Australian Government

BUILDING OUR FUTURE

ARTC InlandRail

Inland Rail Programme

Narrabri to North Star Project

Environmental Impact Statement

Main Report

Image: Newell Highway north of Narrabri, NSW

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Certification

Submission of environmental impact statement

Prepared under Part 5.1 of the Environmental Planning and Assessment Act 1979 (NSW).

Environmental impact statement prepared by:

Name	Kate Day	Aryel Pyliotis
Qualifications	Bachelor of Environmental Science (Honours) Master of Environment	Bachelor of Science (Honours)
Address	GHD Pty Ltd 133 Castlereagh Street, Sydney NSW 2000	
Responsible person name and address (proponent)	Simon Thomas Programme Director Inland Rail Australian Rail Track Corporation Level 12, 40 Creek Street, Brisbane QLD 4000	
The address of the land to which the statement relates	Land within the Narrabri, Moree Plains, and Gwydir local government areas as described within this environmental impact statement.	
Description of the infrastructure to which this statement relates	Construction and operation of a section of Inland Rail, located between Narrabri and North Star in NSW.	
Environmental impact statement	An environmental impact statement is attached addressing all matters in accordance with Part 5.1 of the Environmental Planning and Assessment Act 1979 (NSW) and Schedule 2 of the Environmental Planning and Assessment Regulation 2000 (NSW).	
Declaration	I certify that I have prepared this environmental impact statement in accordance with the Secretary's Environmental Assessment Requirements dated 8 November 2016. The environmental impact statement contains all available information that is relevant to the environmental assessment of the infrastructure to which the statement relates. To the best of my knowledge, the information contained in the environmental impact statement is neither false nor misleading.	
Signatures	K. Day	
Name	Kate Day	Aryel Pyliotis
Date	3 November 2017	3 November 2017

Abbreviations

Abbreviation	Definition
ABS	Australian Bureau of Statistics
AEP	annual exceedance probability
AHD	Australian height datum
AHIMS	Aboriginal Heritage Information Management System
AHIP	Aboriginal heritage impact permit
ANZS	Australia and New Zealand Standard
ARTC	Australian Rail Track Corporation
AS	Australian Standard
ATMS	Advanced Train Management System
BoM	Bureau of Meteorology
CEEC	critically endangered ecological community
CEMP	construction environmental management plan
CHMP	Cultural Heritage Management Plan
CLM Act	*Contaminated Land Management Act 1997* (NSW)
CO	Carbon monoxide
CSIRO	Commonwealth Scientific and Industrial Research Organisation
dB	decibel
dB(A)	A-weighted decibel
EEC	endangered ecological community
EIS	environmental impact statement
EPA	Environment Protection Authority
EP&A Act	*Environmental Planning and Assessment Act 1979* (NSW)
EP&A Regulation	*Environmental Planning and Assessment Regulation 2000* (NSW)
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth)
EPL	environment protection licence
ESD	ecologically sustainable development
FM Act	*Fisheries Management Act 1994* (NSW)
GIS	geographical information system
GHD	GHD Pty Ltd
ha	hectare
IBRA	Interim Biogeographic Regionalisation of Australia
ICB	intermediate bulk containers
IS	infrastructure sustainability
ISCA	Infrastructure Sustainability Council Australia

Abbreviation	Definition
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organisation for Standardisation
km	kilometres
km^2	square kilometres
km/h	kilometres per hour
LEP	Local Environmental Plan
LGA	local government area
LUCRA	Land Use Conflict Risk Assessment
m	metres
m^3	cubic metres
mAHD	metres above Australian Height Datum
mm/s	millimetres per second
NATA	National Association of Testing Authorities
NEPC	National Environmental Protection Council
NEPM	National Environmental Protection Measure
NO_2	Nitrogen dioxide
NPW Act	*National Parks and Wildlife Act 1974* (NSW)
OEH	Office of Environment and Heritage
OEMP	operation environmental management plan
PM	particulate matter
PMF	probable maximum flood
POEO Act	*Protection of the Environment Operations Act 1974* (NSW)
PPV	peak particle velocity
RING	*Rail Infrastructure Noise Guideline* (EPA, 2013)
SEARs	Secretary's Environmental Assessment Requirements (for the EIS)
SEPP	state environmental planning policy
SO_2	Sulphur dioxide
TEC	threatened ecological community
TSC Act	*Threatened Species Conservation Act 1995* (NSW)
VDV	Vibration dose value
WARR Act	*Waste and Resource Recovery Act 2001* (NSW)
µg/L	microgram per litre
$µg/m^3$	microgram per cubic metre
µS/cm	microsiemen per centimetre

Definitions

Term	Definition
Aboriginal object	Defined by the *National Parks and Wildlife Act 1974* as: ‘any deposit, object or material evidence (not being a handicraft made for sale) relating to the Aboriginal habitation of the area that comprises New South Wales, being habitation before or concurrent with (or both) the occupation of that area by persons of non-Aboriginal extraction, and includes Aboriginal remains’.
Aboriginal site	A place where physical remains or modification of the natural environment indicate past and ‘traditional’ activities by Aboriginal people. Site types include artefact scatters, isolated artefacts, burials, shell middens, scarred trees, quarries and contact sites. Includes sites listed on the. Also known as Aboriginal objects.
Aboriginal place	Declared by the Minister for the Environment, in accordance with section 84 of the *National Parks and Wildlife Act 1974* and by an order published in the Gazette, as a place that, in the opinion of the Minister, is or was of special significance with respect to Aboriginal culture.
Aboriginal places of heritage significance	Defined in the *Standard Instrument - Principal Local Environmental Plan* as an area of land, the general location of which is identified in an Aboriginal heritage study adopted by the Council, and that may be shown on the Heritage Map. The term may include (but is not limited to) places that are declared as Aboriginal places under section 84 of the *National Parks and Wildlife Act 1974*.
Absorptive capability	Absorptive capability relates to the ability of the landscape character zones to absorb the proposal within the existing landscape setting
Active control (level crossings)	Where the movement of vehicular or pedestrian traffic across a railway crossing is controlled using devices such as flashing signals, gates or barriers (or a combination of these), with the device/s activated prior to, and during, the passage of a train through the crossing.
Annual exceedance probability (AEP)	The chance of a flood if a nominated size occurring in a particular year. The chance of the flood occurring is expressed as a percentage and, for large floods, is the reciprocal of the annual recurrence interval (ARI). For example, the one per cent AEP flood event is equivalent to the 100 year ARI flood event.
Approved methods	*Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (Department of Environment and Conservation, 2005).
Average recurrence interval (ARI)	The long-term average number of years between the occurrence of a flood of a nominated size.
Ballast	Crushed rock, stone etc used to provide a foundation for a railway track. Ballast usually provides the bed on which railway sleepers are laid, transmits the load from train movements, and restrains the track from movement.
Biobanking agreement	Landowners enter into a biobanking agreement with the Minister for the Environment to establish a biobank site. A biobanking agreement is a conservation covenant that is attached to the land title. A biobanking agreement specifies the management actions that are required to be undertaken on biobank sites to improve biodiversity values and allow biodiversity credits to be created.
Biobank site	A site to which a biobanking agreement applies.

Term	Definition
Biodiversity credits	In accordance with the *Framework for Biodiversity Assessment* (OEH, 2014b) the biodiversity credits, which consist of ecosystem credits and species credits, represent the impacts on threatened species as a result of a proposal. A decision support tool, produced by OEH, is used to determine the number of biodiversity credits required to offset the impacts of the development.
Biodiversity offsets	Biodiversity offsets are measures that benefit biodiversity by compensating for the adverse impacts elsewhere of an action, such as clearing for development. Biodiversity offsets work by protecting and managing biodiversity values in one area in exchange for impacts on biodiversity values in another.
Biophysical environment	The physical environment (water, soil etc) as well as the biological activity within it (plants, animals etc.).
Bulk freight	Bulk freight generally involves large quantities of homogenous product, typically liquid or loose crushed solid material (such as cement, grains and ores), transported en masse without packaging.
Classified road	A road that meets the definition of a classified road and is listed as such under the *Roads Act 1993* – includes main roads, highways, freeways etc.
Climate	The average weather experienced at a site or region over a period of many years, ranging from months to many thousands of years. The relevant measured quantities are most often surface variables such as temperature, rainfall and wind.
Climate scenario	A plausible and often simplified representation of the future climate, based on an internally consistent set of climatological relationships that has been constructed for explicit use in investigating the potential consequences of anthropogenic climate change, often serving as input to impact models.
Crossing loop	A section of track off to the side of the main track/s that allows a train to move to the side so that another can pass.
Construction compound	An area used as the base for construction activities, usually for the storage of plant, equipment and materials and/or construction site offices and worker facilities.
Culvert	A structure that allows water to flow under a road, railway, track, or similar obstruction.
Dangerous goods	Dangerous goods are substances or articles that pose a risk to people, property or the environment, due to their chemical or physical properties. They are usually classified with reference to their immediate risk.
Ecologically sustainable development	Development that uses, conserves and enhances the resources of the community so that ecological processes on which life depends are maintained, and the total quality of life, now and in the future, can be increased.
Ecosystem credit	A measurement of the value of EECs, CEECs and threatened species habitat for species that can be reliably predicted to occur with a plant community type. Ecosystem credits measure the loss in biodiversity values as a result of a proposal, and the gain in biodiversity values at an offset site.
Emission	A substance discharged into the air.
Existing rail corridor	The corridor within which existing rail infrastructure, subject to works as part of Inland Rail, are located. The rail corridor is defined by ARTC to mean everywhere within 15 metres of the outermost rails; or within the boundary fence where boundary fences are provided and are closer than 15 metres; or if the property boundary is less than 15 metres, the property boundary; or a permanent structure such as a fence, wall or level crossing separating the operating rail corridor from other land.

Term	Definition
Formation	The earthworks/material on which the ballast, sleepers and tracks are laid.
Freight	Goods transported by truck, train, ship, or aircraft.
Freight task	The amount of freight transport, usually measured in tonnes or tonne-kilometres.
Hairpin curve	A hairpin turn or bend is a very tight turn with the track resembling a hairpin.
Heritage listed	An item, building or place included on statutory heritage lists maintained by local, State or the Australian Government.
Infrastructure sustainability	Infrastructure that is designed, constructed and operated to optimise environmental, social and economic outcomes of the long-term.
Inland Rail	The Inland Rail programme encompasses the design and construction of a new inland rail connection between Melbourne and Brisbane, via Wagga, Parkes, Moree, and Toowoomba. The route for Inland Rail is about 1,700 kilometres in length. Inland Rail will involve a combination of upgrades of existing rail track and the provision of new track.
Intermodal	The movement of freight using multiple modes of transport (rail, ship, truck) without handling of the freight itself when changing modes. For a railway this usually refers to the transport of freight in containers which may be double stacked on the wagons carrying them.
$L_{A90(period)}$	The sound pressure level exceeded for 90 per cent of the measurement period.
$L_{Aeq(time)}$	Typically used to described ambient (background) noise levels.
$L_{Aeq(1\ hour)}$	The busiest 1-hour 'equivalent continuous noise level', it represents the typical L_{Aeq} noise level from all the proposal noise events during the busiest 1-hour of the assessment period.
$L_{Aeq(9\ hour)}$	The night-time 'equivalent continuous noise level' - it represents the cumulative effects of all the proposal noise events occurring in the night-time period from 10:00 pm to 7:00 am.
$L_{Aeq(15\ hour)}$	The daytime 'equivalent continuous noise level' - it represents the cumulative effects of all the proposal noise events occurring in the daytime period from 7:00 am to 10:00 pm.
$L_{Aeq(24\ hour)}$	The 'equivalent continuous noise level', sometimes also described as the 'energy-averaged noise level' – it represents the cumulative effects of all the proposal noise events occurring in one day.
L_{Amax}	The maximum sound level recorded during the measurement period.
Landscape	All aspects of a tract of land, including landform, vegetation, buildings, villages, towns, cities and infrastructure.
Landscape character	The combined quality of built, natural and cultural aspects that make up an area and provide its unique sense of place.
Landscape character zone	An area of landscape with similar properties or strongly defined spatial qualities, distinct from areas immediately adjacent.
Landscape feature	A component, part or feature of the landscape that is prominent or eye-catching, for example hills, buildings, vegetation.
Landscape quality	Largely subjective judgement based on particular characteristics that influence the way in which the environment is experienced, including special interests such as cultural associations or heritage interests, the presence and/or type of elements and condition.

Term	Definition
Level crossing	A place where rail lines and a road cross at the same elevation.
Level crossing protection	The level of control provided at level crossings, which is determined on a case by case basis, and depends on the particular characteristics of a crossing. It generally falls into two categories: passive protection (uses warning signage only) or active protection (uses either signage and flashing lights only, or signage/flashing lights with boom gates).
Level of service	Defined by Austroads as a measure for ranking operating road and intersection conditions, based on factors such as speed, travel time, freedom to manoeuvre, interruptions, comfort and convenience.
Local road	Road used primarily to access properties located along the road.
Non-bulk freight	Non-bulk freight is generally characterised as any containerised, packaged or other unitised freight, such as: pallets; motor vehicles and trailers; laden transported vehicles and live animals. It is generally placed or lifted onto or into transport vehicles or holds. It often involves heterogeneous goods being moved between dispersed locations. Non-bulk freight varies in density, perishability and fragility.
Passive control (level crossings)	Where the movement of vehicular or pedestrian traffic across a railway crossing is controlled using signs or devices that are not activated by the approach or passage of a train, relying on the road user to detect the approach or presence of a train by direct observation.
PM_{10}	Particulate matter 10 micrometers or less in diameter. Particles in this size range make up a large proportion of dust that can be drawn deep into the lungs. This is a classification of particles by size rather than chemical properties.
Possession	A period of time during which a rail line is blocked to trains to permit work to be carried out on or near the line.
Proposal	The construction and operation of the Narrabri to North Star section of Inland Rail.
Proposal site	The area that would be directly affected by construction works (also known as the construction footprint). It includes the location of proposal infrastructure, the area that would be directly disturbed by the movement of construction plant and machinery, and the location of the storage areas/compounds sites etc, that would be used to construct that infrastructure.
Pioneer line	Rail lines constructed to a lesser standard than main rail lines, providing access to mainly agricultural areas.
Rail alignment	The exact positioning of the track, accurately defined both horizontally and vertically, along which the rail vehicles operate.
Rail corridor	The corridor within which the rail tracks and associated infrastructure are located.
Rail level	The theoretical level of the running surface of the rails.
Rating background level	The underlying level of noise present in an area once transient and short-term noise events are filtered out.
Relic	A relic is defined by the NSW *Heritage Act 1977* as 'any artefact, object or material evidence which relates to the settlement of the area that comprises New South Wales, not being Aboriginal settlement, and which is of State or local heritage significance.'
Sensitivity	The sensitivity of a landscape character area or view and its capacity to absorb change. In the case of visual impact this also relates to the type of viewer and number of viewers.

Term	Definition
Species credit	The class of biodiversity credits created or required for the impact on threatened species that cannot be reliably predicted to use an area of land based on habitat surrogates. Species that require species credits are listed in the threatened species profile database.
Spoil	Material generated by construction.
Strahler stream order	Classification system that gives a waterway an 'order' according to the number of tributaries associated with it.
Section 170 register	Under section 170 of the *Heritage Act 1977*, all state government agencies must keep and administer a database of heritage assets called a Section 170 Heritage and Conservation Register.
Sensitive receivers	Land uses which are sensitive to potential noise, air and visual impacts, such as residential dwellings, schools and hospitals.
Study area	The study area is defined as the wider area including and surrounding the proposal site, with the potential to be directly or indirectly affected by the proposal (for example, by noise and vibration, visual or traffic impacts). The actual size and extent of the study area varies according the nature and requirements of each impact assessment technical report.
Track	The structure consisting of the rails, fasteners, sleepers and ballast, which sits on the formation.
Track formation	Refer to the definition of formation.
Travelling stock routes	Travelling stock routes and reserves are parcels of Crown land reserved under the *Crowns Lands Act 1989* for use by travelling stock.
Turnout	A junction point where a rail vehicle can leave a given track for a branching or parallel track.
Underbridge	A bridge underneath a railway or road. For the proposal, underbridges refer to those structures which allow water from a watercourse to pass under the railway, but are longer in span than culverts.
Visual amenity	The value of a particular area or view in terms of what is seen.
Visual impact	The impacts on the views from residences, workplaces and public places. This can be positive (i.e. benefit or an improvement) or negative (i.e. adverse or a detraction).
Visual catchment	Extent of potential visibility to or from a specific area, feature or proposal.
View	The visual experience from the viewer's perspective.
Waste	Waste is defined by the EPA as any matter (whether liquid, solid, gaseous or radioactive) that is discharged, emitted or deposited in the environment in such volume, constituency, or manner as to cause an alteration to the environment.
Waste management hierarchy	The waste management hierarchy is a set of priorities for the efficient use of resources, which underpins the objectives of the *Waste Avoidance and Resource Recovery Act 2001*. The waste management hierarchy progresses from avoidance (most preferred), to re-use/recycling, to disposal (least preferred).

