already resulted in a highly fragmented landscape.	No impact.
Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species	The Project has the potential to facilitate the movements of feral species such as feral cats and wild dogs which have been known to predate on the adults and young of the migratory species. Feral pigs have been known to be opportunistic and prey on the eggs and nestlings of ground dwelling birds. Feral pigs are also known to cause degradation to a number of habitats utilised by migratory species. These habitats included water holes, creeks and the banks of these particular areas. The Project also has the potential to increase the invasion of non-native vegetation both terrestrial and aquatic. These invasive weed species can lead to area of habitat no longer being suitable particularly watercourse and dams, etc. Some aquatic weeds decrease the water quality and therefore impact on the food resource of species such as the Eastern Great Egret, Cattle Egret and White-bellied Sea-eagle. Terrestrial weeds can smother out native species and although they diminish the native food resource typically most weed species provide a suitable food resource to a number of native species including the Spectacled Monarch and Rufous Fantail. Some terrestrial weeds will take over the native riparian vegetation and make access to water resource and the swallows' difficult for some large species such as the Eastern Great Egret and Cattle Egret. White-throated Needletail is an aerial species and will not be impacted by the Project.	All vehicles and machinery should be washed down a weed certified prior to entering the project during the construction phase. All material being brought onto site such as soils, mulch and the like should have a weed hygiene certificate. Implement weed and pest management and monitoring during both construction and operational phases.

Criteria	Impacts	Mitigation and offsets
Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species?	The study area is not known to support an ecological significant proportion of the population of these migratory species. As such, the Project will not result in a significant impact on a migratory wetland or terrestrial bird.	No impact.

6.7 Offsets Strategy

The following mitigation measures have been or will be implemented to avoid and/or reduce impacts on terrestrial flora and fauna values:

- Route selection through comparative assessment of alignment options to reduce impacts on biodiversity
- Identification of environmentally sensitive areas (significant regional ecosystems, watercourses and habitat for threatened species) as exclusion zones
- Incorporate fauna friendly crossings and exclusion fencing suitable for Koalas into the design
- Pre-clearance surveys for threatened flora species in potential habitat; if found, avoid or translocate
- Vegetation clearing process including sequential clearing and presence of an experienced and licensed fauna spotter-catcher
- Species management plans for least concern, special least concern and threatened wildlife
- Weed and pest animal management plan
- Pathogen management plan.

With the implementation of mitigation measures, the Project will have residual impacts to biodiversity values protected under Commonwealth and State legislation. Offset policies applicable to the Project are the EPBC Act Environmental Offsets Policy (EOP) (if the Project is made a controlled action) and the revised Queensland Biodiversity Offset Policy (QBOP). For the purposes of preparing an offset strategy that aligns with these policies, impacts to be offset have been calculated by overlaying the Project clearance footprint with matters of state environmental significant (MSES) (state significant biodiversity values will be superseded in the anticipated revision to the Queensland environmental offset framework) identified by desktop assessment and field surveys.

Compensation will be required in relation to the revocation of 11.2 ha of Traveston State Forest and 12.0 ha of Woondum State Forest are discussed in **Chapter 3 – Legislative Requirements**.

The process of fulfilling the requirements of these policies is described briefly below. This report identifies and qualifies the values to be offset.

1. Identify and quantify values required to be offset using field data and spatial analysis.
2. Conduct additional field work where necessary to collect vegetation condition data and species population estimates in impact area.
3. Use spatial analysis to locate potential offset site/s, or where potential offset sites have already been identified, use spatial analysis to identify and quantify biodiversity values of offset area/s.
4. Conduct additional field work as necessary to collect vegetation condition data and species population data in proposed offset area/s.

5. Demonstrate ecological equivalence of impacts and proposed offsets using Ecological Equivalence Methodology and the EPBC Act offsets assessment guide.
6. Legally secure proposed offset sites.
7. Prepare offset area management plan (OAMP). The OAMP will include regular monitoring, reporting and adaptive management pathways to enable adjustment of the management approach where necessary. The OAMP will describe each offset area, the values it contains and the specific management actions to be undertaken. The OAMP will cover all aspects of management including signage, fire management, fencing, grazing management, weed and pest control, assisted regeneration and threatened species management. The OAMP will also contain details of timing, responsibilities and performance indicators.
8. Implement OAMP until vegetation has reached remnant status and objectives of the plan have been achieved.

Specific offset requirements under the EPBC Act EOP and the revised QBOP are discussed in **Sections 6.7.1** and **6.7.2** respectively. Note that with respect to threatened species, only species identified as 'known or likely to occur' have been considered for offsets. As part of mitigation measures, pre-clearance surveys will be undertaken for threatened species in the Project clearance footprint during detailed design. In the event any threatened species are identified in the impact areas, these will be included in the offsets strategy. In the case of threatened plants a translocation plan will form part of the OAMP.

6.7.1 EPBC Act Environmental Offsets Policy

If the Project is declared to be a controlled action, offsets will be required for any residual impacts to MNES that cannot be avoided or mitigated. Residual impacts are those that remain after avoidance and mitigation measures have been implemented.

The Project design has sought to avoid impacts to MNES by comparative analysis of route options and by locating ancillary activities outside environmentally sensitive areas (**Sections 6.5.2** and **6.5.3**). Mitigation measures are described throughout **Section 6.5**. These include establishment of environmentally sensitive areas as exclusion zones, pre-clearance surveys, vegetation clearing protocols and fauna spotter-catcher to manage impacts on fauna.

Offsets may be in the form of direct offsets or other compensatory measures, however direct offsets must make up 90% of the total offset package. Direct offsets must result in a net biodiversity gain for the impacted MNES and may include enhancing habitat, creating new habitat, reducing threats or averting loss of an MNES or its habitat. Other compensatory measures include research, educational programs or other relevant actions that are described in an approved recovery plan for the impacted MNES.

MNES expected to be relevant to the Project are listed in **Table 6-18** below.

Table 6-18: Matters of National Environmental Significance potentially impacted by the Project.

MNES	Impact Assessment
World Heritage properties	No impact.
National Heritage places	No impact.
Wetlands of international importance (listed under the Ramsar Convention)	No impact.
Listed threatened species and ecological communities	Black-breasted Button-quail habitat (Vulnerable) Grey-headed Flying-fox (Vulnerable) Koala (Vulnerable)
Migratory species protected under international agreements	White-throated Needletail Eastern Great Egret Cattle Egret White-bellied Sea-Eagle Rainbow Bee-eater Spectacled Monarch Rufous Fantail
Commonwealth marine areas	No impact.
Great Barrier Reef Marine Park	No impact.
The environment, where nuclear actions are involved	No nuclear actions involved.
A water resource, in relation to coal seam gas development and large coal mining development	Not applicable to this Project.
The environment, where actions proposed are on, or will affect Commonwealth land and the environment	No Commonwealth land will be impacted.
The environment, where Commonwealth agencies are proposing to take an action	The proponent is not a Commonwealth agency.

Although migratory species were identified during field surveys, significant impacts to these species are not considered to be likely. Significance of impacts is discussed in more detail in **Section 6.6**.

The area of threatened species habitat impacted by the project is listed in **Table 6-19**.

Table 6-19: Area of MNES species habitat impacted by the Project.

Species	EPBC Act Status	Area of habitat (ha) impacted
Black-breasted Button-quail (*Turnix melanogaster*)	Vulnerable	No direct impact
Grey-headed Flying-fox (*Pteropus poliocephalus*)	Vulnerable	37.1
Koala (*Phascolarctos cinereus*)	Vulnerable	36.1

Further work will be required in the future to collect information to use in the EPBC Act offsets assessment guide. The assessment guide is tool made available by DotE to enable proponents to plan a suitable offset for MNES impacts. The assessment guide is a ‘balance sheet’ that provides a decision framework to standardise the determination of offsets. The guide is used where a project is likely to have a residual significant impact on a threatened species or community.

Information needed to input into the assessment guide includes area and quality of habitat as well as details of the proposed offset area such as risk of loss with and without the offset, time until ecological benefit and future quality with and without the offset.

It is recommended that this work be carried out following the submission of a referral under the EPBC Act and subsequent decision by DotE as the whether the Project is a controlled action.

6.7.2 Queensland Biodiversity Offset Policy

The purpose of the QBOP is to offset impacts on MSES which cannot be avoided or minimised, and are not offset by another Queensland or Commonwealth Government offset policy.

As with the Commonwealth policy, an offset under the QBOP must comprise 90% land-based (direct) offset and no more than 10% offset payment (indirect offset). Direct offsets must be shown to have as high or higher biodiversity value as the impacted values. This is to be demonstrated using the Ecological Equivalence Methodology (Eyre *et al*. 2011). Direct offsets must be managed to enhance the MSES and to allow vegetation to meet remnant status under DNRM's definition. Indirect offsets or offset payments are contributions toward research, habitat mapping or other approved recovery actions. Payments are not accepted for impacts to some values including EVNT species listed under the NC Act.

It is noted that this policy will be replaced under the revised Queensland environmental offset framework in mid-2014.

MSES potentially impacted by the Project are presented in **Table 6-20**. Note that these values overlap and as such the total area to be offset is not to be calculated by adding the individual areas listed.

Table 6-20: Matters of state environmental significance (MSES) impacted by the Project.

MSES	Area (ha)
Vegetation regulated under the VM Act	
Endangered RE (12.5.2a)	0.1
Of Concern REs (12.11.14, 12.3.11, 12.3.2a, 12.11.9)	7.4
Essential habitat - Koala	3.6
Connectivity	26.3
Watercourses	14.8
Protected animals (NC Act)	
Tusked frog (Vulnerable)	9.3
Elf Skink (Near Threatened)	37.1
Grey Goshawk (Near Threatened)	37.1
Koala (Vulnerable)	36.1
Protected plants (NC Act)	
Slender Milkvine	23.5
Giant Ironwood	0.3

Further work will be required in future to identify the condition of vegetation and fauna habitat to be impacted, locate potential offset sites and to demonstrate ecological equivalence between the impacted values and the values provided on the offset sites/s.

It is recommended that potential offset areas be selected by focussing on large landholdings with multiple biodiversity values. This will minimise the complexity of securing an appropriately sized offset area and maximise the potential to co-locate offsets for multiple biodiversity values. At this preliminary stage, it is recommended that a potential offset area of around four times the size of the impact area is identified for further analysis of suitability.

6.8 Summary and Conclusions

The Project will result in the clearing of 27.5 hectares of remnant REs and 15.5 hectares of regrowth vegetation. The clearing will impact ten REs that are classified as Endangered, Of Concern and Least Concern under the VM Act. Of these ten REs, four of these are considered to be ground water dependant ecosystems. The clearing of vegetation impacts on 43.0 ha of habitat for a diversity of fauna species.

Field surveys confirmed the presence of one threatened plant species listed under the NC Act, the Slender Milkvine. Both of these species were located outside the Project clearance footprint; however they were recorded in or adjacent to the study area. The Project will impact on 23.5 ha of potential habitat for the Slender Milkvine and 0.3 ha of potential habitat for the Giant Ironwood. In addition, five threatened fauna species were observed or expected to occur within the study area. These included three EPBC Act listed species, the Black-breasted Button-quail, Grey-headed Flying fox and the Koala, the other three NC Act listed species, Tusked Frog, Grey Goshawk and Elf Skink. The Project will impact on:

- 9.3 ha of wetland habitat for the Tusked Frog
- 37.1 ha of forest habitat for the Elf Skink
- 37.1 ha of forest habitat for the Grey Goshawk
- 37.1 ha of forest habitat for the Grey-headed Flying fox
- 36.1 ha of eucalypt forest habitat for the Koala.

The Project will not clear vine scrub habitat for the Black-breasted Button-quail, however edge effects may degrade habitat in the vicinity of the Project.

Assessment against the EPBC Act Significant Impact Guidelines concluded that the Project is unlikely to have a significant impact on the Black-breasted Button-quail as vine scrub habitat where platelets have been recorded will not be cleared. Appropriate mitigation measures, including incorporation of fauna crossing structures at Jackass Creek, Cobbs Gully, Traveston State Forest and Kybong Creek) will be required to avoid significant impacts on the Koala.

Seven migratory species listed under the EPBC Act were also recorded during the field survey, White-throated Needletail, Eastern Great Egret, Cattle Egret, White-bellied Sea-eagle, Spectacled Monarch, Rainbow Bee-eater and Rufous Fantail. Significant impacts on these species are not anticipated.

The following mitigation measures have been or will be implemented to avoid and/or reduce impacts on terrestrial flora and fauna values:

- Route selection through comparative analysis of the alignment options to reduce impacts on biodiversity
- Identification of environmentally sensitive areas (significant regional ecosystems, watercourses and habitat for threatened species) as exclusion zones
- Incorporate fauna friendly crossings and exclusion fencing suitable for Koalas into the design
- Pre-clearance surveys for threatened flora species in potential habitat; if found, avoid or translocate
- Vegetation clearing process including sequential clearing and presence of an experienced and licensed fauna spotter-catcher
- Species management plans for least concern, special least concern and threatened wildlife.

With the implementation of mitigation measures, the Project will have residual impacts to MSES. The Queensland Biodiversity Offset Policy is being replaced under the new Queensland environmental offset framework and will likely apply to the project. The EPBC Act Environmental Offsets Policy will apply if the Project is declared a controlled action and residual impacts are deemed to be significant. An offset area management plan (OAMP) will be prepared to fulfil the offset requirements of these policies.

During field surveys of the Project a total of eight weed species and three pest animal species declared under the LP Act were observed. Further, two pathogens, Myrtle Rust and Amphibian Chytrid Fungus, have potential to impact on biodiversity as a result of their movement and infection during construction of the Project. Recommendations have been made to implement pest, weed and pathogen management for the construction and operational phases of the project.

7. Aquatic Ecology and Water Quality

7.1 Introduction

This chapter provides an assessment of the impacts of the Project as they relate to the aquatic ecology and water quality.

The Project is located in the Mary River catchment, which has water courses that are known habitat areas for three aquatic species listed as Matters and National Environmental Significance (MNES) under the Commonwealth *Environment Protection and Biodiversity and Conservation Act 1999* (EPBC Act): the endangered Mary River cod (*Maccullochella peelii mariensis*), the endangered Mary River turtle (*Elusor macrurus*) and the vulnerable Australian lungfish (*Neoceratodus forsteri*).

The objectives of this assessment were to:

- Conduct a rapid habitat assessment for a total of 23 waterways and drainage lines along the Project alignment
- Conduct longitudinal habitat assessments at the four main waterway crossings: Traveston Creek, Kybong Creek, Cobbs Gully and Jackass Creek
- Conduct an aquatic fauna survey using electrofishing and fyke netting methods
- Identify the likelihood of occurrence of listed aquatic fauna species in the waterways impacted by the Project
- Identify existing barriers to fish passage in waterways impacted by the Project
- Complete baseline water quality monitoring at waterway crossings identified as likely to have permanent surface water
- Identify potential impacts on the aquatic ecology, riparian habitat and water quality values of the existing environment relating to the construction and operation of the Project
- Identify potential impacts on listed aquatic MNES fauna species known to occur within the Mary River catchment.

7.2 Methodology

Field surveys were conducted between January and May 2012 to assess sites for the presence of permanent surface water, the suitability for water quality monitoring, the presence of existing barriers to in-stream connectivity, and the presence and condition of aquatic habitat.

Water quality monitoring and sampling was conducted at sites identified as likely to have permanent surface water. Surveys for fish and turtles, and longitudinal habitat assessments from upstream to downstream of the proposed crossing were conducted at watercourses with aquatic habitat that was potentially suitable for aquatic fauna including MNES. Surveys extended longitudinally beyond the immediate construction area to provide a more detailed evaluation of the potential MNES habitat condition at or adjacent to the actual location of the proposed road crossings.

Sampling for aquatic fauna species was conducted using backpack electrofishing at Traveston Creek, Kybong Creek, Cobbs Gully and Jackass Creek. Of the four major watercourses, only Traveston Creek was deep and wide enough for fyke nets to be deployed.

Aquatic fauna and longitudinal habitat surveys were not conducted at Six Mile Creek, located at the most northern extent of the project area, as this location is known to provide habitat for all three MNES species (SKM 2007).

The study method was developed to provide baseline information on potential habitat and distribution of MNES species known to occur in the Mary River catchment. Refer to **Table 7-1**.

Table 7-1: Summary of habitat requirements for MNES species.

Species	EPBC Act Status	Habitat Requirements
Mary River turtle (*Elusor macrurus*)	Endangered	**Mesohabitat** Distribution limited to flowing creeks with deep pools (often > 3 metres depth). Cloacal respiration requires flowing, well-oxygenated sections of streams. **Micro habitat** Macrophyte cover, submerged logs, rock crevices. **Movement** Home ranges up to 650 metres per day.
Mary River cod (*Maccullochella peelii mariensis*)	Endangered	**Mesohabitat** Slow-flowing deep pools. Downstream of a constriction of the stream (riffle). **Microhabitat** Large individual logs and log piles **Movement** Home ranges up to 820 metres per day. Migration movements up to 35 kilometres.
Australian lungfish (*Neoceratodus forsteri*)	Vulnerable	**Mesohabitat** Pools of 3-10 metres depth. Riffles. **Microhabitat** Submerged logs, dense banks of aquatic vegetation, underwater caves. **Movement** Migration up to 1 kilometre (rivers with natural flows). Migration up to 48 kilometres (impounded systems).

Source: (Tucker, 1999,Flakus, 2002, Pusey *et al*. 2004, SKM, 2007).

All three species require permanent water bodies and their distribution is associated with deep pools. Furthermore, the Mary River turtle requires perennial flowing habitat so its distribution is further restricted (SKM, 2007).

7.2.1 Rapid Habitat Assessments

Twenty three waterways were visited and surveyed at locations upstream and downstream of the proposed crossing locations (refer to **Appendix K**), eighteen were assessed during February 2012 whilst the remaining five waterways, which had limited access due to rainfall events in February, were assessed in May 2012.

At each site, rapid habitat assessments were undertaken and the following habitat data was recorded.

- Upstream and downstream photographs
- Channel and bank morphology:
  - Bank full and wetted width
  - Bank height
- Flow (flowing, pooled or dry)
- Riparian vegetation:
  - Canopy cover and width
  - Vegetation type and exotic species abundance
- Aquatic habitat condition:
  - Channel habitat types and attributes
  - Mean and maximum depth
  - Substrate type and complexity
- Edge and in-stream cover
- Identification of existing impacts:
  - In-stream barriers
  - Abstraction
  - Land use
- Stream condition
- Riparian condition
- Stream order.

Study reaches were a minimum of 50 metres in length and were selected to represent the characteristics of the waterway at each location, including the variety of natural channel habitats (e.g. riffle, run, or pool) present. Waterways were classified as temporary if depth was shallow (less than 0.5 metres) and if they were judged to be dependent upon rainfall events and would dry during periods without substantial rainfall.

Channel measurements were taken using a five metre telescopic surveyors rule at up to three cross sections within the reach. Wetted width was the width of the water present in the channel at the time of the study; bank full width was measured at the point where channel flows would break over the bank. Bank width and bank heights were also measured.

Water depth was measured using a surveyors rule at several locations to estimate average and maximum depth. In-stream habitat was assessed for each channel habitat type present in the reach and included substrate composition and in-stream cover.

Substrate was expressed as a percentage of different size classes (bedrock, boulder, cobble, gravel, sand and silt). Substrate complexity was categorised as low (>75% single or two contiguous substrates), medium (50 – 75% single or two contiguous substrates) and high <50% single or two contiguous substrates). In-stream cover was estimated from area of channel bed covered by woody debris, leaf litter and benthic algae.

Edge cover was estimated from the length of each wetted channel edge with root mass, undercut banks, trailing, and emergent vegetation. Aquatic habitat condition was assessed using the method of Waterwatch (2002) and included evaluation of channel habitat, bank and riparian characteristics.

Riparian width was measured on each bank. Riparian tree canopy cover, tree heights, percent native versus exotic canopy cover and ground cover were estimated from observation. Riparian condition was assessed for each bank as described by (Werren and Arthingon, 2002).

The suitability for water quality monitoring and fish sampling was assessed for each site. Waterways (excluding artificial water bodies) were considered suitable for water quality monitoring if surface water was likely to be permanent. Fish sampling was considered suitable if surface water was permanent and if the sites were not impacted by major downstream barriers.

Stream order was determined using a 1:15,000 scale map following the hierarchical ordering system based upon the degree of branching (Strahler, 1957). A first order stream has no other stream junctions; a second-order stream is formed by the joining of two first order-streams; the junction of two second-order streams forms a third order stream and so on (DEHP, 2009).

7.2.2 Longitudinal Habitat Assessment

Longitudinal habitat assessments were conducted during August 2012 for the four main waterways impacted by the Project: Traveston Creek, Kybong Creek, Cobbs Gully and Jackass Creek. These waterways were identified as potential habitat for MNES from the Rapid Habitat Assessment. Refer to **Section 7.2.1**. The watercourse at crossing 8 was excluded because the only potential MNES habitat area, located downstream of the crossing, was adequately characterised in the preliminary habitat assessment.

Habitat assessments were conducted continuously along reaches for distances extending approximately 150 metres upstream and downstream of the proposed crossing point. The watercourse was assessed as separate sections at points where conditions distinctly changed, for example at the location of an in-stream impoundment (Traveston Creek), or for multiple channels (two upstream tributaries at Kybong Creek). Aquatic habitat characteristics (depth, wetted width, in-stream cover, edge cover, substrate) and riparian condition were recorded using the methods described in **Section 7.2.1** above.

Aquatic habitat condition was assessed using the Habitat Assessment Field Sheet (DEHP 2009) which includes more in-stream criteria than the method used in the Rapid Habitat Assessment.

7.2.3 Fish Passage Evaluation

Fish passage barriers close to the each site were identified. These barriers typically included road culverts and causeways across channels that form a step change in the grade of the channel bed or an increase in hydraulic head that would be difficult or impossible for aquatic biota to negotiate. In addition, aerial imagery was used to identify substantial impoundments such as farm dams on the channel up to one kilometre upstream and downstream of each site as an indicator of barriers to channel connectivity beyond the immediate crossing location.

With the exception of Six Mile Creek, fish passage at all sites was affected by culverts associated with the existing Bruce highway or smaller roadways. These barriers were included in the risk assessment for all sites but were specified only in the site summaries for sites in close proximity to specific barriers (less than one kilometre).

7.2.4 Aquatic Fauna Surveys

Surveys were undertaken at the four main waterways impacted by the Project: Traveston Creek, Kybong Creek, Cobbs Gully and Jackass Creek. Sampling techniques comprised of backpack electrofishing and fyke netting.

Back pack electrofishing was conducted using a Smith Root model LR24 at all four waterways. Electrical power of the unit was adjusted to the electrical conductivity at each site. Electrofishing effort was recorded from "power on time" in seconds. Sampling was conducted to include the range of available habitats at the site including deep pool areas (greater than one metre in depth), shallow areas and in-stream habitat including woody debris and bank structures near to the location of the proposed crossing. All fish sampled were identified, measured (fork length and standard length) and counted.

Of the four waterways, only Traveston Creek had habitat that was deep and wide enough for fyke nets to be deployed. Two fyke nets (one double wing and one single wing) were set at the upstream site, and three fyke nets (one double-wing and two single wing) were set at the downstream site (refer to **Appendix K**).

Double wing fyke nets were orientated to extend wings across the channel and were facing downstream. Single-wing fyke nets were set with the wing running to the bank and close to large woody debris which provides habitat and refuge for fish and turtle species. A large float was placed in the cod end of each net to provide an air pocket for turtles, diving birds or mammals that may become trapped. Fyke nets were set over night and retrieved the next morning. Species were identified, measured, enumerated and returned.

Turtle species were surveyed using fyke nets concurrently with the fish sampling and by observations conducted during field investigations.

Fish sampling was conducted under Queensland General Fisheries Permit 95581.

7.2.5 Water Quality Assessment

Water quality was monitored and sampled during August 2012 at locations upstream and downstream of the proposed road crossing at watercourses identified from the Rapid Habitat Assessment (refer to **Section 7.2.1**) as likely to have permanent surface water, totalling sixteen sites (refer to **Figure 7-1**). Crossing 14 was only assessed downstream due to access constraints to the upstream area.

Water quality sampling was conducted in accordance with the AS/NZ 5667.11:1998 Water Quality – Sampling Part 1, Part 6 and Part 11. Additional reference was made to the 2009 Queensland Department of Environment and Resource Management Monitoring and Sampling Manual (DEHP 2009). The Water Quality Sampling data sheets (DEHP 2009) were completed for each site to record environmental data to assist in interpretation of results.

In-situ monitoring of surface waters was undertaken using a calibrated YSI 6500 multi-parameter water quality meter. The instrument was lowered approximately 0.3 metres below the water surface for measurement of temperature (°C), pH, electrical conductivity (µS/cm), dissolved oxygen (DO) (mg/L and % saturation), and turbidity (NTU).

Water samples were collected, preserved and transported to Australian Laboratory Services (ALS), a NATA accredited laboratory, within the specific holding times for the following analyses.

- Total Suspended Solids (TSS)
- Metals - total and dissolved (Aluminium (Al), Copper (Cu), Lead (Pb) and Zinc (Zn)
- Total petroleum hydrocarbons (TPH C6-C36).

Water quality values were compared against the most locally relevant water quality objectives (WQO's) and guidelines for protection of aquatic ecosystems in slightly to moderately disturbed environments. For pH, DO, turbidity and TSS the water quality objectives for the Mary River including all tributaries (DEHP 2010) were applied; for EC the Queensland Water Quality Guidelines (QWQG) using the EC 75th percentile from the Sandy coast salinity region (DEHP 2009) were applied; and for dissolved metals the Australian Water Quality Guidelines (AWQG) were applied. The trigger values for heavy metals are not required to be corrected for hardness if waters are soft (< 60 mg/L as $CaCO_3$, (AWQG)). Waters in tributaries to the east of the Mary River catchment, including the Project, are considered to be soft (http://www.mrccc.org.au), and hardness correction of trigger values was not applied. The AWQG trigger values for metals are to be applies to dissolved concentrations rather than total when assessing aquatic ecosystem protection (QWQG).

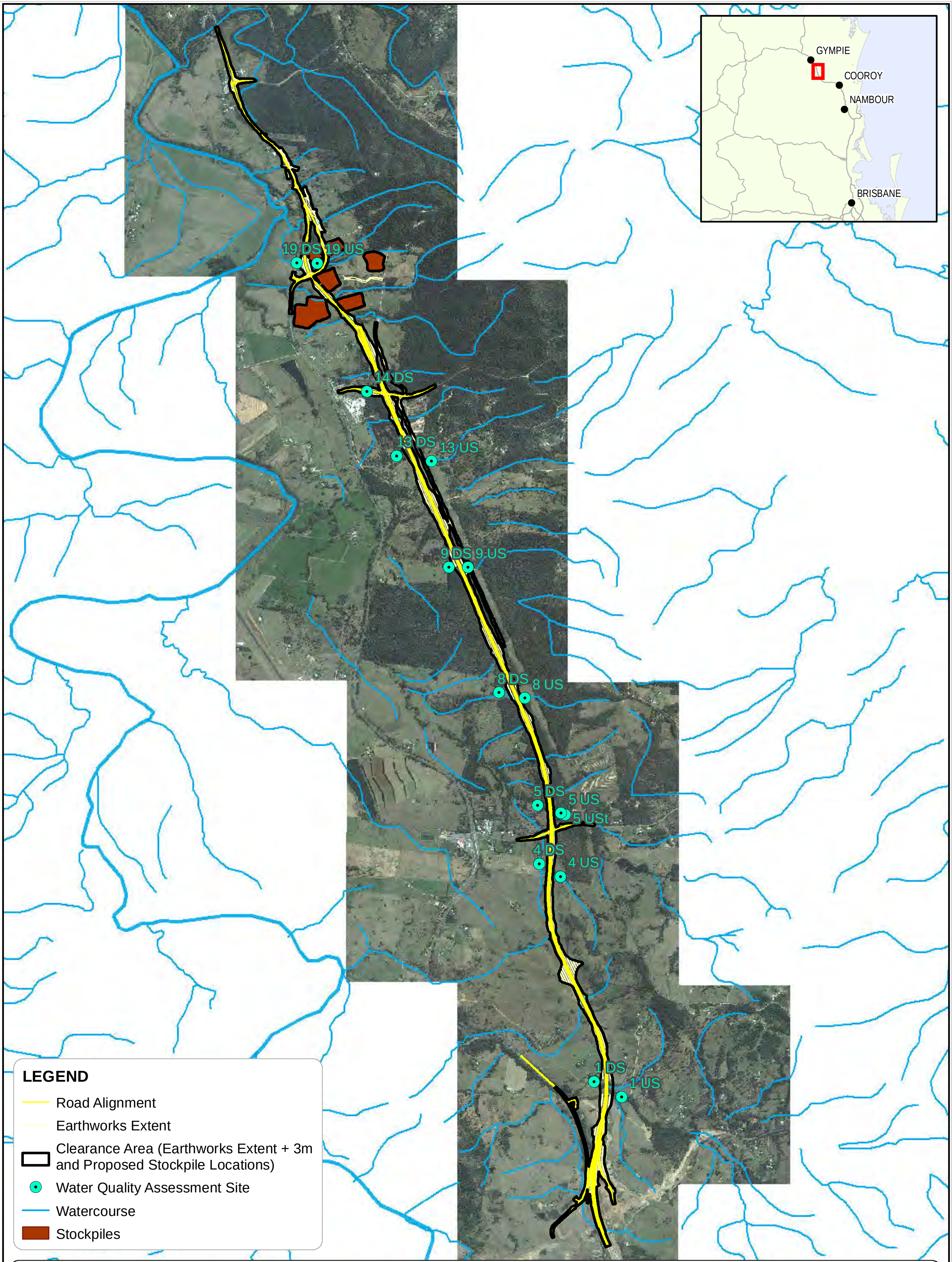

Figure 7-1

Water Quality Assessment Sites

Kilometres
0 0.2 0.4 0.6 0.8 1

MGA - Zone 56 (GDA 94) 1:50,000 @ A4

SKM

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7.2.6 Assessment of Potential MNES Habitat

The physical habitat, connectivity and hydrological attributes of watercourses for all sites were assessed to determine their potential as habitat for the MNES listed aquatic species (Mary River turtle, Mary River cod, or Australian lung fish). Potential habitat was considered on the basis of available aquatic habitat and the connectivity of the sites. The flow and habitat for the waterways at each site were classified with reference to Fairfull and Witheridge (2003), and each waterway class (ranging from major perennial to minor intermittent) was defined in an assessment matrix.

The flow and habitat of waterways were rated according to the following classes:

- **Class 1**: Major permanently flowing waterway (e.g. river or major creek); habitat of a threatened fish species or 'critical habitat'.
- **Class 2**: Permanent or intermittent stream, creek or waterway with clearly defined bed and banks with permanent waters in pools or in connected wetland areas.
- **Class 3**: Waterway with intermittent flow and potential refuge, breeding or feeding areas for some aquatic fauna. Permanent pools form within the waterway or adjacent wetlands after a rain event.
- **Class 4**: Waterway with intermittent flow following rain events only, little or no defined drainage channel, little or no flow or free standing water or pools after rain events (e.g. dry gullies or shallow floodplain depressions with no permanent aquatic flora present).

Connectivity was rated according to the size and number of downstream barriers to fish and turtle passage using the following descriptions, with reference to flow conditions that are affected by the barrier type:

- No barriers
- Single small barrier e.g. road culvert (low flows)
- Multiple smaller barriers (low – medium flows)
- Single large in-stream barrier e.g. earthen dam wall (low to high flows)
- Multiple large in-stream barriers (low to flood flows).

Sites were ordinated within a two dimensional matrix according to their ratings for both variables to determine the potential habitat availability for the MNES species.

7.3 Existing Environment

7.3.1 Climatic and Hydrological Assessment

Rainfall totals during the preceding quarter (400 to 600 mm) and month (200 to 300 mm) of the Rapid Habitat Assessment were high compared to historical data for the same periods from 1965 to 2012. January and February are historically the wettest months of the year with the highest average monthly rainfalls in the Gympie region. The rainfall preceding the study promoted flowing conditions in many of the waterways in the study area particularly in the low order streams with small catchments, in which flow is related with rainfall and often limited to recent rainfall events.

7.3.2 Rapid Habitat Assessment

Habitat assessments for each are provided in **Appendix L**. Of the fifty sites assessed:

- 36 were defined as drainage gullies with intermittent flow, low complexity of channel habitat, and no permanent surface water
- 14 were considered likely to retain water year round and were either runs or pools connected by drainage gullies, or creeks with some variety of channel habitats.

With the exception of Six Mile Creek, all sites were affected by downstream barriers to fish and turtle movement ranging from minor to major.

Rapid Habitat Assessment results for Traveston Creek, Kybong Creek, Cobbs Gully and Jackass Creek are shown in **Table 7-2** to **Table 7-6**.

Table 7-2: Rapid Habitat Assessment – Traveston Creek.

Criteria	Upstream	At Crossing	Downstream	Photos
Start point	26° 19' 43.9" 152° 44' 03.6"	26° 19' 42.3" 152° 44' 01.5"	26° 19' 40. 1" 152° 43' 59.0"	Section 1: Upstream 
End point	26° 19' 42.3" 152° 44' 01.5"	26° 19' 40. 1" 152° 43' 59.0"	26° 19' 36.6" 152° 43' 54.7"	
Channel habitats	Run 90% Pool 10%	Run 90% Pool 10%	Run 90% Pool 10%	
Mean channel width (m)	3.5	4.0	5.5	Section 2: Crossing 
Maximum depth (m)	2.1	1.3	2.2	
Dominant substrate	Silt	Silt	Silt	
Substrate complexity	Low	Low	Low	
Edge cover (%LB/RB)	70/70	80/80	50/60	Section 3: Downstream 
In-stream Cover (%)	25	33	23	
Aquatic habitat condition (%)	44	43	37	
Riparian condition (%)	84	76	72	

Table 7-3: Rapid Habitat Assessment – Kybong Creek upstream sites.

Criteria	Upstream	Upstream tributary	Photos
Start point	26° 18' 14.2" 152° 43' 44.0"	26° 18' 12.7" 152° 43' 45.4"	Section 1: Upstream 
End point	26° 18' 12.7" 152° 43' 45.4"	26° 18' 10.5" 152° 43' 43.5"	
Channel habitats	Run 90% Riffle 10%	Run 80% Pool 15% Riffle 5%	
Mean channel width (m)	1.2	0.8	
Maximum depth (m)	0.5	1.4	Section 2: Upstream tributary 
Dominant substrate	Silt	Silt	
Substrate complexity	Low	Low	
Edge cover (%LB/RB)	85 / 90	50 / 50	
In-stream Cover (%)	10	20	
Aquatic habitat condition (%)	37	40	
Riparian condition (%)	76	76	

Table 7-4: Rapid Habitat Assessment – Kybong Creek crossing and downstream sites.

Criteria	At Crossing	Downstream	Photos
Start point	26° 18' 10.5" 152° 43' 43.5"	26° 18' 10.5" 152° 43' 39.1"	Section 3: Crossing 
End point	26° 18' 10.5" 152° 43' 39.1"	26° 18' 09.7" 152° 43' 36.5"	
Channel habitats	Run 90% Pool 10%	Run 90% Pool 10%	
Mean channel width (m)	0.9	0.9	
Maximum depth (m)	0.7	0.9	
Dominant substrate	Silt	Silt	Section 4: Downstream 
Substrate complexity	Low	Low	
Edge cover (%LB/RB)	50 / 50	50 / 50	
In-stream Cover (%)	15	20	
Aquatic habitat condition (%)	37	37	
Riparian condition (%)	76	76	

Table 7-5: Rapid Habitat Assessment – Cobbs Gully.

Criteria	Upstream	Downstream	Photos
Start point	26° 16' 52.9" 152° 43' 12.9"	26° 16' 52.9" 152° 43' 10.1"	Section 1: Upstream 
End point	26° 16' 52.9" 152° 43' 10.1"	26° 16' 52.1" 152° 43' 07.9"	
Channel habitats	Run 100%	Run 100%	
Mean channel width (m)	1.2	1.5	Section 1: Crossing 
Maximum depth (m)	1.2	0.9	
Dominant substrate	Silt	Silt	
Substrate complexity	Low	Low	
Edge cover (%LB/RB)	40 / 40	25 / 30	Section 2: Downstream 
In-stream Cover (%)	25	25	
Aquatic habitat condition (%)	41	40	
Riparian condition (%)	60	64	

Table 7-6: Rapid Habitat Assessment – Jackass Creek.