Executive summary

Overview

The Australian Government has committed to building a significant piece of national transport infrastructure by constructing a high performance and direct interstate freight rail corridor between Melbourne and Brisbane, via central-west New South Wales (NSW) and Toowoomba in Queensland. Inland Rail is a major national project that will enhance Australia's existing national rail network and serve the interstate freight market.

The Inland Rail route, which is about 1,700 kilometres long, involves:

- using the existing interstate rail line through Victoria and southern NSW
- upgrading about 400 kilometres of existing track, mainly in western NSW
- providing about 600 kilometres of new track in northern NSW and south-east Queensland.

Inland Rail has been divided into 13 projects, seven of which are located in NSW.

This environmental impact statement (EIS) considers the potential impacts of the proposal to construct and operate the Narrabri to North Star section of Inland Rail ('the proposal'). It has been prepared to support Australian Rail Track Corporation's application for approval of the proposal in accordance with the requirements of Part 5.1 of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

The proposal is State significant infrastructure, and is subject to approval by the NSW Minister for Planning. The proposal has also been declared by the Minister for Planning as critical State significant infrastructure under section 115V of the EP&A Act. The EIS addresses the environmental assessment requirements of the Secretary of the Department of Planning and Environment ('the SEARs'), dated 8 November 2016. The proposal is also determined to be a controlled action under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (EPBC Referral 2016/7729), and requires approval from the Australian Government Minister for the Environment and Energy. The EIS focuses on the key assessment requirements specified by the SEARs. It is supported by specialist technical assessment reports.

The proposal

Key features

The proposal consists of 188 kilometres of upgraded track and associated facilities, and is generally located within the existing rail corridor between Narrabri and the town of North Star, via Moree. Some works would also be undertaken outside the rail corridor, including works at Bellata, Moree, and Camurra.

The key features of the proposal involve:

- upgrading the track, track formation, culverts, and underbridges within the existing rail corridor, for a distance of 188 kilometres, between Narrabri and North Star via Moree
- realigning the track within the existing rail corridor at Bellata, Gurley, and Moree stations to conform with required platform clearances for Inland Rail trains
- providing five new crossing loops within the existing rail corridor at Bobbiwaa, Waterloo Creek, Tycannah Creek, Coolleearllee, and Murgo
- providing a new section of rail line at Camurra about 1.6 kilometres long, to bypass the existing hairpin curve ('the Camurra bypass')
- removing three existing rail bridges and providing new rail bridges over the Mehi and Gwydir rivers and Croppa Creek
- realigning about 1.5 kilometres of the Newell Highway near Bellata, and providing a new road bridge over the existing rail corridor ('the Newell Highway overbridge')
- providing a new road bridge over the existing rail corridor at Jones Avenue in Moree ('the Jones Avenue overbridge').

Ancillary work would include works to level crossings, signalling and communications, signage, fencing, and services and utilities within the proposal site.

Timing

Subject to approval of the proposal, construction is planned to commence in mid-2018, and is expected to take about 24 months. Inland Rail as a whole is expected to be operational in 2025.

Operation

The proposal would form part of the rail network managed and maintained by ARTC. Train services would be provided by a variety of operators. Prior to the opening of Inland Rail as a whole, the rail line would be used by existing rail traffic, which includes trains carrying passengers and grain at an average rate of about four trains per day.

It is estimated that the operation of Inland Rail would involve an annual average of about 10 trains per day travelling north of Moree (between North Star and Moree) and 12 trains per day travelling south of Moree (between Moree and Narrabri) in 2025. This would increase to about 19 trains per day north of Moree (between North Star and Moree) and 21 trains per day south of Moree (between Moree and Narrabri) in 2040. In the proposal site, this would be additional to the existing rail traffic using the rail line.

The Inland Rail trains would be a mix of grain, bulk freight, and other general transport trains. Total annual freight tonnages would be about 11.8 million tonnes in 2025, increasing to about 19 million tonnes in 2040 (from the existing 2 million tonnes of grain per year).

Train speeds would vary according to axle loads, and range from 80 to 115 kilometres per hour (for 21 tonne trains) except through Moree where the maximum train speed would be 65 kilometres per hour due to track geometry. Trains would operate 24 hours per day. They would be up to 1,800 metres long; carry double stacked containers; and have a height of 6.5 metres.

Need for the proposal

The proposal is a critical component of Inland Rail, and Inland Rail cannot proceed without the proposal. The proposal has been designed to maximise use of the existing rail corridor, while still contributing to the overall efficiency of Inland Rail.

Objectives of the proposal

The objectives of the proposal are to:

- provide upgraded rail infrastructure that meets the Inland Rail specifications, to enable trains using the Inland Rail corridor to travel between Narrabri and North Star, connecting with other sections of Inland Rail to the north and south
- minimise the potential for environmental and community impacts, by maximising use of the existing rail corridor.

Inland Rail

Objectives

The objectives of Inland Rail are to:

- provide a rail link between Melbourne and Brisbane that is interoperable with train operations between Perth and Adelaide, to serve future rail freight demand, and stimulate growth for inter-capital and regional/bulk rail freight
- provide an increase in productivity that will benefit consumers through lower freight transport costs
- provide a step-change improvement in rail service quality in the Melbourne to Brisbane corridor and deliver a freight rail service that is competitive with road
- improve road safety, ease congestion, and reduce environmental impacts by moving freight from road to rail
- bypass bottlenecks within the existing metropolitan rail networks, and free up train paths for other services along the coastal route
- act as an enabler for regional economic development along the Inland Rail corridor.

Need for Inland Rail

There is no direct continuous inland rail link between Melbourne and Brisbane. Interstate rail freight currently travels between Melbourne and Sydney via Albury, and then between Sydney and Brisbane, generally along the coast. About 70 per cent of the freight between Melbourne and Brisbane is carried by road, principally the Newell Highway in NSW, and connecting highways in Victoria and Queensland.

Growth in freight demand

The Melbourne to Brisbane corridor is one of the most important general freight routes in Australia, supporting key population and employment precincts along the east coast and inland NSW. It is estimated that 21 million tonnes of non-bulk and complementary freight moves along this corridor each year. This is expected to grow to over 40 million tonnes per year by 2050.

With the population of the eastern states forecast to increase by 60 per cent over the next 40 years, the need for efficient and effective freight transport will continue to increase. Strong forecast population growth, accompanied by comparable growth in employment, is likely to place significant pressure on existing infrastructure and services.

Existing freight capacity and infrastructure issues

Without the increased use of rail, the growth in freight demand is likely to result in increasing pressure on the road network and associated safety and environmental issues, increased freight costs, and a loss of economic opportunity. The current national infrastructure network cannot support this projected growth, with increasing pressure on already congested roads through Sydney, and increasing use of heavy trucks such as B-doubles and, potentially, B-triples along the Hume-Pacific and Newell highway corridors.

Rail is generally the most productive and efficient mode for freight travelling from regional areas to export ports and urban destinations. Freight trains travelling along the Melbourne to Brisbane corridor currently travel through the Sydney metropolitan rail network, often experiencing significant delays. Travel time reliability is poor, as a result of the priority given to passenger services, freight transit curfews in the Sydney metropolitan area, and substandard rail alignments elsewhere. Limited capacity during morning and afternoon passenger peaks restricts freight movements at these times.

Summary of the need for Inland Rail

Inland Rail is needed to improve the efficiency of freight moving between Melbourne and Brisbane. Inland Rail will bypass the Sydney metropolitan area, substantially cut the overall journey time to less than 24 hours, and increase the reliability of services between Melbourne and Brisbane. This is expected to increase the competitiveness of rail transport relative to road transport.

In addition, Inland Rail will encourage growth and investment in regional areas along the route through improved freight connections.

As noted by the *Australian Infrastructure Audit* (Infrastructure Australia, 2015), 'Rail offers an alternative to road transport and societal benefits in terms of lower emissions, reduced road congestion and increased safety per tonne kilometre, particularly over longer distances or when carrying heavy goods.'

In summary, Inland Rail is needed to respond to the growth in demand for freight transport, and address existing freight capacity and infrastructure issues. The analysis of demands undertaken by ARTC indicated that there would be sufficient demand for Inland Rail.

Summary of the key findings of the EIS

Traffic, transport and access

The proposal would not result in any significant adverse impacts with respect to traffic and transport issues such as traffic operations, road capacity on the surrounding network, site access, and road safety. During construction, traffic and transport would be managed by a construction traffic management plan prepared prior to the commencement of construction.

The proposal may result in changes to some level crossings. Consultation with potentially affected landowners would be undertaken, and changes would only occur following agreement with the property owner and relevant agencies.

The road network has spare capacity to cater for the estimated construction and operation traffic, and no significant network impacts are predicted. The main operational traffic impacts relate to changes in delays at level crossings, and changes in traffic movements associated with the proposed Jones Avenue overbridge in Moree.

Traffic activity at most level crossings in the study area is low, and the volume of traffic likely to be delayed by train activity is not substantial. There is capacity at each level crossing for delayed traffic to queue clear of adjacent intersections. Within Moree, the Newell Highway and the Moree Bypass run adjacent to the proposal site. The intersections at Alice Street and Bullus Drive would be affected by minor delays at level crossings resulting in queuing traffic.

The proposed Jones Avenue overbridge would benefit the community and road users by improving connectivity across the rail line. Construction of the overbridge and associated road connections would involve closing Joyce Avenue at the northern end, and constructing a new intersection with Tycannah Street. It is predicted that there will be minor operational impacts to traffic movement as a result of the proposal.

The transfer of freight to rail when Inland Rail becomes operational would reduce truck movements on the Newell Highway. This would have safety benefits to the broader community and reduce emissions.

Biodiversity

The majority of the proposal site and surrounds have been heavily modified by past and ongoing disturbances associated with the existing rail corridor and surrounding rural/agricultural activities. Clearance and maintenance of the rail corridor has resulted in fragmentation, a high level of disturbance, and degradation of vegetation communities. However, although the majority of the proposal site consists of non-native vegetation or cleared land, patches of native vegetation remain.

Biodiversity impact assessments of the proposal were undertaken, including a terrestrial biodiversity assessment prepared in accordance with the *Framework for Biodiversity Assessment* (OEH, 2014a), an aquatic biodiversity assessment, and an assessment of the potential impacts on matters listed under the EPBC Act.

The main potential impact of the proposal on biodiversity would occur during construction as a result of the clearing of native vegetation within the proposal site, including vegetation within the rail corridor, and in areas of the proposal site located outside the rail corridor. At this stage of the design, it is estimated that the proposal would require the permanent removal of about 411 hectares of native vegetation. This vegetation includes threatened ecological communities listed under the NSW *Threatened Species Conservation Act 1995* (TSC Act) and/or the EPBC Act.

ARTC is committed to minimising the environmental impacts of the proposal. The area of direct impact would be further refined during detailed design, with the aim of reducing the amount of vegetation clearing required as far as practicable. To mitigate the potential impacts to biodiversity, a comprehensive Biodiversity Offset Strategy has been prepared in accordance with the *NSW Biodiversity Offsets Policy for Major Projects* (OEH, 2014c). This includes consideration of potential offset sites and/or opportunities to purchase biodiversity credits to offset the impacts of the proposal, according to the requirements for major projects under the EP&A Act, and to offset impacts on EPBC Act matters.

The main impacts on aquatic ecological systems would be as a result of the removal and construction of new watercourse crossing structures along the proposal site, and access over watercourses for movement of construction equipment and personnel. These potential impacts would be minimised by implementing the construction mitigation and management measures provided by the EIS. No impacts to aquatic threatened species or communities are predicted.

Noise and vibration

There is the potential for construction noise to exceed relevant criteria at various sensitive receivers along the proposal site. The potential significance of the impacts would be minimised by the mobile nature of the majority of the construction works. Although construction noise would be temporary and localised in nature, the potential impacts would be managed through the implementation of noise control measures provided in the EIS, particularly for those sections of the proposal site located close to sensitive receivers (less than 50 metres).

Construction vibration was assessed, and management and mitigation measures have been provided to minimise the potential for significant human comfort and structural vibration impacts at the nearest sensitive receivers.

The noise modelling predicted that the noise levels at 152 residential receivers have the potential to exceed the redeveloped rail line criteria for operational rail noise by the year 2040. It is anticipated that Inland Rail would be complete in 2025, and this is when train movements would increase above existing numbers with the commencement of train operations between Melbourne and Brisbane. However, the route is not expected to reach design capacity until 2040.

Mitigation options have been identified, and would be refined during detailed design and in consultation with affected sensitive receivers. Post construction noise monitoring would be undertaken at representative locations to verify the effectiveness of the mitigation measures with respect to the appropriate guidelines.

Air quality

The main potential impact on air quality during construction would occur as a result of the generation of dust from construction works and the movement of equipment and machinery. If dust is not adequately controlled, it could impact on surrounding sensitive receivers and agricultural land uses. These issues would be managed by implementing air quality management controls guided by the construction environmental management plan (CEMP).

During operation, the increase in diesel operated freight trains using the corridor has the potential to increase levels of pollutants such as nitrogen oxides and particulate matter. The air quality impact assessment considered the potential increases and concluded that the emissions are expected to be below the relevant impact assessment criteria. Air pollution from transport corridors decreases significantly with distance, and is not expected to be an issue for the proposal given the distance from the majority of potentially sensitive receivers.

Soils and contamination

Construction of the proposal has the potential to result in erosion and sedimentation, and contamination of soils and surface waters. Mitigation measures would be implemented to minimise these risks, including implementation of a soil and water management sub-plan as part of the CEMP, and protocols for construction in areas of potentially contaminated soils.

Implementation of the proposed environmental controls and the CEMP would reduce the risk of potentially contaminating activities impacting on workers, surrounding residents, and the environment.

The risk of contamination associated with operation is expected to be low. Sediment and erosion control plans for exposed soils would be adopted and implemented, which would reduce the risk of environmental impact.

Hydrology and flooding

The proposal involves raising the level of the rail formation along the majority of the proposal site, to achieve ARTC's design standards for flood immunity. This would include installing structures such as culverts on watercourse crossings.

The proposal would be constructed using pre-cast structures where practicable. This would reduce the size of the construction footprint, the extent of earthworks, and the timeframe to construct each structure. Minimising the duration of disturbance at each work site reduces the risk of a significant rainfall event flooding the work area.

The proposal incorporates design measures to avoid or minimise potential impacts on flooding and hydrology during operation. These focus on providing structures at all existing watercourse crossings to minimise the potential for changes in surface water flow paths.

Raising the height of the rail formation would impact surface water flows across the floodplain. This would change the upstream local flooding regime, and lead to more concentrated flows through culverts, which would discharge to downstream watercourses.

Currently, about 11,124 metres of the existing rail corridor in the proposal site is overtopped during a one per cent annual exceedance probability (AEP) local flood event, to a maximum depth of 0.75 metres. Flood modelling predicts that the proposal would reduce the length of rail overtopping in this type of local flood event by 88 per cent, to a length of 1,338 metres and a maximum depth of 0.37 metres. The proposal is predicted to reduce the area of upstream flooding for the majority of local flood events up to the probable maximum flood. The extent of flooding in a one per cent AEP flood event is anticipated to reduce by about six per cent.

Regional flood modelling undertaken for the Gwydir and Mehi rivers indicated that near Moree, flood depths and extents due to the proposal would marginally increase (by about six per cent), compared to the existing situation.

Water quality

The potential impacts of construction relate mainly to erosion and the generation of sediment, particularly during watercourse crossings, construction of new culverts/underbridges, and construction of the proposed new rail bridges over the Mehi and Gwydir rivers and Croppa Creek. To mitigate these impacts, erosion and sediment control measures, including measures for the main watercourse crossings, would be implemented during construction in accordance with the CEMP. A surface water monitoring framework would be prepared to guide the monitoring of water quality.