Criteria	Upstream	Downstream	Photos
Start point	26° 16' 18.6" 152° 43' 01.9"	26° 16' 16.9" 152° 42' 56.9"	Section 1: Upstream 
End point	26° 16' 16.9" 152° 42' 56.9"	26° 16' 16.9" 152° 42' 50.9"	
Channel habitats	Run 90% Pool 10%	Run 90% Pool 10%	
Mean channel width (m)	1.8	1.2	Section 2: Crossing 
Maximum depth (m)	0.9	0.6	
Dominant substrate	Silt	Silt	
Substrate complexity	Low	Low	
Edge cover (%LB/RB)	80 / 75	70 / 70	Section 2: Downstream 
In-stream Cover (%)	30	25	
Aquatic habitat condition (%)	48	44	
Riparian condition (%)	68	64	

7.3.3 Longitudinal Habitat Assessment

All of the sections assessed in the four watercourses were classified as fair condition but values within the class were variable with total scores varying between 37% and 48% (100% representing as undisturbed waterway). **Table 7-7** shows the raw results of the assessment of the each section of the waterways inspected.

Table 7-7: Average scores for the longitudinal habitat assessment.

Assessment Criteria	Traveston Creek	Kybong Creek	Cobbs Gully	Jackass Creek
Bottom substrate	35%	25%	30%	35%
Embededness	20%	15%	15%	30%
Velocity/depth	30%	29%	28%	33%
Channel alteration	47%	47%	47%	47%
Bottom scouring	47%	47%	47%	47%
Pool/riffle/run/bend ratio	27%	37%	47%	47%
Bank stability	80%	70%	80%	80%
Bank vegetative stability	67%	50%	55%	70%
Streamside cover	63%	60%	50%	70%
TOTAL AVERAGE SCORE	**46%**	**42%**	**44%**	**51%**

As shown in **Table 7-7**, all waterways scored in the 'good' range for bank stability and in the 'fair' to 'good' range for bank vegetative stability and streamside cover. Differing conditions between watercourse sections were predominately due to variation of in-stream habitat complexity and degree of siltation. All creeks had substrates dominated by silt although the depth of silt was variable. Siltation was extensive at Kybong Creek, Cobbs Gully and Traveston Creek, particularly at the downstream site.

Sections of each waterway have been mapped and colour coded according to the total score of the habitat assessment (refer to **Figure 7-2** to **Figure 7-5**).

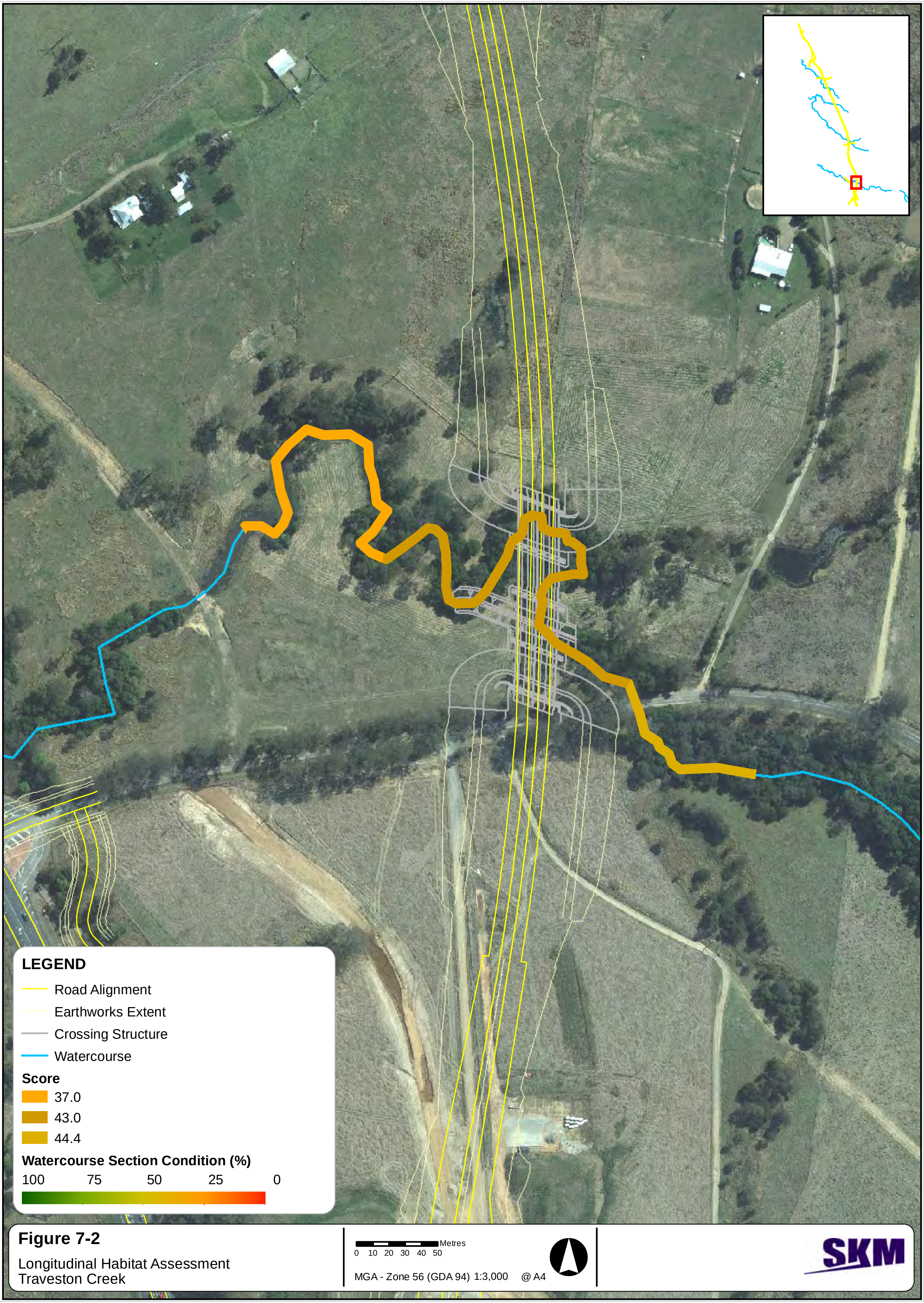

Figure 7-2

Longitudinal Habitat Assessment
Traveston Creek

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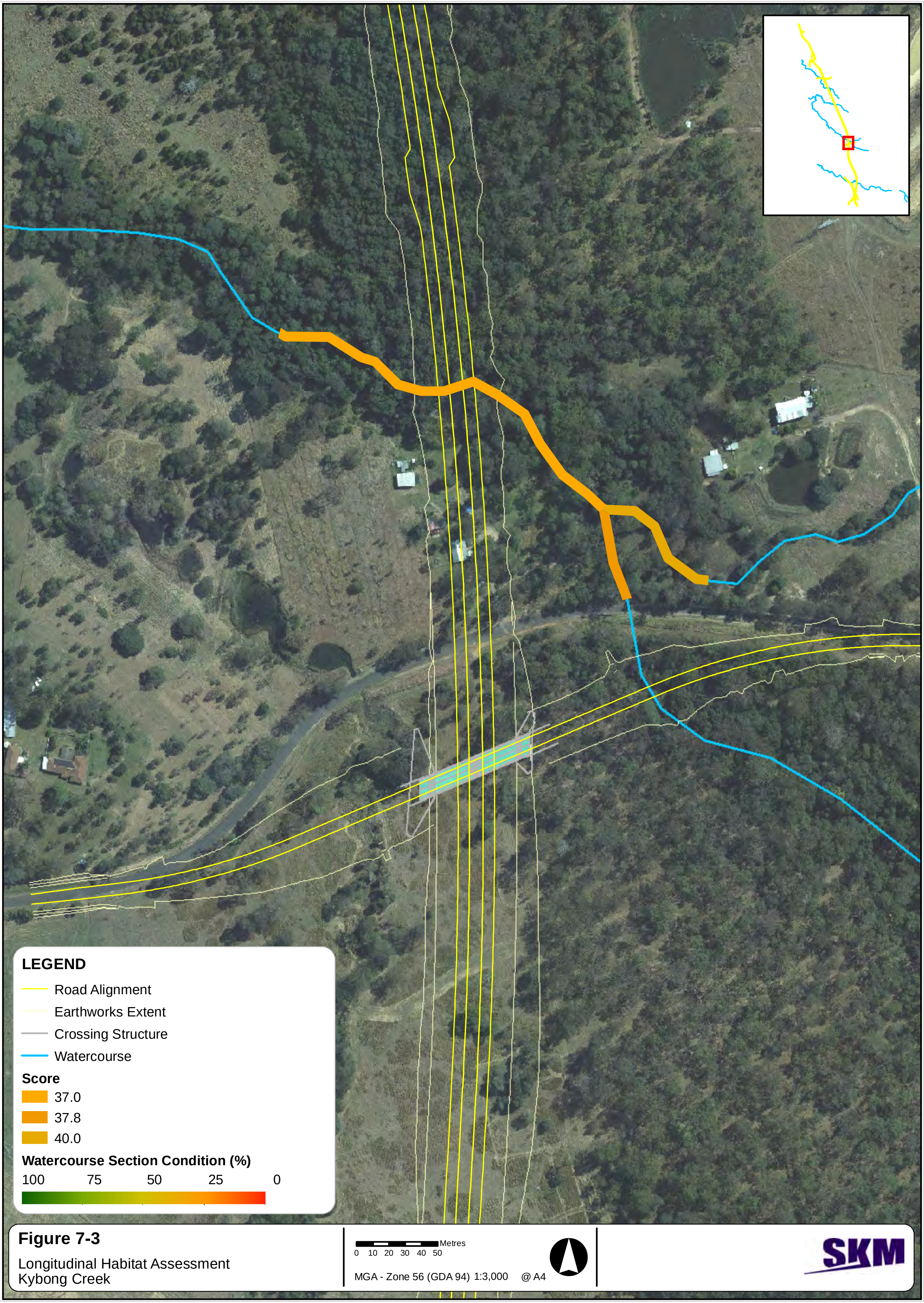

Figure 7-3

Longitudinal Habitat Assessment
Kybong Creek

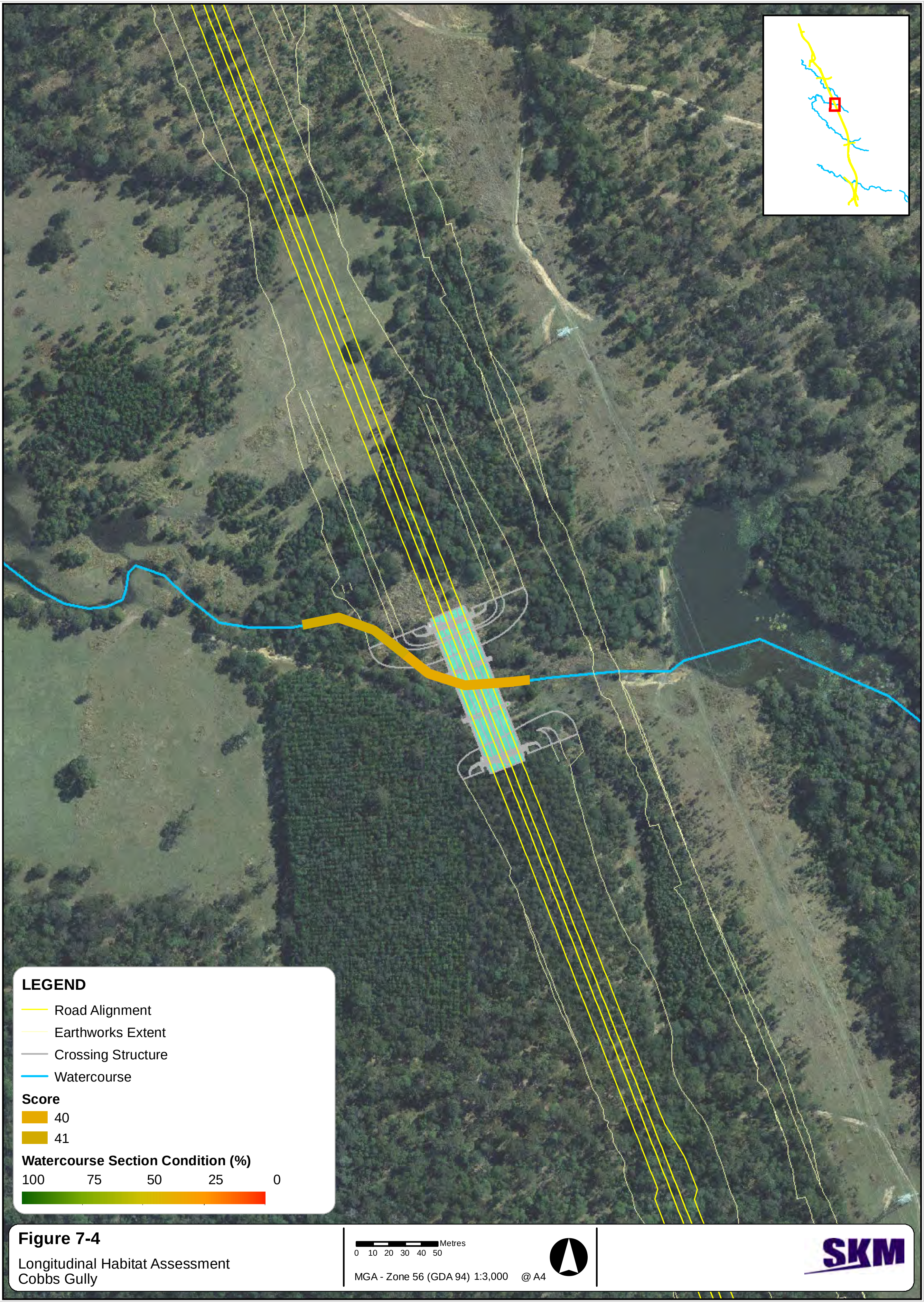

Figure 7-4

Longitudinal Habitat Assessment
Cobbs Gully

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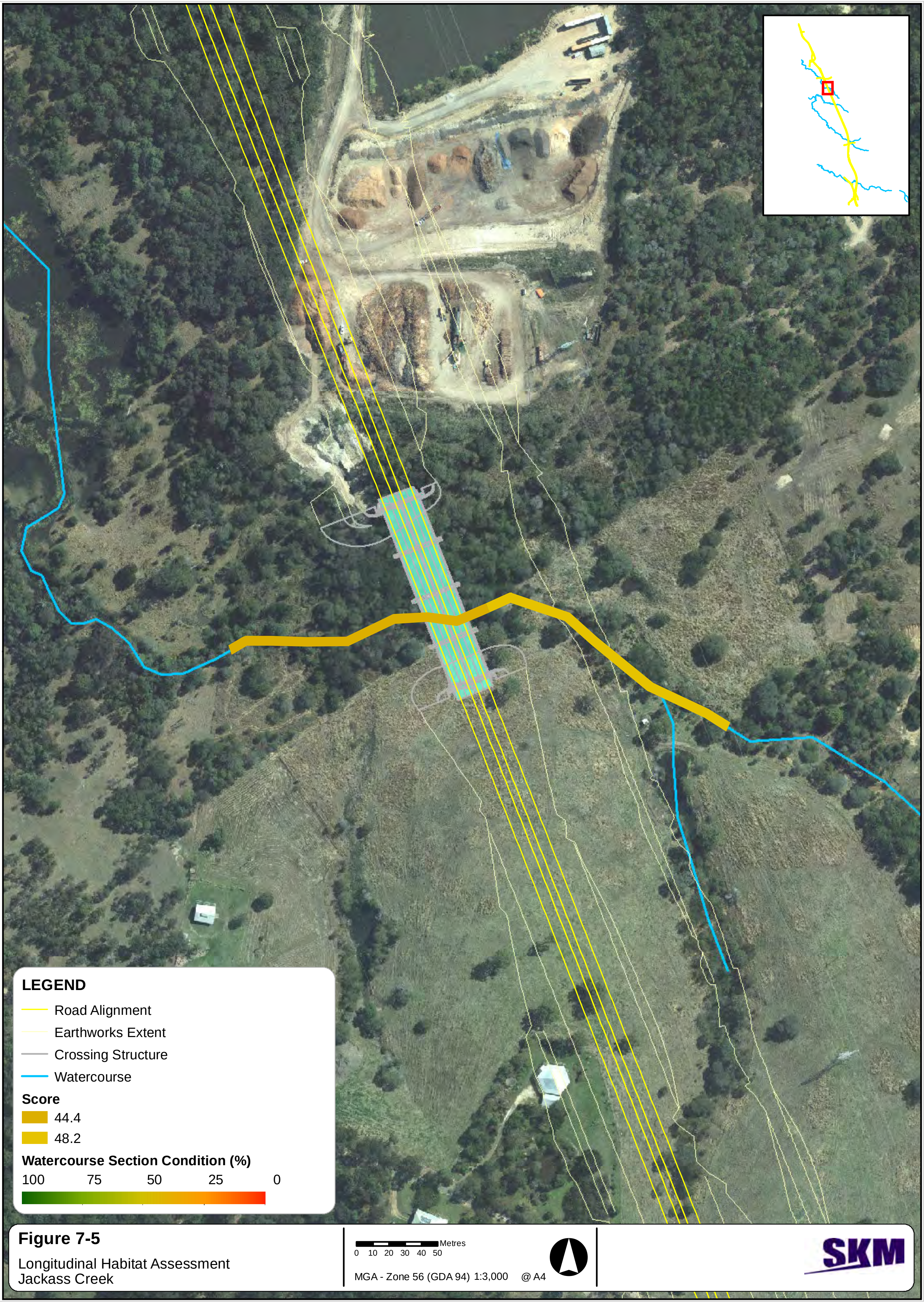

Figure 7-5

Longitudinal Habitat Assessment
Jackass Creek

7.3.4 Fish Passage

The combination of waterway class, degree of waterway connectivity and prominence of existing in-stream barriers was used to assess existing habitat and fish passage values, and the likelihood of MNES species occurrence in the waterways and drainage lines impacted by the Project (refer to **Figure 7-6**).

- Figure 7-6: Waterway values matrix for habitat and fish passage.

	Multiple large in-stream barriers (low to flood flows)	Single large in-stream barrier (low to high flows)	Multiple smaller barriers (low to medium flows)	Single small barrier (low flows)	No barriers
CLASS 1 – Major permanently flowing waterway	No sites	No sites	No sites	No sites	**Six Mile Creek (upstream and downstream sites)**
CLASS 2 – Permanent or intermittent waterway	No sites	No sites	No sites	**Traveston Creek Kybong Creek (downstream site only)**	No sites
CLASS 3 – Waterway with intermittent flow and potential refuge for aquatic fauna.	No sites	**2 sites**	**1 site**	**2 sites**	No sites
CLASS 4 – Waterway with intermittent flow following rain events only	No sites	**20 sites**	**2 sites**	**13 sites**	No sites
Dam sites	**3 sites**	**1 site**	No sites	No sites	No sites

Classification Key		Mary River Turtle habitat	Mary River Cod habitat	Australian Lungfish habitat
Green	High connectivity; permanent flow; permanent water bodies	Suitable	Suitable	Suitable
Amber	Low to high connectivity; intermittent flow; permanent water bodies	Highly Unlikely	Unlikely	Unlikely
Red	Low connectivity; intermittent flow; no permanent water bodies	Highly Unlikely	Highly Unlikely	Highly Unlikely

The majority of sites impacted by the Project were characterised by intermittent flow and existing manmade barriers. Fish passage was restricted at these sites due to the presence of these in-stream barriers. These sites were considered to be highly unlikely to support MNES species due to lack of suitable habitat (all species require deep permanent pools).

Nine sites, including Traveston Creek and Kybong Creek downstream of the proposed crossing, were classified as unlikely to provide suitable habitat for Queensland lungfish and the Mary River Cod. Water quality results presented in **Section 7.3.6** provide further evidence to suggest that these locations are unlikely to support these species.

Six Mile Creek, with perennial flow and no in-stream barriers, had the only sites providing potential habitat for all three MNES species.

7.3.5 Aquatic Fauna

A total of 17 fish from four native species and one exotic species, the mosquito fish (*Gambusia holbrooki*), were captured across all sites from fish sampling (refer to **Table 7-8**). All fish were caught using the backpack electrofishing; the five fyke nets at Traveston Creek caught zero fish from the single overnight deployment. The single large bodied species captured was a juvenile freshwater catfish (*Tandanus tandanus*) at Jackass Creek; all other species were small bodied.

No turtle species were observed or captured in fyke nets during the field assessment.

Table 7-8: Fishing effort and aquatic species captured at all sample sites.

Fish Species	Watercourse Crossing					
	Traveston Creek (Upstream)	Traveston Creek (Downstream)	Kybong Creek	Unnamed tributary of Kybong Creek	Cobbs Gully	Jackass Creek
Rainbow fish (*Melanotaenia duboulayi*)	-	-	-	-	-	2
Carp gudgeon (*Hyspeleotris* spp.)	-	-	-	1	1	-
Purple spotted gudgeon (*Mogurnda adspersa*)	-	-	-	1	1	-
Freshwater catfish (*Tandanus tandanus*)	-	-	-	-	-	1
Mosquito fish (*Gambusia holbrooki*)	-	-	-	-	9	1
Survey details						
Sampling methods	EF / FN	EF / FN	EF	EF	EF	EF
Effort: electrofishing (s) / fyke nets (hrs)	315/13.5	696/14	145	242	395	305

Sampling methods are electrofishing (EF) and fyke nets. Fishing effort was 'power-on time' (seconds) for electrofishing and deployed over one single night (dusk till dawn) for fyke nets.

7.3.6 Water Quality

Water quality assessment was conducted at sixteen sites (refer to **Table 7-9**). Of the sites sampled, two were flowing (Kybong Creek upstream and downstream of the proposed crossing site). Dissolved oxygen saturation was below guideline limits at most sites including the two sites with flow, although technically, guidelines can only be applied at flowing sites (DEHP 2009). Both electrical conductivity and total suspended solids exceed guidelines at seven of the sixteen sites.

Turbidity exceeded the guidelines at three sites. Metals were detected in most watercourses, and concentrations of aluminium and copper exceeded trigger values at eight and six sites respectively.

All sites had at least one water quality indicator outside of guideline values, and the results indicate that in all the water courses the quality of water represents a risk to aquatic ecosystem health and does not maintain the protection level for slightly to moderately disturbed watercourses for the Mary River catchment.

Table 7-9: Water quality at watercourse sites upstream and downstream of proposed road crossing.

	Traveston Creek		Unnamed watercourse		Kybong Creek			Unnamed watercourse		Cobbs Gully		Jackass Creek		Unnamed watercourses		
Water quality variable and WQ guideline (value)	**1 US**	**1 DS**	**4 US**	**4 DS**	**5 US**	**5 USt**	**5 DS**	**8 US**	**8 DS**	**9 US**	**9 DS**	**13 US**	**13 DS**	**14 DS**	**19 US**	**19 DS**
Flow	No	No	No	No	Low	Low	No	No	No	No	No	No	No	No	No	No
Temperature	10.1	14.3	9.6	9.9	10.5	10	9.6	9.7	10.7	13.9	13.4	11.5	12.8	10.8	8.9	14.7
EC (µS cm^{-1}) (626)	**702**	**651**	**1384**	**1313**	475	**2630**	**754**	81	221	214	172	**635**	255	502	270	368
pH (6.5-8)	7.1	7.1	7.6	7.6	7.4	7.3	7.3	6.6	6.5	6.8	6.4	6.7	6.8	6.8	6.9	6.7
DO (mg L^{-1})	5.3	5.7	9.7	8.2	9.2	6.4	7.7	6.8	7.4	10.9	3.7	5.3	5.3	2.4	7.7	4.3
DO (% saturation) (85-110)	***50.3***	***56.3***	84.7	***70.5***	**82.2**	**56.7**	***67.4***	59	67	105.6	***33.1***	***47.6***	***50.3***	***21***	***66.6***	***42.2***
Turbidity (NTU) (< 50)	10.2	13	2.5	0.5	2.6	27.9	5.2	43.7	36.8	**62.5**	**83.4**	15.7	45.2	25.6	18.8	**365**
TSS (mg L^{-1}) (< 6)	3	BDL	1	BDL	-	**7**	3	**6**	**6**	**30**	2	5	**8**	**12**	**8**	**737**
Dissolved metals																
Aluminium (mg L-1) (< 0.06)	**0.06**	**0.06**	BDL	BDL	0.02	**0.20**	0.03	**0.45**	**0.28**	**0.84**	**1.51**	0.05	0.05	0.03	0.05	**0.31**
Copper (mg L-1) h (< 0.0014)	**0.002**	0.001	BDL	BDL	BDL	0.001	0.001	**0.002**	**0.002**	**0.002**	**0.002**	BDL	BDL	BDL	BDL	**0.002**
Lead (mg L-1) h (< 0.0034)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Zinc (mg L-1) h (< 0.011)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.006	BDL	BDL	BDL	BDL	BDL
Total metals																
Aluminium (mg L^{-1})	0.22	0.31	BDL	0.02	0.10	0.59	0.10	1.84	0.24	1.30	2.82	0.13	1.57	0.05	0.13	8.69
Copper (mg L^{-1})	BDL	0.002	BDL	BDL	0.002	0.002	BDL	0.002	0.001	0.002	0.003	0.001	0.003	BDL	0.001	0.021
Lead (mg L^{-1})	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.002	BDL	0.001	BDL	BDL	0.011
Zinc (mg L^{-1})	BDL	BDL	BDL	BDL	BDL	0.012	BDL	0.006	BDL	BDL	0.007	BDL	BDL	BDL	BDL	0.045
Total hydrocarbons																
C6 - C9 (µg L^{-1})	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
C10 - C36 (µg L^{-1})	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL

BDL = below detection limit. **Red/bold** = water quality objectives or guidelines exceeded. ***Italics/bold*** = DO saturation below water quality objectives at non-flowing sites.

7.3.7 Assessment of Potential MNES Habitat

7.3.7.1 Traveston Creek

Traveston Creek had the largest area and greatest range of depth of habitat potentially suitable for fish and turtles and sampling effort was greatest at this watercourse. However, no captures were made using fyke net and backpack methods and no fish or turtles were observed, at either upstream or downstream sites. Aquatic fauna captured was limited to a small number of freshwater shrimp.

High levels of siltation, extensive macrophyte beds, low dissolved oxygen concentrations, ponding, reduced connectivity from the road culverts, and presence of dissolved toxic heavy metals have resulted in a highly disturbed aquatic environment. The proposed alignment crossing at Traveston creek involves a diversion of up to 240 metres of the low flow channel. Whilst the physical habitat for this section of the creek was rated as fair condition (43%), it is very unlikely that MNES would be present considering the degraded condition of habitat and water quality, and the loss of natural flows and in-stream connectivity.

The Mary River cod, Mary River turtle and the Australian lungfish are all species associated with distinct movement patterns requiring in-stream connectivity. The creek section at the alignment crossing has a continuous reach length of approximately 500 metres between the upstream culvert and first of two downstream culverts all of which act as barriers to fish and turtle movement during periods of lower flows. The three species are also intolerant of conditions of poor water quality, particularly low dissolved oxygen concentrations, and evidence indicates degraded water quality is implicated with their population declines (Tucker 1999, Flakus 2002, Pusey *et al*. 2004, SKM, 2007).

7.3.7.2 Kybong Creek

Kybong Creek had very limited available habitat for fish and turtle species and was comprised of shallow disconnected channel pools with substantial siltation and several in-stream impoundments upstream and downstream. No fish were observed or captured, although a number of freshwater shrimp were observed. Electrical conductivity at this creek was high and variable exceeding 2500 µS/cm in one upstream tributary, suggesting local impacts on water quality which would strongly limit suitability of conditions for many of the native obligate freshwater fish species (Pusey *et al*. 2004).

Potential habitat for MNES was not identified at Kybong Creek due to the predominantly shallow water depth, multiple in-stream barriers and degraded water quality. At the proposed alignment crossing the habitat condition was lower than at the upstream condition and rated at 37%.

7.3.7.3 Cobbs Gully

Cobbs Gully had a series of disconnected sections (approximately 40 metres in length) of shallow (less than 0.7 metres) channelled pool habitat, and small native and exotic fish species were present. The disconnected channel, several downstream barriers and shallow depth were likely to restrict the suitability of fish habitat to smaller species tolerant of degraded habitat. The site does not provide suitable habitat for MNES. At the proposed alignment crossing the habitat condition (41%) was slightly higher than at the downstream section (40%). The proposed alignment crossing does not require diversion to the creek.

7.3.7.4 Jackass Creek

Jackass Creek had long sections (approximately 40 metres in length) of shallow (less than 1 metre) channelled pool habitat, but provided the most suitable habitat conditions for fish. The creek was comprised of a series of disconnected pools, although a downstream barrier was present.

Fish abundance was low and was likely to be due to in-stream barriers and limited range of depths, although the freshwater catfish *Tandanus tandanus* was present indicating the habitat was suitable for larger native fish species.

Potential habitat for MNES was not identified due to downstream impoundments and a lack of deep water habitat. At the proposed alignment crossing the habitat condition was lower than at the upstream section and rated at 44%. The proposed alignment crossing does not require diversion to the creek.

7.3.8 Summary of Existing Environment

The most evident impact affecting aquatic habitat condition and suitability for aquatic fauna was in-stream barriers. In-stream barriers were present both upstream and downstream in all watercourses surveyed. The impact of barriers on the habitat in smaller watercourses that naturally function as drainage gullies is limited since they do not have permanent surface water and do not provide distinct aquatic habitat. In some cases impoundments were observed to sustain flows in drainage gullies during dry periods due to seepage from earthen dam walls, for example at crossings 14, 18 and 19.

At the sites with permanent surface water, and particularly in the larger watercourses, the hydrological alteration from in-stream barriers, including road culverts and earthen dams, had resulted in reduced low flows, ponding in channels upstream of barriers and increased siltation. These impacts have altered the aquatic habitat from riverine to ponded environments and consequently provide habitat favourable to species with greater preference and tolerance for lotic habitats, and reduce the habitat available for riverine species (SKM, 2007). In-stream barriers also influence habitat suitability by affecting water quality, in particular dissolved oxygen (DO) concentrations. In-stream barriers were likely to have contributed to the low DO concentrations evident at several watercourses (Traveston Creek, Kybong Creek, Cobbs Gully and Jackass Creek). Dissolved oxygen concentrations tend to decrease in non-flowing environments since turbulence and aeration due to mixing is lower.

The reduction of flows in ponded environments promotes the development of extensive macrophyte beds which have been implicated in fish kills in the Mary River catchment due to low DO concentrations as a result of night time respiration and decomposition (SKM, 2007). In addition, the accumulation of sediment layers that promote anoxic conditions and reduce DO concentrations in the water column occur as water velocities slow and particles drop out of suspension, resulting in increased siltation particularly in channels directly upstream of barriers.

In-stream barriers have very distinct impacts on the distribution, movement and migration patterns of aquatic fauna species, and are particularly evident for large bodied species and species with life histories dependent upon migration and riverine connectivity. The impacts of in-stream barriers result in reduced abundance, diversity and size structure of fish communities and these ecological responses have been observed in the Mary River catchment (Kennard, 2003).

The likely impact on the aquatic environments as a result of land use practices or pollution was evident from the water quality indicators. The occurrence of high concentrations of heavy metals, including aluminium and copper, may be associated agricultural activities (FAO, 1996). Electrical conductivity, which often exceeded guidelines and was very variable over small spatial scales (Kybong Creek), suggested that saline inputs were occurring from localised sources.

The combined effect of these impacts is likely to have greatly limited the abundance and diversity of aquatic fauna at all the watercourses surveyed for fish and turtles. There are 35 species of native fish recorded in the Mary River catchment and an additional 11 species that are exotic or translocated (Kennard, 2003), and five freshwater turtle species (SKM, 2007). Although fish assemblages in the smaller eastern tributaries have lower diversity and a lower proportion of large bodied species than in the main channel and larger tributaries (SKM, 2007), the abundance and diversity of fish recorded in this survey was extremely low in all watercourses, and was consistent with degraded habitats impacted by a range of disturbances. The absence of turtle species at all sites was most likely due to limited habitat availability, lack of connectivity and degraded water quality.

7.4 Potential Impacts and Mitigation Measures

7.4.1 Construction Phase Impacts

Despite the results of the assessment, due care should be taken to avoid further environmental impacts on the existing habitats. The main potential for impacts to occur on aquatic ecology and water quality will be during the construction phase as it involves land disturbance and the removal of vegetation and exposure of soils with dispersive properties.

Although the ancillary activities should be located away from any watercourses and above the Q5 flood level, it may still be possible for sediment to reach the creeks through drainage gullies or low order streams in times of heavy and prolonged rainfall events. In addition, access tracks will be required during the construction phase to transport materials along the alignment and to minimise light and heavy vehicle interactions (for example, Jackass Creek).

It will be important to maintain a high degree of weed hygiene within the construction zone to avoid the spread of weed seeds within the area that may impact on the waterways.

The removal of vegetation along the alignment during the construction phase will have the effect of temporarily de-stabilising the soils due to the removal of tree and grass roots and through direct exposure of the soil to raindrop impact and overland flow. If not managed correctly, this has the potential to result in erosion and subsequent sedimentation of the drainage lines and creeks with detrimental effects on aquatic ecology and water quality. It is therefore imperative that the planning process includes due consideration of erosion and sediment control during the construction phase. It is equally important that the disturbed areas are progressively stabilised and rehabilitated in a timely and effective manner to safeguard water quality and aquatic ecology.

The construction of the waterway structures could also result in direct impacts to aquatic ecology and water quality, as it may be necessary for machinery to work within the bed and banks of the waterways. Standalone environmental management plans should be developed for these high risk areas, as it may be necessary to undertake fish salvage procedures and implement specific in-stream sediment controls (e.g. silt curtains) to avoid downstream impacts.

Successful erosion and sediment control largely depends on developing an understanding of the soil types and characteristics along the alignment. **Chapter 8 – Geology and Soils** contains an erosion risk assessment.

Detailed erosion and sediment control mitigation measures will be included in the Construction Environmental Management Plan (EMP(C)) that will be prepared for the Project. As a further precaution, specific Erosion and Sediment Control Plans (ESCPs) will be prepared by the Contractor and TMR respectively for higher risk areas such as the creek crossings to ensure that impacts to aquatic ecology and water quality are managed appropriately.

7.4.2 Operational Phase Impacts

The operational phase of the project has the potential to cause impacts on fish passage and available habitat through the permanent installation of structures such as bridge pylons, culverts and scour aprons within the bed and banks of a waterway. In addition, the road itself is a large impervious surface that will generate runoff waters that carry pollutants such as oil and grease, litter, weed seeds, sediment and heavy metals.

Runoff waters also have the potential to generate an erosive force in both the table drains and the waterways, resulting in erosion and sedimentation and changed flow hydraulics. Mitigation measures to protect aquatic ecology and water quality may include wide grassed trapezoidal swales, rock dissipaters, gross pollutant traps and sediment basins.

The Project will involve the diversion of Traveston Creek and Kybong Creek to facilitate the installation of waterway crossing structures at these locations. Waterway diversions may result in changes to the hydraulic gradient and flow characteristics of these waterways. An increase in flow velocity may lead to greater potential for erosion and a reduction in fish passage.

7.4.3 Potential Impacts on Aquatic MNES Species

As noted in **Sections 7.3.7.1** to **7.3.7.4**, the main waterways directly impacted by the Project were unlikely to provide habitat for aquatic MNES species. However, the Mary River is known to support these species and all reasonable and practicable measures should be taken to reduce impacts on water quality and aquatic habitat.

Field observations suggest that Six Mile Creek provides suitable habitat for the Mary River cod, Mary River turtle and Australian lungfish. However, the Project is unlikely to have a significant impact on this waterway as the majority of activities are located outside of this sub-catchment.

Direct impacts on aquatic MNES species, including the Mary River cod, Mary River turtle and Australian lungfish are unlikely as a result of the Project. Indirect impacts on these species may occur as a result of water quality degradation, primarily as a result of inadequate erosion and sediment controls. Therefore, effective planning and implementation for erosion and sediment control will be a significant factor in minimising impacts on these MNES species.

7.4.4 Mitigation Measures

A summary of the impacts and mitigation measures associated with the aquatic ecology and water quality aspects of the project is provided in **Table 7-10**.

Table 7-10: Potential impacts and proposed mitigation measures.

Potential Impact	Description	Proposed Mitigation Measures
Water quality degradation resulting from sediment laden runoff during construction	As described in Chapter 8 – Geology and Soils, soil erosion represents a moderate to very high environmental risk for the Project from the initial clearing to final stabilisation stages. Soil erosion may result in increased sediment loads and turbidity in waterways, with subsequent impacts on the aquatic ecology and water quality. Local waterways and the Mary River system may provide habitat for aquatic fauna species. Erosion risk is likely to be greatest during the summer months when rainfall and erosivity is likely to be highest.	• An ESCP will be required, with specific controls for managing high risk areas including waterway crossings. Progressive ESCPs will be developed to manage construction phases and minimise impacts on waterways. • Water quality monitoring should be conducted upstream and downstream of impact area as follows: - Daily visual monitoring for contaminants such as sediment, litter, oil and grease, impacts to flora and fauna. • Weekly water quality monitoring throughout construction at the following locations: - Traveston Creek - Kybong Creek - Cobbs Gully - Jackass Creek - Six Mile Creek - Mary River • Loggers should be installed to record real time water quality parameters during the construction of creek diversions and in stream works.