Construction is not anticipated to impact on groundwater resources. Excavation would be relatively shallow compared to the likely depth of the water table, and is not likely to intercept groundwater aquifers or their flow systems. In locations where piling is required (such as for bridge piers), the detailed design would consider methods to minimise or avoid the potential requirement for dewatering where perched groundwater is encountered.

During operation, surface water runoff would be managed through a drainage system that connects to cross drainage infrastructure at existing drainage lines and watercourses. The drainage system would include measures, such as scour protection at culvert outlets, to minimise the potential for scouring and erosion. Where appropriate, culvert outlets would be lined to minimise scouring.

Aboriginal heritage

Within the existing rail corridor, the construction and maintenance of the existing rail line is likely to have resulted in the removal/relocation of archaeological evidence that may have been present.

Two sites listed under the *National Parks and Wildlife Act 1974* (NPW Act) are located within the proposal site – the Steel Bridge Camp site (10-3-0032), which is an area of potential archaeological deposit at the former Aboriginal fringe camp site, and the Duffys Creek site (10-3-0035), an artefact scatter and area of potential archaeological deposit. These sites were assessed as having low to moderate archaeological significance at ground level, and moderate to high significance below the current depth of disturbance.

In addition, 12 new Aboriginal sites were identified within the proposal site during field surveys. Of these sites, eight are isolated artefacts with low significance, three are artefact scatters with low significance, and one is an artefact scatter with low to moderate significance.

Five areas of moderate or higher archaeological potential were identified within the proposal site.

Detailed design would aim to minimise the potential impacts to these sites and areas as far as possible. Where impacts are unavoidable, the significance of impacts would be minimised by implementing the mitigation measures provided.

Non-Aboriginal heritage

Three locally listed heritage items are located within the proposal site – Moree Station, which is listed on both the *Moree Plains Local Environmental Plan 2011* (the Moree Plains LEP) and Railcorp's section 170 heritage register, and the Mehi River and the Gwydir River rail bridges, which are listed on ARTC's section 170 heritage register. Moree Station is considered by the Moree Plains LEP to have State significance, and the Mehi River and Gwydir River bridges are considered to have local significance.

The proposal involves removing the Mehi River and the Gwydir River rail bridges, and the rail bridge over Croppa Creek (identified as a potential heritage item of local significance), as some of their elements are not compatible with Inland Rail requirements. Removing these bridges would detrimentally impact the heritage significance of the bridges. The option of maintaining these bridges and building new bridges next to them was considered but discounted due to ongoing maintenance requirements and safety issues. The heritage assessment concluded that, although the bridges are considered to be good examples of steel bridges constructed on a pioneer line using American bridge technology, there are other similar examples, both regionally and throughout NSW.

Although the proposal site passes through the boundary of Moree Station, the remaining features of the station, including the island platform layout and refreshment room, would not be directly impacted by the proposal. The station would remain a functioning railway station, easily recognisable and understandable as such. As the station and line would remain operational, the upgrade of the existing rail line would not change the setting or character of this item.

The existing rail line with its remaining elements (such as timber underbridges, the intact railway stations of Edgeroi, Bellata and Gurley, and the remains of former stations) is considered to be a potential heritage item of local significance. The proposal involves removing the existing rail line and associated infrastructure, and providing a new rail line within the same corridor. Retaining all evidence of the existing rail line is not feasible, as significant upgrades to the formation are required for it to comply with the Inland Rail performance specifications. The corridor would be retained for rail usage. The railway stations of Edgeroi, Bellata, and Gurley would not be directly impacted.

The proposal has the potential to impact any remains associated with the former Aboriginal fringe camp site located near the Mehi River bridge. Although not listed as an archaeological site under the *Heritage Act 1977*, it is considered to have archaeological potential.

The main potential for indirect impacts relates to vibration generated by construction. Given the proximity of construction to Moree Station, the former Edgeroi Woolshed (a potential heritage item considered to be of local significance), and remaining structures associated with Edgeroi, Bellata, and Gurley stations, there may be the potential for indirect impacts caused by vibration.

Measures are provided to mitigate and manage the impacts identified.

Landscape and visual amenity

The proposal would generate visual impacts during construction. Construction impacts would be temporary and limited to the construction period.

Operational impacts of the proposal would occur as a result of the introduction of new structures in the landscape, mainly associated with the Newell Highway overbridge, the Jones Avenue overbridge, and to a lesser extent, replacement of the bridges at the Mehi River, Gwydir River and Croppa Creek. There are no anticipated impacts on Siding Springs Observatory as a result of the operation of the proposal.

The proposal has been designed to minimise potential impacts, through careful siting of project elements, and by minimising clearing as far as practicable. Mitigation measures are provided to further reduce the visual impacts of the proposal. These would be implemented during the detailed design and construction phases.

Land use and property

The main potential impacts on land use would occur during construction. Impacts include temporary disruption to land use along the construction corridor for construction areas, compounds, and haulage routes. These impacts, such as soil compaction, disruption of services or utilities, changes in access and interrupted land management, would be short-term and minimised with the implementation of mitigation measures.

Some acquisition of land would be required to construct the Camurra bypass, the Newell Highway and Jones Avenue overbridges. Based on the current design, no properties require complete acquisition; however the option for complete acquisition would be discussed with the landowner where a property is materially affected.

While there would be a slight increase in the number of buildings inundated during a one per cent AEP flood event compared to the existing situation, the overall extent of flooding would decrease and significant impacts due to flooding are not anticipated. Further modelling would be undertaken during detailed design to determine how the proposal can be modified so that existing flooding characteristics with regards to property inundation are not worsened.

Socio-economic impacts

Socio-economic benefits and impacts would result from construction and operation of the proposal. Beneficial impacts during construction include employment (an estimated average workforce of 180 people would be required to construct the proposal), training opportunities, and flow on local and regional economic benefits. Impacts during construction would include potential impacts on the amenity of the local community, and impacts associated with the inflow of the workforce into the local area, including demand for accommodation. Mitigation measures are provided to mitigate and manage the impacts identified.

Beneficial impacts as a result of operation include the following opportunities, which would be refined as Inland Rail progresses:

- better access to and from our regional markets (including via the Moree Gateway intermodal facility)
- enabler for regional economic development along the Inland Rail corridor
- safety and amenity benefits as a result of the reduction of freight transport on major road corridors.

The potential for environmental and social disturbance as a result of construction has to be balanced against the long-term benefits of Inland Rail overall.

Other issues

The main wastes that would generated during construction include excess spoil, vegetation, construction materials, and general waste. All of the spoil generated would be reused on site through the creation of spoil mounds within the rail corridor, except where the presence of contamination is noted.

The potential for cumulative impacts resulting from the interaction of the proposal with other projects either existing or proposed in the surrounding area is considered low. Depending on construction timing of the proposal and other projects, there may be an increase in traffic, and the demand for accommodation and workforce. There are no anticipated cumulative impacts during operation.

Environmental mitigation and management

Potential impacts resulting from the proposal are considered manageable through the implementation of the proposed mitigation and management measures.

The detailed design for the proposal is being developed with the objective of minimising potential impacts on the local and regional environment and the local community. The design and construction methodology would continue to be developed, taking into account the input of stakeholders.

To manage the potential impacts identified by the EIS, and in some cases remove them completely, the assessment chapters outline a range of mitigation measures that would be implemented during construction and operation. The environmental performance of the proposal would be managed as described in Chapter 27, including implementation of the mitigation measures, construction and operation environmental management plans, and the Inland Rail NSW construction noise and vibration management framework. These plans would also ensure compliance with relevant legislation and any conditions of approval.

Part A: **Introduction**

Image: Newell Highway north of Narrabri

1. Introduction

1.1 Overview

The Australian Government has committed to delivering a significant piece of national transport infrastructure by constructing a high performance and direct interstate freight rail corridor between Melbourne and Brisbane, via central-west New South Wales (NSW) and Toowoomba in Queensland. Inland Rail is a major national project that will enhance Australia's existing national rail network and serve the interstate freight market.

The Inland Rail route, which is about 1,700 kilometres long, would involve:

- using the existing interstate rail line through Victoria and southern NSW
- upgrading about 400 kilometres of existing track, mainly in western NSW
- providing about 600 kilometres of new track in northern NSW and south-east Queensland.

Inland Rail has been divided into 13 sections, seven of which are located in NSW.

In 2015 Australian Rail Track Corporation Ltd (ARTC) ('the proponent') developed a ten-year programme to deliver Inland Rail by 2025. ARTC was created after the Australian and State governments agreed in 1997 to the formation of a 'one stop shop' for all operators seeking access to the national interstate rail network. Across its network, ARTC is responsible for:

- selling access to train operators
- developing new business
- capital investment in the corridors
- managing the network
- infrastructure maintenance.

Further information on ARTC and Inland Rail can be found at www.artc.com.au and www.inlandrail.com.au.

1.2 The proposal

The proponent is seeking approval to construct and operate the Narrabri to North Star section of Inland Rail ('the proposal'), which consists of 188 kilometres of upgraded rail track and associated facilities. The proposal forms a key component of Inland Rail.

1.2.1 Location

The proposal is generally located within the existing rail corridor between Narrabri and the village of North Star, via Moree. Some works would also be undertaken outside the rail corridor, including works at Bellata, Moree, and Camurra.

The location of the proposal is shown in Figure 1.1. Chapter 2 provides further information on the location of the proposal, and a description of the proposal site for the purposes of the environmental impact statement (EIS).

1.2.2 Key features

The key features of the proposal involve:

- upgrading the track, track formation, culverts and underbridges within the existing rail corridor, for a distance of 188 kilometres, between Narrabri and North Star via Moree
- realigning the track within the existing rail corridor at Bellata, Gurley, and Moree stations to conform with required platform clearances for Inland Rail trains
- providing five new crossing loops within the existing rail corridor at Bobbiwaa, Waterloo Creek, Tycannah Creek, Coolleearllee, and Murgo
- providing a new section of rail line at Camurra about 1.6 kilometres long, to bypass the existing hairpin curve ('the Camurra bypass')
- removing the existing bridges and providing new rail bridges over the Mehi and Gwydir rivers and Croppa Creek
- realigning about 1.5 kilometres of the Newell Highway near Bellata, and providing a new road bridge over the existing rail corridor ('the Newell Highway overbridge')
- providing a new road bridge over the existing rail corridor at Jones Avenue in Moree ('the Jones Avenue overbridge').

The key features of the proposal are shown in Figure 1.2.

Ancillary work would include works to level crossings, signalling and communications, signage, fencing, and services and utilities within the proposal site.

Figure 1.1 Location of the proposal

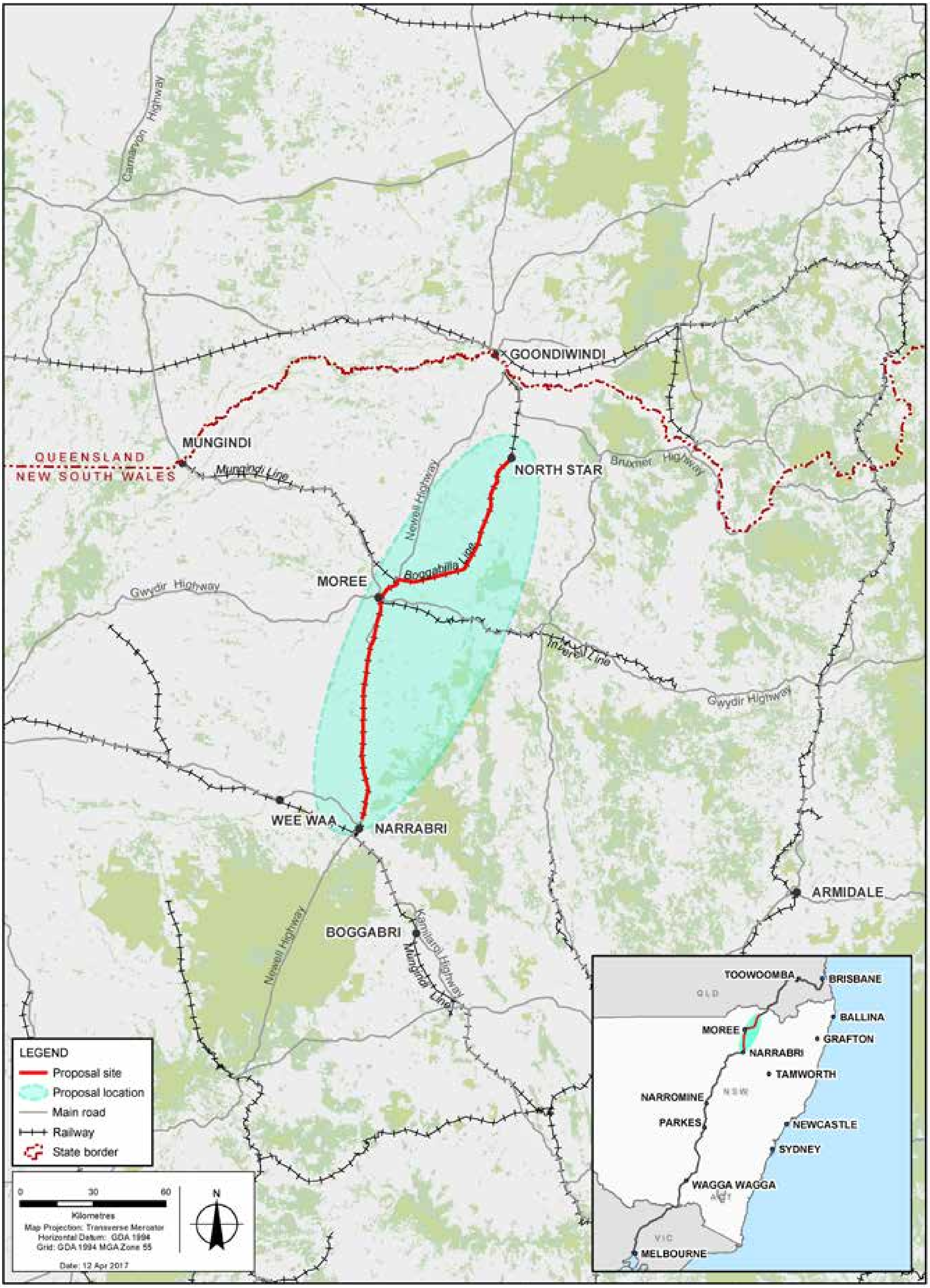
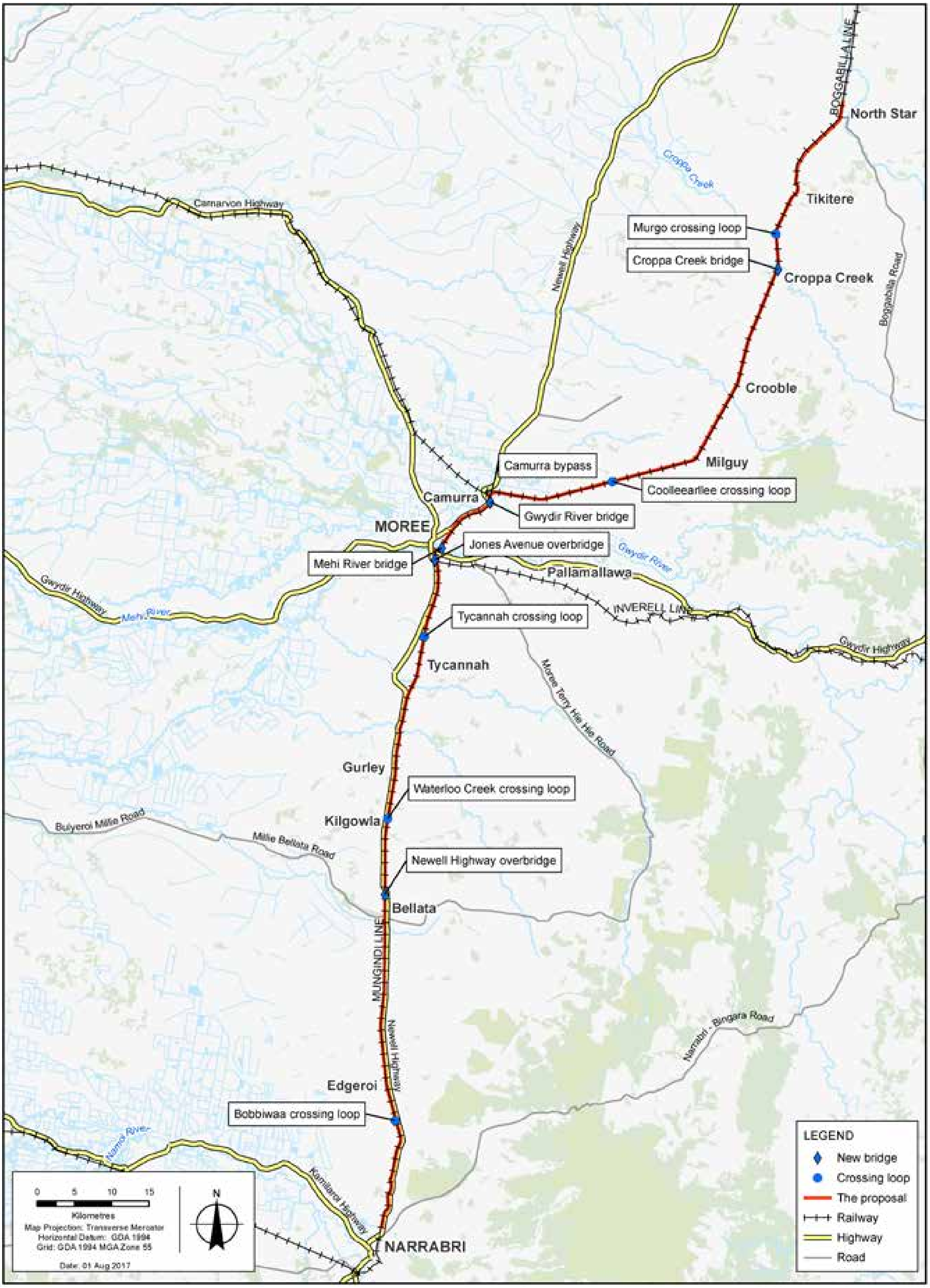


Figure 1.2 Key features of the proposal



The land requirement for the proposal will comprise the existing corridor with an average width of 30 metres, with some variation to accommodate particular infrastructure and to cater for local topography. The corridor will be of sufficient width to accommodate the infrastructure currently proposed for construction, as well as future expansion, including possible future requirement for 3,600 metre trains.