Potential Impact	Description	Proposed Mitigation Measures
Clearing of riparian and aquatic vegetation, and removal of large woody debris	Clearing of riparian and aquatic vegetation will be required for the construction of waterway crossing structures. This vegetation is likely to contribute to the stability of the waterway banks and may provide habitat for aquatic fauna species. Large woody debris will be removed from waterway channels where it is an impediment to construction activities.	Clearing width should be in accordance with the MRTS04 – General Earthworks, including: • Clearing restricted to the plan limits of the bridge plus two metres where possible. • Stumps and roots will be left in situ to maintain the stability of the impacted areas. • Fauna spotter/catchers will be engaged during all clearing activities. Aquatic fauna species will be relocated if required. • Large woody debris will be relocated to appropriate locations outside of the impact area within the waterway channel to maintain habitat value and minimise risk of damage to the infrastructure.
In stream works resulting in scouring of waterway bed and banks and loss of aquatic habitat	In stream works are likely to be required for all major waterway crossings. Minor crossings, including access road crossings such as Jackass Creek, may also involve in stream works. Impacts are likely to be greatest where diversion works are required, including Traveston Creek and Kybong Creek. These activities represent a high risk of erosion and associated water quality impacts, particularly during high flow events.	• Programming of construction works to complete in stream activities during periods of low or no flow. • Design appropriate controls, including temporary diversions, coffer dams or isolation barriers to minimise potential erosion impacts of in stream works. • Minimise disturbance of the bed and banks of waterways and drainage lines to the crossing width required to complete the works.
Changes to waterway bed gradients resulting in increased flow velocities	An increase in flow velocity resulting from the realignment of Traveston Creek and Kybong Creek represents a high environmental risk to the Project. This may lead to increased erosion of the bed and banks of the creek, reduced water quality downstream of the crossing, and create and barrier to fish passage.	• Design of waterway diversions at Traveston Creek and Kybong Creek should be refined during Preliminary Design to maintain natural hydraulic gradient and minimise changes to flow velocities. • Management measures may be required to reduce the velocity of flows to as close to natural levels as possible, while maintaining adequate conditions for fish passage.

Potential Impact	Description	Proposed Mitigation Measures
Installation of waterway crossing structures resulting in physical barriers to fish movement	Crossing structures may impede fish passage by introducing a physical barrier within the waterway. Structures which include a concrete base, such as RCBCs proposed for Kybong Creek, and the concrete arch proposed for Cobbs Gully, may impede fish passage if not constructed at bed level. Bridge piers may also impact on fish passage if located within the low flow channel by altering flows.	• Where possible, bridge piers will be located outside of the low flow channels of waterways. • Crossing structures will be designed and constructed in accordance with Fish Habitat Management Operational Policy (FHMOP 008) – Waterway Barrier Works Development Approvals (DAFF, 2013). • Waterway Barrier Works approvals are likely to be required for the Traveston Creek, Kybong Creek, Cobbs Gully and Jackass Creek crossings. The Contractor will ensure compliance with the conditions of these approvals. • Access tracks requiring bed level crossings will be constructed in accordance with the Code for self-assessable development – Minor waterway barrier works Part 4: bed level crossings. • Temporary waterway barrier works required temporary waterway barrier works required during construction will be managed in accordance with the Code for self-assessable development – Waterway barrier works.
Impact on aquatic fauna species during construction within waterways	Impacts to aquatic fauna may occur during construction activities, particularly in locations with water flow including pools or riffles. Where diversions are required, aquatic habitat will be lost.	• Fauna spotter/catchers will be engaged during all clearing activities. Aquatic fauna species will be relocated if required. • Relocation of fish species will be conducted in accordance with Fish Salvage Guidelines (DPI, 2004).
Environmental incidents during construction resulting in water quality degradation	Plant and equipment required during construction may experience mechanical issues such as the failure of hydraulic hoses and pumps resulting in spills of hydrocarbons to the ground and surface waters.	• Pumps and generators will be bunded with suitable material and located at least 30 metres from the banks of waterways. • The construction contractor will minimise the time that plant and equipment are working within waterways. • Spill kits, including hydrocarbon booms, will be provided at waterway locations during construction of the crossing structures and creek diversions.

Potential Impact	Description	Proposed Mitigation Measures
Introduction of pest flora and fauna species	Clearing of vegetation can activate weed seed banks within disturbed soil. Weed seeds may also be introduced by personnel and machinery.	• Weed wash down facilities will be provided on site or at a nearby location. • All plant arriving at site will require a Weed Hygiene Declaration form and inspection prior to use on site. • Pre-clearing weed treatment will be conducted where existing weed outbreaks are observed during construction. • Disturbed areas will be stabilised as soon as practicable following the completion of works within waterways.
Potential for reduced long term bed and bank stability	Creek diversions and the construction of structures may impact on long term bed and bank stability resulting in scouring of waterways, water quality degradation, sedimentation of creeks and changes to aquatic habitat. Changes to hydrology of creeks, including afflux levels, may cause inundation and destabilisation of banks upstream of the proposed crossing structures.	• Scour protection measures in accordance with MRTS03 – Drainage Retaining Structures and Protective Treatments, such as rock armouring, may be required to protect the bed and banks and crossing structures. • Waterway bank condition should be inspected during construction and after significant rain events to monitor bank stability.
Operational phase water quality degradation	Runoff from the road surface may transport pollutants, including heavy metals, litter, sediment, oil and grease into waterways.	• Conduct modelling of likely operational water quality of road runoff and determine the requirement for treatment train controls in accordance with the TMR Road Drainage Design Manual. • Bridge scuppers should be avoided in favour of directing flow to treatment train controls. • Runoff barriers should be installed at culvert crossings to direct flow towards the side of the alignment.

8. Geology and Soils

8.1 Introduction

This section provides an assessment of the impacts of the Project as they relate to the geology and soils expected to occur on site.

The objectives of this assessment were to:

- Describe the topography, geology and soils located within the Project area.
- Undertake an erosion risk assessment and identify areas of potential highest risk.
- Undertake contaminated land searches of parcels of land impacted by the Project.
- Describe the potential impacts of the Project and propose mitigation measures relating to geology and soils.

This assessment has been carried out using information obtained during the geotechnical investigations of the Strategic Planning Alignment. As a result of the proposed amendment to the alignment adjacent to the existing high voltage transmission line easement, the information from these investigations is considered to be indicative only and will require review following the completion of geotechnical investigations for the amended alignment adjacent to the existing high voltage transmission line easement.

8.2 Existing Environment

8.2.1 Topography

The topography of the Project area and surrounds is hilly and undulating, with natural surface levels varying between 55 metres and 110 metres above AHD. The Mary River flows in a northerly direction and is located to the west of the main alignment. The Project is located entirely within the Mary River catchment and intersects four prominent creeks (Traveston, Kybong, Cobbs Gully and Jackass), all of which are tributaries of the Mary River. The majority of drainage features impacted by the Project are small, ephemeral drainage gullies with poorly defined channels flowing between more elevated terrain units.

The Como Scarp is located to the east of the Project and separates the Mary River catchment from the coastal drainage system (refer to **Figure 8-1**).

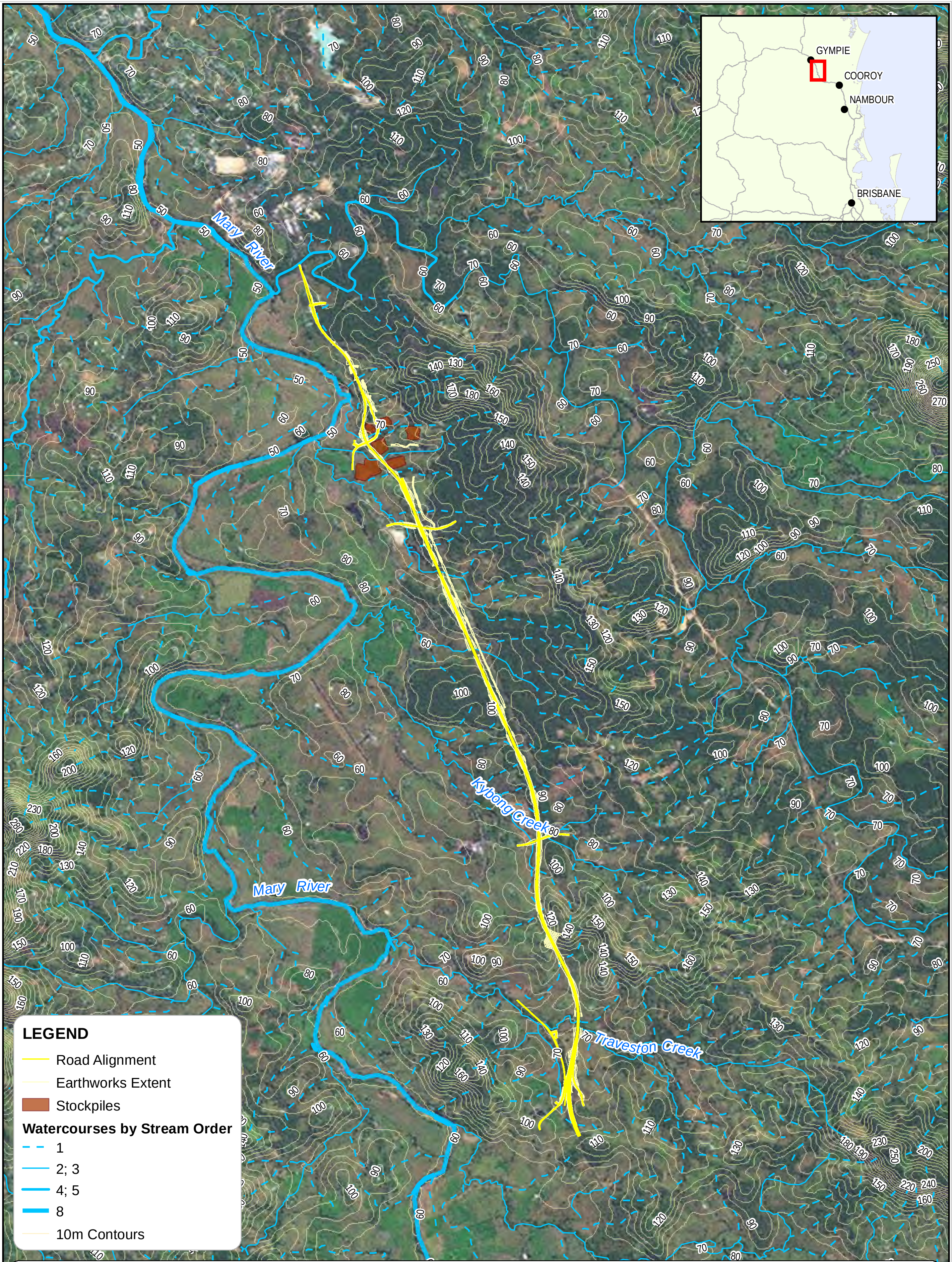

Figure 8-1

Topography and drainage features

0 0.4 0.8 1.2 1.6 2 Kilometres

MGA - Zone 56 (GDA 94) 1:70,000 @ A4

SKM

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8.2.2 Site Geology

The route traverses generally weak sedimentary rocks (belonging to the Gympie Group). The majority of the alignment is underlain principally by the Tamaree Formation (with minor Rammutt Formation). Intersections were also predicted of the older Amamoor Beds and younger Keefton Beds. These often have a deep weathering profile and can be susceptible to erosion when exposed in cuttings. The general geology of the area is shown in **Figure 8-2**.

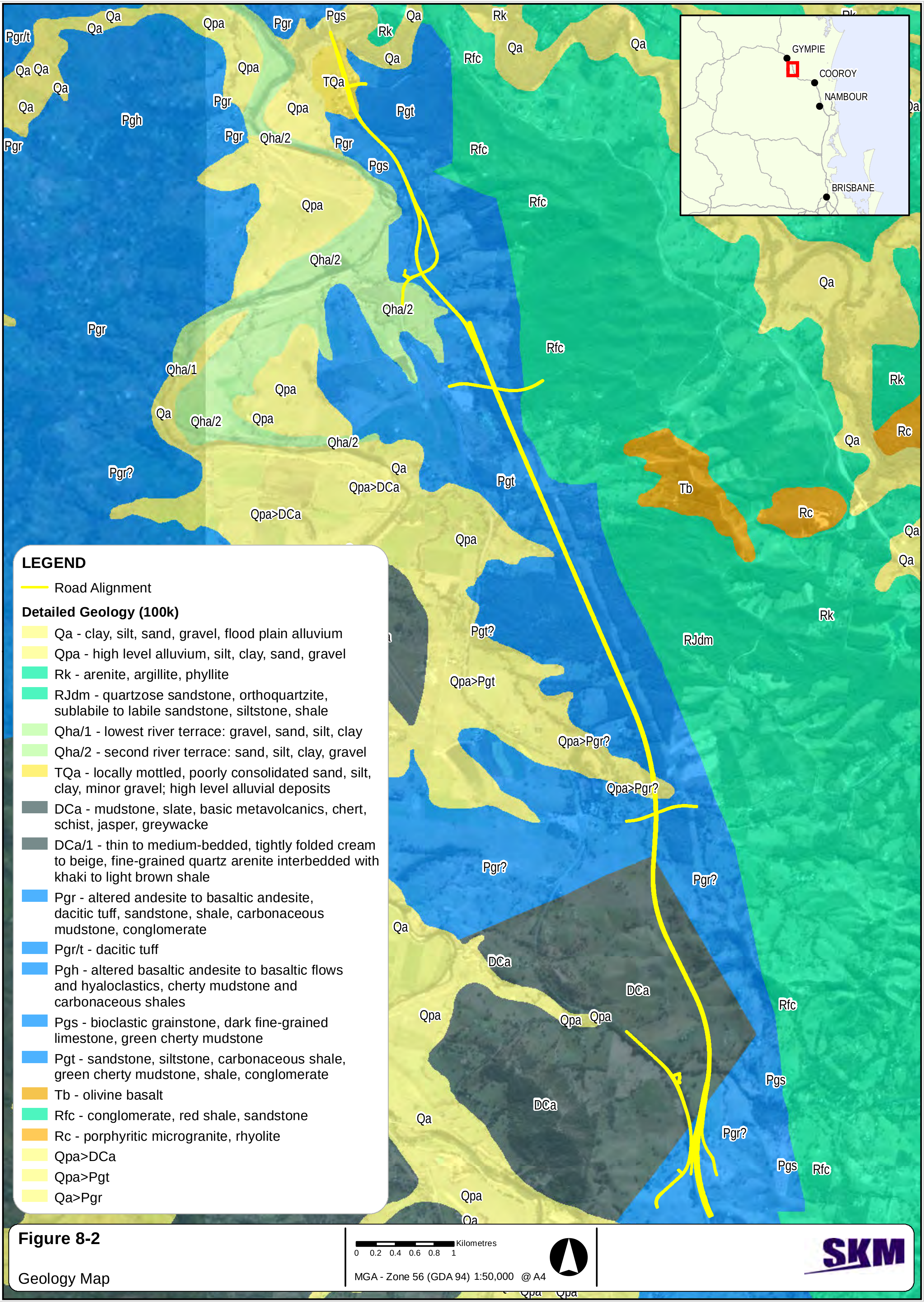

Figure 8-2

Geology Map

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The soil and rock conditions expected to be encountered along the alignment is typified by the following:

- Topsoil typically 0.2 metres thick, with a maximum observed thickness of 0.8 metres.
- Alluvial soils, predominantly stiff to very stiff silty sandy clay, generally 3 metres thick with a maximum thickness of 7 metres.
- Residual soils, predominantly stiff to very stiff silty clay with a maximum thickness of 7 metres.
- Sedimentary rock, which dominates the alignment, comprising indurated to slightly metamorphosed siltstone, sandstone, breccia and conglomerate
- Metamorphic rock at the southern end of the Project comprising metasiltstone.
- Igneous rocks, mainly as dykes, including basalt, dolerite, rhyolite and andesite.

Recent Quaternary alluvial deposits are limited in extent and confined to minor east west trending drainage lines between the more elevated terrain sections. These areas generally coincide with proposed embankment sections. Generally the alluvium is less than three metres thick in most embankment sections. Alluvium material is generally firm to hard and consists of clay, silt and sand mixtures.

Geological contributions along the alignment are approximately 15% metasiltstone, 5% volcanic igneous and the remaining 80% comprising sandstone or siltstone.

8.2.3 Soil Properties

Soils exposed during the construction phase will be subject to erosion and sediment transport during rain and high wind events. Soil properties which influence the potential for environmental harm and the selection and design of mitigation measures include erodibility and particle size distribution.

Soils sampled over the route can be broadly summarised in terms of Major TMR textural soil groups[9] (**Table 8-1**).

Table 8-1: Summary of soil testing (parameters based on 80% confidence level).

Particle Characterisation	Minimum	Maximum
Percentage fines (%)	31	75
Liquid limit (%)	28	45
Percentage sand (%)	16	37

Source: TMR Geotechnical Branch Factual report on geotechnical investigations for bulk earthworks, (Ref Report 3494), dated December 2011.

Based on the above soil types can be broadly grouped in to TMR major textural group's clay loam or light to medium clay. These soils are residual in nature and can expect to grade into more sandy soils with depth (gradational soil). These soils can be expected to have a low to moderate infiltration capacity. These soils are often recorded as being of a firm to hard consistency.

Dispersive soils are likely to be present along the alignment, as gully erosion was observed during field investigation activities for the geotechnical factual report (TMR, 2011). This observation was supported by the Emerson class testing carried out on test pit samples from proposed cut sites along section C ranged between 1 and 8, 72% of which ranged between 1 and 4 (mode = 4, median = 3, n=14). Results of soil testing for preceding Section B suggest highly erodible soils at a local scale beyond the boundaries of the Project, with 69% of samples ranging between 1 and 4 (mode = 1, median = 3, n = 29). These results are notably similar to the conditions recorded by the more recent investigations over Section C.

Observations of soil properties in the project area also suggest that topsoil is likely to be more prone to erosion than the sub soils once grass cover is removed during grubbing activities.

[9] TMR Soil & Revegetation Management Guideline State Wide Edition (2007).

Particle size distribution for sub soils indicates a high proportion of fine grained silt or clay material with a diameter of less than 0.075 mm (mean = 40%, n = 77). The particle size distribution and likely presence of dispersive soils will require the use of erosion and sediment controls suitable for these soil types to manage the potential for environmental harm through the discharge of sediment laden waters to the receiving environment.

The majority of the material along the alignment in cut locations has been determined to be Class A or B and is therefore likely to be suitable for use as embankment material. A low proportion of material was classed as unsuitable and will be managed during construction in accordance with **Section 2.9.3.3**.

8.2.4 Contaminated Land

Contaminated land searches have been undertaken on all parcels of land impacted by the Project. There were no parcels of land registered on the Contaminated Land Register (CLR). Two parcels of land were registered on the Environmental Management Register (EMR), shown in **Table 8-2**.

Table 8-2: Results of EMR search for properties impacted by the Project.

Site/Lot	EMR Result	Ownership
Lot 1073, M37442	The site has been subject to the following Notifiable Activity pursuant to section 374 of the Environmental Protection Act 1994. LIVESTOCK DIP OR SPRAY RACE - For the majority of rural properties only a small area may be affected by the chemicals used in livestock dips and spray races.	Department of Transport and Main Roads
Lot 3, RP208996	The site has been subject to the following Notifiable Activity pursuant to section 374 of the Environmental Protection Act 1994. LIVESTOCK DIP OR SPRAY RACE - For the majority of rural properties only a small area may be affected by the chemicals used in livestock dips and spray races.	Department of Transport and Main Roads

These lots are located between approximate chainage 128450 and 129500. A site visit was undertaken in February 2014 as part of a pre-clearance preliminary structure investigation and an opportunistic survey of both lot 1073 on M37442 and Lot 3 on RP208996 were ground truthed for the cattle dips. A cattle dip was found along the adjoining boundary of both lots (western extent of the properties, shown in **Figure 8-3**). As the proposed alignment traverses the eastern extent of the properties, it is highly unlikely that the project will impact on areas of contaminated land.

The Project will also include works in close proximity to a service station near the corner of the existing Bruce Highway and Keefton Road. This service station is listed on the EMR as the operation of a service station is a notifiable activity. Field investigations are required to determine the likelihood of contamination within the Project area at this location.

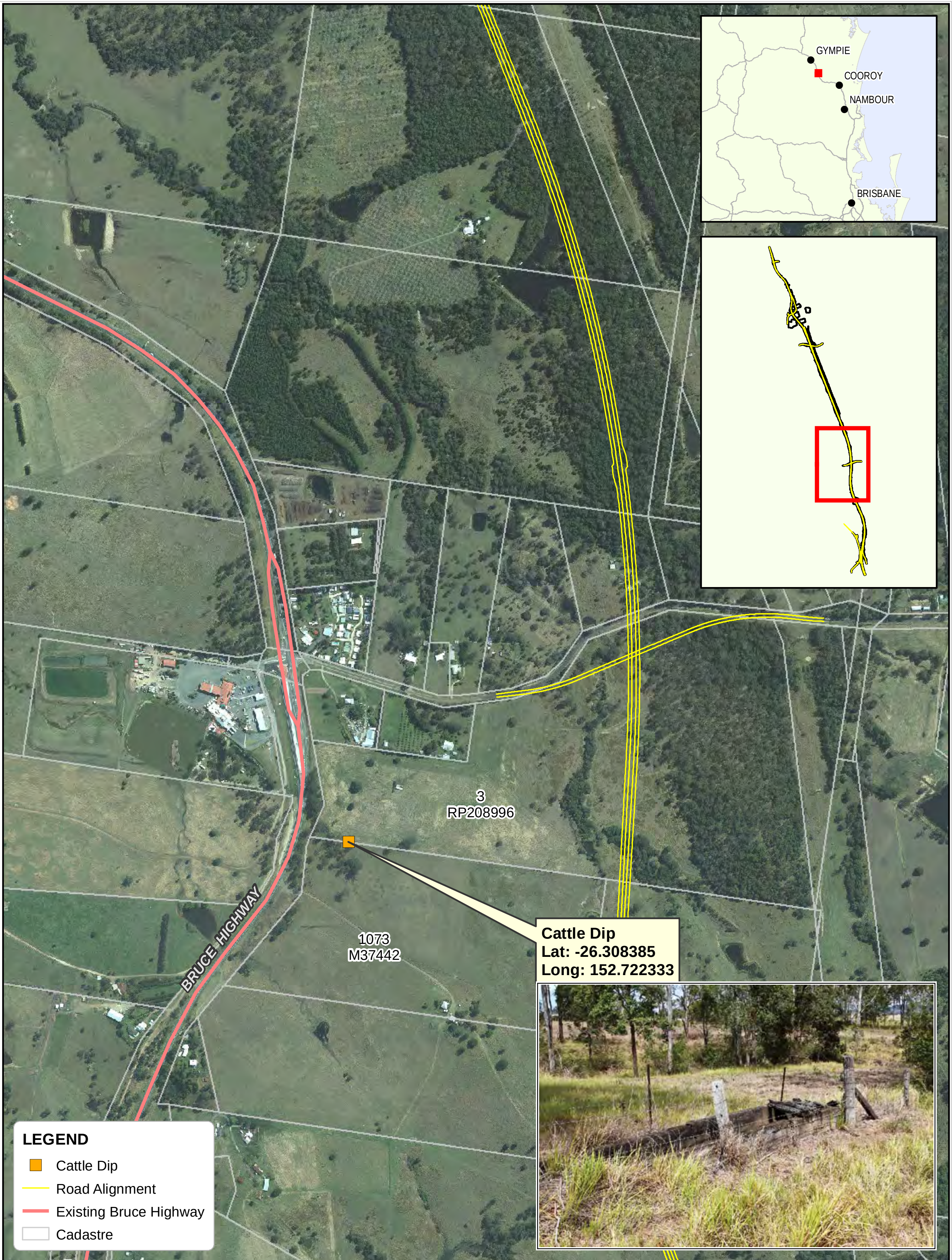


Figure 8-3

Location of Cattle Dip

0 50 100 150 200 250 Metres

MGA - Zone 56 (GDA 94) 1:10,000 @ A4

SKM

I:\QBIF\Projects\QB10237\Technical\Spatial\ArcGIS\Figures\REFupdate\140225_REF_Figure_CattleDip.mxd Produced: 25/02/2014

8.2.5 Unexploded Ordnance

Unexploded ordnance (UXO) is ammunition that has been fired but has not detonated as intended. As items of UXO may be unstable due to corrosion and exposure to the elements, there is a risk that these items may detonate if disturbed, even after remaining dormant for long periods of time.

Statistics from a search of the UXO website for the Gympie Regional Council Local Government Area (LGA) are shown in **Table 8-3**.

Table 8-3: UXO statistics for the Gympie Regional Council LGA.

Substantial	Slight	Other	Total
1	41	2 256	2 298

A search of the land parcels impacted by the Project did not find any properties impacted by UXO.

8.2.6 Acid Sulfate Soils

The project is located at elevations ranging between approximately 55 metres and 110 metres above AHD. Acid sulphate soils generally occur below 5 metres above AHD and are therefore unlikely to be encountered on the Project.

8.3 Potential Impacts and Mitigation Measures

The majority of potential impacts of the Project relating to geology and soils are likely to occur in the construction phase. Impacts during operations are expected to be minimal, but may include scouring around bridge piers and abutments.

Erosion risk is likely to be highest during the period between initial disturbance and final stabilisation and revegetation of disturbed areas. Soil erosion and subsequent transport and deposition into waterways within the Mary River catchment represent significant risks for the Project. A description of erosion risk is provided in **Sections 8.3.1** and **8.3.2**.

The main environmental impacts associated with the geology occurring along the Project alignment relate to the requirement for ripping and blasting and the associated noise, vibration and air quality impacts which have been discussed in **Chapter 10 – Noise** and **Chapter 11 – Air Quality**, respectively.

A summary of the potential impacts and mitigation measures is provided in **Table 8-9**.

8.3.1 Erosion Risk Assessment – Main Alignment

Erosion risk was assessed through an objective assignment of values to each of these factors for two scenarios:

1. Natural surface levels with exposed topsoil
2. Design surface levels with exposed sub soils.

These scenarios were selected to represent the potential erosion risk associated with the initial clearing and grubbing phase, where erosive topsoils are exposed and slope gradients are generally higher, and the bulk earthworks phase prior to the stabilisation of soils through the application of the subgrade materials.

The TMR Road Drainage Design Manual (RDDM) identifies four major factors in assessing erosion risk:

- Rainfall erosivity
- Soil erodibility
- Slope gradient and length

- Vegetation cover

Soil erodibility

Soil erodibility is the natural susceptibility of a soil to detach and be transported by the action of rainfall impact and associated flow of water. The soil cohesiveness, texture, permeability and particle size will determine a soil's erodibility. Soil erodibility has been objectively assessed using the criteria displayed in **Table 8-4** in combination with the Emerson testing results described in **Section 8.2.3**. Alluvial and residual soils have been classed as 'sub soils' for the purpose of the assessment.

Table 8-4: Soil erodibility criteria.

Erodibility Rating	**1** **Very Low**	**2** **Low**	**3** **Moderate**	**4** **High**	**5** **Very High**
Soil	Hard clay	Very stiff clay	Stiff clay/sandy clay	Firm clay/sandy clay	Topsoil, soft clay/sandy clay

Rainfall erosivity

Rainfall erosivity is a product of the total storm energy and the maximum 30 minute intensity of each storm. This product is referred to as the Erosion Index (EI). Values for average annual EI and highest monthly proportion of the annual average EI for Gympie are provided in the RDDM which have been used in this assessment.

Slope gradient and length

Slope gradient has a strong influence on flow velocity, and therefore, erosion. Flow velocity increases as slope gradient increases. However, slope length is also an important factor in determining flow velocity.

Increasing slope length increases the capacity of runoff water to concentrate and thus increases the potential for detachment and loss of soil particles. Levels from the longitudinal section have been used to determine natural surface level and design surface level slope gradients and slope lengths for the Project.

Rating values for slope gradient and length were taken from the RDDM.

The values used in the assessment do not consider flow diversion structures which may be installed during construction.

Vegetative cover

Vegetation cover influences erosion by reducing flow velocities and providing structure and protection for the underlying soil. Rating values for vegetative coverage were taken from the RDDM.

Each factor was assessed in accordance with the RDDM and allocated a rating of 1 to 5 for the two scenarios (refer to **Table 8-5**). The average and peak values of these ratings were used to determine the overall erosion risk for the main alignment.

Table 8-5: Erosion risk assessment for the main alignment.

Factor	Project Assessment	Natural surface level with exposed topsoil	Design surface level with exposed sub soils
Rainfall erosivity	Table 2.6 of the RDDM shows an Average Annual EI for Gympie between the years 1963 to 1981 of 495. Table 2.7 identifies the highest monthly proportion of the Average Annual EI as 23.2%, which occurs in January. The Erosivity Rating for Gympie falls into the Low (2) category. However, it is noted that both the Average Annual EI and monthly proportion of the Average Annual EI are <10% from the upper boundary of their respective categories. Therefore, the Erosivity Rating for Gympie is on the boundary of the Moderate (3) category.	Low to Moderate (2 to 3)	Low to Moderate (2 to 3)
Soil erodibility	The major soil types noted in Section 8.2.2 include: Topsoil Alluvial soils – stiff to very stiff sandy clay Residual soils – stiff to very stiff silty clay	High (5)	Low to Moderate (2 to 3)
Slope gradient and length	**Natural Surface Level** Median slope gradient: 4.6% (gently inclined). Maximum slope gradient: 17.6% (moderately inclined). Mean slope length 107 metres Median slope length: 80 metres Maximum slope length: 480 metres **Design Surface Level** Median slope gradient: 1.3% (very gently inclined). Maximum slope gradient: 3.5% (gently inclined). Mean slope length 491 metres Median slope length: 80 metres Maximum slope length: 1,660 metres	Median slope gradient: Moderate (3) Maximum slope gradient: High (4) Slope length: High (5)	Median slope gradient: Low (2) Maximum slope gradient: Moderate (3) Slope length: High (5)
Vegetative cover	This assessment is based on the construction phase impacts of erosion; therefore it is assumed that vegetation cover will be removed along the alignment during the highest risk period.	Very High (5)	Very High (5)

The average and peak erosion risk ratings are provided **Table 8-6**.

Table 8-6: Erosion Risk Ratings for the main alignment.

	Scenario 1: Natural surface levels with exposed topsoil	Scenario 2: Design surface levels with exposed sub soil
Average Erosion Risk Rating	4.1 - High	3.4 – Moderate to High
Peak Erosion Risk Rating	4.3 – High to Very High	3.7 – Moderate to High

Erosion risk will be higher during months with higher rainfall intensity and duration, particularly December, January and February. Average monthly EI as a percentage of average annual EI is presented in **Chapter 5 – Climate**.

Erosion risk will vary along the alignment in proportion to the factors assessed above. **Table 8-7** shows the potential high risk locations along the alignment for the two scenarios on the basis of slope gradient and slope length.

Table 8-7: Potential high erosion risk locations along the main alignment.

Start Chainage	End Chainage	Slope Length	Slope Gradient	Waterway and Drainage Features
Natural Surface Levels				
126400	126700	300	-6.0%	Traveston Creek is located within 100 m of the base of this slope.
126900	127240	340	5.9%	
127780	128060	280	11.5%	
128060	128120	60	-15.4%	
128520	128640	120	-8.1%	
128680	129080	400	-3.8%	Adjacent to unnamed drainage gully (ch129100).
129200	129680	480	-2.1%	Kybong Creek is located at the base of this slope.
129900	130040	140	8.7%	
130080	130260	180	-6.3%	
130400	130600	200	7.4%	
130640	130820	180	-8.7%	
130980	131340	360	7.4%	
131400	131700	300	-6.1%	
132080	132220	160	7.0%	Cobbs Gully is located at the base of this slope.
132360	132480	120	7.7%	
132540	132600	60	17.0%	
132940	133040	100	-17.6%	
133240	133460	160	-10.2%	Jackass Creek is located at the base of this slope.
133480	133560	80	14.7%	
133680	133800	120	-11.8%	Unnamed drainage gully (ch133800).
133800	134000	200	8.6%	
134040	134160	120	-8.9%	Unnamed drainage gully (ch134300).
134420	134500	80	11.8%	
134660	134800	140	-6.9%	
Design Surface Levels				
125000	125875	875	-2.1%	
125875	126821	946	1.0%	Traveston Creek (ch126840).
127361	128320	959	3.0%	
128320	129372	1052	-3.5%	Unnamed drainage gully (ch129100).
129627	131292	1665	0.7%	Kybong Creek (ch129700).
132900	134200	1351	-1.3%	Cobbs Gully (ch132220 to 132300). Unnamed drainage gully (ch134300).

8.3.2 Erosion Risk Assessment – Batter Slopes

In addition to the erosion risk assessment process outlined in the RDDM, a modified assessment using a theoretical combined objective and quantitative assessment was conducted to determine the erosion risk associated with both cut and embankment batters. This modified assessment technique considered additional factors in relation to slope erosion, including slope roughness and slope area (refer to SKM Technical Note QB10237-1120-ECC-CA-E2-0017_Slope Stability).

The outcomes of this assessment suggest that the proposed batter design of 1 in 2 (vertical: horizontal) is susceptible to high to very high erosion rates where erosive site soils are present and a high to very high rainfall (ratings) conditions are anticipated during construction. Erosion risk increases with batter slope length, with erosion potential demonstrating an approximately linear relationship with batter height. Batter heights will be restricted to a maximum of approximately seven metres for the Project, with benches installed where batters are above this height.

Embankment batters in the vicinity of the Woondum Interchange are likely to be exposed to inundation as this location is below the Q100 flood level for the Mary River. These embankment slopes will require suitable stabilisation to prevent erosion when flood waters recede in this location.

8.3.3 In Stream Works

In stream works will be required for the construction of crossing structures at Traveston Creek, Kybong Creek, Cobbs Gully and Jackass Creek. The clearing of riparian vegetation at a width suitable to accommodate construction activities will be required prior to the construction of these crossing structures. Clearing width should be in accordance with the MRTS04 – General Earthworks, specifically:

- Clearing should be restricted to the plan limits of the bridge plus two metres where possible
- Stumps and roots will be left in situ to maintain the stability of the bed and banks of the impacted areas.

In stream works will require the design of site specific controls to prevent or minimise erosion and manage flows through the impacted area. This may involve the construction of temporary diversions, coffer dams or isolation barriers.

Changes to bed slope associated with the proposed creek realignments at Traveston Creek and Kybong Creek are likely to result in increased flow velocities. An increase in flow velocity will result in an increased erosion risk within these waterways. The final design of these realignments will require suitable scour protection to prevent erosion of the bed and banks with consideration of fish passage requirements under the *Fisheries Act 1994*. Further detail relating to changes in flow regime and impacts on fish passage is provided in **Chapters 7** and **9** respectively.

The realignment of these waterways should maintain the natural bed slope to the greatest degree possible to minimise risks associated with scour and impacts on fish passage.

8.3.4 Cuttings

The excavatability of material in cuttings has been estimated based on available borehole and seismic refraction data.

This assessment indicates that rock may prove difficult to excavate even with a D11 tractor unit where moderately to slightly weathered sandstone and siltstone (Pgt Tamaree) is present in the base of cuttings at the locations shown in **Table 8-8**. These rocks were typically only encountered at depths of over ten metres below existing ground level.

Table 8-8: Summary of non-rippable material quantities for the Project.

Section Chainage	Main Line Cut General Quantities	Non-Rippable	
	Total (m^3)	% Volume	m^3
128000 to 128100	84,679	40%	33,872
131300 to 131400	45,248	17%	7,692
132800 to 132900	66,887	50%	33,444
132900 to 133000	84,105	25%	21,026
134000 to 134100	44,863	12%	5,384
Miscellaneous locations	329,743	NA	43,664
TOTAL	1,245,440 m^3	TOTAL	145,081 m^3

Non-rippable areas will require the use of rock breakers or blasting prior to excavating to the design surface level.

The potential requirement for blasting in the locations shown in **Table 8-8** introduces risks to surrounding properties from vibration and air blast overpressure impacts. In addition, air and noise impacts to local sensitive receptors may occur where excavatability conditions approach or exceed the non-rippable threshold and non-blasting methods such as rock breakers are used.

All blasting activities will be conducted in accordance with MRTS55 – Use of Explosives in Roadworks.

8.3.5 Stockpiles

A number of stockpile locations are likely to be utilised during the Project, including:

- Large spoil stockpiles in the vicinity of the Woondum Interchange required to accommodate excess material
- Topsoil stockpiles primarily located parallel to the main alignment and access roads for use in rehabilitation
- Spoil stockpiles may be established along the main alignment as required to facilitate construction works.
- Unsuitable material may be temporarily stockpiled prior to reuse or disposal
- Subgrade material may be temporarily stockpiled prior to use.

Soil stockpiles will be highly susceptible to erosion and transportation of sediment if not adequately stabilised. Stockpiles will be managed in accordance with MRTS04 – General Earthworks, including:

- Limiting the height of stockpiles to three metres
- Limiting the width of the base of stockpiles to ten metres
- Adopting batter slopes, protective cover and drainage which reduce the potential for erosion and/or segregation
- Avoiding the placement of stockpiles within the Q5 flood zone of local waterways and the Q100 flood level for the Mary River (with the exception of stockpiles proposed in the vicinity of the Woondum Interchange).