Proposal construction will be a single-track standard gauge railway, with crossing loops to accommodate double stacked freight trains up to 1,800 metres long. Components of the construction will include infrastructure to accommodate possible future augmentation and upgrades of the track, including a possible future requirement for 3,600 metre trains. Clearing of the corridor will occur to allow for construction and to maintain the safe operation of the railway.

The operational phase at year 2040 will be of a single track with crossing loops to accommodate double stacked freight trains up to 1,800 metres long. Impact assessment will be undertaken for the proposed development described in the *Inland Rail 2015 – Melbourne to Brisbane Inland Rail, Attachment A: ARTC 2015 Inland Rail Programme Business Case* ('Programme Business Case') (ARTC, 2015) for rail traffic and associated activities projected at the year 2040.

1.2.3 Timing and operation

Subject to approval of the proposal, construction of the proposal is planned to start in mid-2018, and is expected to take about 24 months. Construction is expected to be completed in mid-2020.

The proposal would form part of the rail network managed and maintained by ARTC. Train services would be provided by a variety of operators. Prior to the opening of Inland Rail as a whole, the rail line would be used by existing rail traffic, which includes trains carrying passengers and grain at an average rate of about four trains per day.

Existing train operations along the proposal site would continue prior to, during, and following construction. Train numbers are not anticipated to significantly increase until all 13 sections of Inland Rail are complete, which is estimated to be in 2025.

It is estimated that the operation of Inland Rail would involve an annual average of about 10 trains per day travelling north of Moree (between North Star and Moree) and 12 trains per day travelling south of Moree (between Moree and Narrabri) in 2025. This would increase to about 19 trains per day north of Moree (between North Star and Moree) and 21 trains per day south of Moree (between Moree and Narrabri) in 2040. The trains would be a mix of grain, intermodal (freight), and other general transport trains. The EIS assesses the operational impacts of the use of the proposal as part of Inland Rail.

Further information on the proposal is provided in Chapters 7 and 8.

1.3 Objectives of the proposal and Inland Rail

The objectives of the proposal are to:

- provide upgraded rail infrastructure that meets the Inland Rail specifications, to enable trains using the Inland Rail corridor to travel between Narrabri and North Star, connecting with other sections of Inland Rail to the north and south
- minimise the potential for environmental and community impacts, by maximising use of the existing rail corridor.

The objectives of Inland Rail as a whole are to:

- provide a rail link between Melbourne and Brisbane that is interoperable with train operations to Perth, Adelaide, and other locations on the standard gauge rail network, to serve future rail freight demand, and stimulate growth for inter-capital and regional/bulk rail freight
- provide an increase in productivity that will benefit consumers through lower freight transport costs
- provide a step-change improvement in rail service quality in the Melbourne to Brisbane corridor and deliver a freight rail service that is competitive with road
- improve road safety, ease congestion, and reduce environmental impacts by moving freight from road to rail
- bypass bottlenecks within the existing metropolitan rail networks, and free up train paths for other services along the coastal route
- act as an enabler for regional economic development along the Inland Rail corridor.

1.4 EIS purpose and structure

This environmental impact statement (EIS) supports an application for approval of the proposal under Part 5.1 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act). It addresses the environmental assessment requirements of the Secretary of the Department of Planning and Environment (the SEARs) dated 8 November 2016 (refer to Appendix A). The proposal is also a controlled action under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), and requires approval from the Australian Minister for the Environment and Energy. The EPBC Act assessment requirements are specified by the SEARs.

The EIS (Volume 1) is structured in four parts as follows:

- **Part A Introduction - including:**
  - an introduction to the environmental assessment (Chapter 1)
  - a description of the general biophysical and socio-economic environment within which the proposal would be located, including the regional setting and a description of the proposal site (Chapter 2)
  - an overview of the statutory context for the proposal and the approval requirements (Chapter 3)
  - a summary of the consultation that occurred during the proposal development and environmental assessment process, and the consultation proposed during public exhibition, detailed design, and delivery (Chapter 4).
- **Part B The proposal - including:**
  - an overview of the strategic context and need for the proposal (Chapter 5)
  - a summary of the alternatives to the proposal as a whole, and the options considered during development of the concept design for the proposal (Chapter 6)
  - a description of the proposal features and operation (Chapter 7), including the approach to avoiding or minimising impacts, design features and infrastructure proposed, operation, maintenance, and other related information
  - an indicative description of the likely construction process and activities (Chapter 8).
- **Part C Environmental assessment – including:**
  - the results of the assessment of key environmental issues identified by the SEARs, including information on the existing environment, potential construction and operation impacts, and the proposed approach to mitigation and management (Chapters 9 to 26).
- **Part D EIS synthesis - including:**
  - a consolidated summary of the key potential impacts, a description of the proposed approach to environmental management, and a compilation of the mitigation measures (Chapter 27)
  - conclusion and justification for the proposal (Chapter 28).

An assessment of environmental risks is provided in Appendix B of Volume 1. The assessment was undertaken to provide a preliminary identification of the potential risks to be considered in more detail by the EIS. Other appendices in Volume 1 provide supporting information and data.

The specialist technical reports prepared as an input to the EIS are provided in Volumes 2 and 3.

2. General biophysical and cultural environment

This chapter provides a description of the proposal site, including a summary of its general biophysical and cultural (including community, land use and socio-economic) environment.

2.1 Regional setting

The proposal site is located in north-west NSW in an area also known as the North-West Plains. The North-West Plains is an extensive pastoral area covering over 32,000 square kilometres, featuring prime agricultural land mainly drained by the Namoi and Gwydir rivers and their tributaries. Major towns include Moree and Narrabri (Regional Development Australia, 2013).

The proposal site traverses three local government areas (LGAs), with the southern section of the proposal located in the Narrabri LGA, the middle section in the Moree Plains LGA, and the northern section in the Gwydir LGA (shown in Figure 2.1). The three LGAs are predominantly rural, with the main local industries based around agriculture (mainly cotton and grain growing) and grazing. The Moree Plains and Gwydir LGAs both adjoin the NSW–Queensland border.

Narrabri is located in the Narrabri LGA at the southern end of the proposal site. The town is about 447 kilometres south-west of Brisbane, 521 kilometres north-west of Sydney, and 939 kilometres north-east of Melbourne. It is located on the Namoi River at the junction of the Kamilaroi and Newell highways.

Moree is located in the Moree Plains LGA about 96 kilometres north of Narrabri. It is located on the Mehi River at the junction of the Newell and Gwydir highways.

The small village of North Star is located at the northern end of the proposal site in the Gwydir LGA. North Star is about 80 kilometres north-east of Moree, and 30 kilometres south of the Queensland border.

The regional context for the proposal site is shown in Figure 2.1.

2.2 Description of the proposal site

2.2.1 Definition

The proposal site is defined as the area that would be directly impacted by the construction of the proposal and includes the location of operational infrastructure. The majority of works associated with the proposal would be undertaken within the existing corridors for the Mungindi and Boggabilla rail lines, between Narrabri and North Star. The proposal site (shown in Figure 2.2) also includes the location of infrastructure located outside the existing rail corridor, including the Camurra bypass; the new Newell Highway overbridge and associated highway realignment near Bellata and the Jones Avenue overbridge in Moree.

For the purposes of the EIS, the proposal site is generally considered to have a width of 30 metres, providing for a 15 metre buffer on each side of the alignment centreline. The proposal site is assumed to include all the required track and associated infrastructure, cess drains, haul roads, culverts, level crossings, and spoil mounds. The proposal site also includes the location of construction compounds (described in Chapter 8).

The land requirement for the proposal will comprise the existing corridor with an average width of 30 metres, with some variation to accommodate particular infrastructure and to cater for local topography. The corridor will be of sufficient width to accommodate the infrastructure currently proposed for construction, as well as future expansion, including a possible future requirement for 3,600 metre long trains.