Proposed spoil stockpiles in the vicinity of the Woondum Interchange may be subject to inundation as this location is within the Q100 flood level for the Mary River. The material in these stockpiles is likely to be used during the construction of the potential future additional ramps for the Woondum Interchange or the main alignment for Section D. These stockpiles will require suitable long term stabilisation to prevent erosion as flood waters recede.

8.3.6 Unsuitable Material

Unsuitable material generally includes any excavated material that does not meet the required specifications for use in construction. Examples of unsuitable material likely to be encountered during construction of the Project include:

- Material from the bottom of dams and creeks
- Material from the upper one metre of cuttings, which is likely to be dispersive and prone to erosion
- Material from the lower part of cuttings, which may be too coarse for compaction
- Contaminated soil (refer to **Section 8.3.7**).

It is estimated that approximately 12,700 cubic metres of unsuitable material will require management during the construction of the Project. Of this total volume, approximately 9,500 cubic metres will be used on site in the core of zoned embankments, to fill localised drainage gullies and divert overland flow longitudinally to larger drainage features.

Management of unsuitable material on-site will be carried out in accordance with MRTS04. Specifically, unsuitable material will be:

- Placed in uniform lines which will remain stable and free draining in the long term.
- Compacted by traversing with construction machinery.
- Treated by topsoiling and grassing or equivalent method so that it is not subject to erosion.

The remaining 3,200 cubic metres will be disposed of at an off-site location.

8.3.7 Contaminated Land

A cattle dip was found along the adjoining boundary of Lot 1073, M37442 and Lot 3, RP208996 (western extent of the properties, shown in **Figure 8-3**). As the Project traverses the eastern extent of the properties, it is highly unlikely that the Project will impact on soil contaminated by this activity as the dip site is located approximately 540 metres from the alignment.

Earthworks on Lot 1073, M37442 and Lot 3, RP208996 will include removal of topsoil and any unsuitable material. The final landform will include a combination of cut and fill sections on these properties. The sections between chainages 128490 to 128590 and 129160 to 129500 are designed to be in cut requiring the excavation of up to four metres of material. The remainder of earthworks in this location is proposed to be a fill section.

A permit to remove and dispose of contaminated soil in accordance with section 424 of the EP Act will be required if the proposed construction works require the disposal of contaminated land. This permit will require the completion of an in-situ Stage 2 contaminated land investigation in accordance with the Draft Guidelines for the Assessment and Management of Contaminated Land in Queensland, including the laboratory testing to determine the extent and concentration of contamination.

The site may also require remediation or encapsulation works to prevent the leaching and transport of contaminants disturbed during construction.

8.3.8 Mitigation Measures

A summary of the impacts and mitigation measures associated with the geology and soil aspects of the project is provided in **Table 8-9**.

Table 8-9: Potential impacts and proposed mitigation measures.

Potential Impact	Description	Proposed Mitigation Measures
Soil erosion: • Main alignment • Waterway crossings • Cut and fill batters • Stockpiles	As described in Section 8.3.1, soil erosion represents a moderate to very high environmental risk for the Project from the initial clearing to final stabilisation stages. Soil erosion will result in increased sediment loads and turbidity in waterways, with subsequent impacts on the water quality and aquatic ecology of the local waterways and Mary River system. Erosion risk is greatest in locations of high slope gradient and slope length, and where dispersive soils are found. These conditions are likely to be encountered during construction and are often found in the vicinity of waterways and drainage lines as shown in **Figure 8-1**. In addition, erosion risk will be greatest during the summer months when rainfall and erosivity is likely to be highest.	• An ESCP will be required for the project. Control measures included in the ESCP will include: • Laboratory testing of topsoil and sub soils along the alignment to confirm erosive properties, particle size distribution (including clay fraction <0.02 mm), and appropriate ameliorants. This information will be used to inform the design or controls within the ESCP. • Early installation of clean water diversion drainage. • Installation of Type D sediment basins in the vicinity of waterways for treatment and discharge of site runoff. • Water carts may be used during construction to reduce wind erosion of disturbed areas and stockpiles.
In stream works resulting in scouring of waterway bed and banks	• In stream works are likely to be required for all major waterway crossings. Minor crossings, including drainage lines and access road crossings, will also involve in stream works. • Impacts are likely to be greatest where diversion works are required, including Traveston Creek and Kybong Creek. These activities represent a high risk of erosion and associated water quality impacts, particularly during high flow events. • Installation of structures at Kybong Creek (box culverts) and Cobbs Gully (concrete arch) will require the excavation of material to accommodate these structures. • Disturbance of in stream vegetation and subsequent exposure of soils associated with these activities represents a high risk for erosion to occur.	• Programming of construction works to complete in stream activities during periods of low or no flow. • Minimise disturbance of the bed and banks of waterways and drainage lines to the crossing width required to complete the works. • Design appropriate controls, including temporary diversions, coffer dams or isolation barriers to minimise potential erosion impacts of in stream works.

Potential Impact	Description	Proposed Mitigation Measures
Stockpile management	Stockpiles of materials required for construction will be required along the Project alignment.	• Stockpile locations should be located outside of sensitive environmental areas, including: - Avoiding the placement of stockpiles within the Q5 flood zone of local waterways. - Areas with established native vegetation. - Locations of known fauna habitat. • Stockpiles will be managed in accordance with MRTS04 – General Earthworks, including: - Limiting the height of stockpiles to three metres. - Adopting batter slopes, protective cover and drainage which reduce the potential for erosion and/or segregation.
Hydrocarbon spills	Hydrocarbons are likely to be stored at the workshop. In addition, small quantities may be transported around the site during construction to fuel pumps and generators. Plant and equipment required during construction may experience mechanical issues such as the failure of hydraulic hoses resulting in spills of hydrocarbons to the ground.	• Hydrocarbons will be stored in bunded areas in accordance with Australian Standard 1940:2004. • Spill kits will be provided at appropriate locations along the alignment during construction. • Contaminated material will be disposed of as soon as practicable. If temporarily stored on site, appropriate controls will be installed in designated areas.
Inundation of embankments and stockpiles	Flood modelling of the Mary River shows that areas of the Project will be inundated during the Q100 flood. Inundation of embankments and stockpiles will occur in the vicinity of the Woondum Interchange at the northern end of the Project.	• Appropriate stabilisation of surfaces subject to inundation from regional flooding as shown in **Chapter 9 – Hydrology and Hydraulics**.
Excavation of non-rippable material	Areas of non-rippable material were identified along the main alignment as shown in **Table 8-8**. These excavations are likely to require the use of rock breakers or blasting to remove material to the design level. The main environmental impacts associated with blasting and rock breaking relate to air, noise and vibration impacts on sensitive receptors.	• Consultation to be undertaken with potentially affected land owners prior to the commencement of any blasting activities. • Pre-condition surveys to be completed for potentially impacted properties and structures, including Public Utility Plant such as 275 kV electricity towers. • Design of blasts will be in compliance with MRTS55 – Use of Explosives in Roadworks.

Potential Impact	Description	Proposed Mitigation Measures
Management of unsuitable material	• Approximately 12,700 cubic metres of unsuitable material is likely to require management during construction. • Approximately 9,500 cubic metres is likely to be utilised on site. • Approximately 3,200 cubic metres will require disposal at an offsite location. • Unsuitable material is likely to be susceptible to erosion.	• The ESCP will consider the management of unsuitable material during construction and rehabilitation. • Offsite disposal options should be investigated during consultation with local landowners and government agencies. • Stockpiles of unsuitable material will be managed in accordance with general stockpile requirements detailed in MRTS04 – General Earthworks and environmental constraints detailed in the Environmental Management Plan (Construction)
Contaminated land	The service station at the corner of the existing Bruce Highway and Keefton Road is also listed on the EMR.	• A permit to remove and dispose of contaminated soil in accordance with section 424 of the *Environmental Protection Act 1994* will be required if the proposed construction works require the off-site disposal of contaminated land.
Ongoing erosion resulting from inadequate stabilisation and revegetation	Cut and fill batters may be susceptible to erosion if soil amelioration and revegetation works do not provide adequate protection from raindrop impact.	• The ESCP will consider soil ameliorants required to provide a stable substrate and suitable growing conditions for revegetation species. • The Rehabilitation Plan will include species suitable to stabilise exposed areas included cut and fill batters. • Monitoring and maintenance will be conducted during the defects liability period and in accordance with the Rehabilitation Plan.

9. Hydrology and Hydraulics

9.1 Introduction

This section provides an assessment of the impacts of the Project as they relate to the hydrology and hydraulics of waterway and drainage line crossings of the alignment.

The objectives of this assessment were to:

- Describe the existing hydrology within the region and the Project area
- Undertake an assessment of the hydrological impacts on the Project, particularly with regard to the flow components that may be affected by the Project and the impact on water quality
- Propose mitigation measures relating to water management, addressing control of erosion and scour, and water quality.

This assessment has been carried out using information obtained from previous hydrological studies (Arup, 2007) and Technical Notes associated with the development of the Business Case, specifically Technical Note 13: Hydrology and Hydraulics (SKM, 2013) and Technical Note 28: Major Watercourse Crossing Assessments (SKM, 2013a).

9.2 Existing Environment

9.2.1 Regional Hydrology

The Mary River runs to the west of the proposed alignment, with the existing Bruce Highway located between the river and the alignment. The Project area consists primarily of farmland, with patches of dense vegetation along the creeks. The terrain is steep with slopes greater than 5% in many locations.

Previous flood reports (SKM, 2010) have concluded that the Mary River influences the creeks that cross the existing Bruce Highway and that they will act as one system during a regional flood event, with peak flood levels being caused by backwater from the river.

The proposed Project alignment crosses four main waterways which flow west towards the Mary River. These are:

- Traveston Creek (approximate chainage 126840)
- Kybong Creek (approximate chainage 129700)
- Cobb's Gully (approximate chainage 132220)
- Jackass Creek (approximate chainage 133460).

In addition to these crossings, several small ephemeral drainage lines cross the proposed alignment along its length.

Previous hydrological studies (Arup, 2007) used a Tuflow model to assess the Q100 flood levels from the Mary River. The results of this assessment are shown in **Figure 9-1A** to **Figure 9-1C**. This assessment indicates that flooding from the Mary River will have a significant influence on the proposed alignment, with flooding predicted along the western side from chainage 133000 to the northern end of the alignment in a 100 year annual recurrence interval (ARI) event. In addition, flooding events at three of the four main waterway crossings along the alignment: Traveston Creek, Cobb's Gully and Jackass Creek, will be influenced by backwater from the Mary River flood.

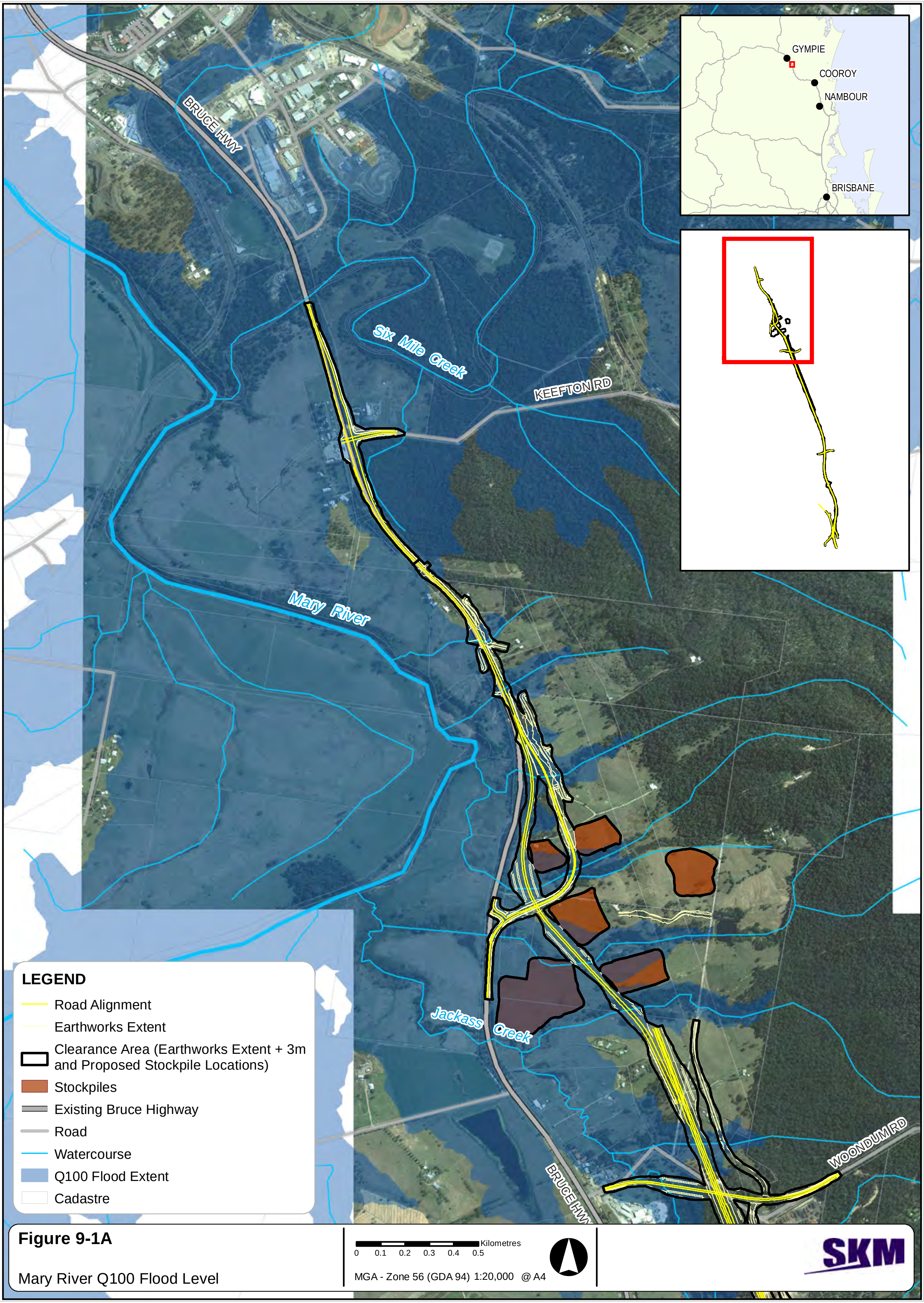


Figure 9-1A

Mary River Q100 Flood Level

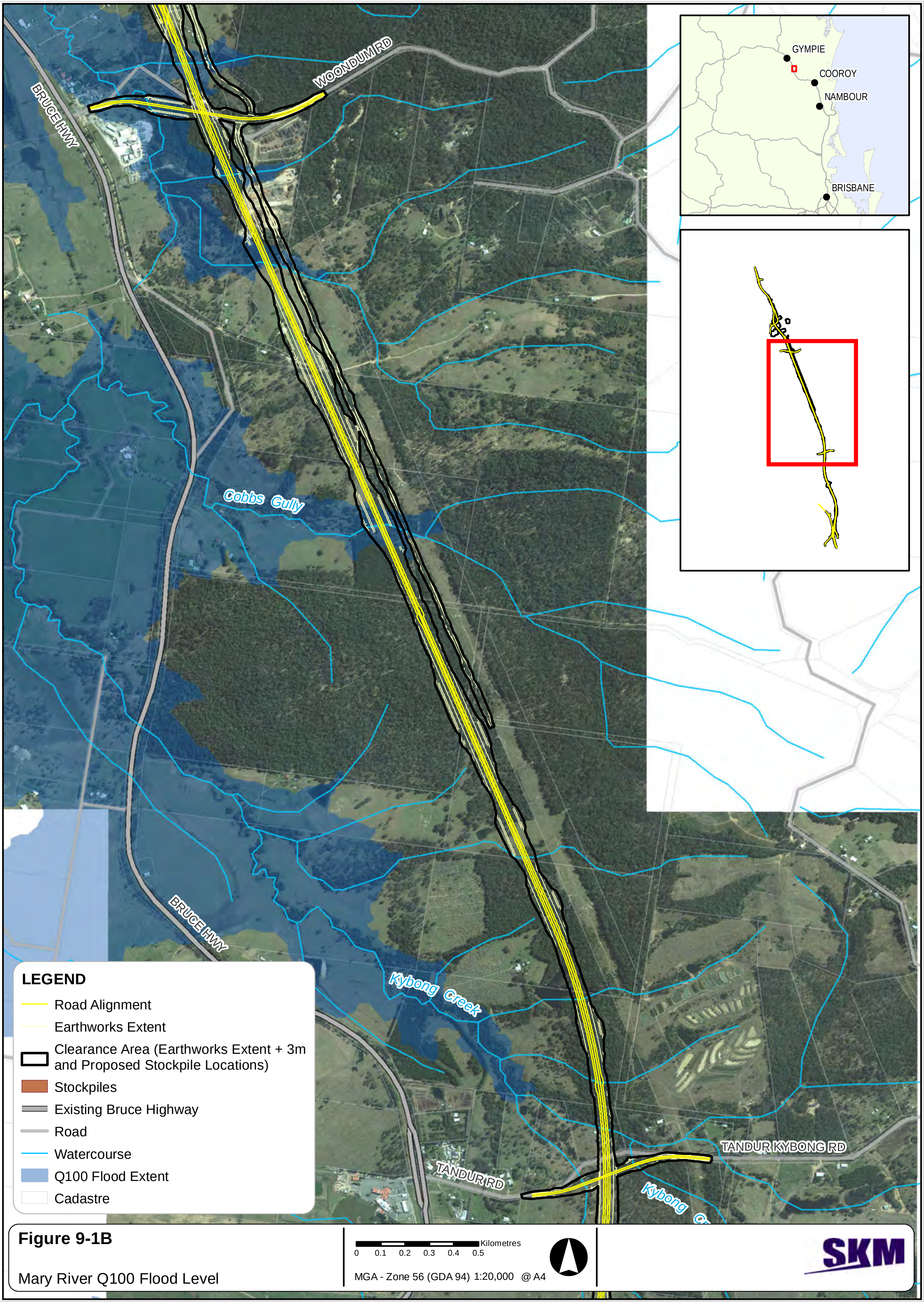


Figure 9-1B

Mary River Q100 Flood Level

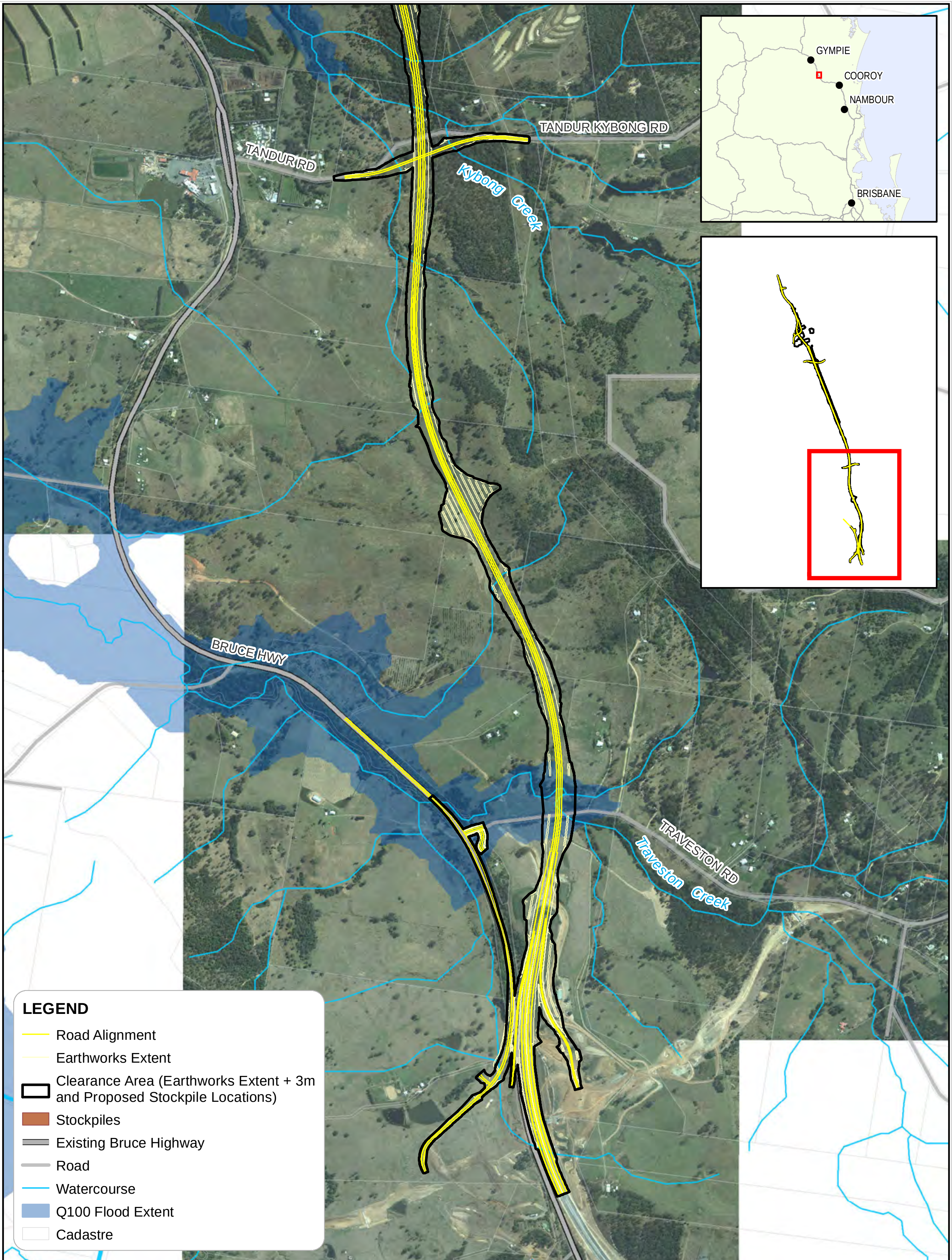


Figure 9-1C

Mary River Q100 Flood Level

Kilometres
0 0.1 0.2 0.3 0.4 0.5

MGA - Zone 56 (GDA 94) 1:20,000 @ A4

I:\QBIF\Projects\QB10237\Technical\Spatial\ArcGIS\Figures\Hydrology\130919_Hydrology_Q100_Floodline.mxd Produced: 26/11/2013

9.2.2 History of Flooding

Previous flood studies by ARUP and Kinhill Cameron McNamara (SKM, 2013) have assessed the existing Bruce Highway through this section and ascertained that the existing highway has a flood immunity as little as a 2 year ARI event, with an average time of closure of 33 hours for some crossings. In this area the existing highway was inundated in April 1989, with a subsequent closure for 60 hours in February 1992. The most recent closure occurred in February to March 2012 with the highway closed for several days.

The closure times for sections of the Bruce Highway is summarised below in **Table 9-1**.

Table 9-1: Existing Bruce Highway dependent time of closure for sections.

Location	Average (h)	AATC* (h/yr)
Carlson Road to Green Ridge	7	0
Green Ridge to Kybong Hall	17	3
Kybong Hall to Keefton Road	35	18

*Annual Average Time of Closure

Maximum flood levels along the existing Bruce highway at Traveston Creek and Traveston Crossing were observed during the 1989 and 1992 flood events (Arup 2007). These are shown in **Table 9-2**.

Table 9-2: Flood levels at Traveston Creek and Traveston crossing (Arup, 2004).

Location	Road Level (mAHD)	Flood Level (mAHD)	Depth over road (m)
April 1989			
Traveston Creek	63.2	65.0	1.8
Traveston Crossing	60.5	64.3	3.8
February 1992			
Traveston Creek	63.2	64.8	1.6
Traveston Crossing	60.5	64.8	4.3

9.2.3 Hydrology of Waterway Crossings

Hydraulic modelling using Hec-Ras software was undertaken on the main waterway crossings for the proposed alignment, with the exception of Cobb's Gully where a simple hydraulic analysis was used as it is a small, constrained catchment (SKM, 2013).

As discussed in **Section 9.2.1**, modelling of a 100 year ARI storm event for the Mary River shows that Traveston Creek, Cobb's Gully and Jackass Creek will be significantly affected by backwater from the river. As such, modelling scenarios were completed for both a 'free flowing' waterway and a 'flood constrained' waterway at each of the key alignment crossings. The results of this modelling are shown in **Table 9-3** with a discussion of the results for each waterway in the following sections.

Table 9-3: Regional and local waterway 100 year ARI flood events.

Location	Regional Influence/Flood Constrained Conditions (m AHD)	Existing State / Free Flowing Conditions (m AHD)
Traveston Creek	68.0	65.9
Kybong Creek	N/A	68.9
Cobb's Gully	65.6	64.8
Jackass Creek	64.5	62.1

9.2.3.1 Traveston Creek

Traveston Creek is a permanent waterway with distinct banks bordering intact native riparian vegetation and cleared grazing land. The channel habitat is composed of a meandering run with wider and deeper pooled sections. It has two channels which merge into one directly upstream of the proposed alignment, and there is a high degree of meandering where the creek crosses the alignment. The Project crosses Traveston Creek approximately 2.6 kilometres upstream of its confluence with the Mary River. The 100 year ARI inundation area (refer to **Figure 9-1C**) indicates this crossing is located within the influence zone of the Mary River regional flood event, with backwater from the Mary River for a 100 Year ARI event being significant.

The hydrologic modelling confirms that the regional flood is the critical event for the Traveston Creek. During a 100 year ARI event, it is expected that the depth of water in this crossing location would range between three to four metres (68.0 m AHD). In these events, flow estimates are relatively low, at approximately 125 cubic metres per second, indicating a backwater influence. A mean channel velocity of 0.7 metres per second would be expected in these events (SKM, 2013a). During major flood events in the area, it is expected that the flow area will extend beyond the existing main creek channel.

9.2.3.2 Kybong Creek

Kybong Creek is a highly modified waterway running through partly cleared native forest with pool habitats present and no continuous runs. The Project crosses Kybong Creek approximately 3.7 kilometres upstream of its confluence with the Mary River. Kybong Creek is fed by two independent branches that converge to form one channel directly upstream from the proposed alignment. At the proposed crossing location, the creek is characterised by a crescent shaped meander bend.

The Mary River flood mapping shown in **Figure 9-1B** indicates that, in a 100 year ARI event, the regional influence of the Mary River extends up Kybong Creek to come within close proximity of the crossing with the proposed alignment. Although the crossing location itself is outside the regional influence zone, it is likely that the receiving channel downstream of the alignment will experience some backwater effects. It is expected that the surface water level would be 68.9 m AHD in a 100 year ARI event at the proposed location of the crossing structure.

Preliminary hydrologic modelling was undertaken to define the existing catchment area and flow regime for Kybong Creek. The hydrological assessment generated a flow estimate for a 100 year ARI storm of approximately 92 cubic metres per second, with a mean channel velocity of 1.5 metres per second at the proposed alignment.

9.2.3.3 Cobb's Gully

Cobb's Gully is a heavily modified, wide ephemeral drainage gully flowing through terrestrial and non-native vegetation, which crosses the proposed alignment approximately 1.6 kilometres upstream from its confluence with the Mary River. The flood mapping in **Figure 9-1B** indicates that it is located within the influence zone of the regional flood.

On Cobb's Gully, a large man made dam is located upstream of the proposed alignment. Most of the catchment associated with Cobb's Gully flows directly into the dam and then discharges over the dam's weir, which has diverted the natural flow path of the main channel. Overflow from the dam has created a 'wetland' area downstream with no distinct main flowing channel.

Downstream dams, channel modification and culverts under the existing Bruce Highway are a barrier to fish passage and have significantly simplified the upstream channel habitat.

Under the existing conditions, a flow width of at least twenty metres is expected in a 100 year ARI storm event. A maximum flood level of two to three metres (65.6m AHD) would be expected at the crossing point with the regional influence of the Mary River.

Using the contributing catchment area and flow regime expected from the surrounding rural terrain, a 100 year ARI storm event would generate flows of approximately 39 cubic metres per second at the crossing location, with approximate channel velocity of 1.5 metres per second.

9.2.3.4 Jackass Creek

Jackass Creek is a permanent waterway with defined banks, running through mostly cleared land with abundant non-native ground cover. Existing downstream culverts under the Bruce Highway and Woondum Road, plus a large dam located downstream from the crossing location, are barriers to fish passage and have significantly simplified the upstream channel habitat.

The proposed alignment crosses the Jackass Creek waterway approximately 1.6 kilometres upstream from its confluence with the Mary River. The flood mapping in **Figure 9-1B** and subsequent hydrological modelling indicate that this crossing is within the zone of influence of a 100 year ARI Mary River regional flood event.

The existing channel has a channel slope of greater than 2% at the proposed crossing site. The hydrologic modelling shows that, in a regional 100 year ARI event, the depth of water at the proposed crossing site would be between four to five metres (64.5 m AHD), with a flow estimate of approximately 57 cubic metres per second, and a mean channel velocity of 2.1 metres per second.

9.2.3.5 Drainage channels

The local drainage comprises small seasonal streams which are tributaries of the more major creeks. They tend to occur along east-west trending drainage lines between the more elevated terrain units. The direction of flow for all the creeks and tributaries is generally west to the Mary River.

The local flood for these drainage channels is dependent on the capacity of the drainage structure and downstream overland flow paths at these locations.

9.3 Potential Impacts and Mitigation Measures

9.3.1 Realignment of Tandur Road to Woondum Road Section

The Strategic Planning alignment crossed to the east of the high voltage power line easement north of Tandur Road, before crossing back to the west of this easement, north of Woondum Road. Due to engineering constraints, a comparative assessment of an alignment option located entirely on the western side of the high voltage transmission line easement and the Strategic Planning alignment was completed.

The western alignment was found to have fewer impacts than the Strategic Planning alignment and was adopted as the preferred option for the business case. In relation to waterway crossings, the western alignment reduced the requirements to divert Jackass Creek and tributaries by approximately 1.2 kilometres.

9.3.2 Operational Impacts

The proposed alignment does not require any major catchment or creek diversions of defined waterways. Long term operational impacts to the flow path are likely to be limited to minor works around drainage structures, with relatively short diversions of Traveston Creek and Kybong Creek, with works likely to be limited to the extent of existing waterways.

Flows through existing waterways will be maintained through the construction of crossing structures. There may be some realignment of minor drainage lines, by redirection of flows along the alignment to appropriately sized crossing structures.

The main impacts to hydrology from the Project are associated with the construction of the four main waterway crossings. As discussed in **Section 9.2.1**, these are:

- Traveston Creek
- Kybong Creek
- Cobb's Gully
- Jackass Creek.

In addition to these crossings, the Project will impact on a number of small drainage lines along the alignment.

Potential long term location specific impacts associated with the waterway and drainage line crossings are discussed in **Section 9.3.2.2** through **Section 9.3.2.6**.

The extent of construction impacts in relation to installation of waterway crossing and other drainage structures will be mainly dependent on the presence of water flow during construction. Potential impacts from construction and associated mitigation measures are discussed in **Section 9.3.3.**

9.3.2.1 Runoff from the Proposed Bruce Highway

Water quality may be impacted downstream of the waterway crossings through increased turbidity or contamination from road run-off. Drainage management measures will be required at the crossing sites to prevent road run-off directly entering waterways or drainage lines. These may include:

- No installation of scuppers at the bridge crossings
- Installation of run-off barriers at culvert crossings
- Installation of treatment train controls in accordance with the TMR Road Drainage Design Manual to treat road runoff
- Directing of flows to capture areas at the side of the alignment.

Further details of existing water quality, potential impacts and proposed mitigation measures are included in **Chapter 7 – Aquatic Ecology and Water Quality**.

9.3.2.2 Traveston Creek Bridge

The preferred design option for Traveston Creek is a three by 30 metre span bridge (refer to **Figure 9-2**). Due to the high level of meandering of the low flow channels and the convergence of two upstream channels into one, it is not considered feasible to provide a bridge span configuration to avoid all impact to the existing low flow channel. The preferred option provides a configuration that minimises the impact on this low flow channel, with part of the channel removed to accommodate the northern abutment and road approaches, resulting in the realignment of approximately 240 metres of Traveston Creek.

The final bridge design for the Traveston Creek crossing will limit the upstream afflux affected zone to within acceptable limits to avoid adverse impacts on third party properties. Additional hydrologic modelling will be required during design development to further assess potential impacts.

The realignment of approximately 240 metres of Traveston Creek at the location of the crossing will reduce the overall length of the stream flow path and thus increase the gradient and the velocity of flows. This increase in flows represents a potential risk to the Project of increasing erosion of the bed and banks of the creek, reducing water quality downstream of the crossing, and impeding fish passage in Traveston Creek.

Ongoing environmental inputs will be required during design development to minimise the environmental impacts from the realignment of Traveston Creek. Management measures will be required to reduce the velocity of flows to as close to natural levels as possible. These may include widening the flow-path and/or introduction of rock in the creek bed. The final design will include scour protection measures to prevent damage to the bed and banks of the realigned creek. These measures will be in accordance with MRTS03: Drainage, Retaining Structures and Protective Treatments (TMR, 2010) and are likely to include a rock apron downstream of the crossing. Any scour protection measures should be installed taking into account the requirement for fish passage.

The final bridge design will minimise the incidence of piers within the waterway. If bridge piers are required within the waterway they will be oriented for hydraulic efficiency, however, there is a medium risk that these piers may alter the hydrology and current patterns of the creek causing erosion and scouring of the bed and banks, particularly around the bridge structures. Scour protection measures such as rock armouring may be required to address this.

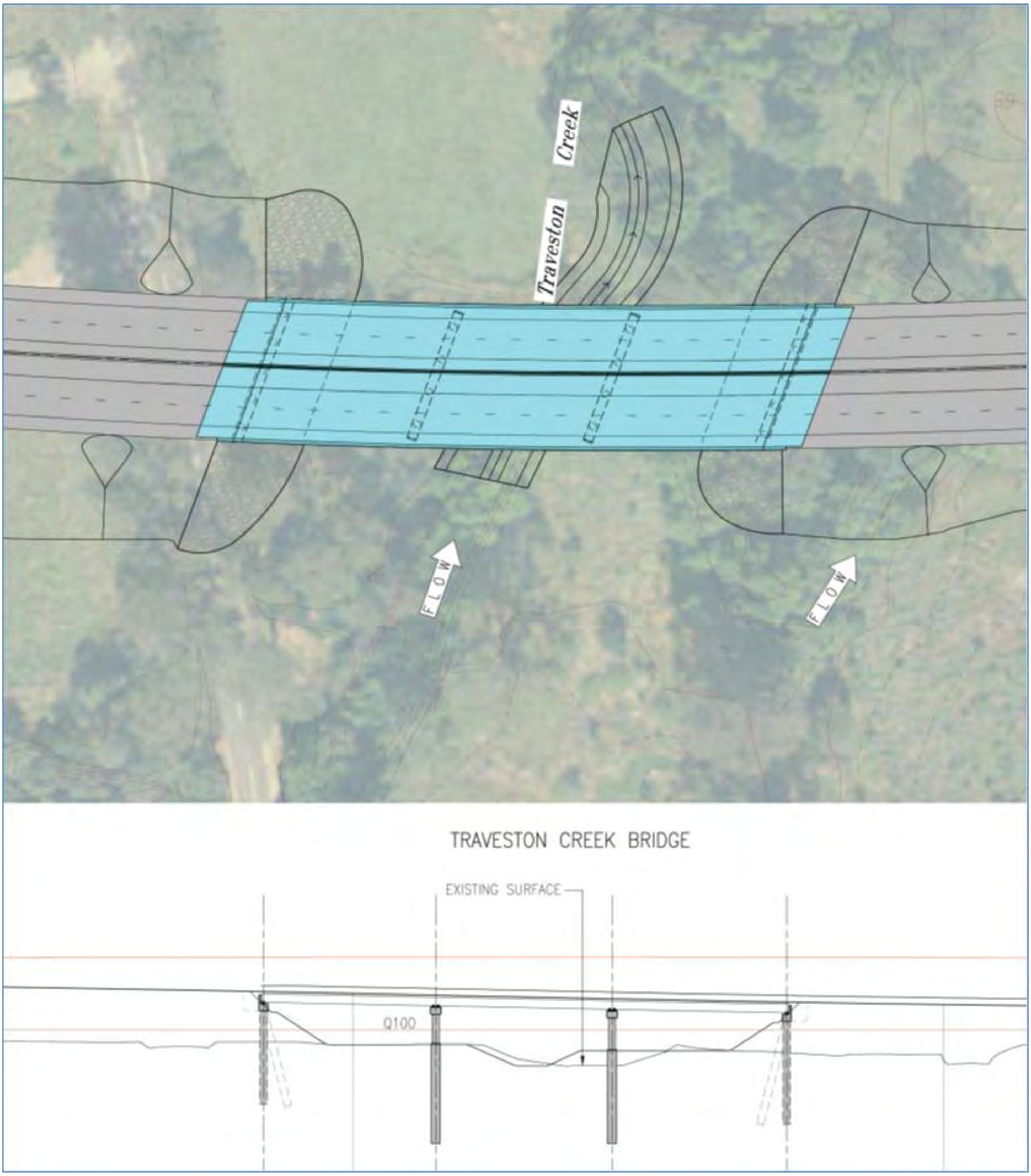
As a result of the proposed realignment works and installation of a structure within the waterway, the proposed works at Traveston Creek are likely to require the following approvals:

- Development approval for waterway barrier works under the *Fisheries Act 1994*[10].
- Operational works that is the taking or interfering with water under the *Water Act 2000*.