Figure 2.1 Regional context

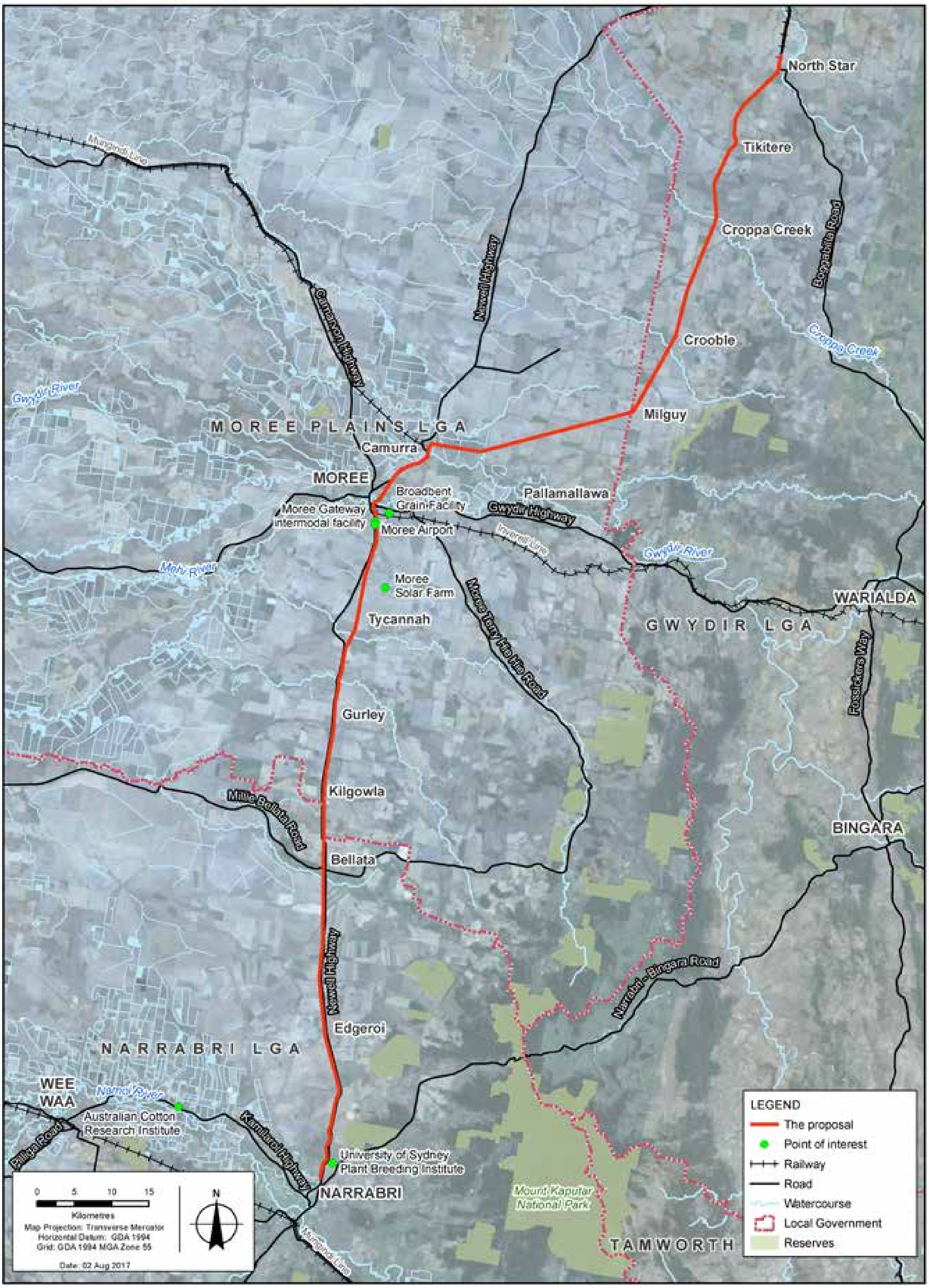


Figure 2.2a Proposal site

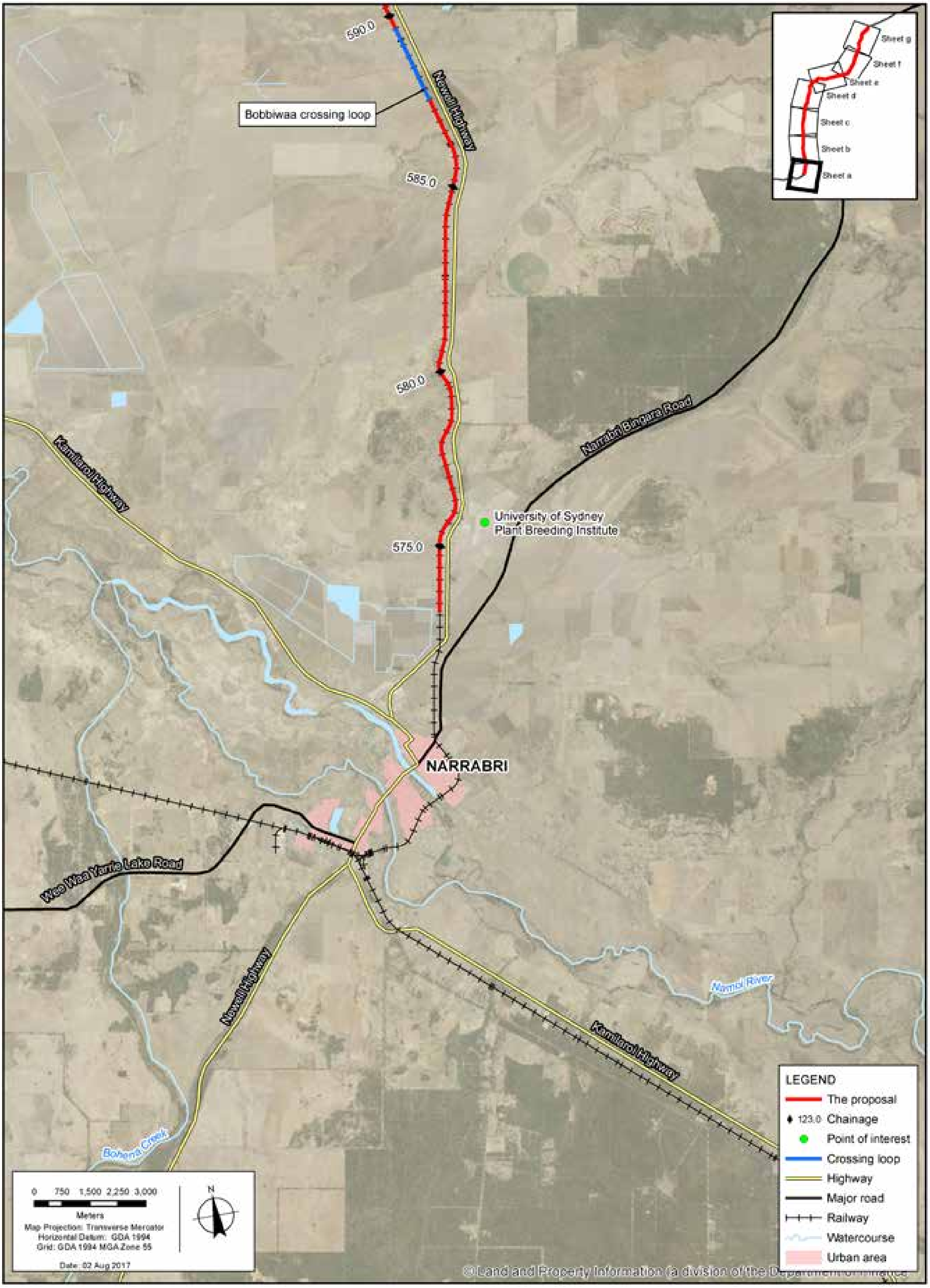


Figure 2.2b Proposal site

Figure 2.2c Proposal site

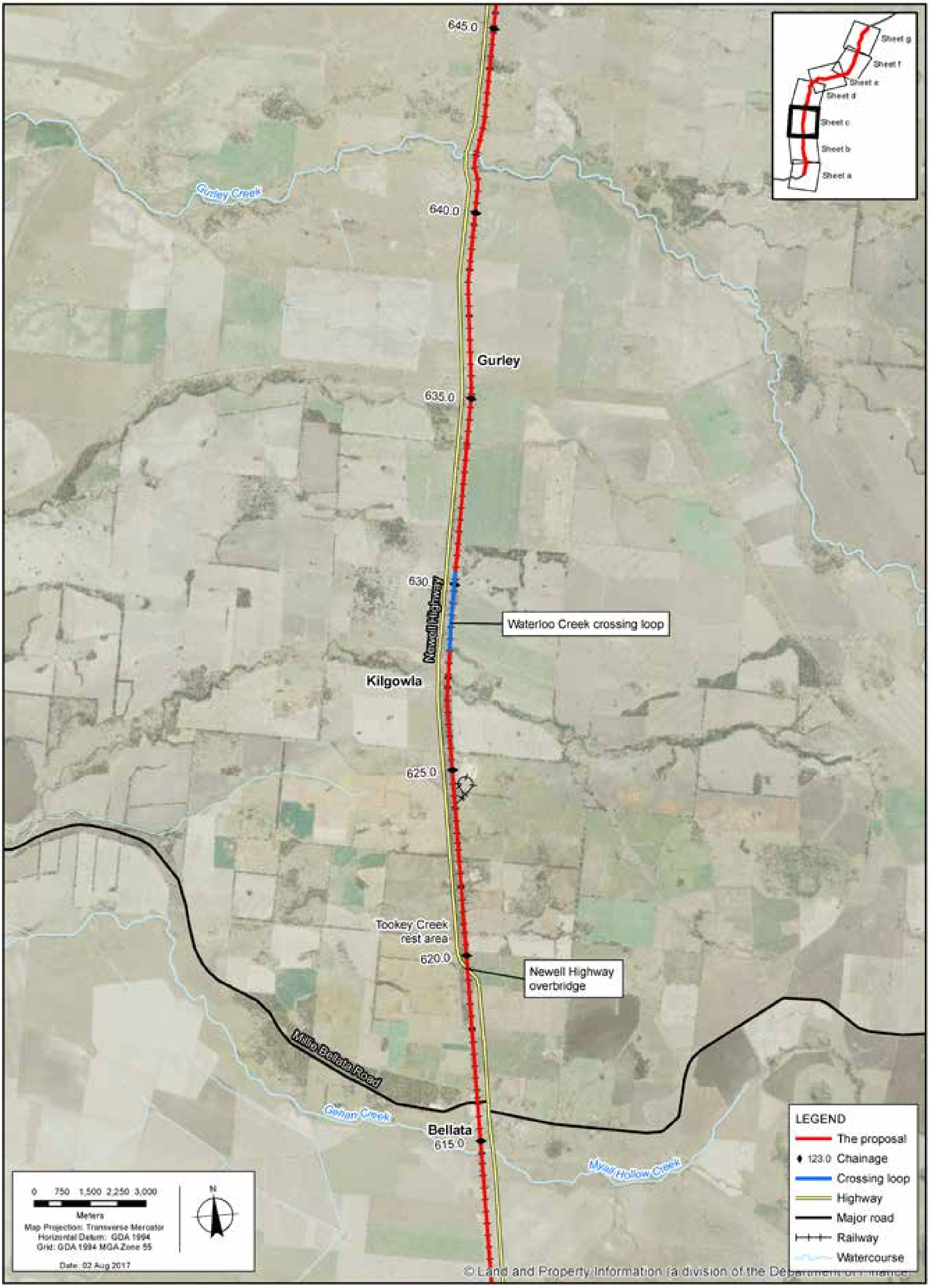


Figure 2.2d Proposal site

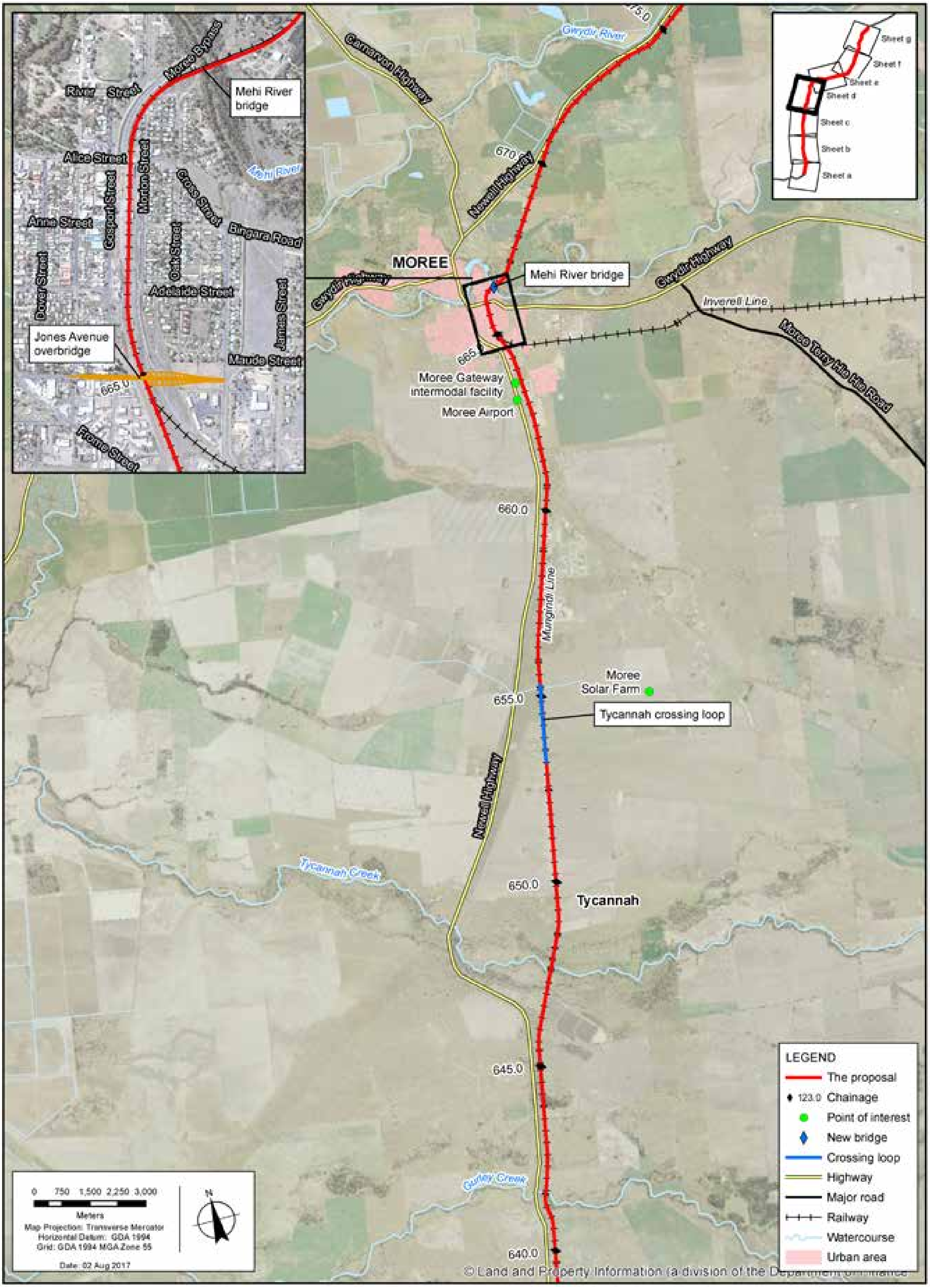


Figure 2.2e Proposal site

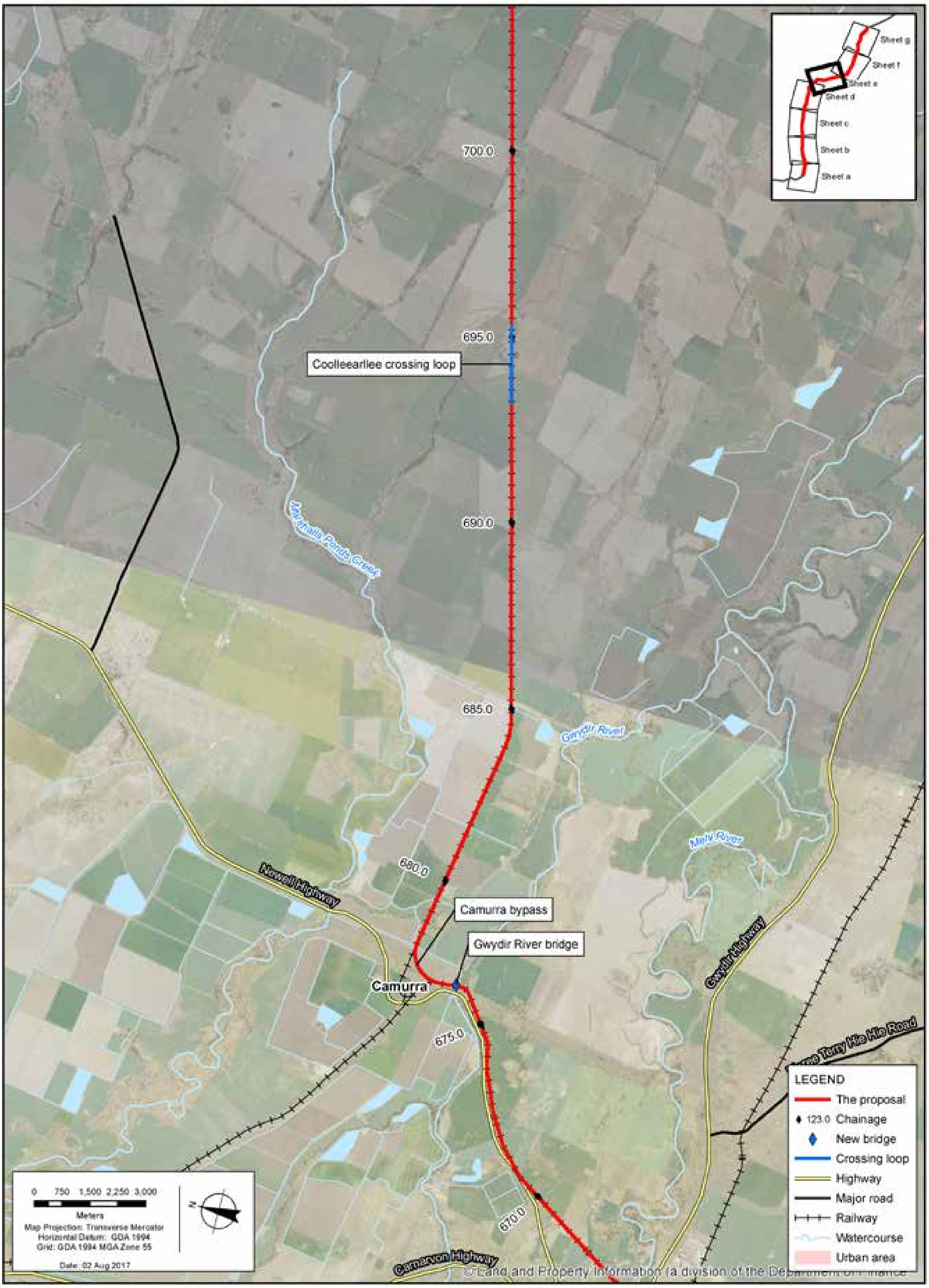
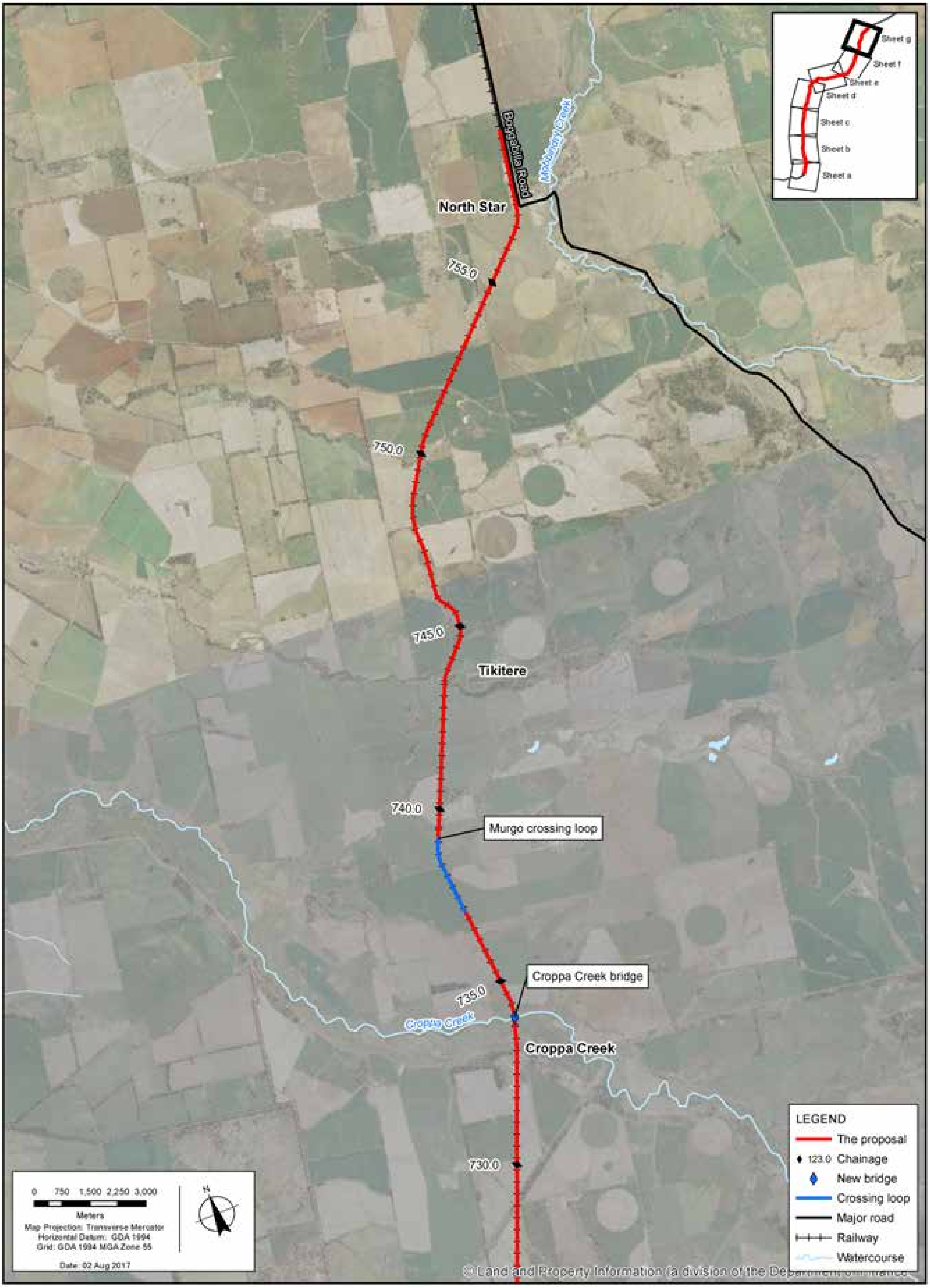


Figure 2.2f Proposal site

Figure 2.2g Proposal site



The proposal is for construction of a single-track standard gauge railway, with crossing loops to accommodate double stacked freight trains up to 1,800 metres long. Components of the construction will include infrastructure to accommodate possible future augmentation and upgrades of the track, including a possible future requirement for 3,600 metre trains. Clearing of the corridor will occur to allow for construction and to maintain the safe operation of the railway.

The operational phase at year 2040 will be of a single track with crossing loops to accommodate double stacked freight trains up to 1,800 metres long. Impact assessment will be undertaken for the proposed development described in the Programme Business Case (ARTC, 2015) for rail traffic and associated activities projected at the year 2040.

The following additional assessment areas outside the proposal site have also been considered for the biodiversity and heritage assessments:

- an approximate 60 metre buffer around culverts/underbridges and the new bridges over the Mehi and Gwydir rivers and Croppa Creek
- an approximate 120 metre buffer around level crossings, and some additional areas to provide flexibility for future planning and design work.

These areas do not currently form the proposal site for the purposes of the EIS.

The need for works in these additional assessment areas would be determined during detailed design. The design of works in these areas would take into account the findings of the biodiversity and heritage assessments.

2.2.2 Description

The southern end of the proposal site commences in Narrabri just to the north-east of the town. From Narrabri, the proposal site extends along the existing Mungindi line rail corridor in a north–south direction for a distance of about 94 kilometres, to just south of Moree (existing rail lines in the study area are described in Section 2.5). In the Narrabri to Moree section, the proposal site is located generally adjacent to the Newell Highway.

Between Narrabri and Moree, the proposal site travels through the towns of Edgeroi, Bellata, and Gurley. From just north of Narrabri to about 3.5 kilometres north of Bellata (a distance of about 46 kilometres), the proposal site is located adjacent to (just to the west of) the road corridor for the Newell Highway. At about 3 kilometres north of Bellata, there is an existing road overbridge to allow the Newell Highway to pass over the rail corridor. At this location, the proposal site includes the location of the proposed new Newell Highway overbridge and approaches,
as well as the works within the rail corridor.

The proposal site is then located to the east of the Newell Highway for a distance of about 43 kilometres until just south of Moree near Bulluss Drive. At this point (about 1.3 kilometres south of Moree Station) the highway deviates to the west and travels to the west of Moree via the new Moree Bypass.

The proposal site then passes through Moree along the existing rail corridor in a north-easterly direction towards the locality of Camurra. On the north-eastern outskirts of Moree the proposal site travels over the Mehi River, where a new bridge would be built. Closer to Camurra (which is about 10 kilometres to the north-east of Moree), the proposal site also travels over the Gwydir River and includes a new bridge over the river on the same alignment as the existing bridge. At Camurra, the proposal site includes a new section of rail line to bypass the existing hairpin curve where the corridor for the Mungindi line connects with the Boggabilla line.

From Camurra, the proposal site travels to the east, and then to the north through rural lands and the localities of Crooble and Croppa Creek until it reaches the town of North Star (a distance of about 80 kilometres). At Croppa Creek, the proposal site includes a new bridge over the creek on the same alignment as the existing bridge.

The northern end of the proposal site is located at the western edge of the town of North Star, about 2,200 metres north of North Star Road.

2.3 General biophysical environment of the proposal site

A summary of the key biophysical characteristics of the study area is provided below.

2.3.1 Biodiversity

The majority of the study area has been heavily modified by past and ongoing disturbances associated with the active rail corridor and agricultural activities. Clearance and maintenance of the existing rail corridor has resulted in fragmentation, a high level of disturbance, and degradation of vegetation. No conservation areas, reserves, or large areas of native remnant vegetation are located within or close to the proposal site.

The majority of the proposal site consists of non-native vegetation or cleared land, with patches of native vegetation scattered within and around the proposal site. These patches generally comprise a woodland community, with the dominant canopy species including bimble box, belah, silver-leaved ironbark, and white cypress pine. Extensive areas of natural grasslands also exist. Of the native vegetation present, nine native plant community types were identified, with the most common community being Queensland Bluegrass Mitchell Grass grassland.

Four threatened ecological communities listed under the *Threatened Species Conservation Act 1995* (TSC Act), and four listed under the EPBC Act were identified, including the *Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland* community, which is listed as critically endangered under the EPBC Act.

Three threatened flora species and seven threatened fauna species listed under the TSC Act were recorded during field surveys. Of these, one flora species and two fauna species are also listed under the EPBC Act.

Further information is provided in Chapter 10.

2.3.2 Soils

The proposal site is characterised by an alluvial flood plain associated with the Mehi and Gwydir rivers. The terrain is typically near level to gently undulating. The proposal site is located in the Gunnedah Basin crossing the Goondiwindi thrust fault into the New England Fold Belt east of Camurra.

The subsurface conditions of the Gunnedah Basin are dominated by Quaternary and Tertiary aged river plain sediments, including black and red clayey silt, and black and yellow brown clay soils. Exceptions to this include the Jurassic aged clayey sandstone unit north of Narrabri, and partially consolidated polymictic gravel around Bellata.

Further information is provided in Chapter 14.

2.3.3 Water

The southern end of the proposal site around Narrabri is located in the Namoi River catchment, which includes the Namoi and Peel rivers. The middle section of the proposal site (including Moree) is located in the Gwydir River catchment, within which the Gwydir River is the dominant river system. The northern end of the proposal site is located in the Border Rivers catchment. This catchment comprises the Dumaresq, Severn and Macintyre rivers in northern NSW. The Border Rivers are part of the Murray-Darling Basin.

The proposal site crosses numerous watercourses, including rivers (the Mehi and Gwydir rivers), creeks (such as Croppa, Mulgate, Bobbiwa, Gehan, Tookey, and Gil Gil creeks), other ephemeral watercourses, and canals constructed to convey irrigation waters. There is no existing water quality data for the watercourses crossing the proposal site.

Groundwater around Moree and to the north-west to North Star is generally sourced from the Great Artesian Basin, with numerous wells, dams and irrigation channels noted around Moree in particular.

In general, the study area is characterised by relatively flat land, and the proposal site is located within an area that has been subject to significant floods.

Further information on hydrology, flooding, and water quality is provided in Chapters 15 and 16.

2.4 General cultural environment of the proposal site

A summary of the main cultural characteristics (including land use, heritage, and socio-economic) of the proposal site is provided below.

2.4.1 Land use and property

Land within the proposal site is mainly used for transport (rail) purposes. Apart from within the town of Moree, the land surrounding the proposal site is used mainly for agriculture and grazing purposes, with large rural properties surrounding the majority of the proposal site. Other land uses include roads (including the Newell Highway) and residential (in the towns).

In Moree, the proposal site is surrounded by a mix of land uses, including residential, industrial, open space and transport (roads).

Further information is provided in Chapter 20.

2.4.2 Heritage

Aboriginal heritage

The majority of historical sources indicate that the proposal site generally extends over the country of the Gomeroi people.

The proposal site has been subject to significant disturbance. Within the existing rail corridor, the construction and maintenance of the existing rail line is likely to have resulted in the removal/relocation of archaeological evidence that may have been present. Similarly, there is limited archaeological potential in agricultural land surrounding the existing rail corridor, as this area has been impacted by historical and current agricultural practices.

Sections of the proposal site within the existing rail corridor have been assessed as having low archaeological potential, with the exception of the terrace landforms bordering the Mehi River, Gwydir River and Croppa Creek where deposits may be present below the depth of current disturbance and modern flood deposit. Five areas within the proposal site were identified as having moderate or higher archaeological potential.

Two sites listed under the *National Parks and Wildlife Act 1974* (NPW Act) are located within the proposal site – the Steel Bridge Camp site (10-3-0032), which is an area of potential archaeological deposit at the former Aboriginal fringe camp site, and the Duffys Creek site (10-3-0035), an artefact scatter and area of potential archaeological deposit. These sites were assessed as having low to moderate archaeological significance at ground level, and moderate to high significance below the current depth of disturbance.

In addition, 12 new Aboriginal sites were identified within the proposal site during field surveys. Of these sites, eight are isolated artefacts with low significance, three are artefact scatters with low significance, and one is an artefact scatter with low to moderate significance.

Further information on Aboriginal heritage is provided in Chapter 17.

Non-Aboriginal heritage

The region in which the study area is located was first explored by Europeans around 1812. The first squatter in the Narrabri area established a station in 1834. The Moree to Camurra section of the Mungindi line and the Boggabilla line were opened in 1913 and 1932 respectively as 'pioneer lines' (rail lines constructed to a lesser standard than main rail lines, providing access to mainly agricultural areas).

Three locally listed heritage items are located within the proposal site – Moree Station, which is listed on both the Moree Plains Local Environmental Plan 2011 (the Moree Plains LEP) and Railcorp's section 170 heritage register, and the Mehi River and the Gwydir River rail bridges, which are listed on ARTC's section 170 heritage register. Moree Station is considered by the Moree Plains LEP to have State significance, and the Mehi River and Gwydir River bridges are considered to have local significance.

Nine heritage listed items are located within 80 to 100 metres of the proposal site – three of these are located in Moree, and the rest are located in Bellata.

The heritage assessment noted a number of potential heritage items within/close to the proposal site:

- the existing rail line and remaining elements (such as timber underbridges and remains of former stations) between Narrabri and North Star
- Croppa Creek bridge
- Edgeroi Woolshed (near the site of the former Woolenget Station)
- Anzac Day Crossing of the Boggabilla line at Crooble.

An assessment of significance of the potential heritage items concluded that these items are generally of local significance.

The site of a former Aboriginal fringe camp is located near the Mehi River bridge. Although not a listed archaeological site (under the *Heritage Act 1977*), this area is considered to have archaeological potential.

Further information is provided in Chapter 18.

2.4.3 Socio-economic

The community surrounding the proposal site is concentrated in Narrabri and Moree (described below). Much smaller populations are located in towns/localities around the proposal site, including Bellata and North Star. Scattered residences are located on rural properties.

Narrabri

At the 2011 census, Narrabri had a population of 5,890 people. Both Narrabri and Moree are important regional towns providing a range of services to the surrounding areas. The Newell Highway, a major arterial road linking Melbourne and Brisbane, runs through Narrabri.

Agriculture and mining are the main industries in Narrabri Shire. Agricultural production includes cotton, wheat, barley, oilseeds, grapes and peanuts, with livestock production comprising sheep, cattle, and pigs. Narrabri Shire is located in the Gunnedah Basin, which has one of the largest coal reserves in NSW. Numerous coal and gas operations are located between Narrabri and Gunnedah (Narrabri Shire Council, 2011).

Narrabri has large processing plants for cereal crops and cotton seed. Two important agricultural research institutes are located outside Narrabri – the Australian Cotton Research Institute, which is located about 22 kilometres north-west of the town, and the University of Sydney Plant Breeding Institute, which is located about two kilometres north-east of the town adjoining the proposal site.

Moree

At the 2011 census Moree had a population of 9,346 people. Moree is located at the junction of two major arterial roads – the Newell and Gwydir highways. It is an important agricultural centre, noted for its part in the Australian cotton-growing industry, which was established there in the early 1960s. Wheat and pecan nuts are important crops in the LGA, and sheep and cattle grazing also contribute to the agricultural economy.

Similar to Narrabri, Moree has large processing plants for cereal crops and cotton seed. Key developments around the town include the Moree Gateway and the Moree Solar Farm. The Moree Gateway is a logistics and transport hub located on a 215 hectare site about 3 kilometres south of the town, adjacent to the proposal site, the Newell Highway and the Moree Airport. The Moree Solar Farm is located on a 350 hectare site about 10 kilometres south of town, and about 2.9 kilometres to the east of the proposal site.

2.5 Existing rail facilities and operations

2.5.1 Rail infrastructure

Narrabri and Moree are located on the Mungindi (North West) line, which branches from the Main North line at Werris Creek Station and heads north-west through the towns of Gunnedah and Narrabri to Moree.

Narrabri Station opened in 1897, which was when the Mungindi line was extended from Boggabri to Moree. The existing Moree Station opened in 1904, replacing the original station (located to the north of the existing station), which opened in 1897 when the line was extended from Boggabri.

From Moree, the Mungindi line travels north-west to Mungindi on the NSW-Queensland border. The line was closed between Weemelah and Mungindi in 1974 when rail services were withdrawn following flooding.

The line to Inverell, east of Moree, branches from the Mungindi line at Moree. The Inverell line, which was completed in 1902, was progressively closed between 1987 and 1994. In 2017, a 2.8 kilometre section of the Inverell line was reinstated under the NSW Government's Fixing Country Rail program, between Moree and the Broadbent Grain receival facility to the east of Moree.

North Star is located on the disused Boggabilla line, which branches from the Mungindi line at Camurra (about 10 kilometres north-west of Moree). North Star Station was opened in 1932 with the opening of the Boggabilla line. From Camurra, the Boggabilla line travels north for about 130 kilometres to Boggabilla on the Queensland border. In 1987 the line was truncated at North Star. The remainder of the line was closed to normal operations in 2013 but is still used occasionally.

Figure 2.3 provides a schematic drawing of the rail network in the study area.

Track characteristics

The existing track is a mixture of rail weights (47 and 53 kilograms per metre) mainly supported on steel sleepers. The track was originally constructed for light traffic on the existing sub-grade materials. Over time, the track has been re-ballasted and maintained, but no significant improvements have been made to the track formation.

Sections of track pass through low lying flood prone areas, and wash-aways have occurred in the past after heavy rain events. The maintenance access track along the existing rail corridor is not continuous and can be impassable during and after wet weather.

There are about 12 sidings between Narrabri and North Star that provide access to and from the main line for private operations.

2.5.2 Rail operations

Passenger services

The Northern Tablelands Xplorer, run by NSW TrainLink, travels between Sydney and Moree via Werris Creek and Narrabri. In the proposal site, trains stop at Bellata and Moree twice a day (to and from Sydney Central).

Freight services

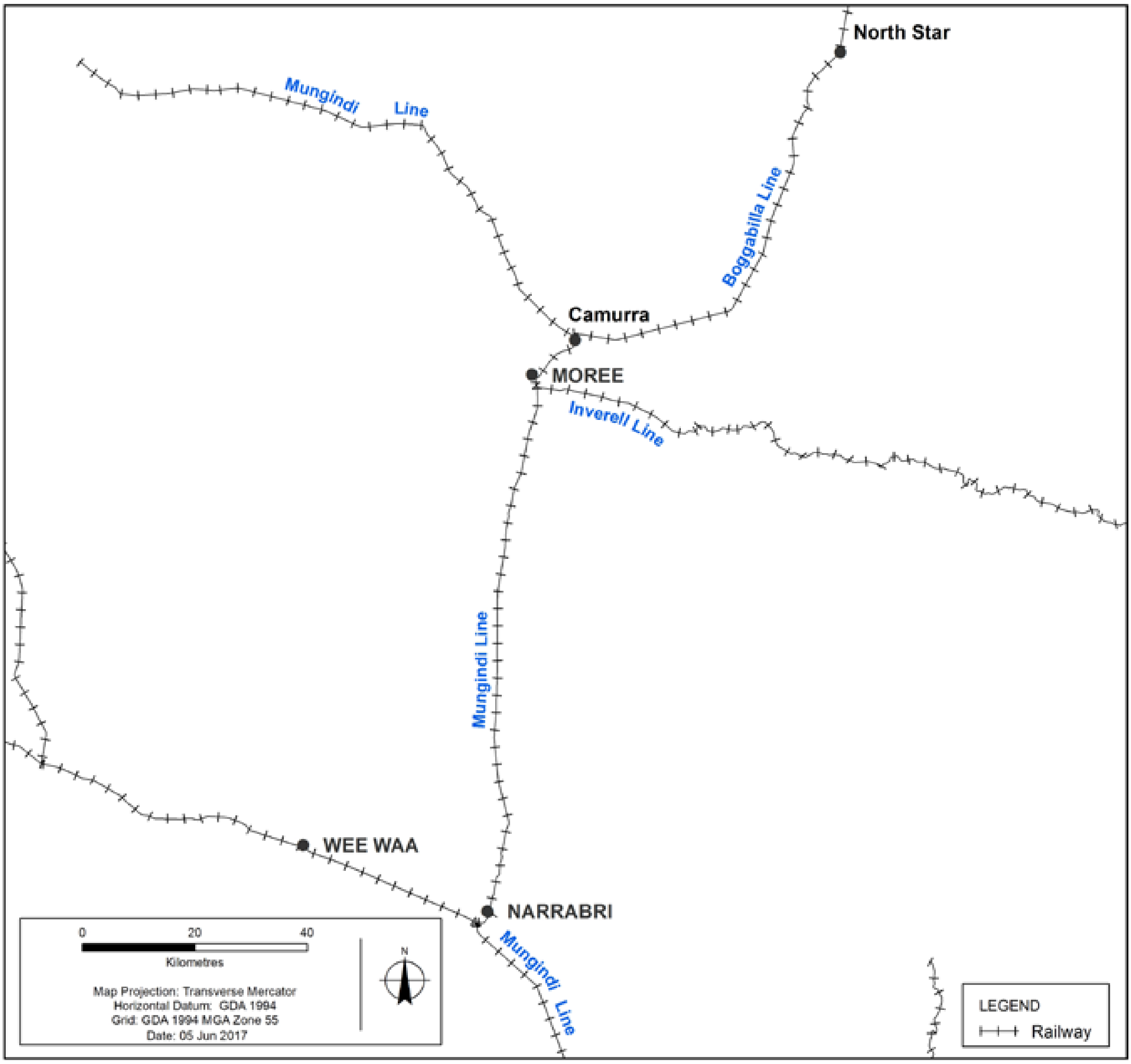
Occasional grain/goods trains operate on an as needs basis. Annually, there is currently an average of two grain trains per day carrying about 1.7 million tonnes of grain per year. This is likely to increase with the opening of the section of the Inverell line between Moree and the Broadbent Grain facility.