The exemption under the *Water Act 2000* pertaining to the taking of water detailed in **Chapter 3 – Legislative Requirements** does not apply to diverting the flow of water outside a watercourse.

[10] Traveston Creek is mapped as an amber waterway under the DAFF Guide for the determination of waterways.

Figure 9-2: Traveston Creek crossing.



9.3.2.3 Kybong Creek RCBC

An eight cell, 3600 mm long by 1200 mm high reinforced concrete box culvert (RCBC) has been selected as the most appropriate crossing and drainage structure at this Kybong Creek (refer to **Figure 9-3**).

The morphology of Kybong Creek at the proposed crossing location is characterised by a crescent shaped meander bend which will require realignment of approximately 120 metres of the waterway to accommodate the proposed RCBC.

The final design for the Kybong Creek crossing will limit the upstream afflux zone to within acceptable limits to avoid adverse impacts on third party properties. Additional hydrologic modelling will be required during design development to further assess potential impacts.

The realignment of approximately 120 metres of Kybong Creek at the location of the crossing will reduce the length of the flow path and thus increase the gradient and the velocity of flows. This increase in flows represents a potential environmental risk to the Project of increasing erosion of the bed and banks of the creek, reducing water quality downstream of the crossing, and impeding fish passage in Kybong Creek.

Ongoing environmental inputs will be required during design development to minimise the environmental impacts from the realignment of Kybong Creek. Management measures will be required to reduce the velocity of flows to as close to natural levels as possible. These may include placement of rocks in the base of the culvert, installation of riffle pools downstream to slow outlet flows, and installation of baffles that provide for fish passage. The final design will include scour protection measures to prevent damage to the bed and banks of the realigned creek. These measures will be in accordance with MRTS03 and are likely to include a rock apron downstream of the crossing. Any scour protection measures should be installed taking into account the requirement for fish passage.

As a result of the proposed realignment works and installation of the RCBC structure within the waterway, the proposed works at Kybong Creek are likely to require the following approvals:

- Development approval for waterway barrier works under the *Fisheries Act 1994*[11].
- Operational works that is the taking or interfering with water under the *Water Act 2000*.

The exemption under the *Water Act 2000* pertaining to the taking of water detailed in **Chapter 3 – Legislative Requirements** does not apply to diverting the flow of water outside a watercourse.

[11] Kybong Creek is mapped as a red waterway under the DAFF Guide for the determination of waterways.

Figure 9-3: Kybong Creek crossing.

9.3.2.4 Cobb's Gully Reinforced Concrete Arch

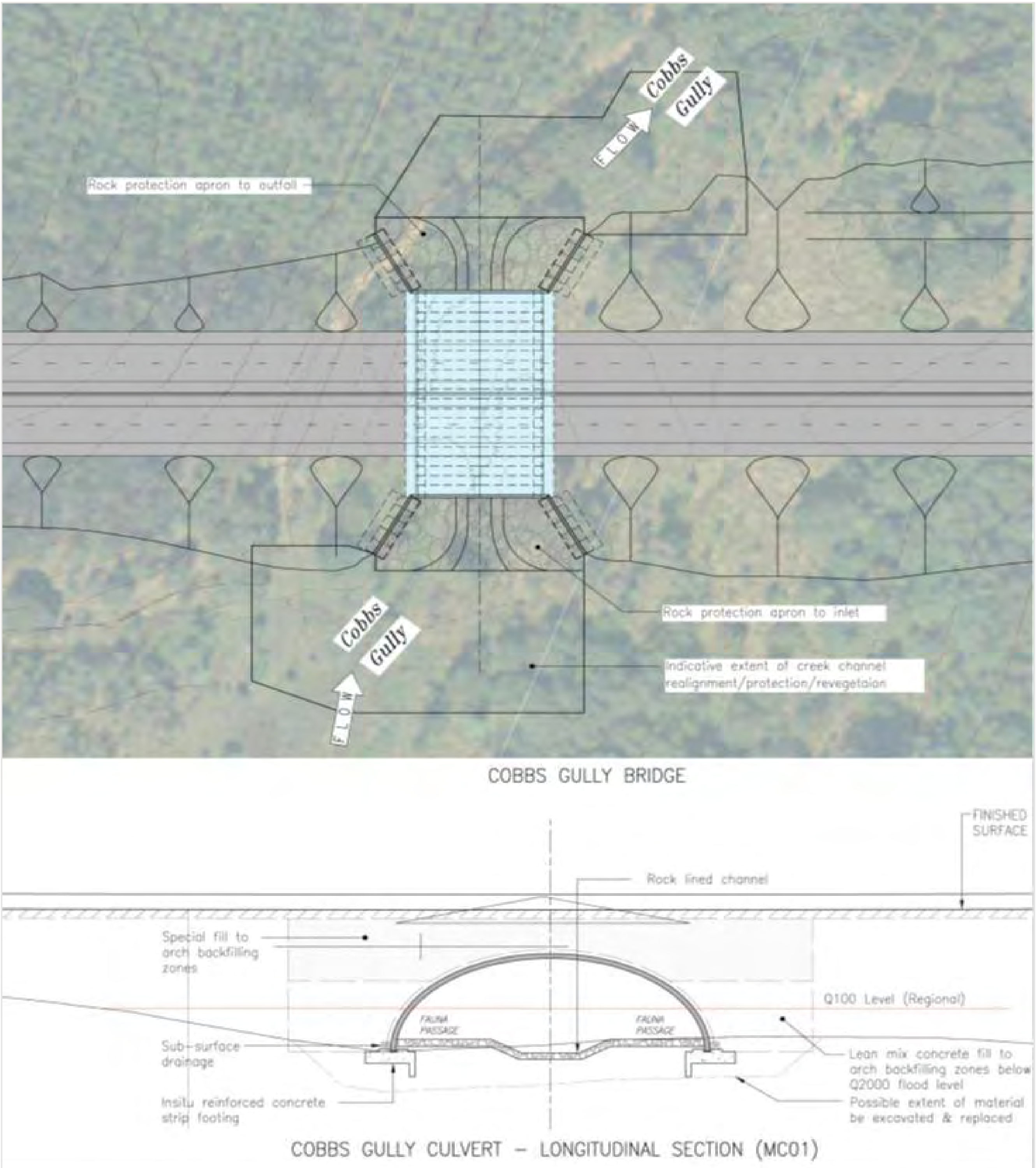
A 21 metre span, seven metre high reinforced concrete arch with a large elliptical opening that spans the low flow channel is the preferred option for this location (refer to **Figure 9-4**). The final design may incorporate piles to support the arch footings. Works within the drainage line will be required to permit a straight crossing of the road embankment. It is expected that the arch footings will be located outside of the low flow drainage line.

The final design for the Cobb's Gully crossing will contain the upstream afflux zone to within the upstream land property under the control of TMR. Additional hydrologic modelling will be required during design development to further assess potential impacts, and also should the existing upstream dam be removed prior to construction.

Ongoing environmental inputs will be required during design development to minimise the environmental impacts from the construction of the Cobb's Gully crossing. The proposed design is unlikely to affect the velocity of flows at the crossing point, which are estimated to be approximately 1.5 metres per second. The final design is likely to require minor scour protection measures at the inlet and outlet of the crossing. Any scour protection measures should be installed taking into account the requirement for fish passage. Works should be undertaken in accordance with the Code for self-assessable development – Minor waterway barrier works (DAFF, 2013). If works cannot comply with this Code, a development approval for constructing or raising a waterway barrier under the *Fisheries Act 1994*[12] will be required.

[12] Cobbs Gully is mapped as an amber waterway under the DAFF Guide for the determination of waterways.

Figure 9-4: Cobbs Gully crossing.



9.3.2.5 Jackass Creek Bridge

Due to the relatively straight alignment of the low flow channel and the steeper slopes to the channel, a four by 30 metre span bridge that spans the extents of the high flow channel (refer to **Figure 9-5**) is the preferred option for this crossing. Due to the relatively straight alignment of the low flow channel at the proposed alignment, the bridge configuration utilises span lengths that avoid major impact to the existing low flow creek channel.

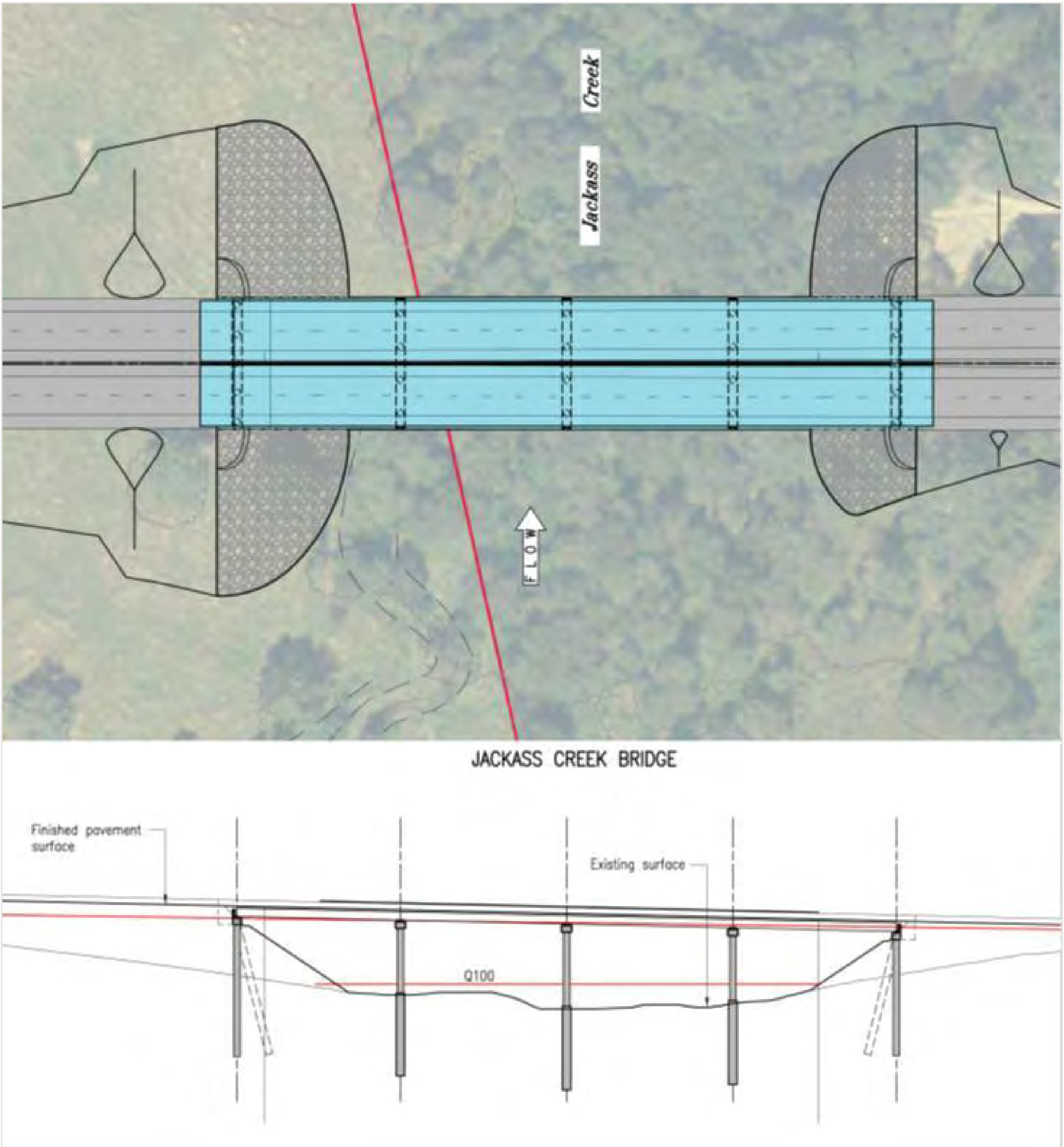
The final bridge design for the Jackass Creek crossing will limit the upstream afflux affected zone to within acceptable limits to avoid adverse impacts on third party properties. Additional hydrologic modelling will be required during design development to further assess potential impacts.

The proposed design is unlikely to affect the velocity of flows at the crossing point, which are estimated to be approximately 2 metres per second.

The final bridge design will minimise the incidence of piers within the waterway. If bridge piers are required within the waterway they will be oriented for hydraulic efficiency, however, there is a risk that these piers may alter the hydrology and current patterns of the creek causing erosion and scouring of the bed and banks, and around the bridge structures. Scour protection measures in accordance with MRTS03, such as rock armouring, may be required to address this. Works should be undertaken in accordance with the Code for self-assessable development – Minor waterway barrier works (DAFF, 2013). If works cannot comply with this Code, a development approval for constructing or raising a waterway barrier under the *Fisheries Act 1994*[13] will be required.

[13] Jackass Creek is mapped as an amber waterway under the DAFF Guide for the determination of waterways.

Figure 9-5: Jackass Creek crossing.



9.3.2.6 Minor Drainage Lines

Apart from the main crossings discussed previously, the remaining transverse drainage infrastructure will be designed to provide capacity for a 100 year ARI event. Ongoing environmental input will be required during design development to minimise the environmental impacts from the construction of this infrastructure.

These drainage lines, which exclude the four larger waterways discussed above and two unnamed tributaries of Jackass Creek near the Woondum Interchange, are mapped as green waterways under the DAFF Guide for the determination of waterways. As a result, the assessment requirements for works in these locations will be self-assessable under the relevant code.

9.3.3 Construction Impacts and Mitigation Measures

Both Traveston Creek and Jackass Creek are permanent waterways, with Kybong Creek, Cobb's Gully and the minor drainage lines being ephemeral in nature. Where construction of the crossings will require in stream works, these have a high risk of creating erosion and reducing water quality downstream of the crossing.

Management measures that may be implemented during the construction period include:

- Undertaking works in periods of low or no flow. As noted in **Chapter 5 – Climate**, works in waterways should be programmed for the period between April and September when rainfall and erosivity is likely to be lowest.
- Minimising disturbance of the bed and banks of waterways and drainage lines to the crossing width required to complete the works.
- Where flow is present during construction, additional management measures may include:
  - Construction of temporary diversions, coffer dams or isolation barriers.
  - Use of silt curtains to minimise turbidity and sediment build up downstream of the construction site.
  - Construction of run-off bunds where necessary to prevent run-off due to construction water entering the waterway.
  - Covering of any local drains with a geotextile membrane to prevent entry of sediment into the drain.
  - Regular inspection for erosion in susceptible areas around the bridge crossing, including creek banks, access tracks and construction areas.
  - Monitoring to assess and manage water quality downstream of the crossing against agreed trigger levels throughout the construction and rehabilitation period. Further details are included in **Chapter 7 – Aquatic Ecology and Water Quality**.
  - Works should be undertaken in accordance with the Code for self-assessable development – Minor waterway barrier works (DAFF, 2013) or the conditions contained in development approvals.

Following construction, rehabilitation measures may include:

- Removal of all spoil and discarded construction material from site.
- Grading of all batters and surfaces.
- Removal of temporary facilities.
- Revegetation of all disturbed sites in accordance with a Rehabilitation Plan agreed for the Project. The Rehabilitation Plan shall be developed in accordance with the TMR Landscape and Revegetation Works Technical Standard suite.

9.3.4 Summary of Mitigation Measures

A summary of the impacts and mitigation measures associated with the hydrology aspects of the project is provided in **Table 9-4**.

Table 9-4: Potential impacts and proposed mitigation measures.

Potential Impact	Description	Proposed Mitigation Measures
Operational Impacts		
Reduction in water quality downstream of waterway and drainage line crossings	Water quality may be impacted downstream of the waterway crossings through increased turbidity or contamination from road runoff.	Drainage management measures will be required at the crossing sites to prevent road run-off entering waterways or drainage lines. These may include: • No installation of scuppers at the bridge crossings. • Installation of run-off barriers at culvert crossings. • Installation of treatment train controls in accordance with the TMR Road Drainage Design Manual to treat road runoff. • Directing of flows to capture areas at the side of the alignment. Further details in this regard are included in **Chapter 7 – Aquatic Ecology and Water Quality**.
Increase in erosion resulting from increased flow velocity in Traveston Creek and Kybong Creek following realignment in the vicinity of the crossing.	An increase in flow velocity from realignment of Traveston and Kybong Creek is a high environmental risk to the Project of increasing erosion of the bed and banks of the creek, reducing water quality downstream of the crossing, and impeding fish passage.	Ongoing environmental inputs will be required during design development to minimise the environmental impacts from the realignment of Traveston and Kybong Creek. Design of waterway diversions at Traveston Creek and Kybong Creek should be refined during Preliminary Design to maintain natural hydraulic gradient to minimise changes to flow velocities. Management measures will be required to reduce the velocity of flows to as close to natural levels as possible. At Traveston Creek, these may include: • Widening the flow-path. • Introduction of rock in the creek bed. At Kybong Creek, these may include: • Placement of rocks in the base of the culvert. • Installation of riffle pools downstream to slow outlet flows. • Installation of baffles that provide for fish passage. Scour protection measures in accordance with MRTS03 will be required to prevent damage to the bed and banks of the realigned creeks. These are likely to include a rock apron downstream of the crossings, with rock armouring installed at bed level to avoid creating a barrier to fish passage. Works should be undertaken in accordance with the Code for self-assessable development – Minor waterway barrier works (DAFF, 2013).

Potential Impact	Description	Proposed Mitigation Measures
Erosion and scour at waterway crossings and drainage lines from installation of crossing structures and drainage infrastructure.	There is potential for the installation of bridge piers within Traveston Creek and Jackass Creek. There is a risk that these piers may alter the hydrology and current patterns of the creek causing erosion and scouring of the bed and banks, and around the bridge structures. There is potential for minor scouring at the inlet and outlet of Cobb's Gully.	• Where bridge piers are required within the waterway, they will be designed with and orientation to maximise hydraulic efficiency. • Scour protection measures in accordance with MRTS03, such as rock armouring, may be required to protect the bed and banks and crossing structures. • Ongoing environmental inputs will be required during design development to minimise the environmental impacts from the construction of all crossing structures and drainage infrastructure. • Works should be undertaken in accordance with the Code for self-assessable development – Minor waterway barrier works (DAFF, 2013).
Upstream flooding at crossing points.	Crossing or drainage design creates upstream afflux resulting in flooding of property in the zone of influence.	• Final design for the waterway crossings will limit the upstream afflux zone to within acceptable limits to avoid adverse impacts on third party properties. • Additional hydrologic modelling will be undertaken during design development to further assess potential impacts.
Construction Impacts		
Erosion and reduction of water quality downstream of crossing points	Where construction of crossings will require in stream works or diversion of channels, these have a high risk of creating erosion and reducing water quality downstream of crossing points.	For all waterway and drainage line crossings, works should be undertaken in periods of low or no flow. Minimise disturbance of the bed and banks of waterways and drainage lines to the crossing width required to complete the works. Where flow is present during construction, additional management measures may include: • Construction of temporary diversions, coffer dams or isolation barriers. • Monitoring to assess and manage water quality downstream of the crossing against agreed trigger levels throughout the construction and rehabilitation period. Further details of this are included in the Chapter 7 – Aquatic Ecology. • Works should be undertaken in accordance with the Code for self-assessable development – Minor waterway barrier works (DAFF, 2013). Following construction, rehabilitation measures will include: • Removal of all spoil and discarded construction material from site. • Grading of all batters and surfaces. • Removal of temporary facilities. • Revegetation of all disturbed sites in accordance with a Rehabilitation Plan developed in accordance with the TMR Landscape and Revegetation Works Technical Standard suite (MRTS 16, and 16A through 16E).

10. Noise

10.1 Introduction

This section provides a preliminary assessment of potential noise impact associated with the Project.

Noise is considered as a low risk for this project as there are limited numbers of noise sensitive receptors along the proposed corridor. Therefore, TMR required a qualitative noise assessment only for the business case. A detailed assessment of potential noise impacts will be undertaken later in the project development supported by noise monitoring and modelling.

The potential noise impact associated with the Project has been assessed by:

- The review of legislative requirements and guidelines that may be applicable to noise from the motorway upgrade
- A description of the methodology used in assessing potential traffic noise impacts
- An estimate of the likely future traffic noise level from the Project
- An analysis and discussion of the potential traffic noise impacts
- Provision of recommendations regarding opportunities, constraints, and future actions for the Project.

Only indicative traffic noise levels are provided as predictions do not incorporate topography in the noise prediction.

10.2 Noise Criteria

10.2.1 Operational Traffic Noise Criteria

The *Environmental Protection Act 1994* (EP Act) provides for the protection of Queensland‘s environment while allowing for development in accordance with the principles of ecologically sustainable development. Since the introduction of the EP Act by the Queensland Government, a number of supporting documents have been developed to assist in preventing adverse impacts on Queensland’s acoustic environment.

The *Transport Infrastructure Act 1994* (TI Act) provides a regime that allows for and encourages effective integrated planning and efficient management of a system of transport infrastructure. In particular, the objective of this TI Act is to establish a regime under which impacts on development from environmental emissions generated by State-controlled roads are addressed.

The TMR Road Traffic Noise Management: Code of Practice (January 2008) outlines criteria for the control of road traffic noise at existing and approved future sensitive receptor locations as a result of road projects.

Table 10-1 and **Table 10-2** present the noise level criteria relevant to the Project for new roads and the upgrade of existing roads respectively.

Table 10-1: Road Traffic Noise Criteria for New Access Controlled Roads.

Receptor Type	Predicted (or Measured) Road Traffic Noise Level	Consideration for Noise Attenuation
Existing Residential Dwelling	If external noise level LA10 (18 hour) > 63 dB(A) and an increase of at least 3 dB(A) above the pre-construction levels greater than 55dB(A)[a] If external noise level LA10 (18 hour) > 60 dB(A) and an increase of at least 6 dB(A) above the pre-construction levels of 55 dB(A)a or less	Aim to reduce levels to LA10 (18 hour) ≤ 63 dB(A) Aim to reduce levels to LA10 (18 hour) ≤ 60 dB(A)
Educational, Community and Health Buildings	If external noise level LA10 (1 hour) > 55dB(A)	Aim to reduce external noise level to LA10 (1 hour) ≤ 55 dB(A)
Parks, Outdoor Educational and Recreational Areas	If external noise > LA10 (12 hour) 63 dB(A)	Aim to reduce noise level to LA10 (12 hour) ≤ 63 dB(A)

[a] Predicted or measured at 1 metre in front of the most exposed facade of the dwelling within the 10 year period following upgrading

Table 10-2: Road Traffic Noise Criteria for Existing Roads and Road Upgrades.

Receptor Type	Predicted (or Measured) Road Traffic Noise Levela	Consideration for Noise Attenuation
Existing Residential Dwelling	If external noise level LA10 (18 hour) > 68 dB(A)	Aim to reduce levels to LA10 (18 hour) ≤ 68 dB(A)
Educational, Community and Health Buildings	If external noise level LA10 (1 hour) > 63 dB(A)	Aim to reduce external noise level to LA10 (1 hour) ≤ 63 dB(A)
Parks, Outdoor Educational and Recreational Areas	If external noise level LA10 (12 hour) > 63 dB(A)	Aim to reduce noise level to LA10 (12 hour) ≤ 63 dB(A)

[a] Predicted or measured at 1m in front of the most exposed facade of the dwelling within the ten year period following upgrading

10.2.1.1 Project Specific Traffic Noise Criteria

The majority of the Project is located within a new road corridor and the traffic noise criteria for New Access Roads (refer to **Table 10-1**) will apply. Noise monitoring to be conducted in future development of the project will determine whether the $L_{A10\ (18\ hour)}$ 60 dB(A) or 63dB(A) criteria should apply.

For the section that is within the existing road corridor, the $L_{A10\ (18\ hour)}$ 68dB(A) noise criteria will be applicable.

10.2.2 Construction Guidelines

There are currently no construction specific noise criteria in Queensland, other than for noise from blasting. The Environmental Protection (Noise) Policy 2008 (EPP (Noise)) establishes acoustic quality objectives for enhancing or protecting the environmental values that can be used as a guide in the assessment for potential noise impacts from construction activities. The acoustic quality objectives contained in Schedule 1 of the EPP (Noise) for sensitive receptors in the Project area are reproduced in **Table 10-3**.

Table 10-3: Schedule 1 – Acoustic Quality Objectives.

Sensitive receptor	Time of day	Acoustic quality objective (measured at the receptor) dB(A)			Environmental value
		$L_{Aeq,adj,1hr}$	$L_{Aeq,adj,1hr}$	$L_{Aeq,adj,1hr}$	
Dwelling (for outdoors)	daytime and evening[a]	50	55	65	health and wellbeing
Dwelling (for indoors)	daytime and evening	35	40	45	health and wellbeing
Dwelling (for indoors)	night-time[a]	30	35	40	health and wellbeing, in relation to the ability to sleep
Library and educational institution (including a school, college and university) (for indoors)	when open for business or when classes are being offered	35			health and wellbeing
Park or garden that is open to the public for use other than for sport or organised entertainment	anytime	the level of noise that preserves the amenity of the existing park or garden	the level of noise that preserves the amenity of the existing park or garden	the level of noise that preserves the amenity of the existing park or garden	community amenity

Notes: [a] Day time, evening and night are defined as 7 am to 6 pm, 6 pm to 10 pm and 10 pm to 7 am respectively.

These acoustic quality objectives are not aimed for the control and management of construction noise and are only used as a guide.

10.3 Existing Environment

10.3.1 Local Setting and Sensitive Receptors

Noise sensitive receptors are defined as locations which have the potential to be impacted by noise emissions from the Project.

Noise sensitive receptors include:

- Residences
- Local businesses (e.g. real estate, pet store)
- Medical institutions (e.g. hospitals and surgeries)
- Recreational facilities (e.g. parks and sports grounds).

The nearest sensitive receptors to the project were identified from aerial photography. The locations of the nearest sensitive receptors are presented in **Section 2 – Project Description**.

10.4 Potential Impacts and Mitigation Measures

10.4.1 Traffic Noise Prediction

This section of the report presents the traffic noise estimation process, the traffic data used in estimation and the estimated traffic noise levels at the identified noise sensitive places adjacent to the proposed road corridor.

10.4.1.1 Traffic Noise Estimation

Noise monitoring has not been undertaken as detailed assessment of potential noise impacts will be undertaken later in the project development. Therefore, indicative traffic noise levels only have been provided and the noise level predictions do not incorporate the effect of topography.

Road traffic noise levels were estimated using the UK Department of Transport (1988) 'Calculation of Road Traffic Noise' method (CoRTN), which predicts $L_{A10,\ 18\ hour}$ values. $L_{A10,\ 18\ hour}$ is the arithmetic average of L_{A10} hourly values for each of the eighteen one-hour periods between 6 am and 12 midnight. The CoRTN algorithm is the preferred calculation method prescribed in TMR's Code of Practice.

The traffic noise levels were estimated using the following information and assumptions:

- Proposed road design with no topographical information
- Open graded asphalt (OGA) road surface
- Aerial imagery, and building and cadastral data
- Traffic data for the year of opening (2020) and 10 years post opening (2030).

Traffic Data

Traffic data for the year of opening (2020) and 10 years post construction (2030) are shown in **Table 10-4**.

Table 10-4: Projected Traffic Numbers for the Project.

Year	AADT (number of vehicles)	Heavy Vehicle Percentage (%)	Posted speed limit (km/h)
Opening year 2020	17,800	25%	80 - 110
10 years post construction 2030	25,400	25%	80 - 110

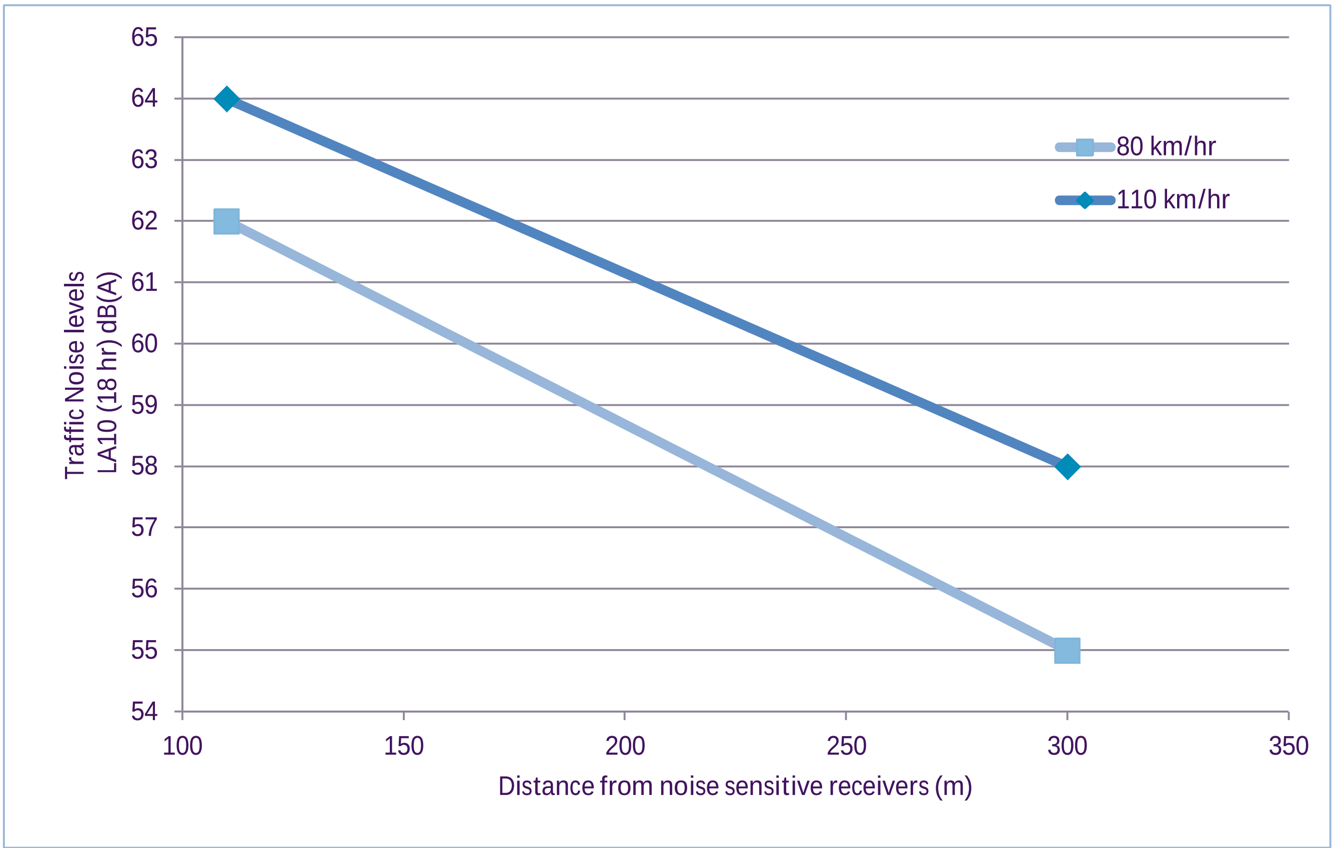
Predicted Noise Levels

There are approximately 34 noise sensitive receptors located between 50 and 400 metres from the proposed alignment. The estimated range of year 2030 traffic noise levels at the noise sensitive receptors are tabulated in **Table 10-5** and graphically presented in **Figure 10-1**.

Table 10-5: Estimated Year 2030 Traffic Noise Levels at the Noise Sensitive Receptors.

Posted speed limit (km/hr)	Distance from noise sensitive receptors (m)	Traffic Noise Levels LA10,18 hour dB(A)
80	110	62
80	300	55
110	110	64
110	300	58

Figure 10-1: Estimated Traffic Noise Levels for Different Speed Limits.



The predicted year 2030 traffic noise levels from the Project are estimated to range between $L_{A10,\ 18\ hour}$ 55 and 64 dB(A) at the noise sensitive receptors, dependent on distance from the road alignment and posted speed limits.

At these levels, future traffic noise levels from the Project may comply or exceed the noise criteria depending on the applicable noise criteria determined from future noise monitoring and whether the relevant section is within or outside the existing road corridor. It should be noted that these estimated noise levels are indicative only as predictions did not incorporate the effect of topography.

10.4.2 Construction Noise

Construction noise at sensitive receptors will vary with the distance from construction activities, the type and number of equipment operating, topographical shielding and meteorological influences. Detailed construction and earthworks schedules were not assessed in this study and this section of the report discusses typical noise levels from common construction equipment and considerations for construction noise management.

Key construction activities having the potential to generate noise may include:

- Earth moving
- Materials handling
- Use of compressors and generators
- Compacting.

Table 10-6 shows indicative sound power levels of different equipment that may be used for the activities listed above. Based on the sound power data, indicative noise levels were calculated for a range of distances from the equipment.

Table 10-6: Typical A-weighted sound power levels from site equipment (AS 2436-2010) and estimated noise levels at distance 'R' from the equipment.

Plant	Avg measured $L_w(A)$ dB(A), ref10^{-12}W	Estimated A-weighted noise levels at distance 'R' from the source, in dB(A)					
		50 m	100 m	150 m	500 m	1000 m	1500 m
Earth moving equipment							
Bulldozer	108	66	60	56	46	40	36
Excavator	107	65	59	55	45	39	35
Grader	110	68	62	58	48	42	38
Scraper	116	74	68	64	54	48	44
Materials handling							
Concrete pump truck	108	66	60	56	46	40	36
Loader (wheeled)	105	63	57	53	43	37	33
Crane (mobile)	104	62	56	52	42	36	32
Truck (dump)	117	75	69	65	55	49	45
Compressor and generator							
Compressor (silenced)	101	59	53	49	39	33	29
Generator (diesel)	99	57	51	47	37	31	27
Compactor							
Rock breaker	118	76	70	66	56	50	46
Compactor	113	71	65	61	51	45	41

Construction may be as close as 50 metres from sensitive receptors and construction activities have the potential to exceed the recommended noise levels presented in (EPP (Noise)) at the nearby noise sensitive receptors. There is a greater potential for noise impacts where construction activities are to occur at night time. To minimise potential noise impacts, the noise control measures outlined in **Section 10.4.4** may be considered when establishing the construction noise management plan.

10.4.3 Construction Vibration

It is difficult to predict ground vibration levels accurately due to the dependence of vibration transmissibility on soil type and intervening geology. The most common way to minimise ground vibration impact is to maintain an adequate buffer distance between the vibration source and receptor.

As blasting is likely to be required for the Project, vibration and airblast may impact on nearby sensitive receptors. Blasting will be carried out in accordance with MRTS55 – Use of Explosives in Roadworks and will include:

- Consultation with Gympie Regional Council
- Pre-construction building condition surveys of potentially impacted properties and structures
- Design of blasts in accordance with vibration and airblast overpressure limits
- Monitoring of blasts to determine compliance with vibration and airblast overpressure limits.

Operation of construction plant may also result in vibration impacts on nearby properties and structures. For construction work that involves the use of heavy vibratory rollers, a buffer distance of at least 20 metres is recommended.

It is recommended that ground vibration monitoring also be performed during the construction works when in close proximity to dwellings.

10.4.4 Construction Noise Mitigation

Detailed construction and earthworks schedules were not available during this study. A detailed construction noise management plan should therefore be prepared prior to the construction phase of the Project. Construction activities occurring close to sensitive receptors will require noise mitigation where noise impacts are predicted. Potential mitigation options for construction noise include:

- Use of more efficient exhausts or silencers on equipment engines.
- Scheduling of noise intensive activities (such as rock breaking) during the day, between 7 am and 6 pm.
- Equipment not being used to be turned off and not left idling for long periods of time.
- Construction of temporary noise walls where extended periods of noise intensive activities will occur near residents.
- Use of earth bunds or material stockpiles as noise barriers as practicable.
- Where night time construction activities are necessary, noise should be managed in conjunction with the local community.
- Stationary plant, which emits noise strongly in one direction, should be positioned so noise is directed away from noise sensitive areas.
- Locate material lay down areas away from sensitive receptor locations.
- Application of effective acoustic enclosures for noisy pieces of equipment such as rock drills and diesel power plants, especially for night time construction works if required
- Replacement of regular reversing beepers with ‘quacker’ or ‘Broadband’ reversing alarms by reverse alarms with a self- volume adjusting function.
- Periodic noise monitoring during noise intensive activities, especially at the commencement stage of long term noise intensive works.
- Possible provision of temporary alternative accommodation (if other mitigation measures are ineffective) for occupants of noise sensitive receptors.
- If permanent noise barriers are to be installed these could be constructed early in the process to reduce noise levels at sensitive receptors.
- It is recommended that construction activities are to be carried out in general accordance with the construction noise control guidelines described in the Australian Standard AS 2436-2010.

10.4.5 Further Investigations

During further design development a detailed traffic noise assessment is recommended and should include:

- Detailed noise monitoring information sessions at selected noise sensitive receptors within the vicinity of the Project.
- 3D noise modelling which incorporates topography to predict the potential noise impacts for individual sensitive receptors in the vicinity of the Project.
- Examination presentation of noise mitigation options where required.
- Identification of potential impacts of blasting on nearby properties and structures.
- Pre-construction building condition surveys of potentially impacted properties and structures.
- Detailed investigation of potential construction noise and vibration issues upon availability of construction equipment and construction details.