Trains using the line have a maximum length of 1,800 metres. Train speeds between Narrabri and Moree are limited to a maximum of 90 to 100 kilometres per hour, with local speed restrictions due to limitations associated with the existing track. Between Moree and North Star, train speeds are limited to a maximum of 80 kilometres per hour. There are also local speed restrictions.

Maintenance

Maintenance works and other minor works along the Mungindi line, and along the Boggabilla line as far as North Star, are undertaken by ARTC in accordance with existing ARTC procedures and processes, and relevant State legislative requirements.

Figure 2.3   Existing rail lines in the study area



3. Statutory context

This chapter provides a review of the legislation and environmental planning instruments that are relevant to the environmental assessment and approval of the proposal. The permissibility and approval pathway is summarised, and other planning instruments and legislation that are relevant to the assessment and approval of the proposal are considered.

3.1 Overview of the approval pathway

The proposal would be permitted without consent in accordance with *State Environmental Planning Policy (Infrastructure) 2007* (the Infrastructure SEPP), and is subject to assessment under Part 5 of the *Environmental Planning and Assessment Act 1979* (EP&A Act). The capital investment value of the proposal is estimated to be over $50 million, and as a result, the proposal is State significant infrastructure under *State Environmental Planning Policy (State and Regional Development) 2011* (State and Regional Development SEPP). The proposal is therefore subject to approval under Part 5.1 of the EP&A Act. Approval requirements under the EP&A Act are described in Section 3.2.

Other approvals and permits are also required, including approval as a controlled action under the EPBC Act. The requirements under other legislation are described in Sections 3.4 and 3.5.

3.2 Environmental Planning and Assessment Act 1979

The EP&A Act and the *Environmental Planning and Assessment Regulation 2000* (EP&A Regulation) provide the framework for development assessment in NSW. The EP&A Act and the EP&A Regulation include provisions to ensure that the potential environmental impacts of a development are considered in the decision making process prior to proceeding to construction.

The key requirements of the EP&A Act in relation to the assessment and approval of the proposal are considered below.

3.2.1 Application of Part 5 of the EP&A Act

Part 5 of the EP&A Act defines the assessment process for proposals that do not require development consent. In accordance with section 110(1), ARTC would be the proponent and a determining authority for the proposal.

Section 111 imposes a duty on a determining authority to *'examine and take into account to the fullest extent possible all matters affecting or likely to affect the environment by reason of that activity'*.

Section 112(1) provides that *'a determining authority shall not carry out an activity, or grant an approval in relation to an activity …. that is likely to significantly affect the environment (including critical habitat) or threatened species, populations or ecological communities, or their habitats, unless (a) the determining authority has obtained or been furnished with and has examined and considered an environmental impact statement in respect of the activity'*.

In accordance with the requirements of section 112, ARTC considers that the proposal has the potential to significantly affect the environment. As a result, an EIS is required.

3.2.2 State significant infrastructure and the application of Part 5.1 of the EP&A Act

State significant infrastructure is development that is so declared under section 115U of the EP&A Act. Under section 115U(2), development may be declared to be State significant infrastructure by a State environmental planning policy. Section 115U(3) specifies that:

> *'Development that may be so declared to be State significant infrastructure is development of the following kind that a State environmental planning policy permits to be carried out without development consent under Part 4:*
>
> *(a) infrastructure,*
>
> *(b) other development that (but for this Part and within the meaning of Part 5) would be an activity for which the proponent is also the determining authority and would, in the opinion of the proponent, require an environmental impact statement to be obtained under Part 5.'*

The proposal is for infrastructure, and is for an activity for which the proponent is the determining authority and, in their opinion, requires an EIS (refer to Section 3.2.1).

Clause 14 and Schedule 3 of the State and Regional Development SEPP operate to make the proposal State significant infrastructure (refer to Section 3.3.2). The proposal is therefore subject to Part 5.1 of the EP&A Act. Under section 115W of the EP&A Act, the approval of the Minister for Planning is required for State significant infrastructure.

In accordance with section 115X (Application for approval of State significant infrastructure):

> *'(1) The proponent may apply for the approval of the Minister under this Part to carry out State significant infrastructure.*
>
> *(2) The application is to:*
>
> *(a) Describe the infrastructure, and*
>
> *(b) contain any other matter required by the Director-General.*
>
> *(3) The application is to be lodged with the Director-General.'*

This document provides the information required to support the proponent's application for approval of the proposal. In accordance with the requirements of section 115X it addresses the SEARs (refer to Section 3.7.1).

Critical State significant infrastructure

Section 115V of the EP&A Act provides for the declaration of critical State significant infrastructure.

Critical State significant infrastructure projects are high priority infrastructure projects that are essential to the State. Section 115V of the EP&A Act provides that any State significant infrastructure may also be declared to be critical State significant infrastructure, if it is '…of a category that, in the opinion of the Minister, is essential for the State for economic, environmental or social reasons.'

As critical State significant infrastructure the proposal would be permissible without consent under clause 16(a) of the State and Regional Development SEPP. The proposal remains subject to assessment under Part 5.1 of the EP&A Act and requires the approval of the Minister for Planning.

The proposal has been declared by the Minister for Planning as critical State significant infrastructure under section 115V of the EP&A Act. The Minister has amended Schedule 5 of the State and Regional Development SEPP.

3.2.3 Land owner's consent/ notification requirements

Clause 193 of the EP&A Regulation provides owner's consent and notification requirements for State significant infrastructure projects. Clause 193(1) specifies that:

> *'The consent of the owner of the land on which State significant infrastructure is to be carried out is required for an infrastructure application or modification request unless the application or request relates to any of the following:*
>
> *(a) State significant infrastructure proposed to be carried out by a proponent that is a public authority,*
>
> *(b) critical State significant infrastructure.*
>
> *(c) State significant infrastructure comprising any one or more of the following:*
>
> *(i) Linear transport infrastructure,*
>
> *(ii) Utility infrastructure,*
>
> *(iii) Infrastructure on land with multiple owners designated by the Secretary for the purposes of this clause by notice in writing to the person making the application or request.'*

As the application for the proposal is being made by a public authority and is for linear transport infrastructure, the consent of individual land owners will not be required to make the application. However, the proponent needs to give notice of the application in accordance with the requirements of clause 193(4).

This clause requires:

> *'(4) Notification if consent not required*
>
> *If the consent of the owner of the land is not required for an infrastructure application or modification request under this clause, the proponent is required to give notice of the application or request:*
>
> *(a) by written notice to the owner of the land before, or no later than 14 days after, the application or request is made, or*
>
> *(b) advertisement published in a newspaper circulating in the area in which the infrastructure is to be carried out:*
>
> *(i) in the case of an infrastructure application—at least 14 days before the environmental impact statement that relates to the infrastructure is placed on public exhibition, or*
>
> *(ii) in the case of a modification request—no later than 14 days after the request is made.*

Notification under clause 193(4) was undertaken in the Narrabri Courier and the Moree Champion on 12 September 2017, and in the Warialda Standard on 13 September 2017.

3.2.4 Environmental Planning and Assessment Regulation 2000

Clauses 6 and 7 of Schedule 2 of the EP&A Regulation set out requirements for the form and content of an EIS. These requirements are included in Appendix C.

In addition, clause 193A specifies that:

> *'For the purposes of section 115ZM (e) of the Act, a proponent must, when preparing an environmental impact statement for State significant infrastructure on land less than 200 kilometres from the Siding Spring Observatory, take into consideration the Dark Sky Planning Guideline.'*

The proposal at the Narrabri end is within 200 kilometres of the Siding Spring Observatory. Therefore, consideration has been given to the *Dark Sky Planning Guideline: Protecting the observing conditions at Siding Spring* (Department of Planning and Environment, 2016) in Chapter 19.

3.3 NSW environmental planning instruments

3.3.1 State Environmental Planning Policy (Infrastructure) 2007

The Infrastructure SEPP clarifies the consent arrangements for infrastructure projects. According to clause 8(1) *'if there is an inconsistency between this policy and any other environmental planning instrument, whether made before or after the commencement of this policy, this policy prevails to the extent of the inconsistency'*.

The proposal meets the definition of rail infrastructure facilities, which are defined by clause 78 of the Infrastructure SEPP as 'railway tracks, associated track structures, rail freight terminals, sidings and freight intermodal facilities'.

Clause 79(1) provides that development for the purpose of a railway, or for rail infrastructure facilities, may be carried out by or on behalf of a public authority without consent on any land. This clause also specifies the conditions whereby such development can be carried out without consent on land reserved under the *National Parks and Wildlife Act 1974* (NPW Act). As the proposal site is not reserved under the NPW Act, these conditions do not apply, and the proposal is permissible without consent.

3.3.2 State Environmental Planning Policy (State and Regional Development) 2011

Sections 89C(2) and 115U(2) of the EP&A Act provide that a SEPP may declare any development, or any class or description of development, to be State significant infrastructure or State significant development. The State and Regional Development SEPP provides definitions of State significant infrastructure and State significant development. The proposal does not meet the definitions of State significant development.

Clause 14 of the State and Regional Development SEPP provides that development is State significant infrastructure if it is wholly or partly permissible without development consent under Part 4 of the Act, by virtue of the operation of a SEPP, and it meets the definitions provided in Schedule 3 to the State and Regional Development SEPP.

As noted above, the Infrastructure SEPP provides that the proposal is permissible without consent. Schedule 3 (item 3) of the State and Regional Development SEPP includes the following definition of 'rail infrastructure' - *'Development for the purpose of rail infrastructure by or on behalf of the Australian Rail Track Corporation that has a capital investment value of more than $50 million.'* The capital investment value of the proposal is over $50 million. As the proposal meets the requirements of clause 14 it is defined as State significant infrastructure.

3.3.3 Other environmental planning instruments

Section 115ZF(2) of the EP&A Act provides that environmental planning instruments do not apply to or in respect of State significant infrastructure, except where they apply to the declaration of infrastructure as State significant infrastructure.

3.4 Other NSW legislative requirements

3.4.1 Approvals not required

The following approvals are not required for approved State significant infrastructure (in accordance with section 115ZG of the EP&A Act):

- a permit under section 201, 205 or 219 of the *Fisheries Management Act 1994* (FM Act)
- an approval under Part 4, or an excavation permit under section 139, of the *Heritage Act 1977*
- an Aboriginal heritage impact permit under section 90 of the NPW Act
- an authorisation referred to in section 12 of the *Native Vegetation Act 2003* (or under any Act repealed by that Act) to clear native vegetation or State protected land
- a bushfire safety authority under section 100B of the *Rural Fires Act 1997*
- a water use approval under section 89, a water management work approval under section 90, or an activity approval (other than an aquifer interference approval) under section 91 of the *Water Management Act 2000* (Water Management Act).
- Division 8 of Part 6 of the *Heritage Act 1977* (relating to making heritage orders) does not apply to prevent or interfere with the carrying out of approved State significant infrastructure.

3.4.2 Approvals to be applied consistently

The following approvals cannot be refused if necessary for the carrying out of approved State significant infrastructure (in accordance with section 115ZH of the EP&A Act):

- an environment protection licence under chapter 3 of the *Protection of the Environment Operations Act 1997* (POEO Act)
- consent under section 138 of the *Roads Act 1993* (Roads Act).

The approval requirements of these Acts as they relate to the proposal are summarised below.

3.4.3 Consideration of requirements under other NSW Acts

Other NSW environmental planning legislation that are directly relevant to the approval and assessment of the proposal are considered below.

Protection of the Environment Operations Act 1997

The POEO Act establishes, amongst other things, the procedures for issuing licences for environmental protection on aspects such as waste, air, water and noise pollution control. Environment protection licences are generally required for scheduled activities or scheduled development work.

The definitions of scheduled activities provided in Schedule 1 include:

> *'33 Railway systems activities*
>
> *1. This clause applies to railway systems activities, meaning:*
>
> *a) The installation, on site repair, on-site maintenance or on site upgrading of track. Including the construction or significant alteration of any ancillary works.*
>
> *b) The operation of rolling stock on track.'*

The proposal meets this definition and would therefore require an environment protection licence.

ARTC would obtain an environment protection licence for construction of the proposal. In relation to operation, ARTC currently holds a licence to carry out railway systems activities on other parts of the NSW rail network (licence number EPL3142). It may be appropriate to either amend this licence to include the operation of the proposal or to obtain a new licence. Licensing requirements for the proposal would be considered in consultation with the Environment Protection Authority (EPA).

Roads Act 1993

Under Section 138, Part 9, Division 3 of the *Roads Act 1993*, approval from the relevant roads authority is required to impact, or carry out work on or over, a public road. Clause 5(1) of Schedule 2 of the Roads Act exempts public authorities from this requirement, except in relation to works on or over classified and Crown roads.

The proposal would involve works to the Newell Highway as part of the proposed road overbridge near Bellata. Approval would be sought under section 138 for these works. As noted in Section 3.4.2, approval under section 138 of the Roads Act cannot be refused if it is necessary to carry out a State significant infrastructure project.

Water Management Act 2000 and Water Act 1912

The Water Management Act and *Water Act 1912* (Water Act) control the extraction of water, the use of water, the construction of works such as dams and weirs and the carrying out of activities in or near water sources in NSW. The provisions of the Water Management Act are being progressively implemented to replace the Water Act. Since 1 July 2004 the new licensing and approvals system has been in effect in those areas of NSW covered by operational water sharing plans.

Temporary dewatering and construction activities that interfere with aquifers are generally identified as aquifer interference activities in accordance with the Water Management Act and the *NSW Aquifer Interference Policy* (Department of Primary Industries), 2012). However, the aquifer interference approval provisions of the Water Management Act have not commenced, and licensing of these activities is carried out under Part 5 of the Water Act. A licence under Part 5 is required for any dewatering activity that would require the extraction of more than 3 megalitres of groundwater per year. Excavation would be undertaken as part of the proposal. Although groundwater may be intercepted, it is unlikely that any dewatering would exceed 3 megalitres of groundwater per year.

Extraction of groundwater is proposed as part of the requirements for water during construction (described in Chapter 8). A licence would be sought under Part 5 of the Water Act if required.

Crown Lands Act 1989

The *Crown Lands Act 1989* (Crown Lands Act) sets out how Crown land is to be managed. In particular, in relation to actions affecting Crown land:

- All actions are to be consistent with the 'principles of Crown land management'.
- An assessment must be carried out prior to any dealings in Crown land (such as a lease).
- Specific use of Crown land generally needs to be authorised by a lease, licence or other permit.

In summary, the principles of Crown land management are that, as appropriate:

- environmental protection principles be observed
- natural resources be conserved wherever possible
- public use and enjoyment, and multiple use be encouraged
- the land and its resources be sustained in perpetuity
- it be occupied, sold, or otherwise dealt with consistent with these principles.