11. Air Quality

11.1 Introduction

This chapter provides a qualitative assessment of the potential air quality impacts of the Project.

The objectives of this assessment were to:

- Conduct a review of air quality objectives and qualitatively assess the air quality impact of the Project.
- Describe the existing environment including local setting, meteorology and air quality.
- Conduct a qualitative air quality assessment for the construction of the Project and operation of the proposed road.
- Identify mitigation measures for potential air quality impacts of the Project.

Air quality monitoring and modelling was not completed for this assessment as the Project team identified air quality impacts as a low risk for the Project. Further investigations will be carried out during the development phase if required.

11.2 Air Quality Objectives

The *Environmental Protection Act 1994* provides for the management of the air environment in Queensland. Air quality objectives are specified by the Department Environment and Heritage Protection (DEHP) in the Queensland *Environment Protection (Air) Policy 2008* (EPP(Air)).

In December 2009, TMR produced the *Road Traffic Air Quality Management Manual*. This guideline sets out the obligations, goals and procedures relevant to the prediction and management of air quality impacts of air pollutant emissions associated with State-controlled roads in Queensland.

The ambient air quality objectives that should not be exceeded at sensitive receptor locations are presented in **Table 11-1**. The guideline levels are taken from Table 3.3.1 of the *Road Traffic Air Quality Management Manual* (DTMR, 2009) and have been developed from the air quality objectives in the Environmental Protection (Air) Policy 2008 (EPP (Air)).

Table 11-1: Ambient Air Quality Objectives.

Pollutant	Air Quality Objective		Averaging time	Allowable Exceedance
Nitrogen dioxide (NO2)	250 µg/m3	0.12 ppm	1 hr	1 day per year
	62 µg/m3	0.03 ppm	1 yr	none
Sulphur dioxide (SO2)	570 µg/m3	0.2 ppm	1 hour	1 day each year
	230 µg/m3	0.08 ppm	24 hours	1 day each year
	57 µg/m3	0.02 ppm	1 yr	none
Particles (as TSP)	90	-	1 yr	none
PM10	50 µg/m3	-	24 hours	5 days each year
PM2.5	25 µg/m3	-	24 hours	none
	8 µg/m3	-	1 yr	none
Insoluble dust deposition	4 g/m2/month	-	1 month	none
Carbon monoxide (CO)	11,000 µg/m3	9 ppm	8 hr	none
Benzene	10 µg/m3	0.003 ppm	1 yr	none

11.3 Existing Environment

11.3.1 Local Setting and Sensitive Receptors

Sensitive receptors are locations which have the potential to be impacted by air emissions from a project. Air quality sensitive receptors include:

- Residences
- Local businesses (e.g. real estate, pet store)
- Medical institutions (e.g. hospitals and surgeries)
- Recreational facilities (e.g. parks and sports grounds).

The nearest sensitive receptors to the project were identified from aerial photography. The locations of the nearest sensitive receptors are presented in **Section 2 – Project Description**.

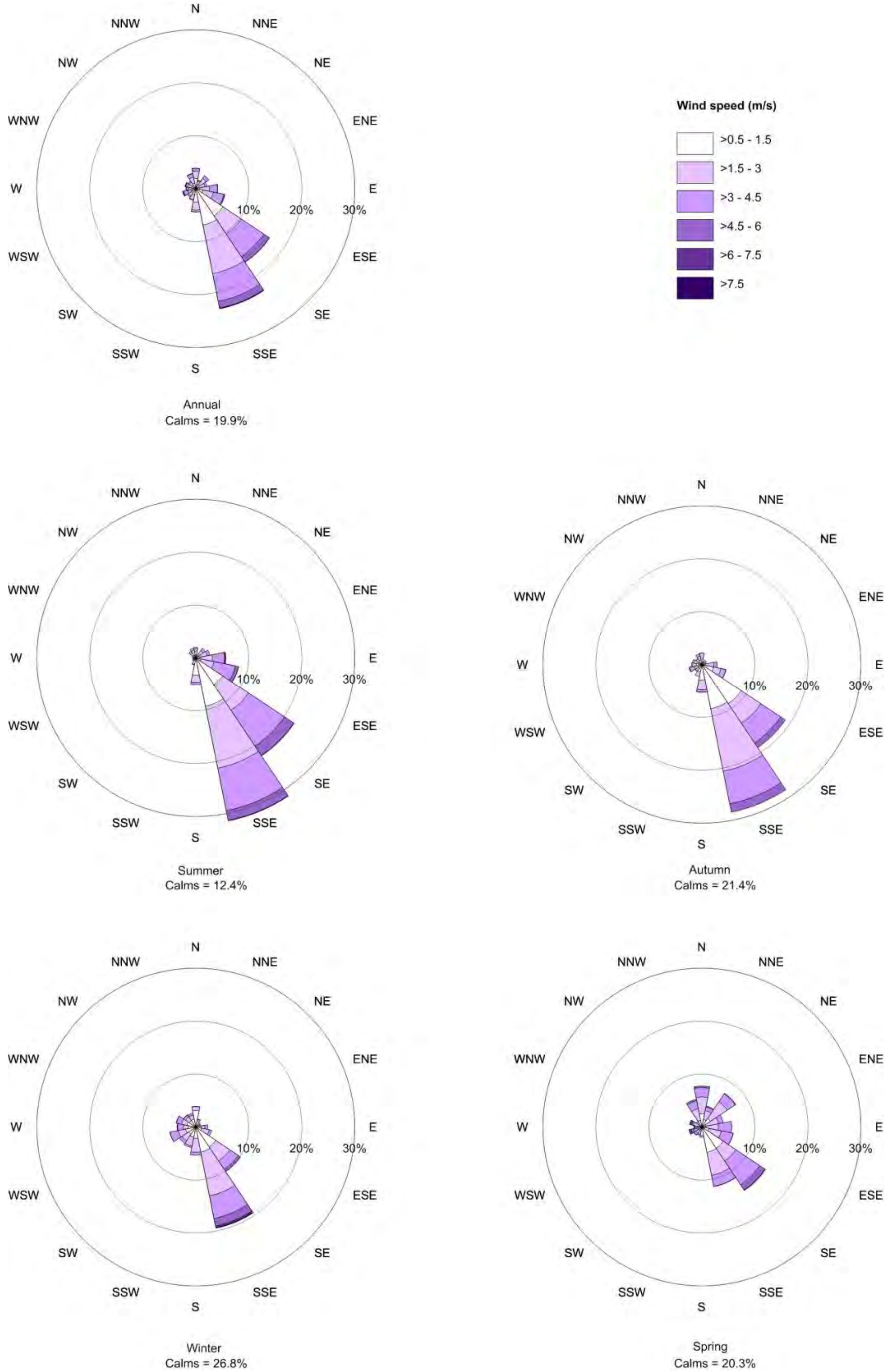
11.3.2 Regional Climate and Dispersion Meteorology

The climate in the Gympie region has been described in **Chapter 5 – Climate**. The dispersion meteorology may influence localised air quality impacts, and is described based on meteorological data collected by the Bureau of Meteorology (BoM) at Gympie.

The wind roses show the frequency of occurrence of winds by direction and strength (refer to **Figure 11-1**). The wind roses indicate that there are dominant winds from the south to southeast in summer, autumn and spring. The winter months also contain a high frequency of south-easterly winds with a small percentage of winds from north to northeast.

The sensitive receptors most likely to be affected by air quality impacts from the Project will be positioned in the northwest of the road corridor.

Figure 11-1: Seasonal and annual wind roses for Gympie BoM station.



11.3.3 Existing Air Quality

Existing air quality in the project area is influenced by local sources of air emissions. The following sources contribute to air emissions within the project area:

- Motor vehicle exhaust emissions from cars and trucks using the existing Bruce Highway and local roads
- Motor vehicle emissions from roads near the Project
- Occasional bushfires and controlled burns
- Biogenic emissions from vegetation.

A review of the DEHP website identified Mountain Creek as the closest monitoring station to describe the air quality in the vicinity of the Project. The monitoring station is approximately 36 kilometres southeast of Cooroy and continuously measures nitrogen dioxide (NO_2) and particulate matter with an aerodynamic radius of less than ten microns (PM_{10}), which are key assessment pollutants for the Project.

The Woolloongabba monitoring station has been reviewed to obtain background air quality data for carbon monoxide (CO). The Woolloongabba station is located approximately 140 kilometres south of the Project and is adjacent to major roads in a highly trafficked area. Pollutant concentrations at the Woolloongabba station are predicted to be significantly higher than for sensitive receptors in the vicinity of the Project.

A summary of the ambient air quality from the Mountain Creek and Woolloongabba are provided below in **Table** 11-2. The air quality monitoring data for NO_2 and CO have been below the ambient air quality guidelines over a five year period. The maximum air quality concentrations for PM_{10} (2008 and 2009) have exceeded the ambient air quality goals. The exceedance for PM_{10} has generally been the result of either dust storms or bushfire events (DERM 2008, 2009).

Table 11-2: Summary of DEHP ambient air quality monitoring at Mountain Creek and Woolloongabba.

Pollutant	Criteria	Year	Concentrations (µg/m^3)		
			Max	Max	Max
Nitrogen Dioxide (NO2) (Mountain Creek)	250 µg/m^3, 1 hr	2011	65.6	43.0	NA
		2010	59.5	43.1	18.5
		2009	61.5	43.1	16.4
		2008	61.5	43.1	20.5
		2007	69.7	45.1	18.5
PM10 (Mountain Creek)	50 µg/m^3, 24 hrs	2011	49.5	19.3	12.6
		2010	33.7	18.9	12.6
		2009	863.8	24.7	14.5
		2008	53.3	23.4	14.9
		2007	41.9	21.1	13.7
Carbon Monoxide (CO) (Woolloongabba)	11, 000 µg/m^3, 8 hrs	2011	2,375	1,250	750
		2010	3,375	1,375	500
		2009	3,000	1,875	625
		2008	3,625	2,250	625
		2007	1,375	1,250	875

11.4 Potential Impacts and Mitigation Measures

11.4.1 Impacts from Construction

There are two main sources of emissions that can have an impact on localised air quality during the construction phase of the project. They are dust generated from surface works activity and combustion emissions from light vehicles and heavy machinery.

Dust generation from construction activities has the potential to cause nuisance to nearby sensitive receptors. The main sources of dust are likely to be from topsoil stripping, windblown dust from exposed areas and stockpiles, and wheel generated dust from light and heavy vehicles driving on exposed soil roads and access tracks.

The dust emissions are likely to have temporary short term impacts in the vicinity of the Project during construction.

The emissions from vehicles and machinery during construction are primarily associated with the products of combustion of diesel and, to a lesser extent, unleaded fuel. The common pollutants resulting from combustion include:

- Particulate matter (as PM_{10} and $PM_{2.5}$)
- CO
- NO_2
- Sulfur dioxide (SO_2)
- Volatile organic compounds (VOCs) and polyatomic aromatic hydrocarbons (PAHs)
- Metals.

Discharges to air of dust and combustion emissions during construction are primarily a management issue and can be minimised with good management practices such as regular watering of access tracks, and servicing of heavy machinery. It is considered unlikely that construction activities will result in exceedance of the air quality objectives described in EPP (Air).

11.4.2 Impacts from Operation

The primary air pollution source associated with operation of the proposed project is likely to be emissions from fuel combustion in vehicles. As discussed above, the main air pollutants of concern in vehicle emissions are the products of combustion.

The factors which influence emissions from vehicles include the mode of travel (stop start nature of traffic flow), the grade of the road, the type of vehicles using the road, and the age and design of the vehicle.

Roadside air quality monitoring has been undertaken by the EPA (Neale and Wainwright 2001) at a number of locations adjacent to major roads carrying vehicles with varying traffic mix, flow and speed conditions. The 99^{th} percentile concentrations for CO, NO_2 and PM_{10} for each monitoring site, along with information relevant to whether the site may have been influenced by vehicle emissions, is presented in **Table 11-3**. The potential air quality impacts from the operation of the Project have been assessed qualitatively based on air quality monitoring data recorded near roadsides in southeast Queensland.

Table 11-3: Locations of roadside air quality monitoring.

Site	Road	Distance from kerb (m)	Traffic Volume (max 24 hr)	Speed Limit (km/hr)	%CV	At Inter-section	99th % Concentrations		
							CO (8 hr)	NO_2 (1 hr)	PM_{10} (24 hr)
Woolloongabba	Ipswich Road	11	43,500	60	16	Yes	7,500	97	36
Fortitude Valley	Ann Street	19	33,100	60	13	Yes	2,125	111	40
Mount Gravatt	Logan Road	14	30,700	60	5	No	1,625	47	28
Dutton Park	Annerley Road	14	20,400	60	7	No	2,750	92	22
Graceville	Oxley Road	16	16,600	60	4	No	2,625	74	24
Alderley	Enoggera Road	11	48,500	60	6	Yes	3,375	78	30
Coorparoo	Stanley Street East	14	39,700	60	5	Yes	2,500	70	31
Bowen Hills	Bowen Bridge Road	16	71,800	60	8	Yes	3,875	64	33
Coopers Plains	Beaudesert Road	15	45,500	60	14	No	1,875	84	70
Virginia	Sandgate Road	16	62,200	60	9	No	3,875	99	35
Goodna	Ipswich Motorway	20	76,600	100	10	No	2,625	117	42
Tingalpa	Wynnum Road	10	43,700	60	7	Yes	2,875	70	24
Nundah	Sandgate Road	1	38,700	60	7	Yes	10750	88	-

The roadside monitoring study found:

- CO concentrations were generally below EPP (Air) goals at each of the sites. The only exceedance of the CO standard occurred at Sandgate Road, Nundah, due to the restricted dispersion of emissions occurring in the 'street canyon' environment (and possibly because of the close proximity of the sampling point to the kerb).
- No exceedances of the NO_2 standards were measured at any of the roadside monitoring sites, even under conditions conducive to an accumulation of NO_2.
- Roadside concentrations of NO_2 were similar to ambient air quality concentrations to those recorded at the monitoring sites at Eagle Farm, Brisbane central business district and Rocklea.
- Maximum PM_{10} concentration at Beaudesert Road, Coopers Plains, exceeded the National Environmental Protection Measures (NEPM) and EPP (Air) goal. Heavy vehicles make up 14% of traffic on this road and the monitoring station was located adjacent to a section of Beaudesert Road where vehicles often come to a stop for traffic lights and were then required to accelerate from a stationary position.

The historical and projected traffic numbers has been presented in **Table 11-4**. The annual average daily traffic (AADT) data has been collected from a permanent traffic counter (PTC) site on the Bruce Highway at Six Mile Creek for 2010. The PTC site is located at the northern end of Section C and is considered representative of the traffic numbers for Section C of the Project.

Table 11-4: Projected traffic numbers for the Project.

Year	AADT (number of vehicles)	Heavy Vehicle Percentage (%)
Historical year 2010	15,420	22%
Opening year 2020	17,800	25%
Projected year 2030	25,400	25%
Projected year 2050	45,800	25%

A gradual increase in daily traffic is forecast for the period from 2010 to 2020 with a large increase in the 2050 projected year with approximately 3 times the amount of vehicles than current traffic conditions. The forecasted traffic in 2050 is similar to the vehicle count at Woolloongabba and Coopers Plain (refer **Table 11-3**) and assessed as part of the roadside air quality study undertaken by the Environmental Protection Agency (EPA) (now referred to as Department of Environment and Heritage Protection) (Neale and Wainwright 2001). The measured pollutant concentrations at these two sites are considered representative of potential for air quality impacts from the Project.

The 99th percentile concentrations as shown in the table were below the air quality objectives in the EPP(Air) for NO_2 and CO. The 99th percentile 24 hour average PM_{10} concentration at Coopers Plains exceeded the air quality objective in the EPP (Air). The exceedance was attributed to the stop start nature of the traffic near the monitoring station and the high percentage of heavy vehicle traffic.

Comparison of the expected air quality impacts at the Project with the locations presented in **Table 11-3** is considered a conservative approach. The Project location will have much higher average speed and is freer flowing than Coopers Plains and will not have the same localised air quality impacts from constant stopping and acceleration. Furthermore the closest existing sensitive receiver to the Project is much further away from the source (114 m) than the roadside monitoring data in **Table 11-3**.

Over the last 10 years there have been improvements in air quality and it is generally accepted that the increasing proportion of vehicles meeting tighter emission standards can play a major part in these air quality improvements (DIT 2012).

It is unlikely the operation of the project will result in exceedance of the air quality objectives described in EPP (Air).

11.4.3 Mitigation Measures

The potential impacts on local air quality from construction of the project and recommended mitigation measures are presented below in **Table 11-5**.

Table 11-5: Proposed mitigation measures.

Potential Impact	Project Phase	Proposed Mitigation Measures
Nuisance dust from surface works	Construction	• Avoid undertaking works during dry and windy conditions (winds >10 m/s).
Wheel generated dust		• Dust suppression by regular water spraying.
Dust emissions from exposed areas		• Regular water spraying or covering of exposed surfaces • Minimising areas of cleared or disturbed land • Exposed areas to be re-vegetated soon as practically possible
Combustion emissions		• Plant or equipment are not to be parked idling for extended periods of time • Maintaining operation and exhaust systems of construction plant, vehicles and machinery in accordance with manufacturer's recommendations to minimise emissions to the atmosphere

11.5 Summary

This report has qualitatively assessed the air quality impacts of the Project. It is unlikely that the air emissions from the construction and operation of the project will result in exceedance of the air quality objectives in the EPP (Air). The mitigation measures are considered adequate to further control any localised impacts on air quality.

12. Waste Management

12.1 Introduction

The purpose of this Chapter is to provide an assessment of the potential wastes that will be generated by the Project, including a discussion of the impacts and management measures recommended for those wastes.

The assessment methodology implemented for the Project comprised:

- Identification of potential wastes generated by the Project, using waste management data reported from the construction of Section B of the Cooroy to Curra project
- Assessment of the potential environmental impacts caused by the generation and handling of the wastes
- Identification of appropriate management measures to reduce the level of environmental risk associated with managing the wastes. This includes requirements such as storage, transport, treatment disposal and documentation.

Specific legislation in relation to the overall project including waste management is identified in Chapter 14 – Legislative Requirements. However, the main set of legislation that applies to waste management in Queensland is:

- *Environmental Protection Act 1994*
- *Environmental Protection Regulation 2008*
- *Environmental Protection (Waste Management) Regulation 2000*
- *Waste Reduction and Recycling Act 2011*
- *Waste Reduction and Recycling Regulation 2011.*

In late 2010, Queensland's *Waste Reduction and Recycling Strategy 2010-2020* was introduced to encourage an increased focus and commitment towards managing waste, including targets designed to reduce the volume of waste going to landfill.

12.2 Potential impacts of waste

The potential impacts associated with wastes generated by the Project are:

- Health risks and potential contamination of land, surface water and ground water from inappropriate storage and handling of hazardous substances
- Unnecessary transport and disposal of waste materials to landfill, with a resulting depletion of landfill space
- Increased costs associated with the mismanagement of resources such as vegetation and soils that can become contaminated and therefore classified as wastes
- Increased demand for raw materials during the construction process through lost opportunities for recycling construction materials
- Increased potential for environmental emergencies and incidents due to the handling of waste products.

12.3 Identification of potential wastes generated by the Project

An inventory of the wastes likely to be generated by the Project, including waste classifications and management measures is shown in **Table 12-1** below. An important aspect of waste management is to identify and assess each waste stream for potential reuse and recycling opportunities as an alternative to landfill disposal. The Construction Environmental Management Plan (EMP(C)) will provide details on how waste streams will be managed in terms of segregation, storage, collection and transportation, recycling and/or disposal.

Table 12-1: Potential wastes generated by the Project.

Waste type	Classification	Management measures
Cleared vegetation	Green waste	• Minimise the area required to be cleared through appropriate planning • Establish clear boundaries during the construction phase through the use of stakes, flags, hi-visibility tape, barrier mesh or earthen bunds • Undertake weed eradication prior to clearing vegetation to avoid weed seeds spreading throughout cleared vegetation • Stockpile cleared vegetation for later re-spreading or mulching across the disturbed area. Under no circumstances should the cleared vegetation be burnt or transported off-site to landfill • Avoid mixing the cleared vegetation with soils or any other foreign matter.
Unsuitable fill materials	General waste	• Materials unsuitable for fill should be verified as weed and contaminant free, and stockpiled on-site until a suitable destination is identified • Avoid mixing unsuitable fill with topsoils and subsoils. Use signposts to identify stockpiles.
Bitumen, road base aggregates	General waste	• Reuse during the road stabilisation process or on future projects
Waste concrete	General waste	• Minimise the generation of waste concrete through accurate estimation of required volumes • Reuse concrete where possible or return to supplier • Avoid concrete washouts on-site. If equipment/vehicles must be cleaned on-site, then perform the wash out in areas to be concreted next. If this is not possible, design and construct a temporary wash down area that ensures all concrete wastes are contained and collected via a geo-fabric liner.
Washdown waters and sludges	General waste	• Avoid the generation of wastewaters and sludge on-site by washing vehicles/machinery in purpose built areas available in most Council areas (weed wash down facilities and truck wash areas) • If site washdown is necessary, a temporary wash down bay (specific design) should be constructed to ensure weed seeds, concrete, silt, sediment and oily water is contained and removed for subsequent disposal. Any such facility should be constructed at least 50 metres away from watercourses and drainage lines.
Sediment and silt collected through drainage controls	General waste	• Reuse sediment/silt on site for landscaping and rehabilitation purposes
Food products, litter and other waste	General waste	• Stored in covered bins for collection and offsite disposal in landfill.

Waste type	Classification	Management measures
Contaminated soils	Regulated waste (cyanide, arsenic, hydrocarbons, other chemicals etc.)	• Stockpile in a secure bunded area at least 50 metres away from watercourses and drainage lines • Undertake testing to determine contaminant types and concentrations • If required during construction, off-site disposal of contaminated soils will require a permit under section 424 of the Environmental Protection Act 1994. • Contaminated soils should only be collected and transported by a licensed regulated waste transporter. Waste tracking documentation should be maintained to account for the final treatment and/or disposal of the soil. • Arrange collection by a licensed waste transporter for treatment and disposal according to contamination levels.
Containers contaminated with a regulated waste	Regulated waste	• Waste drums containing greater than 5% total volume of a regulated waste (including oil products) are classed as a regulated waste – do not wash out on-site • Return to supplier for reuse • Recycle at a suitable licensed facility.
Hydrocarbons & mineral oils, oily water mixtures and emulsions, spent spill kit materials and absorbents	Regulated wastes	• To be stored in bunded and covered facility in accordance with AS1940:2004 – The storage and handling of flammable and combustible liquids • Arrange for collection by a licensed contractor for offsite recycling or disposal. Waste tracking documentation to be maintained.
Batteries (lead-acid)	Regulated wastes	• Batteries are regulated wastes that can be transported in road vehicles loads under 250kg • Deliver batteries to a resource recovery facility (e.g. Council depot or approved collection service)
Tyres	Regulated wastes	• Avoid disposal to landfill as tyre recyclers are available • Treat as a regulated waste if quantities in excess of 250kg are being collected and transported by a road vehicle
Pesticides	Regulated wastes	• Storage and re-use of excess chemicals (e.g. solvents, herbicides) on future projects • Disposal must be in accordance with local government advice.
Hazardous wastes (not identified above)	Regulated wastes	• All hazardous liquid wastes will be stored in a bunded facility (compound, temporary or pallet) and flammable or combustible liquids are to be stored in a bund constructed in accordance with AS1940:2004 • To be managed in accordance with the requirements of the EP (Waste Management) Regulation • Disposal must be in accordance with local government advice.

Waste type	Classification	Management measures
Sewage sludge and residues, including night soil and septic tank sludge	Regulated wastes	• Collection by a licensed waste contractor for disposal at an appropriate licensed facility in accordance with local government requirements.
Timber pallets and skids	Recyclable	• Construction contractor will be responsible for returning timber skids and pallets to the supplier for recycling or re-use.
Metals (steel & aluminium scrap)	Recyclable	• To be segregated and collected by a licensed scrap metal recycler.
Waste drums with no hazardous residue	Recyclable	• Return to supplier for reuse • Recycle.
Paper & cardboard	Recyclable	• Stored in recycling bins for collection and recycling offsite.
Glass & plastics	Recyclable	• Maximise recycling opportunities if feasible at work sites

12.4 Waste Data – Cooroy to Curra Section B

The waste data shown in **Table 12-2** was provided by TMR for the previously constructed Section B Project.

Table 12-2: Section B waste data.

Waste type	Units	January 2012	February 2012	March 2012	April/May 2012
General waste sent to landfill	m^3	20	28	28	85
General recyclables (paper, plastic, aluminium	m^3	10	3	4	15
Photocopy boxes sent for reuse	Qty	7	13	17	32
Vegetation/timber waste reused on-site	m^3	17	0	1,000	90
Fill material/ Virgin Excavated Natural Material reused on-site	m^3	50,000	40,000	70,000	No data
Septic pump out (regulated waste)	Litres	11,800	33,100	71,100	105,600
Tyres (regulated waste)	Qty	No data	110	0	0
Oil filters	Qty	No data	2	0	0
Contaminated waste	m^3	No data	15	0	0
Printer cartridges	Qty	No data	No data	No data	16
Office batteries	Qty	No data	No data	No data	5

12.5 Facilities

There are a number of waste management facilities in the surrounding area of the Project capable of accepting the types of waste generated. A summary of the facilities located in the Sunshine Coast and Gympie Regional Councils is presented **Table 12-3** below.

Table 12-3: Summary of waste management facilities in the Project area

Types of waste	Cooroy	Eumundi	Pomona	Gympie
Construction and demolition waste disposal	No	Yes	No	Yes
Contaminated soil disposal (catchpit/silt trap waste/muddy water)	No. Clean only	Yes	No. Clean only	No. Clean only
Disposing of batteries and tyres	Yes	Yes	Yes	Yes
Disposing of commercial quantities	Yes	Yes	Yes	Yes
Disposal of liquid waste (20 L maximum)	No	Yes	No	Yes
Disposal of fuel or diesel	No	No	No	No
Domestic waste disposal	Yes	Yes	Yes	Yes
Recyclables	Yes	Yes	Yes	Yes

12.6 Recommended Mitigation Measures

The construction contractors shall produce an Environmental Management Plan (Construction) (EMP(C)) which must include requirements for waste management in accordance with TMR environmental systems. The EMP(C) will use the waste management hierarchy of avoid, reduce, re-use, recycle, recover, treat and dispose as defined in section 9 of the *Waste Reduction and Recycling Act 2011*. **Table 12-4** outlines the potential impacts in relation to waste management, and the general actions and management measures to mitigate these impacts.

No waste or litter shall be burnt or buried on site. All waste removed from the project site will be transported and disposed of by a contractor licensed to transport waste under the *Environmental Protection Act 1994.*

Table 12-4: Potential impacts and mitigation measures.

Potential Impacts	Mitigation measures
Requirement to dispose of or store excess fill	The design will be developed with the objective of balancing earthworks. Further investigations in bulking factors will be conducted to minimise the requirement for off-site disposal of fill.
Excessive waste sent to landfill	Project design to be aware of the need to reduce the consumption of raw materials, minimise waste generation and maximise the opportunities for reuse and recycling of products.
Pollution of the environment	The EMP(C) will be prepared in accordance with MRTS51 – Environmental Management and may include documents and/or diagrams indicating: • Training and induction on waste management. • Assessment of the wastes expected to be generated, and strategies for each waste type (avoidance, reuse, recycling, energy, recovery, disposal). • Descriptions of spill kit locations and containment structures. • Destinations for waste disposal and licensed waste transporter details. • Monitoring, reporting and auditing: details of monitoring regimes, including inspection frequencies and responsibilities, monthly reporting to the Principal's Representative and participation in waste management audits. • Strategies for dealing with emergencies and incidents including reporting responsibilities and record keeping.
Incorrect disposal of waste	The Contractor will provide appropriate waste disposal containers for the collection and disposal of all waste generated onsite. No waste shall be disposed of onsite.
	No waste or litter shall be burnt onsite.
	Regulated waste (fuels, oils and lubricants) will be stored in bunded facilities that comply with Australian Standards. Recycling of lubricants and oils used by vehicles and plant on site, where applicable.
	Disposal of contaminated soils from spills of oils, fuels or other compounds shall be sent to a licensed waste management facility. Removal of contaminated soils requires approval under section 424 of the Environmental Protection Act 1994.
	Portable toilets will be required if facilities are not available and will be regularly serviced by a licensed contractor and the waste material disposed of or treated offsite at a licensed waste management facility.
	A register of waste shall be maintained including details of the type and quantity of waste generated and the fate of the waste.
	The Contractor will be required to comply with all regulated waste tracking requirements applicable at the time of construction.

13. Landscape and Visual Amenity

13.1 Introduction

This chapter provides an assessment of the landscape and visual values associated with the Project.

The objectives of the visual amenity assessment for the Project include:

- Describe existing landscape and visual values of the Project location and surrounds
- Assess the photographic documentation from various locations within the study corridor to determine the visibility of the Project, particularly to sensitive visual receptors
- Identify potential changes to visual values as a result of the Project
- Recommend mitigation measures based on identified potential changes to visual values.

13.2 Methodology

The methodology of the visual amenity assessment involved:

- Review of documentation and background information for the Project, including design drawings
- Review of aerial photography and contour maps
- A review of the *Cooloola Shire Planning Scheme 2005* and the Desired Environmental Outcomes relating to visual amenity
- Identification of sensitive visual receptors
- Site appraisal conducted on 13 March 2012 that included the collection of photographic documentation of the study corridor of the Project to identify landscape characteristics and visual values.

13.2.1 Sensitive Visual Receptors

Perceived visual impacts are relatively subjective and are predominantly related to the sensitivity of the viewer at a particular view point. Sensitive visual receptors are locations that are likely to contain people that may be able to experience changes to their visual environment. The potentially sensitive receptors include:

- Residential dwellings
- Identified locations of public and private importance
- Tourist destinations and heritage sites
- Users of major and secondary roads.

Residential dwellings are only considered as sensitive visual receptors to the extent that they would be occupied during construction and operation of the Project.

Roads are only considered as sensitive receptors to the extent that views are altered for vehicle occupants. As a result, visual impacts as viewed from roads are generally considered minimal and confined to the duration of time that an impact is in view of a vehicle occupant.

13.2.2 Landscape Character

The description of landscape character provides an overview of the varying, distinctive landscapes that exist within an environment. Rather than defining landscapes that are visually better or worse, landscape character describes the differences between landscapes and the elements that make them unique.

In order to understand how a particular noticeable change to the visual environment would impact on identified sensitive receptors, it is necessary to determine the overall sensitivity of a particular landscape to a noticeable change. Landscape sensitivity refers to the overall potential impact that could be expected on a sensitive receptor as a result of a noticeable change to the landscape. Landscape sensitivity does not define the nature and scale of the proposed activity, but rather, describes the overall ability of the existing environment to accommodate change. Landscape sensitivity levels are:

- **Low sensitivity** – Very few visual impacts would be experienced as a result of the proposed change to the visual environment. A low sensitivity to visual change is either as a result of the proposed activity integrating efficiently with the existing environment and/or there are a very small number of, or no, sensitive receptors with potential views of the proposed activity.
- **Medium sensitivity** – Some visual impacts would be experienced as a result of the proposed change to the visual environment. A medium sensitivity to visual change is either as a result of the proposed activity only partially integrating with the existing environment and/or there are limited sensitive receptors with potential views of the proposed activity.
- **High sensitivity** – Significant visual impacts would be experienced as a result of the proposed change to the visual environment. A high sensitivity to visual change is either as a result of the proposed activity not integrating with the existing environment and/or there are numerous sensitive receptors with potential views of the proposed activity.

Landscape character for the Project study corridor and the broader regional area is described in **Section 13.3**.

13.2.3 Viewshed Analysis

A viewshed analysis is an assessment of the overall level of visibility a specific vantage point would have of the existing landscape. The analysis models the elevations of the terrain to determine the overall extent of the environment that would be visible from the vantage point. This analysis provides for an understanding of the overall visibility of the surrounding environment, prominent sight lines and the potential sensitivity to visual change.

As a viewshed analysis only considers terrain in its assessment, it does have its limitations, and as a result, it should not be used in isolation. It is used as a tool to assist in developing a better understanding of the potentially visible components of the landscape. Factors that are not considered in a viewshed analysis include:

- The height of the viewer or the height of a structure that the viewer may be standing on that may increase the overall visibility.
- The presence of vegetation, buildings or other non-topographical features that may constrain the overall level of visibility.

A viewshed analysis was undertaken for the Project using the alignment as the central point of the viewshed. The viewshed analysis forms the basis for developing an understanding of the overall level of visibility that the sensitive visual receptors would have of the Project. The viewshed analysis is discussed further in Section 13.3.6.

13.2.4 Visibility Analysis

An assessment of the potential visual impact of the Project has been undertaken. In order to undertake the assessment of the Project, key views were appraised based on the consideration of the sensitivity of the landscape surrounding the Project and six key criteria (refer to **Table 13-1**).

Table 13-1: Visual assessment criteria.

Criteria	Description
Distance	Greater distances between the viewing location and the visible components of the project site reduce the level of detail that is observable within the view. Greater distances also make it difficult to distinguish the project site from its background.
Elevation	Project sites that are elevated higher than the viewing location would be viewed against the sky. Project sites that sit lower than the viewing location would be viewed against the surrounding landscape allowing it to be better accommodated within the visual environment.
Size	The larger the project features and activities within the visual environment, the greater the level of visibility from the viewing location.
Context	The degree to which the Project is in character with the context of the surrounding environment.
Activity	Movement of vehicles and light reflection changing with movement attract the eye making the project site more visually prominent. Static, neutral coloured project features are less noticeable within the visual environment.
Change	The degree of change in the view and the rapidity of the process of change contribute to the overall visibility of the project site.

13.3 Landscape and Visual Values

This section identifies the existing landscape and visual values of the Project study corridor.

13.3.1 Planning Considerations

The Project is located in the Gympie Regional Council Local Government Area (LGA). It is also situated within the former Cooloola Shire Council LGA in which the *Cooloola Shire Planning Scheme 2005* (Planning Scheme) applies. As the Project includes the duplication and upgrading of a State-controlled road, all works for the Project are exempt from assessment against the Planning Scheme. Further discussion of the planning requirements of the Project is provided in **Chapter 8 – Planning and Land Use**. However, to ensure the amenity values of the areas surrounding the Project are considered, the Planning Scheme's provisions relevant to visual amenity have been considered for the purposes of this assessment.

The Planning Scheme identifies Desired Environmental Outcomes (DEOs) for the region that are intended to be achieved through the implementation of the Planning Scheme's instruments. **Table 13-2** identifies the DEOs most relevant to visual amenity.

Table 13-2: Planning Scheme DEOs relevant to visual amenity.

DEOs relevant to visual amenity	Comment
The amenity, cultural heritage, ecological and recreational values of significant natural features including the Great Sandy National Park, Inskip Point and other coastal areas, the Mary River and other waterways, Mothar Mountain, Kenilworth Bluff and other mountains of the Shire are protected and enhanced	The Project will not impact on the Great Sandy National Park, Inskip Point or other coastal areas and it is unlikely that views of the Project from Mothar Mountain and Kenilworth Bluff will not be possible.
The standard of the built environment reflects community expectations and contributes to the amenity of the Shire	The Project will be constructed in accordance with current design standards in excess of the quality of the existing Bruce Highway. The existing Bruce Highway is a prominent feature in the existing visual environment.

The Project may result in changes to visual values and amenity. Visual impacts of the Project are discussed in **Section 13.4** and mitigation measures are provided in **Section 0**.

13.3.2 Existing Landscape Character and Visual Values

The Project study area is primarily characterised by Hilly Farmland landscape character type (refer to **Table** 13-3). This landscape character type contains a mix of woody vegetated and grasslands that are typical of grazing lands within the broader region. The undulating nature of the topography creates numerous vantage points throughout the landscape. Homesteads and rural residential properties are generally located on high points within the landscape.

Large patches of remnant vegetation are generally located along ridgelines where farming activities are not viable, and to the north of Tandur Road. The Traveston State Forest and Woondum State Forest are located within the local landscape and contribute to the considerable amount of remnant vegetation.

Commercial activities, such as service stations, small industrial land uses and short-term accommodation attract business from travellers along the existing Bruce Highway are located at the intersections with Tandur Road, Woondum Road and Keefton Road. Industrial activities are more common within the landscape around the southern extent of the City of Gympie.

Major transport and infrastructure networks are visually prominent features within the landscape. The existing Bruce Highway runs to the west of the Project study corridor and the Gympie North Rail Line to the east. An existing Powerlink transmission line easement is located adjacent to the Project alignment.

Overall, the landscape character of the Project and surrounds has a medium sensitivity to change due to mainly agricultural land uses and expansive views from numerous vantage points, particularly from rural residential properties along the ridgelines to the east and north east. The number of sensitive visual receptors increase as the Project approaches more built up areas in the southern parts of Gympie. However, the project is consistent in nature to the existing major infrastructure within the landscape, lessening the sensitivity to change. The industrial activities in the southern area of Gympie, north of Keefton Road, would also contribute to lessening the sensitivity to change.

Different landscape character types identified within and around the Project and their overall level of perceived sensitivity are detailed in **Table 13-3**.

Table 13-3: Landscape character types applicable to the Project.

Landscape Character Unit	Description	Landscape Sensitivity	Relationship to Project
Flat Farmland	The landscape typically contains a mix of vegetated and cleared flat farming land. Tree-lined verges may still exist along property boundaries and roads. The landscape can include smaller constructed elements, such as road and rail networks, homesteads and farm buildings, fences and power lines. The landscape is predominately flat and expansive views are likely within cleared areas.	Sensitivity to Change: Medium Although modified from its natural form, views are generally over an undeveloped, expansive landscape. Any changes to the landscape are likely to be visible from a considerable distance.	Some areas surrounding the Project are categorised as flat rural farmland. This landscape is primarily used for grazing and some cropping. Homesteads in these areas are sensitive visual receptors. Vegetation is mostly cleared, but exists along road verges, particularly the existing Bruce Highway, fence lines and banks of watercourses.
Hilly Farmland	The landscape typically contains a mix of woody vegetated and grassland farming land. Tree-lined verges still exist along property boundaries, roads and hilltops. The landscape can include smaller constructed elements, such as road and rail networks, homesteads and farm buildings, fences and power lines. The landscape undulates and views can either be restricted or expansive depending on the viewer's location within dips or on rises.	Sensitivity to Change: Medium Although modified from its natural form, views are generally over an undeveloped, expansive landscape. Depending on the viewing location, the rise and fall of the landscape provides the opportunity for both vantage points and visual barriers.	Undulating, woody vegetated grazing land is the predominant landscape type within the visual environment. This landscape is primarily used for grazing and some cropping. Homesteads in these areas are sensitive visual receptors. The landscape is also categorised by rural residential properties on the ridgelines to the east and north east of the Project. Vegetation primarily exists in this landscape character type along ridgelines that are not viable for farming, road verges, particularly the existing Bruce Highway, fence lines and banks of watercourses.

Landscape Character Unit	Description	Landscape Sensitivity	Relationship to Project
Remnant/ Natural Forest	The landscape occurs primarily in National Parks, State Forests, State Parks, Regional Parks and local reserves; however, it can also exist in rural areas that have not been subjected to prior clearing activities. Generally, the vegetation is dense and very few modifications have been made to the landscape. Access into and within this landscape is usually limited to minor roads and access tracks.	Sensitivity to Change: High Large scale changes to this landscape would be highly visible from external vantage points. However, due to the development restrictions generally in place, large scale changes to the landscape are unlikely. As vantage points within this landscape are limited, most views will be from external locations. Due to the dense nature of the vegetation, this landscape provides the opportunity to act as a visual barrier between a particular vantage point and the point of interest.	This landscape occurs in mainly hilly grazing areas on ridgelines where farming is not viable. The Traveston State Forest and Woondum State Forest are traversed by the Project. There are large areas of remnant vegetation to the north of Tandur Road.
Regrowth Forest	The landscape has been previously cleared, and vegetation has begun to regrow. Generally, the vegetation within this landscape is not as dense as the vegetation within a remnant forest. Access into and within this landscape is usually limited and confined to old access tracks.	Sensitivity to Change: High Changes to this landscape as a whole would be highly visible from external landscapes. However, due to the history of the landscape, it is likely to be more acceptable than if the changes were to occur in a remnant forest. As vantage points within this landscape are limited, most views will be from external locations. This landscape provides the opportunity to act as a visual barrier between a particular vantage point and the point of interest. Views of different components of the project site, such as the road surface or the interchanges, will result in different levels of sensitivity.	Areas of regrowth vegetation are scattered throughout the visual environment. These areas are generally located around residential properties and along the verges of the existing Bruce Highway and local roads.

Landscape Character Unit	Description	Landscape Sensitivity	Relationship to Project
Rural Townships	This landscape occurs at different locations throughout the broader environment, usually along major road networks, and exists primarily to provide minor services or accommodation to travellers. Development within this landscape is characterised as low-scale residential properties, retail, commercial and industrial activities.	Sensitivity to Change: Medium Minor changes to this landscape are unlikely to conflict with the overall character. Views of this landscape will consist primarily of buildings, infrastructure and some vegetation. Due to the increased intensity of the sensitive receptors within this landscape, there is an increased level of sensitivity that should be considered.	There are low-scale retail activities servicing travellers along the existing Bruce Highway, such as service stations, as well as short-stay accommodation. These activities are located at the intersections of the existing Bruce Highway and Tandur Road, Woondum Road and Keefton Road.
Townships	This landscape is generally located at key locations throughout the broader environment, such as watercourses or large scale employment opportunity opportunities, such as rail yards, ports or industrial facilities. Development within this landscape generally consists of residential properties situated around a town centre and the employment, education and health services.	Sensitivity to Change: Medium Minor changes to this landscape are unlikely to conflict with the overall character. Views of this landscape will consist primarily of buildings, infrastructure and some vegetation. Due to the increased intensity of the sensitive receptors within this landscape, there is an increased level of sensitivity that should be considered.	Although the Project does not traverse Gympie, the town has been considered in this assessment to give a context of the regional landscape character.

Landscape Character Unit	Description	Landscape Sensitivity	Relationship to Project
Coastal Towns	This landscape is generally located at key locations along the coastline along major transport networks or around areas with high levels of tourism amenity. Coastal towns generally have a high level of amenity. Development within this landscape generally consists of residential properties, low-scale accommodation and small retail and business operations supporting local residents and the tourism industry.	Sensitivity to Change: High Changes to this landscape would be likely to conflict with the overall character due to high levels of amenity. However, coastal towns generally have development restrictions in place to protect their high level of amenity. Therefore, large scale changes to the landscape are unlikely. Due to the increased intensity of the sensitive receptors within this landscape, there is an increased level of sensitivity that should be considered.	The coastal towns of Tin Can Bay and Rainbow Beach have been considered in this assessment to give a context of the regional landscape character.
Industrial	This landscape is generally located in the outer areas of towns and in close proximity to major transport networks. Development within this landscape generally consists of medium to large warehouse-style buildings usually drawing considerable levels of commercial vehicles and trucks.	Sensitivity to Change: Low Changes to this landscape are unlikely to conflict with the character. Industrial land uses have low levels of amenity and are generally suitably located near major infrastructure or visibly intrusive development.	Industrial land uses are located in the southern areas of Gympie.

13.3.3 Key Landscape Features

The existing landscape and visual values of the Project and surrounds are categorised as:

- An undulating landscape containing mainly grazing land uses with some areas of cropping with associated homesteads and farming infrastructure
- Vegetation concentrated along roadsides and ridgelines, particularly to the east of the Project, and numerous patches north of Tandur Road, including the Traveston State Forest and Woondum State Forest
- Rural residential properties to the east and north-east of the Project along Burridge Road, Cobb and Co. Road, Noosa Road and Penny Road
- Small areas of retail use servicing travellers at the intersections of the existing Bruce Highway and Tandur Road, Woondum Road and Keefton Road
- Industrial uses in the southern area of Gympie, north of Keefton Road and scattered throughout the Project study area
- A number of roads, both sealed and unsealed, providing access to farming properties and rural residential properties
- A public lookout, Arrawatta Lookout, located on Traveston Crossing Road
- Major infrastructure routes including the Bruce Highway, the Gympie North Rail Line and the Powerlink high voltage transmission line easement.

13.3.4 Visibility of Existing Environment

In order to determine the general visibility of the existing environment, it is necessary to determine the potential vantage points and the overall level of visibility from these locations. Typically, vantage points are considered as important public locations, such as roads or parks, or private locations, such as residential dwellings.

Throughout the broader landscape surrounding the Project, the overall visibility of the environment is determined by the presence of vegetation and elevation. Vantage points that are elevated with limited near vegetation (refer to **Figure 13-1**) provide for more expansive views than vantage points at low elevations with near vegetation (refer to **Figure 13-2**). Man-made structures within this environment are generally characterised as homesteads and farm buildings, rural residential properties and transport and infrastructure routes and therefore do not represent a significant impediment to the overall visibility of the landscape.

Figure 13-1: Example of an elevated vantage point with limited near vegetation.

Figure 13-2: Example of a vantage point at a low elevation.

13.3.5 Sensitive Visual Receptors

- Sensitive visual receptors considered in this assessment include:
- Rural residential properties located on grazing land on both sides of the Project, particularly between Traveston Road and Tandur Road and Woondum Road and Keefton Road.
- Rural residential properties located on the ridgelines to the east and north-east. Numerous properties located on the ridgeline to the east of the Project in the vicinity of Burridge Road are generally surrounded by established vegetation.
- Travellers using the existing Bruce Highway and local roads, mainly on high points, including:
  - Traveston Road
  - Tandur Road
  - Woondum Road
  - Keefton Road
  - Kenman Road
  - Lehman Road
  - Burridge Road
  - Meads Road
  - Scrub Road
  - Cobb and Co. Road.

Similar to the vegetation surrounding the rural residential properties, a large proportion of the nearby roads contain established roadside vegetation. This vegetation can provide a visual screen that limits expansive views over the local and regional landscapes.

13.3.6 Viewshed Analysis

In order to determine the general visibility of the existing environment from the identified sensitive visual receptors, a viewshed analysis has been undertaken to determine the Project's potential visual footprint. This provided an overview of the potential nearby locations that may have views of the Project. The sensitive visual receptors located within the viewshed were considered in the assessment. The viewshed analysis is shown in **Figure 13-3**.

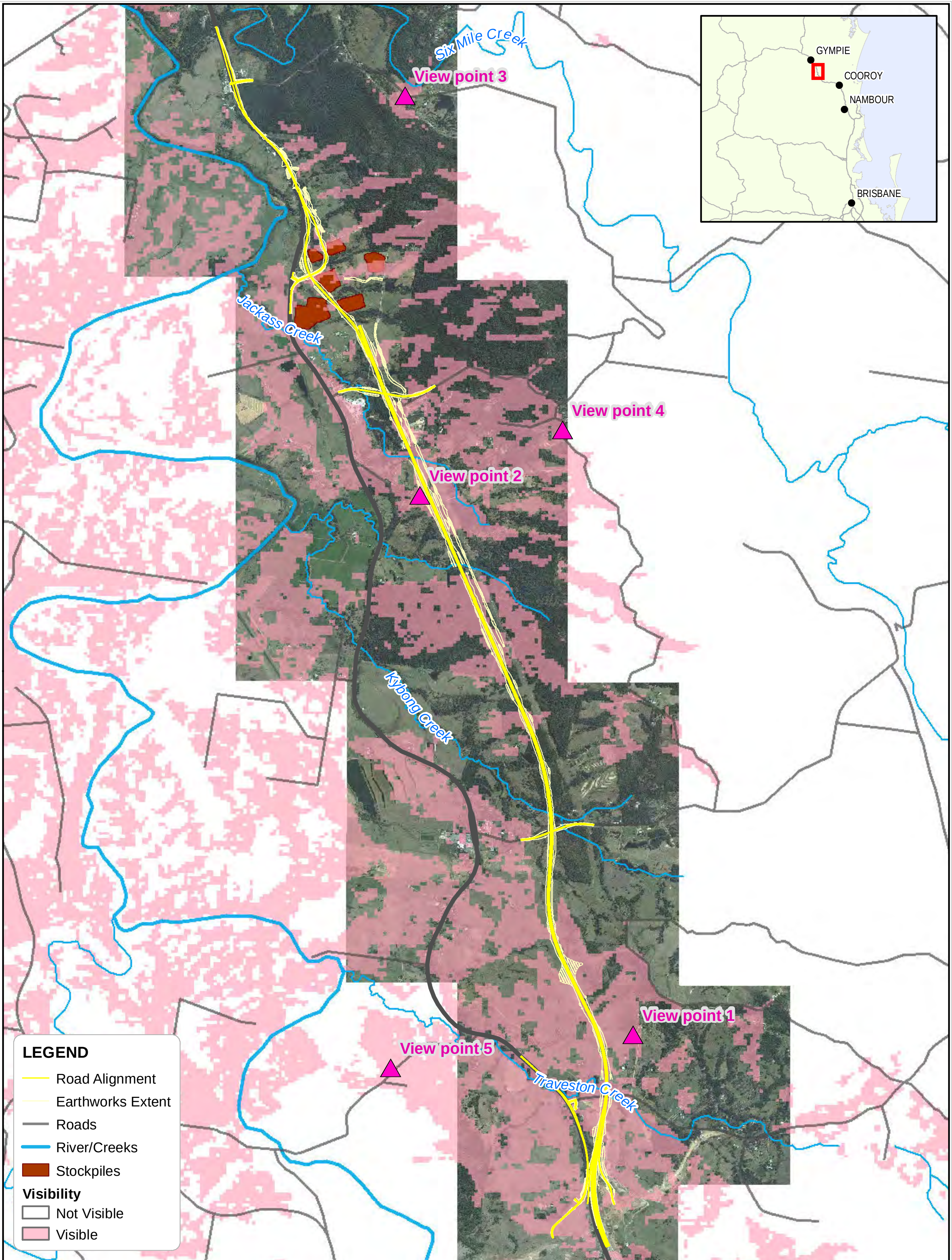


Figure 13-3

Viewshed Analysis

0 0.2 0.4 0.6 0.8 1 Kilometres

MGA - Zone 56 (GDA 94) 1:50,000 @ A4

SKM

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13.4 Potential Impacts an Mitigation Measures

This section identifies the potential impacts to the visual environment from the Project.

13.4.1 Key Project Elements

The key elements of the Project relevant to the visual amenity assessment include:

- Extensive areas of cut and fill as the Project crosses the undulating topography and numerous watercourses and drainage lines
- The Tandur Road and Woondum Road overpass structures and associated earth embankments
- The Woondum Interchange that will include a number of raised structures
- Where required to address worker safety requirements, construction works may be carried out at night and would require lighting. However, this is likely to affect a small proportion of the Project
- Night lighting from street lights near the Woondum Interchange and traffic at night during operation
- Construction vehicles both within the Project alignment and on surrounding local roads.

13.4.2 Construction

Construction activities for the Project, including lay down areas, plant, site offices and stock piles, are likely to cause short term changes to visual values. Lighting to illuminate work areas at night will also become a new element within the existing visual environment.

Construction traffic on local roads accessing the construction easement may also result in a short term change to visual values.

As the topography of the study area is undulating, the Project incorporates substantial cut and fill into its design. This would result in raised embankments in areas of the landscape that are existing low points. Similarly, sections of the Project that cut into hills and ridges will result in a change to the landscape. The design of batters has taken into account the requirements for revegetation. The more vegetated areas to the north of Tandur Road would also provide some screening of the Project.

13.4.3 Operation

During operation, the Project is likely to be a visually prominent feature within the existing visual environment. The road corridor, including the changed landscape from sections of cut and fill during construction, will be visible from numerous locations.

The Tandur Road and Woondum Road overpasses, and the Woondum Interchange are likely to be prominent features of the environment as they include numerous raised structures, such as embankments and on and off ramps. The existing Bruce Highway does not currently contain any overpasses and as such, these new structures are likely to be uncommon features of the visual environment.

The Project would also result in increased night lighting at the Woondum Interchange, which is an area that currently features limited lighting. Headlights from traffic would also cause changes to visual values from sensitive visual receptors surrounding the Project.

However, as the Project is an upgrade to the existing Bruce Highway, this form of infrastructure is considered a common feature of the existing visual environment. This would be likely to contribute to lessening the perceived change to the existing environment as a result of the Project.

13.4.4 Visual Impact Assessment

A visibility analysis has been undertaken for the Project by providing an assessment of the potential impact on the existing viewshed from a number of surrounding key locations. These locations are shown in **Figure 13-4**.

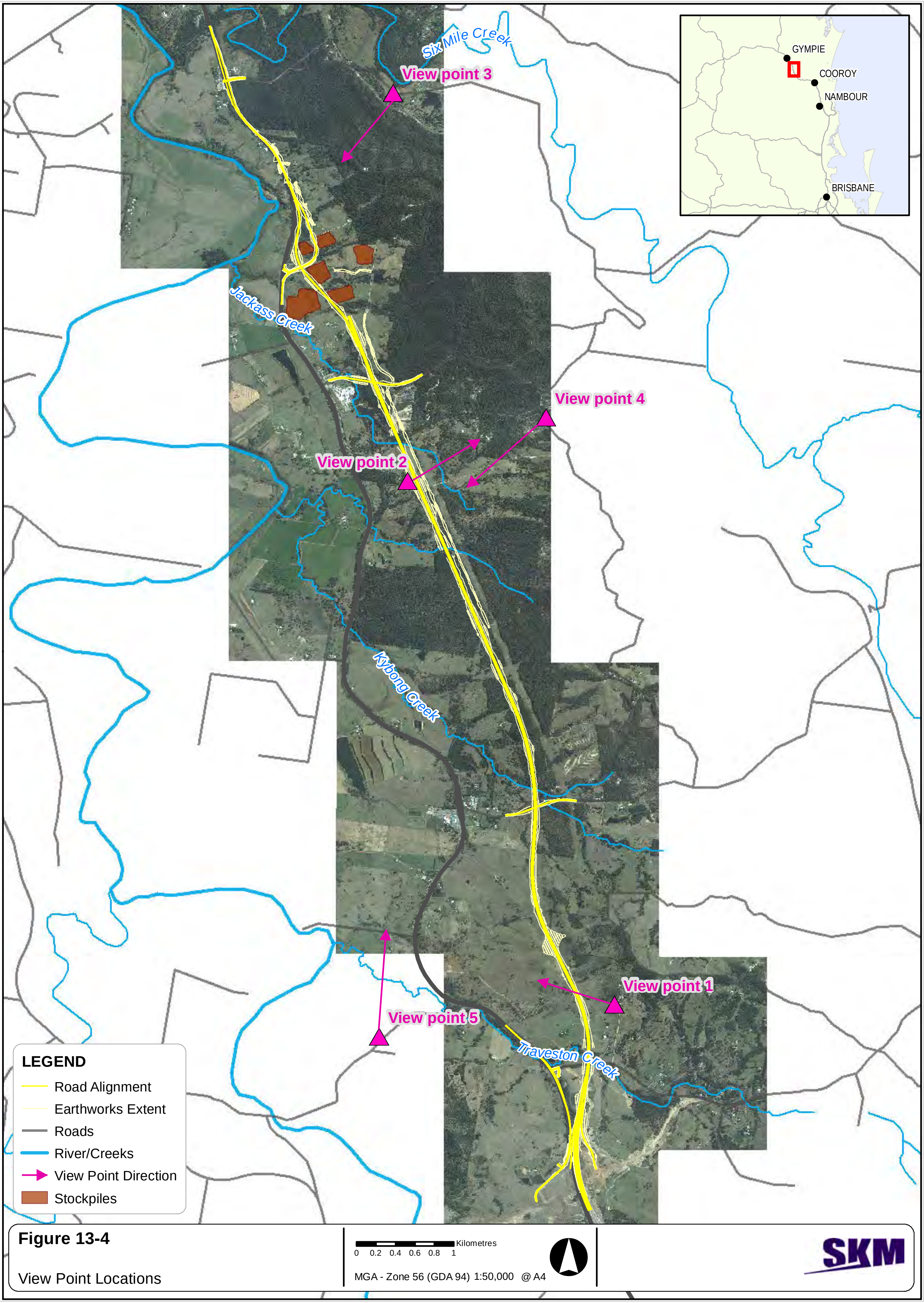


Figure 13-4

View Point Locations

13.4.5 Visibility Analysis

An assessment of the impact of the Project on the existing visual environment from a number of key locations is provided in **Figure 13-5** to **Figure 13-9**.

Figure 13-5: View point location 1 – looking west 600 metres north of Traveston Road.

Description:

This photograph was taken from a high point approximately 600 metres north of Traveston Road looking west. The view point location is in the vicinity of five rural residential properties, including the Traveston Homestead.

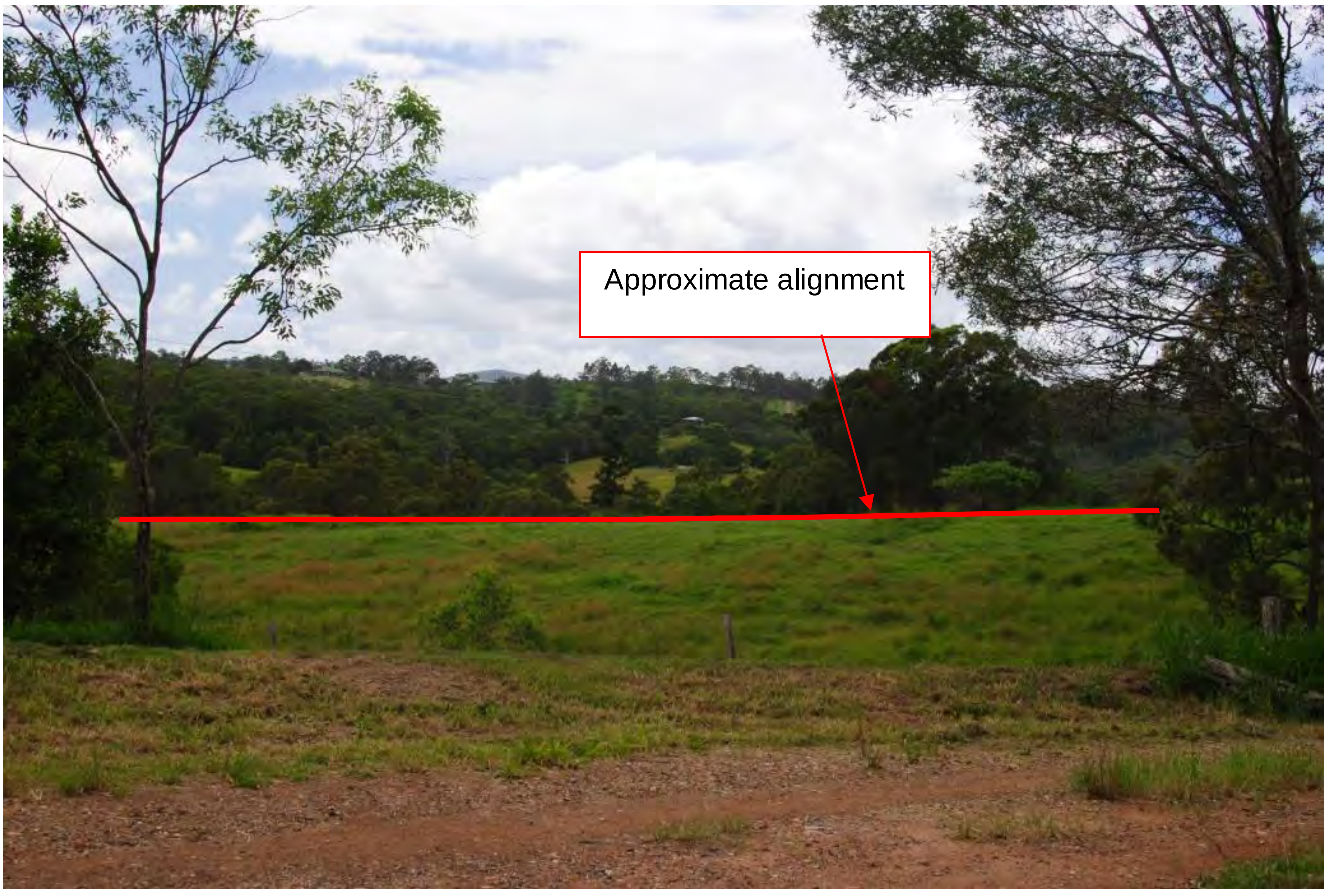
This is a representative view of an expansive view of the landscape from sensitive visual receptors located on high points on cleared grazing and cropping land. Views at this location can be experienced for a distance of over 25 kilometres, depending on the presence of hills, ridgelines and vegetation.

Potential Impact:

The Project alignment will be located approximately 400 metres from this view point location. Due to the close proximity of the Project to the view point location and the expansive views, the visibility of the Project will be prominent and will result in a significant change to visual values, including an increase in night lighting. This location is considered to be the most sensitive area to visual change.

There are five rural residential properties expected to have views of the Project from this location which would experience a change to visual values during both construction and operation.

Figure 13-6: View point location 2 – looking east from Gresham Road.



Description:

This photograph was taken from Gresham Road looking east, approximately 100 metres west of the Project alignment. This view point location is in the vicinity of three rural residential properties.

This is representative of view from a sensitive visual receptor in close proximity to the Project. Views at this location are somewhat expansive. However, the presence of established vegetation and the undulating landscape reduces views in some directions.

Potential Impact:

Due to the close proximity of the Project to this location, changes to the visual environment are likely to be experienced. The existence of vegetation and undulating topography may aid to reduce the overall impact of the Project on sensitive visual receptors in this location. Furthermore, the alignment of the Project follows a depression in the topography in this location which would aid to reduce the extent of change to visual values.

Figure 13-7: View point location 3 – looking south-west from Keefton Road, east of Woondum State Forest.

Description:

This photograph was taken from Keefton Road to the east of Woondum State Forest looking south-west. The location is on the opposite side of the ridgeline to the Project alignment.

This viewing location represents views from the eastern side of the ridgeline running between the Project and Cobb and Co. Road.

Potential Impact:

There will be no impact to the visual environment to the east of the ridgeline in the vicinity of Cobb and Co. Road. From this viewing location, the Project will not be visible. The ridgeline running between the Project and this viewing location, along with the high amount of vegetation contained within Woondum State Forest, will block the Project from view. Sensitive visual receptors to the east of Woondum State Forest would not have views of the realigned Bruce Highway.

Figure 13-8: View point location 4 – looking south-west from Burridge Road.

Description:

This photograph was taken from Burridge Road looking south-west. The view point location is in the vicinity of four homesteads.

This is a representative view of an expansive view of the landscape from sensitive visual receptors located on high points along the ridgeline to the east of the Project. Views at this location can be experienced for a distance of over 20 kilometres, depending on the presence of hills, ridgelines and vegetation. There is generally an extensive amount of established vegetation surrounding rural residential properties in this location.

Potential Impact:

From this viewing location, the Project is approximately 1.3 kilometres from this view point location. Due to the expansive views at this location, the Project would result in a change to visual values. There are two rural residential properties that are expected to have views of the Project from this location. However, the distance of the Project from this location and the presence of established vegetation would contribute to reducing the visibility of the Project.

Figure 13-9: View point location 5 – looking north from Arrawatta Lookout.

Description:

This photograph was taken from Arrawatta Lookout on Traveston Crossing Road looking north. The potential view of the Project is approximately 7.5 kilometres from this location. This view point was chosen for the visibility analysis as it is a public lookout. The landscape from this location is categorised as undulating with numerous patches of remnant vegetation.

Potential Impact:

From this viewing location, the Project would have limited influence on the visual environment. It is expected that a combination of distance, established vegetation and the undulating landscape would contribute to reducing changes to visual values. However, it is expected that the Woondum Interchange and any stockpiles as described in **Chapter 2 - Project Description** would be viewable from this location.

13.4.6 Mitigation Measures

Table 13-4 outlines the mitigation measures that are recommended to minimise changes to visual values caused by the Project. Through the implementation of these mitigation measures, the Project may be better accommodated within the visual environment.

Table 13-4: Issues and mitigation measures.

Issue	Mitigation Measure
Retention of existing vegetation	• The retention, where practical, of existing vegetation would assist in partially screening the Project and may assist in limiting expansive views from sensitive receptors. • Well-established vegetated areas to the north of Tandur Road should be protected either side of the alignment. Existing established vegetation should be retained to screen the Project from sensitive visual receptors.
Provision of vegetation	• Where appropriate, the planting of vegetation adjacent to the Project should be considered to provide a visual screen between sensitive receptors and the highway. This would include planting between carriageways and on fill areas. • Provision of vegetation should be focussed to areas south of Tandur Road as these grazing areas currently contain limited vegetation.
Night lighting	• Where practical, street lighting associated with construction should be screened to minimise extraneous light impacts. • Operational lighting should include shielding to limit extraneous light where necessary.
Landscape Management Plan	• Development of a Landscape Management Plan that provides specific details on the implementation and ongoing management of vegetation activities for the Project. • As well as detailing the landscaping requirements generally required for the Project, the Landscape Management Plan should incorporate the visual impact mitigation measures to be delivered through vegetation planting outlined in this table.
Further identification of impacts	• Ongoing consultation with impacted landholders should occur to identify specific impacts to properties and address community concerns. • As required, residences should be consulted in order to determine if future perceived impacts require mitigation. If so, discussions should be conducted as to what form of mitigation is acceptable. For example, a tree screen at the back of a house to completely screen the views of the Project.

13.5 Conclusion

The Project will cause noticeable changes to the visual environment during construction; particularly south of Tandur Road where it traverses mainly cleared grazing land. The construction of the Tandur Road and Woondum Road overpasses, and the Woondum Interchange will also be prominent features of the visual environment as they involve raised structures and overpasses which are not a common element of the existing Bruce Highway. The undulating topography and ridgelines to the east and north-east of the Project create numerous vantage points and expansive views from sensitive visual receptors.

During operation, the Project will continue to be a visually prominent feature in the landscape. However, with the implementation of appropriate mitigation measures and the removal of features specific to construction, such as lay down areas, plant, site offices and stock piles, the Project may be better accommodated within the visual environment.

The retention and provision of vegetation on either side of the Project is important in providing screening from sensitive visual receptors. Provision of vegetation should be focussed around the grazing areas traversed by the Project to the south of Tandur Road. This area currently contains limited vegetation and is considered the most sensitive area to accommodate for visual change as a result of the Project.

Although there are numerous sensitive visual receptors along the ridgeline to the east of the project with expansive views, the presence of established vegetation provides some screening of the Project. Consultation with affected landholders should also be considered to ensure effective mitigation measures.

14. Socio-Economic Assessment

14.1 Introduction

The purpose of this chapter is to identify and assess the socio-economic impacts of construction of the Project and the operation of the realigned Bruce Highway.

The objectives of the socio-economic assessment of the Project were to:

- Describe the existing socio-economic environment of those areas potentially affected by the Project
- Identify and assess changes to or impacts on the existing conditions from the Project
- Identify mitigation measures to maximise benefits and minimise impacts of the Project on local and regional communities.

14.1.1 Methodology

Key steps in the socio-economic assessment included:

- Scoping the likely range of potential social impacts of the Project's construction and operation for local and regional communities, based on the TMR guidelines and consideration of socio-economic impacts from similar road projects elsewhere
- Analysis of the existing socio-economic conditions and values of the study area, including population and demographic characteristics, social infrastructure (i.e. education, recreation and health services and facilities), and housing and accommodation
- Identification and assessment of potential socio-economic impacts of the Project's construction and operation, including on local and regional communities, property, access and connectivity, social infrastructure and local community values
- Identification of mitigation and management measures to offset the identified impacts and enhance the benefits associated with the Project.

The description of the existing socio-economic environment principally draws on data and information from the Australian Bureau of Statistics (ABS) 2011 Census of Population and Housing. This is supplemented with data and information from:

- Queensland Government, relating to population projections
- Gympie Regional Council, relating to social infrastructure and community values
- Real Estate Institute of Queensland on housing sales and costs.

14.1.2 Study Area

The Project is located approximately five kilometres south of the town of Gympie, near the communities of Tandur, Kybong and Traveston.

The study area for the socio-economic assessment includes those communities that are expected to experience changes as a result of the Project.

The study area is shown in **Figure 14-1** and is defined as:

- ABS Statistical Area 1 3151441, which covers the area of Kybong
- ABS Statistical Area 1 3151447, which covers the Tandur area located east of the Bruce Highway

- ABS Statistical Area 1 3151440, which covers the area of Traveston located south of the Bruce Highway.

The assessment also considers impacts on the wider Gympie region, including the Gympie urban centre. The regional study area for the socio-economic assessment includes the ABS Statistical Area 2s of Gympie North, Gympie South and Gympie Region.

Gympie is the main administrative centre for the Gympie Regional Council and is an important service centre for the region. It provides a range of retail, education, health and other support and services for rural populations in surrounding areas, including those located close to the Project.

Kybong mostly consists of rural residential uses, with a number of small businesses and industrial land uses located along the Bruce Highway, particularly at the intersections of Keefton, Woondum and Tandur Roads. Tandur and Traveston mostly comprise of rural residential lots, with areas of dense vegetation.

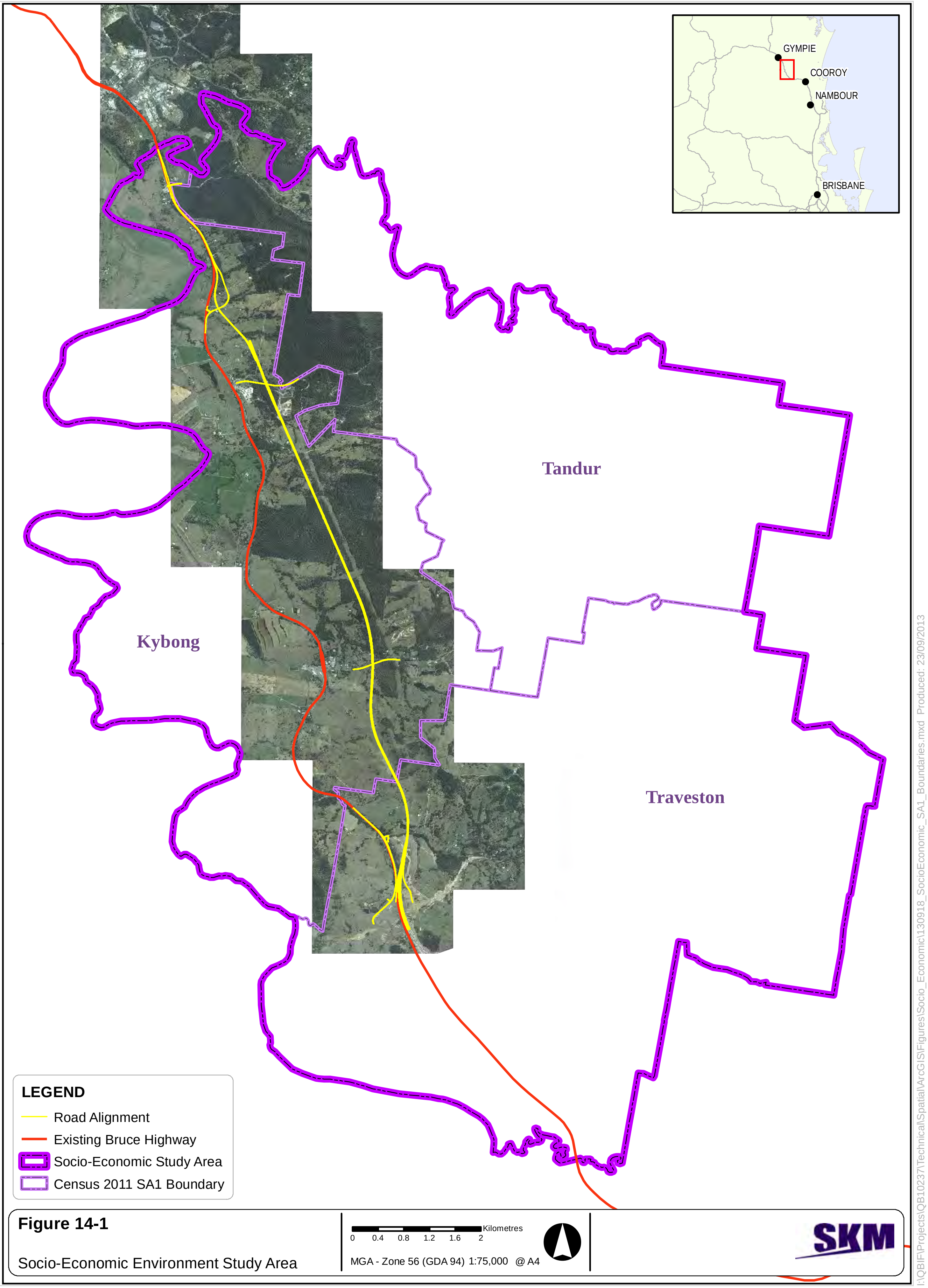


Figure 14-1

Socio-Economic Environment Study Area

Data Source: Australian Bureau of Statistics

14.2 Description of Existing Socio-Economic Values

This section describes existing socio-economic values and conditions in the study area. This provides a basis for predicting and managing potential changes from the Project.

14.2.1 Social Policy Context

Bruce Highway Action Plan

The Bruce Highway Action Plan was released in October 2012 by TMR. It sets out a detailed program of works for the Bruce Highway over the next ten years. The plan focuses on the three important areas, all of which have relevance to improving the socio-economic environment of the study area and region. The three areas are:

- **Safety** – improving appropriate safety standards and specific treatments of sections with poor safety ratings and undertaking critical maintenance
- **Flooding** – reducing flood impacts for highway sections and connections to cities
- **Capacity** – enhancing or making better use of infrastructure to overcome persistent congestion problems.

The Project is listed as a High Priority 1 under the capacity area. As detailed in **Chapter 1 –Introduction**, providing a road with improved safety and flood immunity are also key objectives for the Project.

Wide Bay Burnett Regional Plan

The Wide Bay Burnett Regional Plan (the Regional Plan) was released in September 2011. It identifies the regional framework and desired regional outcomes for the region over the next twenty years and provides a structure to assess and respond to challenges and opportunities. The purpose of the Regional Plan is to manage regional growth and change in the most sustainable way to protect and enhance quality of life in the region.

The desired regional outcomes articulate the preferred direction for the development and land-use outcomes for the region, and include specific policies and programs to management future growth of the region. The key desired regional outcomes relevant to the socio-economic environment include:

- Environment
- Rural Futures
- Strong Communities
- Managing Growth
- Strong Economy
- Infrastructure.

The Project will provide improved and safer access and connectivity to key service centres for residents and visitors as well as provide improved access for regional freight movements. This would support improved economic growth and development and stronger communities.

Regional Development Australia Wide Bay Burnett Regional Roadmap Version 2.0

The Regional Roadmap was produced following six months of extensive consultation with community leaders and representatives across the Wide Bay Burnett and the review of over ninety regional plans and strategies. The purpose of the Roadmap is for the Regional Development Australia Wide Bay Burnett organisation, in collaboration with Queensland Government, to maintain a sound and collaborative approach to planning to advance sustainable and managed growth throughout the region.

Through consultation with communities, Government departments and businesses, many needs and opportunities were identified and informed the development of the following key priorities which has relevance to the socio-economic environment:

- Strengthening our Regional Profile
- Driving Economic Prosperity and Job Creation
- Fostering Natural Resource Management and Sustainability
- Advancing Education and Training
- Supporting our Community and Social Wellbeing.

The Project is likely to address the above priorities by improving economic growth and community wellbeing, through the provision of safer access and connectivity to key service centres. The Roadmap is a ‘living’ document and will continue to evolve over time.

Gympie Region Community Plan 2030

The *Gympie Region Community Plan 2030* was released by the Gympie Regional Council in August 2011. The Community Plan seeks to maintain and enhance the many assets of the Region and guide further improvement in the economy, environment and social aspects of the community.

Overarching outcomes relevant to the socio-economic assessment of the Project include:

- Planned infrastructure that meets community needs
- Business Development
- Strong Local Communities
- Sustainable Environments
- A Community for all Ages
- An Inclusive and Diverse Community
- A Valued Heritage and Creative Community.

The plan also sets out a number of detailed actions to achieve the desired outcomes and objectives. The Project would support in achieving the outcomes of the plan by providing improved road infrastructure, thus improving the economic, environmental and social aspects of local and regional communities.

14.2.2 Community Profile

This section describes the existing socio-economic environment of the study area and the wider region. Further information on the study area’s population and demography is provided in **Appendix M**.

It should be noted that the population and demographic information presented in this section is sourced from the ABS 2011 Census unless otherwise stated.

14.2.2.1 Population

At the 2011 Census, the study area had a total population of approximately 1,024 people, of which 318 people lived in Kybong, 236 people in Tandur and 470 people in Traveston.

Population projection data is not available at the study area level. However, data is available for the ABS Statistical Area 2 Gympie Region which covers the study area. The population of the Gympie Region is expected to increase by 1,080 persons over a ten year period from 2011, to 19,282 persons in 2021. This represents an average annual growth rate of 0.6 per cent. This is considerably less than the growth rate expected to occur in Queensland over the same period (1.9 per cent). By 2031, the Gympie Region's population is projected to grow to about 23,846 persons (Government Statistician 2011).

In 2011, the study area had a higher proportion of males compared to Queensland as a whole. Males comprised 53.1 per cent of the study area's population, while they comprised 49.6 per cent of Queensland's total population.

The median age of the study area ranged from 38 years in Tandur to 51 years in Kybong in 2011. This is compared to 40 years in the wider region and 36 years for Queensland. In 2011, 16.6 per cent of people in the study area were aged 65 years or over, compared to 13.1 per cent for Queensland. This reflects the trend being experienced across the wider Wide Bay Burnett area, which has seen "retirees moving to the area and young people leaving the region to seek further education, job opportunities and life experiences" (WBBRP 2011).

The population in the study area is relatively stable with 82.3 per cent of residents living at the same address one year prior to the 2011 Census and 53.1 per cent living at the same address as five years prior. This is compared to about 76.7 per cent and 48.5 per cent respectively in Queensland.

14.2.2.2 Family and household composition

In 2011, there were approximately 426 households in the study area of which 43.3 per cent were located in Traveston. The study area has a relatively high proportion of lone person households, reflecting the area's older population. In 2011, lone person households comprised 27.1 per cent of all households in the study area compared to 24.7 per cent in the Gympie region and 22.8 per cent in Queensland.

Average household size within the study area ranged from 2.0 people per household in Kybong to 2.7 people per household in Tandur. This is compared to an average household size of 2.5 people in the Gympie region, and 2.6 people in Queensland as a whole.

In 2011, there were 531 families in the study area. The study area had a high proportion of couple families with children (at 51.2 per cent) compared to Queensland (at 42.8 per cent).

14.2.2.3 Education

Overall, the Project area had lower levels of education compared to Queensland, with fewer people having completed Year 12. In 2011, approximately 34.6 per cent of people aged 15 years or over in the study area had completed Year 12, while approximately 35.8 per cent had completed Year 10. This is compared to Queensland where 48.0 per cent had completed Year 12 and 31.8 per cent had completed Year 10. This is likely to reflect the older population and rural nature of the study area.

14.2.2.4 Housing, property prices and housing affordability

In 2011, there were approximately 426 dwellings in the study area, of which 87.8 per cent were occupied. The majority of dwellings comprised separate detached houses, consistent with the area's rural nature. A total of 35.0 per cent of dwellings in Kybong comprised 'other dwellings', including caravans and cabins. This is likely due to the location of the caravan park at the intersection of Keefton Road and the Bruce Highway, which provides accommodation for permanent residents, as well as short term stays for holiday makers.

Housing tenure in the study area generally reflects the area's older population and also the rural natural of the area. Overall, the study area had a relatively high proportion of owner occupiers, with high proportions of dwellings that were either fully owned or being purchased.

In 2011, approximately 77.8 per cent of houses in the study area were either owned or being purchased, compared to 63.5 per cent in Queensland. At the same time, the study area had relatively low levels of rental housing with approximately 17.6 per cent of dwellings in the study area being rented in 2011, compared to 33.2 per cent in Queensland.

Property and housing prices across the study area and region were generally lower than Queensland as a whole. For the Gympie Regional Council area, the median house sales price was $265,000 for the March quarter of 2013 (REIQ, 2013). Over a five year period from March 2008, the Gympie Regional Council area experienced a decrease in median house prices of 3.6 per cent (REIQ, 2013). At August 2013, median house price in the study area ranged from $270,000 in Traveston to $380,000 in Kybong (RP Data 2013). Between 2010 and 2013, median house prices remained relatively stable in the study area, ranging from $350,000 to $475,000 (RP Data 2013).

Households in the study area generally had lower median monthly mortgage repayments and weekly rents compared to Queensland at the 2011 Census. However, a relatively large proportion of households in study area experienced some level of housing stress, paying 30 per cent or more of their gross income on housing. In particular, 19.2 per cent of households in Tandur spent 30 per cent or more of their household income on mortgage repayments, compared to 9.7 per cent in Queensland as a whole.

14.2.2.5 Vehicle ownership

Overall, the study area has high levels of vehicle ownership compared to Queensland. Traveston had the highest level of car ownership in the study area with all households having at least one vehicle and 72.6 per cent of households having two or more vehicles. This is compared to 54.5 per cent of households in Queensland with two or more vehicles. In 2011, only 3.1 per cent of households in the study area did not have access to a vehicle, compared to 7.2 per cent for Queensland. This is likely to reflect the rural nature of the study area and the general lack of alternative transport options for residents.

14.2.2.6 Vulnerability and disadvantage

‘Need for assistance’ refers to persons requiring help or assistance in one or more of the three core activity areas of self-care, mobility and communication, because of a long-term health condition, a disability or old age. In 2011, the study area had a slightly higher proportion of persons requiring assistance compared to Queensland, generally reflecting the older population of the study area.

A community’s level of disadvantage or access to economic resources may influence the ability of that community to cope with changes from the project. The ABS produces a range of indices that indicate relative levels of socio-economic advantage and disadvantage. The index of relative socio-economic disadvantage is derived from Census variables such as low income, low educational attainment, unemployment and dwellings without motor vehicles. Low decile values (i.e. scores of one to three) generally represent areas of disadvantage while high decile values (i.e. scores of seven to ten) generally represent areas of least disadvantage. In 2011, Tandur and Traveston had decile scores of five and four respectively, indicating average levels of advantage/disadvantage. At the same time, Kybong recorded levels of relative disadvantage with a decile score of two. This suggests that the location has higher levels of people on low incomes, without qualifications or in lower skilled occupations.

14.2.2.7 Workforce participation and median incomes

In 2011, the study area and the region had a relatively low rates of workforce participation compared to Queensland as a whole. Approximately 56.1 per cent of the study area’s working aged population participated in the workforce and were either working or looking for work. This is compared to 54.3 per cent and 62.8 per cent in the region and Queensland respectively. The lower rate of workforce participation may reflect some farmers, including hobby farmers, not registering as employed or unemployed.

In 2011, the study area had varying rates of unemployment. Tandur had a relatively high proportion of unemployed people, with 10.3 per cent of its workforce looking for work. On the other hand, Traveston had a low proportion of unemployed people, with 1.6 per cent of its workforce looking for work. This is compared to 7.5 per cent in the region and 6.1 per cent in Queensland.

Overall, the study area had high proportions of low income households (less than $600 per week) and low proportions of high income households (more than $2,000 per week) compared to Queensland as a whole. In 2011, the median household income in the study area ranged from $637 per week in Kybong to $916 per week in Traveston, with the region recording a median household income of $776 per week. This is compared to a median household income of $1,187 per week in Queensland. The low level of income may impact the ability of a household to adapt to changes brought about by the Project.

14.2.2.8 Industry of employment

Agriculture, construction and retail trade are dominant industries of employment in the study area. In 2011, 12.4 per cent of workers in the study area were employed in the primary industries, compared to 7.7 per cent in the region and 2.7 per cent in Queensland. This reflects the rural nature of the area and the importance of the agriculture and forestry industries for local residents. Further, approximately 12.4 per cent of workers in the study area were employed in the construction industry, compared to 9.0 per cent in both the region and in Queensland.

The retail trade industry is also a significant industry of employment in the study area, with about 13.1 per cent of the study area's workforce employed in this industry at the 2011 Census.

14.2.2.9 Business and industry

Local businesses near the Project are mainly located adjacent to the Bruce Highway. They include:

- Service stations, with supporting retail and food services, located at the Tandur Road and Keefton Road intersection
- Retail outlets, including landscaping supplies, stone mason, rocks and minerals supplier, and antiques store
- A boarding cattery and kennels
- Small cattle breeding farms
- A wood chipping industry.

Gympie's main industrial area is located approximately 800 metres north of Keefton Road on the eastern side of the Bruce Highway. Businesses located in Gympie's main industrial area include removal and storage facilities, a motorway and kart club, and agriculture supply stores.

The rural areas throughout the region are important to the region's economy, supporting both primary production and tourism. The Bruce Highway is an important tourism route for providing access to and from local tourist attractions, such as Woondum National Park and the Mary Valley, as well as attractions in the broader region and state.

14.2.2.10 Access and connectivity

The Bruce Highway is the primary road transport corridor for residents, tourists and freight in the region. The highway connects Brisbane and the wider South East Queensland region to Central and Far North Queensland. The highway currently runs through the Gympie urban centre.

Community consultation conducted in 2011 for the Gympie Region Community Plan 2030 identified the need for improvements to the highway to allow easy, safe and convenient travel to Brisbane and other major centres in South East Queensland (Gympie Regional Council 2011). The need for a higher standard of road safety was also identified through consultation for the community plan.

Locally, the Bruce Highway provides access to services and facilities located in Gympie, such as education and health services, as well as access to private property, local roads and businesses located in Kybong, Tandur and Traveston.

A number of local roads currently cross the new alignment, including:

- Traveston Road.
- Tandur Road
- Gresham Road
- Woondum Road
- Keefton Road.

These roads provide access to properties as well as for residents living east of the Project to the Bruce Highway. Travel by car is the dominant mode of transport for residents of the study area. In 2011, the study area had a slightly higher proportion of people who travelled to work by car, either as driver or passenger, compared to Queensland as a whole. Additionally, the study area had a larger proportion of people who travelled to work via truck compared to Queensland, which may be reflective of the agricultural and manufacturing industries in the study area.

There are no formal pedestrian and cycling facilities along the Bruce Highway in the study area. Three school bus routes currently operate along the Bruce Highway within the study area. These generally operate from:

- The intersection of Tandur Road and the Bruce Highway at Kybong to Gympie, via Keefton Road
- The intersection of Tandur Road and the Bruce Highway at Kybong to Gympie, via Traveston Road and Tandur Road
- Traveston Road, Noosa Road and the Bruce Highway to Gympie.

The University of the Sunshine Coast, located at Sippy Downs, also offers a free bus service for students in Gympie and the wider region, which travels via the Bruce Highway. Queensland Rail provides train services to Gympie from Brisbane twice daily. The railway traverses the study area and is located east of the new alignment. However, no railway stations are located near to the Project.

14.2.2.11 Community values

Community values are those elements considered to be important to quality of life and wellbeing. They include physical elements such as parks, buildings and landscapes, and social elements such as sense of belonging and community identity.

Communities in the study area value the area's rural character and amenity as well as the area's natural setting and pockets of densely vegetation. The importance of the region's rural character is recognised in the Wide Bay Burnett Regional Plan as a lifestyle draw card, with many residents settling in the region in search of a rural lifestyle (WBBRP 2011). Agricultural uses in the study area are a strong contributor to the area's sense of the place, particularly given the industry is a large employer of local residents.

Changes to the area's rural character are currently occurring with traditional farms increasingly being subdivided into lifestyle hobby farms and for rural residential living. Hobby farms are generally small farms that are maintained for pleasure without the expectation of being a primary source of income, but rather for a secondary income or a lifestyle choice.

Other features identified through consultation on the Gympie Region Community Plan 2030 as being of value to local residents include the region's scenic environment, the strong sense of community, friendly people, community involvement, the strong economy and the facilities and services available (Gympie Regional Council

2011). Safe and efficient transport links to local and regional centres was also identified during community consultation for the community plan as an important goal for communities in the region.

14.2.2.12 Social infrastructure and community facilities

Social infrastructure refers to community facilities, services and networks which help individuals, families, groups and communities meet their social needs, maximise their potential for development and enhance community wellbeing.

Social infrastructure and community facilities which serve the needs of residents and visitors to the study area are generally located in Gympie urban centre. This includes education, government, health and medical, sport, recreation and cultural, tourist accommodation, shopping and community support services.

Gympie Airport is located within the study area west of the Bruce Highway. While no commercial airlines or recreational businesses currently operate at Gympie Airport, the airport plays an important role for emergency services by providing access to the Royal Flying Doctor Service and CareFlight helicopter services.

Kybong Hall, currently owned by Gympie Regional Council, has historical and social significance and is listed as having local heritage significance. The hall is located east of the Bruce Highway, adjacent to the Gympie Airport. Throughout the twentieth century, the hall served as an important community facility providing many recreational services such as tennis courts and an indoor bowls club as well as served as a venue for dances and social events. Recently, the hall has experienced difficulty in filling committee positions as well as securing funding for much needed renovations[14].

Public open space is plentiful in the study area, providing significant recreational opportunities for the community and tourists. The Six Mile Creek Rest Area is located within the study area north of Keefton Road along the Bruce Highway. It offers a twenty hour maximum stay for visiting caravans and campers and provides a range of facilities including a water tap, toilets, electric BBQ, tables and benches and a dump point. The Kybong Tandur Pioneer Memorial Park is located approximately 250 metres east of the Bruce Highway and Tandur Road intersection. The study area covers part of Woondum State Forest, which provides some recreational opportunities such as hiking. Access to Woondum State Forest is generally via Noosa Road and Hill Road, located to the east of the new highway alignment.

14.2.2.13 Sensitive receptors

A number of sensitive receptors are located near to the Project that may experience impacts due to changes in noise, air quality and visual amenity (refer to **Figure 2-3**). A description of sensitive receptors pertaining to noise is provided in **Chapter 10**, sensitive receptors relevant to air quality is provided in **Chapter 11**, and sensitive receptors pertaining visual amenity are discussed in **Chapter 13**.

14.2.3 Summary of Socio-Economic Values

Overall, the study area includes a number of groups that may be sensitive to changes brought about by the project due to such things as age, income, access to economic resources. In particular, the socio-economic environment of the study area is characterised:

- A high proportion of people aged 65 years or older, which is typical of many rural areas and is likely to reflect the trend for young people leaving the region to seek employment and education opportunities elsewhere
- A relatively stable population, with high proportions of owner occupiers and people that had lived at the same address both one year and five years prior to the 2011 Census

[14] http://www.gympietimes.com.au/news/kybong-hall-improvements-threatened/525051/ (viewed 24 August 2013)

- Relatively high levels of low income households, a high proportion of households that experienced some level of housing stress at the 2011 Census and high levels of relative disadvantage in Kybong
- High level of vehicle ownership, reflecting the area's general lack of alternative transport options
- Relatively low rates of workforce participation, with high levels of unemployment in Tandur and high proportions of workers employed in primary industries, construction and retail trade.

Other features of the socio-economic environment relevant to the study area include:

- A number of businesses are located adjacent to the Bruce Highway in the study area, including some that that are dependent on passing trade (i.e. service stations)
- The study area has limited social infrastructure and community facilities, with residents accessing community services and social infrastructure in Gympie
- The study area's rural lifestyle, agricultural history, and strong sense of community, which is valued by local residents.

14.3 Potential Impacts and Mitigation Measures

This section provides an overview of the potential socio-economic impacts relating to the construction of the Project and the operation of the realigned Bruce Highway. Mitigation measures are also identified to minimise or avoid potential impacts on the socio-economic environment and maximise or enhance the Project's benefits.

Key impacts relating to the socio-economic environment are summarised in **Table 14-1**.

14.3.1 Property

14.3.1.1 Directly impacted properties

As described in **Chapter 2 – Project Description**, the Project will involve the partial or whole acquisition of a total of 52 impacted properties.

Of the properties impacted, approximately:

- 38 properties comprise rural residential uses, of which some include agricultural uses such as cattle grazing and hobby farming
- 10 properties comprise commercial and industrial uses, such as wood chipping, masonry works and a driver training facility
- Four properties are owned by other Government departments, including the Traveston State Forest and Woondum State Forest and land reserved for local government.

Properties directly impacted by the Project will be acquired by TMR in accordance with the provisions of the *Acquisition of Land Act 1967*. TMR has commenced consultation with directly affected property owners about the property acquisition process and impacted properties. At the request of property owners, TMR has commenced purchasing properties in accordance with the Queensland Government's hardship policy. This aims to provide certainty and flexibility for these property owners in relation to property decisions and financial security.

14.3.1.2 Impact of property acquisition

The acquisition of residential properties for the Project may require the relocation of some residents prior to construction. Some residents have already relocated due to property previously purchased by TMR, while others may be leasing the properties back from TMR.

The relocation of residents may impact on community cohesion through the disruption of social networks. As indicated in **Section 14.2.2,** the study area has high proportions of elderly people, people with a need for assistance and low income households. In addition, many families in the study area are likely to have lived on the same property for many generations. People in these groups are more likely to depend heavily on social and community networks. As such, special consideration may be required during the relocation process.

Stress and anxiety about property acquisition and possible relocation may also impact on the health and wellbeing of those residents. On-going consultation by TMR with directly affected property owners about property acquisition, and where appropriate, early acquisition of properties under the Queensland Government's hardship policy, will assist in reducing anxiety and stress for these residents.

The partial acquisition of properties for the Project and location of the new alignment may also result in severance and fragmentation of some larger properties into two or more parts or separate a property from adjoining land parcels. This may impact on access to and within the property.

Approximately fifteen properties will be fragmented by the new alignment (refer to **Table 2-3**). Most of these properties comprise of large rural residential lots. Property fragmentation is likely to have the greatest impact on larger cattle grazing properties potentially impacted on the movement of cattle and farm machinery between paddocks. Depending on the area of property affected, this may impact on the viability of some properties. Consultation with affected property owners to identify suitable alternate access arrangements for cattle and machinery will be important to minimise impacts of severance and fragmentation of properties.

The Project would also require the revocation and partial acquisition of the Woondum and Traveston State Forests. This is not expected to impact on the use of these properties. Other potential impacts on land use are discussed further in **Chapter 4 – Planning and Land Use**.

14.3.1.3 Impact on property values

Uncertainty about the property acquisition process and timing of the proposed works may impact property values of those properties closest to the new alignment. TMR is continuing to consult with property owners and local communities in the study area about property impacts and the timing of the proposed works, which will assist in reducing uncertainty for local communities.

Changes to local amenity as a result of the highway moving closer, may also impact property values in some locations, particularly those located near the Traveston intersection. Where the Project is realigned from the existing Bruce Highway, there is potential for the Project to have a positive impact on property values through improvements in local amenity in those areas currently located near to the Bruce Highway.

14.3.2 Access and Connectivity

The Project would change access and connectivity within the study area, including to individual properties.

At the regional level, the Project will result in additional road capacity, facilitating safer and quicker access to other areas of Queensland for freight, residents and visitors. The Project will also help to improve the safety of the highway, helping to reduce the likelihood and severity of vehicle crashes on the new alignment.

Locally, the new alignment crosses a number of local roads and access routes to properties and communities in the study area. These include:

- Traveston Road
- Tandur Road
- Gresham Road
- Woondum Road

- Keefton Road
- Small number of unnamed roads.

Overpasses of Tandur and Woondum roads would be constructed as early works packages, which will allow cross corridor connectivity to be maintained during construction of the Project as well as during operation. However, temporary road closures and disruptions for Tandur and Woondum roads may occur during construction of the overpasses. Alternative access would be provided to allow for continuity of through traffic if required.

During construction, the majority of access to the construction site for construction vehicles will most likely be via an unsealed road along the new alignment. This will reduce the amount of construction vehicles required to travel on the local road network.

Following construction, the existing Bruce Highway will be used as local service road. This would allow improved access to private properties located along the existing highway, due to reduced traffic volumes. In particular, separation of through traffic from local traffic would reduce the number of heavy vehicles and high traffic volumes travelling through Tandur, Kybong and Traveston, improving safety and ease of access for these communities.

The Project will require the closure of the access easement off Gresham Road west of the new alignment and Traveston Road also west of the new alignment. This will result in changes to the local road network, and changes to the way people move between properties and areas. In particular, those properties located to the east of the new alignment and in close proximity to Gresham Road or Traveston Road would be required to seek an alternative route, potentially resulting in longer distances to access the Bruce Highway and the new alignment. In addition, these properties may also lose direct access to neighbouring properties located west of the new alignment. These changes would impact on a small number of residential properties located on Gresham and Traveston Roads. While this is likely to be a concern for these residents, overall these changes are expected to have a minor impact.

Property access from Gresham Road will be affected by the Project. Alternative access will be established by TMR and the new access routes communicated to the property owners and local community. As noted in **Chapter 2 – Project Description**, the access to Lot 6, RP185500 will be provided by TMR via an access track to the east of this property. However, this is outside of the scope of the Project and not considered further in this assessment.

Property accesses located along Tandur, Woondum and Keefton Roads will not be directly impacted as local access will be maintained via the Bruce Highway.

Access to social infrastructure and community facilities and services available in Gympie will be maintained for the residents of the study area via the Bruce Highway or the new alignment. It is anticipated that school bus routes will generally continue to use existing routes, although some bus operators may modify bus routes or add services in response to the new alignment. As such, no impact on accessibility to social infrastructure and community facilities and services is expected.

14.3.3 Amenity

During construction, impacts on local amenity could be experienced for local residents due to construction noise and dust. Further detail regarding these issues is provided in **Chapter 10 – Noise** and **Chapter 11 – Air Quality**.

In particular, impacts would be experience by residents closest to the project works. This includes:

- Residents located adjacent to the existing Bruce Highway north of Woondum Road, for the works on the existing highway. This includes residents of the caravan park at Kybong

- Residents near to the construction of the Traveston interchange
- Residents near to the new alignment.

Construction activities would generally occur during day time hours, however some activities may need to be undertaken at night time to minimise traffic disruptions. This is likely to be required for road works along the existing Bruce Highway and also construction of the Traveston Interchange connections. These works may adversely affect the night time amenity or sleeping patterns for some residents closest to the construction activities. Ongoing consultation will be undertaken with local residents and other stakeholders during construction about likely impacts, including the timing, duration and management measures. This would also include information on the procedure for reporting grievances and complaints.

Access to the construction site for construction vehicles would be via an unsealed road along the new alignment. During construction, potential impacts on amenity may be experienced at those properties located near construction haulage roads, due to increased noise and dust from construction traffic, including heavy vehicles.

During operation, improvements in local amenity may be experienced for residents of properties located adjacent to the existing Bruce Highway due to reduced traffic and associated traffic noise. However, amenity impacts may be experienced at those properties located close to the new alignment that are currently remote from the existing highway. This may include increased traffic noise and emissions, and impact on visual amenity due to surface infrastructure. In addition, impacts of lighting may be experienced for residents located near to the Project, particularly those residents located near the Traveston Interchange and adjacent to the existing Bruce Highway north of Woondum Road. Environmental management measures will be implemented to minimise the effects of operation activities, such as vegetation screening along the new alignment. Impacts on visual amenity are further discussed in **Chapter 13 – Landscape and Visual Amenity**.

The Project will require the removal of some vegetation from within the Traveston and Woondum State Forests. This may change visual values for some properties located near the forests. In relation to Woondum State Forest, small areas of vegetation are expected to be cleared along Woondum Road and also north of the Keefton Road and Bruce Highway intersection. As such, those properties located along Woondum Road and within the vicinity of the Keefton Road intersection may experience reduced visual amenity. The new alignment traverses the eastern corner of Traveston State Forest and will require the removal of approximately 7.6 hectares of vegetation. However, due to the limited number of dwellings surrounding Traveston State Forest, the removal of vegetation is expected to have a minimal impact on the visual values of the study area.

14.3.4 Community Values

The Project may impact on community values within the study area through:

- The relocation of households and subsequent loss of social networks
- Loss of agricultural land impacting on the area’s rural character and amenity
- Noise and dust from construction activities for residents near surface works, impacting on the area’s rural character and amenity.

Some residents impacted by property acquisition may be required to relocate away from the study area. This may result in the relocation of some long term neighbours, and changes in familiar routines and social networks. This may particularly impact on the long-term residents, elderly people and people with a disability who may find it more difficult to adapt to new surroundings or make new social connections.

The loss of agricultural land for the project may be a concern for some community members. A number of residents may have chosen to reside in the study area due to its rural lifestyle, and as such, a change in rural amenity and landscape may alter people’s connection and value of the land. While this is likely to be a concern for communities in the study area and particularly for those directly impacted, regionally, the project is only expected to impact on a small amount of agricultural land at a regional level.

The Project may impact on local amenity of the study area, particularly for those properties located adjacent to the new alignment, adjacent to the road widening works along the Bruce Highway and near the Traveston intersection. This is discussed in **Section 14.3.3**.

As the existing Bruce Highway will operate as a local road, the amenity for those properties located adjacent to the road may improve due to a reduction in traffic, including a reduction to traffic incidents.

14.3.5 Business and Industry

A small number of businesses are located on the Bruce Highway that may be impacted due to the realignment of the highway and changes to existing access arrangements.

The new alignment will directly impact on the wood chipping industry located at Woondum Road. This would require this business to relocate. It is expected that suitable alternate locations are available elsewhere either in the study area or the wider region. Landscaping, revegetation and rehabilitation works may also be required on land acquired by TMR where the current land use will be discontinued, including the wood chipping industry that fronts Woondum Road. An investigation into the activities conducted at these sites and the permits and approvals obtained will be required to determine the nature and extent of the rehabilitation works required.

A number of businesses are located at the intersection of Tandur Road and the Bruce Highway that rely on passing trade, including the Matilda Fuel Stop and associated retail and food services. While access to these businesses would be maintained via the existing Bruce Highway, access to these businesses from the new alignment would be via the Traveston interchange, located approximately 3.3 kilometres south of the Tandur Road intersection. The realignment of the highway will reduce the volume of passing traffic, including tourist and motorists. This may impact on the viability of these businesses. TMR will continue to consult with businesses in the study area to provide business owners with Project updates and notification of any changes to access.

The Project will result in a small loss of agricultural land. The study area has a number of small scale cattle grazing operations located on properties that may be traversed by the new alignment. However, due to the small amount of land required, it is expected that farming operations would continue. TMR will continue to consult with local farmers to present options to allow movement of cattle across TMR's properties.

14.3.6 Social Infrastructure and Community Facilities

As identified in **Section 14.2.2**, social infrastructure and community facilities are limited in the study area. Consequently, the Project would not directly impact on any social infrastructure and community facilities. However, the Project may result in longer travel times to access social infrastructure and community facilities in Gympie for some residents in the study area, particularly those located at Gresham and Traveston roads, which will no longer have direct access to the existing Bruce Highway once the Project is in operation.

14.3.7 Summary of Impacts and Mitigation Measures

Table 14-1 provides a summary of impacts on the socio-economic environment of the study area as a result of the Project, and recommends mitigation measure to offset the impacts and enhance the benefits.

Table 14-1: Potential impacts and mitigation measures.

Impact	Description	Mitigation Measures
Property	Acquisition and fragmentation of property	TMR will continue to acquire property in accordance with TMR's land acquisition process

Impact	Description	Mitigation Measures
	Anxiety and stress for those residents whose property awaiting acquisition	TMR will continue consultation with all affected landowners and tenants, particularly to provide Project updates and responds to issues and concerns TMR will continue purchasing properties in accordance with the Hardship Policy
	Uncertainty about property acquisition impacting on property values	TMR will continue consultation with property owners about acquisition and the timing of proposed works
Access and Connectivity	Severance of access routes to property, particularly those located along Gresham Road	TMR will provide alternative access routes as detailed in Chapter 2 – Project Description and notify landowners and stakeholders affected by the Project of changes to access
	Decreased connectivity in study area due to changes to local roads network	TMR will inform local residents and road users of planned changes to traffic and access conditions undertaken as a result of the Project's construction
	Changes to the local roads network during operation, such as the elimination of Gresham and Traveston roads as through roads, resulting in residents to seek alternative routes	TMR will notify and consult with landowners and stakeholders affected by the Project of new access arrangements
Amenity	Increased dust, noise and lighting from construction activities	TMR will implement environmental management control strategies and measures to minimise dust and noise impacts. Further detail on these measures is provided in Chapter 10 – Noise and Chapter 11 – Air Quality).
	Decreased rural amenity for properties located near the new alignment, the Traveston interchange or adjacent to the road widening works of the Bruce Highway	A landscape plan will be developed for the Project in accordance with MRTS16 – General Requirements Landscape and Revegetation Works. TMR will consider screening and landscape planting to reduce the noise and visual impacts of the new alignment and project infrastructure.
Community Values	Reduced rural and agricultural character due to loss of vegetated land	TMR will implement environmental management control strategies and measures such as vegetation screening along new alignment
	Loss of social networks due to relocation of residents and families	TMR will continue to consult with the community to provide Project updates and respond to issues and concerns

Impact	Description	Mitigation Measures
Business and Industry	Reduction of activity in the agriculture industry due to fragmentation of agricultural land	TMR will continue to consult with local farmers to present options to allow movement of cattle across TMR's properties
	Loss of trade for those businesses fronting the Bruce Highway, particularly those located at the intersection on Tandur Road and the Bruce Highway	TMR will construct overpasses for Tandur Road and Woondum Road.
	Rehabilitation of existing industrial properties acquired by TMR	Requirements for landscaping, revegetation and rehabilitation works should be addressed in the Development Phase for land acquired by TMR where the current land use will be discontinued, including the wood chipping industry that fronts Woondum Road. An investigation into the activities conducted at these sites and the permits and approvals obtained will be required to determine the nature and extent of the rehabilitation works required.

14.4 Conclusion

At the regional level, the Project will result in additional road capacity, facilitating safer and quicker access to other areas of Queensland for freight, residents and visitors. However, the Project will also result in changes to the socio-economic environment of the study area, including through the acquisition of properties, a potential reduction in accessibility and connectivity within the area via local roads, and a potential reduction in rural values for local residents.

TMR has commenced consultation with directly affected property owners about property impacts and the property acquisition process. At the request of property owners, TMR has also commenced purchasing properties in accordance with the Queensland Government's hardship policy. This aims to provide certainty and flexibility for these property owners in relation to property decisions and financial security.

During construction, the Project will impact on local access and connectivity in the study area as property access and local roads may be temporarily disrupted. Impacts on amenity may also be experienced at properties located close to the new alignment, adjacent to the road widening works on the Bruce Highway or near the Traveston Interchange due to increased dust and noise from construction activities. Environmental management measures will be implemented during construction to manage impacts on local amenity.

The project will directly impact on one business through property acquisition. Impacts on business may also be experienced by the bypass of businesses located along the Bruce Highway and the reduction in passing traffic.

As the existing Bruce Highway will operate as a local road, the amenity for those properties located adjacent to the road may improve due to a reduction in traffic, including a reduction of traffic incidents. As such, those households may experience greater value for the area due to improved safety and increased rural amenity.

15. Cultural Heritage

A cultural heritage risk assessment was completed by Tanja Harding (TMR) on 10 September 2013 to determine areas of known and/or potential Aboriginal and historic cultural heritage values within the project alignment.

15.1 Methodology

A desktop assessment was undertaken and included searches of relevant publicly available and relevant data sources including the Department of Aboriginal, Torres Strait Islander and Multicultural Affairs (DATSIMA) heritage database, the Australian Heritage Register, the Queensland Heritage Register and the Gympie Regional Council Heritage Register.

TMR's Cultural Heritage Officer Tanja Harding also attended the ground truthing site visit in February 2014.

15.2 Existing Factors

A search of the DATSIMA heritage database indicated that there were no registered sites of Aboriginal or Torres Strait Islander significance within the study area. However this does not imply a lack of Aboriginal cultural heritage sites. Locations of minimal disturbance occur within the proposed work area, and therefore present a high likelihood of containing previously unrecorded site of Aboriginal significance. A Cultural Heritage Management Agreement is currently being developed and agreed with the Kabi Kabi First Nation People (QC2013/003) for the BHU Section C Project. This includes mitigation of preliminary works such as geotechnical investigations.

A search of the Australian Heritage Register and the Queensland Heritage Register identified no known sites of historic significance within the project area. A search of the Gympie Regional Council Heritage Register identified one known site of historic significance within the project area:

Place details:	Traveston Homestead
Lot on Plan:	Lot 1 on RP176437
Assessment number:	18478

The study area encompasses a large tract of land comprising of agricultural properties, residential properties, state forestry and existing road reserve. The landscape is traversed by a number of watercourses of varying significance. Environmental factors, such as topography, climate, geology, vegetation and fauna patterns are indicators of site predictability.

Topography can indicate the predictability of Aboriginal camp sites, and exploitation of specific areas. Climate determines food resources that would have been available throughout the year, with species availability fluctuating according to season. Archaeological deposits can contain floral and/or faunal deposits that identify seasonal exploitation of the areas resources. Geology provides an understanding of rock materials available for exploitation by Aboriginal people. Certain lithic material was commonly utilised for stone artefact manufacture (e.g. basalt, siltstone, mudstone, jasper, silcrete and chert), and other cultural activities, such as axe and seed grinding activities, and can be an indicator of sites such as quarries or knapping floors.

Vegetation relates directly to the types of plant species available for exploitation for food and cultural; activities by Aboriginal people, and indirectly to faunal species that the vegetation is capable of supporting. Vegetation in the study area is conducive to a wide variety of resource exploitation for food and material sources. Fauna species relate to vegetation and water availability, these include terrestrial fauna and marine resources. The study area has varied terrain and numerous water sources which, in conjunction with vegetation type would have been highly conducive to past Aboriginal exploitation.

The environmental factors within the study area would indicate a high probability of archaeological sites being present due to past resource exploitation by Aboriginal people. While vegetation may not be as dense and remnant as in the past the all the environmental factors combined indicate a past landscape that was highly conducive to Aboriginal activity and therefore presenting a high level of site predictability.

15.3 Recommendations

Due to the high site predictability it is recommended that all staff undertake a site specific cultural heritage induction prior to commencement of initial works. This is to be a two – part induction with a cultural awareness induction undertaken by a representative of the Kabi Kabi First nation Claimant Group, and a legislative requirements and TMR processes presented by the TMR Cultural Heritage Officer.

Prior to ground disturbance activities a site assessment will need to be conducted in by the Department's Cultural Heritage Officer and representatives of the Kabi Kabi First Nation Claimant Group to ensure there will be no impact on Aboriginal cultural heritage.

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