An authorisation under the Crown Lands Act to allow occupation of Crown land must be obtained. The potential impacts of the proposal on land use, including Crown land, are considered in Chapter 20.

Transport Administration Act 1988

The *Transport Administration Act 1988* (Transport Administration Act) provides for the administration and management of transport infrastructure and transport agencies in NSW. Under section 99B of the Transport Administration Act, a rail infrastructure owner may close any level crossing provided that, prior to closing the crossing, it notifies Roads and Maritime and the local council, and receives Ministerial approval.

Transport for NSW reviews all applications for level crossing closures before they are submitted to the Minister to ensure that the relevant issues have been considered, and adequate consultation has been undertaken.

As described in Chapter 7, the proposal includes changes to a number of level crossings. ARTC is undertaking, and will continue to undertake, necessary consultation to confirm the changes required. Approval for closures, if required, would be obtained in accordance with the requirements of the Transport Administration Act.

3.5 Commonwealth requirements

3.5.1 Environment Protection and Biodiversity Conservation Act 1999

Under the EPBC Act, proposed 'actions' that have the potential to significantly impact on matters of national environmental significance, the environment of Commonwealth land, or that are being carried out by an Australian Government agency, must be referred to the Australian Minister for the Environment and Energy for assessment. If the Minister determines that a referred project is a 'controlled action' under the EPBC Act, the approval of the Minister would be required.

An EPBC Act protected matters search was undertaken on 7 September 2015 for an area within a 10 kilometre radius of the proposal site. The results of the search indicated that the proposal has the potential to impact on two protected matters:

- threatened ecological communities – four EPBC Act listed threatened ecological communities have the potential to be impacted
- threatened species – two EPBC Act listed fauna species and one flora species have the potential to be impacted.

As a result of the potential for impacts on protected matters, the proposal was referred to the (then) Australian Minister for the Environment in June 2016 (EPBC Referral 2016/7729). On 26 September 2016, the Australian Government Department of the Environment and Energy notified that the proposal is a controlled action, with the controlling provision being 'listed threatened species and communities' (under section 18 of the EPBC Act).

As part of the overall approval process for the proposal, the proposal will be assessed by the NSW Department of Planning and Environment in accordance with the Bilateral Agreement made (between NSW and the Commonwealth) under section 45 of the EPBC Act relating to environmental assessment. The assessment requirements are defined by the SEARs (provided in Appendix A). Following this assessment, the Australian Minister for the Environment and Energy will make a separate decision whether or not to approve the proposal under the EPBC Act.

Further information on potential biodiversity impacts, including the assessment of the potential impacts on EPBC Act listed threatened species and communities, is provided in Chapter 10.

3.6 Summary of approval and notification requirements

In summary:

- The proposal is permissible without consent under the Infrastructure SEPP. The proposal is State significant infrastructure, and it requires approval from the Minister for Planning under Part 5.1 of the EP&A Act.
- An environment protection licence under the POEO Act is required for the construction and operation of the proposal.
- Landowners need to be notified in accordance with clause 193(4) of the EP&A Regulation.
- Approval to close level crossings may be required under section 99B of Transport Administration Act.
- A licence would be sought under Part 5 of the Water Act if extraction of more than 3 megalitres of groundwater per year is required to construct the proposal.
- The proposal is a controlled action under the EPBC Act and requires approval under the EPBC Act from the Australian Minister for the Environment and Energy.

3.7 The assessment process

3.7.1 Environmental assessment requirements

Under section 115Y(1) of EP&A Act, *'When an application is made for the Minister's approval for State significant infrastructure, the Secretary is to prepare environmental assessment requirements in respect of the infrastructure'*. These identify the general requirements for the EIS, and the key issues to be assessed. The SEARs for the proposal were originally issued on 17 February 2016. Amended SEARs, which included the original SEARs with slight amendments, and additional assessment requirements for matters of national environmental significance under the EPBC Act, were issued on 8 November 2016.

The requirements outlined in the SEARs, together with where they are addressed by this EIS, are provided in Appendix A.

3.7.2 Public exhibition and submissions

If the EIS is considered to meet the requirements, the Department of Planning and Environment would place it on public exhibition for at least 30 days. During the exhibition period, submissions would be invited from relevant agencies and members of the public. The Department would provide ARTC with a copy of the submissions. ARTC would then be asked to respond to the issues. ARTC may modify the proposal if required and practicable. If the proposal is modified in response to the issues raised, a preferred infrastructure report would be prepared to describe the scope of the revised project. Otherwise, a submissions report would be prepared. The Department would make the required report publicly available.

Further information on the proposed approach to consultation during the exhibition period is provided in Chapter 4.

3.7.3 Assessment and approval

Following the exhibition period, the Department of Planning and Environment will, on behalf of the Minister for Planning, review the EIS and the submissions/preferred infrastructure report. The Department will prepare an assessment report, which is submitted to the Minister for Planning for determination. The Minister may refuse the proposal, or approve it with any conditions considered appropriate. The Minister's approval and the assessment report would be published on the Department of Planning and Environment's Major Projects website following determination. Approval under the EPBC Act from the Australian Minister for the Environment and Energy will be advised separately.

4. Consultation

This chapter summarises the community and stakeholder consultation undertaken prior to and during preparation of the EIS, and the consultation proposed to be undertaken during the design and delivery of the proposal. The key issues relevant to the EIS are summarised. Further information is provided in the consultation report, included in Appendix D.

4.1 Consultation approach, objectives and strategy

4.1.1 Overall approach and objectives

ARTC's values commit the organisation to active engagement with stakeholders and the community. For Inland Rail, effective communication and stakeholder engagement are fundamental to reducing risk, optimising route alignment, minimising social and environmental impacts, securing statutory approvals, and gaining and maintaining the social licence to operate. ARTC believes that identifying, engaging and effectively communicating with stakeholders is critical to the successful delivery of Inland Rail.

ARTC's approach to consultation for Inland Rail aims to:

- build awareness, understanding, and support for Inland Rail among customers, stakeholders and the community
- harness a sense of ownership through advocates of Inland Rail
- create an active dialogue with customers, communities and other stakeholders
- identify and manage issues and opportunities
- achieve a design that minimises the potential for environmental and community impacts
- actively seek opportunities to create beneficial outcomes for stakeholders, while not compromising the scope and budget of Inland Rail (for example, improving local rail and road interfaces where it benefits Inland Rail and improves community safety and amenity).

4.1.2 Consultation plan

Stakeholder and community engagement for Inland Rail is an evolving process that commenced in 2010. In early 2015, ARTC developed the *Inland Rail Strategic Stakeholder and Engagement Plan*. The aim of the plan was to inform early engagement with key local councils, including those within which the proposal site is located, ahead of the commencement of formal consultation and fieldwork.

ARTC's approach to stakeholder engagement during this early stage was as follows:

- provide an update to key stakeholders
- revisit issues raised by councils and other local stakeholders during early consultations
- discuss any issues identified during technical studies in the priority construction areas
- understand the council's views of Inland Rail within their respective Regional Plans
- seek input regarding key local stakeholder groups (local business and community leaders) to be engaged through future consultation
- identify new opportunities and issues associated with delivery of Inland Rail at a local level.

This approach was welcomed by the local councils, who were actively seeking information and urging early engagement.

Later in 2015, ARTC developed the *Communication and Engagement Plan Narrabri to North Star* to guide engagement with the local community. As defined by the plan, consultation has been, and will continue to be undertaken, over five phases:

- development of the business case
- planning, design and approvals (including preparation of the EIS)
- construction
- commissioning and handover
- operation.

The communication and engagement activities are tailored in the plan for each phase, and generally include:

- meetings and briefings
- workshops
- community information sessions
- phone, email and written correspondence
- project website
- distribution of information, including mail outs.

4.1.3 Stakeholder identification

A stakeholder is defined as a person, group or organisation who has an interest in a project and/or is directly or indirectly impacted by the project.

The key stakeholders for Inland Rail include:

- elected members of the parliaments of NSW and Australia
- local councils
- government agencies
- landowners and residents with the potential to be directly or indirectly impacted by the proposal
- community and environment groups
- traditional owners
- utility providers
- representatives of neighbouring and related projects.

A full list of stakeholders is provided in the consultation report in Appendix D.

4.2 Consultation process and activities

4.2.1 General activities

A summary of the activities and tools employed to provide information on the proposal is provided in Table 4.1.

Table 4.1 Consultation tools

Consultation and communication tool	Purpose	Timing
Community contact mechanisms: - toll free community information line (1800 732 761) - project email (inlandrailenquiries@artc. com.au) - Inland Rail website (www.inlandrail.com.au)	- Obtain feedback and measure awareness of the proposal . - Provide information and promote channels through which stakeholders can communicate their views, issues, and concerns.	Commenced in 2014 and ongoing.
Printed information – distributed to people on the mailing list and at communication sessions: - fact sheets - project information packs - mail outs	- Raise awareness and understanding of the proposal. - Provided to stakeholders to increase understanding of the proposal. - Provide information on land access guidelines and procedures.	Commenced in 2014 and ongoing.
Community information sessions	- Provide information on the proposal to the local community. - Seek local input to inform the design process and EIS.	Held in Moree and Narrabri in May 2016 and again in Narrabri in November 2016. Held in North Star in June and October 2016.

Consultation and communication tool	Purpose	Timing
Workshops	▸ Discuss the proposal and address specific questions and concerns in person. ▸ Provide an opportunity for stakeholder input to inform the design process and EIS.	Commenced in August 2015 and held on a regular basis.
Landowner face-to-face meetings	▸ Raise awareness of the proposal and the potential impacts on landowners. ▸ Provide an opportunity for landowners to ask questions and have input into the design and EIS.	Commenced in March 2016 and ongoing.
Stakeholder meetings and briefings	▸ Opportunity to address specific questions and issues in person. ▸ Provide an opportunity for stakeholder input to inform the design process and development of the EIS.	Commenced in 2014 and ongoing.
Submissions	▸ Submissions from local councils and businesses have been invited to provide an opportunity for local knowledge and views to be shared with the proposal team.	Early 2015.
Local media: ▸ advertisements ▸ media releases	▸ Raise awareness and understanding. ▸ Provide information and promote channels through which stakeholders can communicate their views, issues and concerns. ▸ Celebrate project milestones publicly.	Ongoing.
Project database	▸ Record all correspondence relating to the proposal, including feedback, concerns, and comments.	Established in 2014, ongoing.

4.3 Results of consultation relevant to the EIS

A summary of the key issues raised during consultation relevant to the EIS, including the potential impacts to be considered and the information to be provided by the EIS, is provided in Table 4.2. More detailed information on the issues raised by individual stakeholders is provided in Appendix D.

Table 4.2 Summary of issues raised relating to the EIS

Issue category	Issues raised in relation to potential impacts to consider	Where addressed in the EIS
Traffic/access	Impacts on private and public level crossings.	Chapters 7 and 9
	Impacts on heavy vehicle movements particularly during peak harvest times.	Chapter 9
	Safety impacts associated with proposal and motorists and heavy vehicle movements over the rail alignment.	Chapters 9 and 25
	Consideration of pedestrian safety at crossings and illegal corridor access in Moree.	Chapters 9, 21 and 25
Biodiversity	Impact of weeds and management strategies to prevent spread to neighbouring agricultural properties. Impact on threatened flora and fauna and associated management.	Chapter 10
Noise	Impact of noise and vibration during operation.	Chapters 11 and 12
Flooding	Impact of flooding on construction and operation. Flooding impacts on farmer accessibility, due to proposal.	Chapter 15
Heritage	Impacts on culturally important locations to be assessed.	Chapter 18
Socio-economic/safety	Potential benefits of the wider Inland Rail project including increased opportunities for education, employment and vocational training; increased modal competition between road and rail; improved road safety and community amenity. Amenity impacts to residential receivers near the proposal. Impacts on safety and the need for rail safety education. Consider impacts on Moree Gun Club and current firing range. Impacts on community due to community division in Moree (due to rail line in centre).	Chapter 21 and 25
Visual amenity	Visual impacts during operation, and the need to consider mitigation strategies such as tree screening.	Chapter 19
Land use/properties	Process of property acquisition. Potential impacts on travelling stock reserves.	Chapters 20 and 21
Bushfire	Corridor maintenance to avoid bushfire and other damage.	Chapter 25

4.3.1 Consultation undertaken as an input to the SEARs

A summary of issues raised by government agencies consulted by the Department of Planning and Environment during preparation of the SEARs is provided in Table A.4 in Appendix A, together with a reference to where they are addressed in the EIS.

4.4 Consultation during exhibition of the EIS

The EIS will be placed on public exhibition for a minimum of 30 days. During that time, the consultation tools implemented during preparation of the EIS will continue to be used, where relevant. Consultation tools used during this period will include:

- advertisements in the local media giving information regarding the proposal and display of the EIS
- issuing of newsletters to the community (Council newsletters, e-newsletter, other)
- briefings to key stakeholders including Councils
- community information sessions.

The EIS will be available for viewing at the following locations:

- Moree Plains Shire Council – Administration/ Customer Service Centre, Level 2, 30 Heber Street, Moree, NSW, 2400
- Moree Community Library – 36 Balo Street, Moree, NSW, 2400
- Narrabri Shire Council – Admin Building, 46-48 Maitland Street, Narrabri, NSW, 2390
- Narrabri Library – 8 Doyle Street, Narrabri, NSW, 2390
- Wee Waa Library – 106 Rose Street, Wee Waa, NSW, 2388
- Dhiiyaan Aboriginal Centre – 38 Albert Street, Moree NSW 2400
- Gwydir Shire Council – 33 Maitland Street, Bingara, NSW, 2404
- Gwydir Shire Council – 58 Hope Street, Warialda, NSW, 2402
- North Star Post Office – 17 Edward Street, North Star, NSW, 2408
- Croppa Creek Store – 6 Buckie Road, Croppa Creek, NSW, 2411.

The EIS will also be made available for viewing on the Department of Planning and Environment and Inland Rail websites. The public will be able to review the EIS and send submissions to the Department of Planning and Environment for consideration.

Community information sessions and briefings will be held during the public exhibition period to enable community members and representatives to ask questions.

At the completion of the public exhibition period the Department of Planning and Environment will provide ARTC with a copy of all public and government submissions. ARTC will deal with any submissions received in accordance with the *Environmental Planning and Assessment Regulation 2000*. A submissions report will be prepared responding to the issues raised, and will be made available for viewing on the Department of Planning and Environment website. ARTC will continue to liaise directly with key stakeholders regarding the proposal's progress. If changes to the proposal need to be made, a preferred infrastructure report would be prepared.

While all submissions received will be posted on the Department of Planning and Environment website, if requested, the privacy of submitters will be protected by removing names from submissions.

4.5 Consultation during design and delivery of the proposal

4.5.1 Consultation and community feedback

Consultation with the community and key stakeholders would be ongoing in the lead up to, and during construction. The consultation activities would ensure that:

- the community and stakeholders have a high level of awareness of all processes and advanced notice of activities associated with the proposal
- accurate and accessible information is made available
- a timely response is given to issues and concerns raised by the community
- feedback from the community is encouraged
- opportunities for input are provided.

The 1800 phone number and proposal email address would continue to be available during construction, along with a 24-hour construction response line. Targeted consultation methods, such as letters, notifications, signage and face-to-face communications, would continue to occur. The Inland Rail website and social media platforms would also include updates on the progress of the proposal.

The following communication tools and activities used during the construction phase would include:

- development of a communication management plan detailing a complaints handling process
- proposal email address
- 1800 phone number
- updates to the Inland Rail website
- targeted consultation and notifications such as letters, notifications, and face to face communication
- construction signage.

4.5.2 Complaints management

The construction contractor engaged to construct the proposal would be required to implement a complaints management procedure during construction of the proposal. This procedure would be defined within the construction environmental management plan (CEMP), which the contractor would be required to prepare and have approved by ARTC prior to construction commencing.

The complaints management procedure would include the following at a minimum:

- contact details for a 24-hour project response line and email address, for ongoing stakeholder contact throughout the proposal
- provision of accurate public information signs while work is in progress
- staging of works, developed in consultation with relevant stakeholder groups, to minimise disruption and impacts to community activities and functions
- management of complaints in accordance with ARTC's emergency management procedure, specifically:
  - details of all complaints received will be recorded
  - verbal and written responses describing what action will be taken will be provided to the complainant within time limits (unless the complainant agrees otherwise).

Part B: **Proposal**

Image: Newell Highway near Edgeroi, NSW

5 Strategic context and need for the proposal

This chapter describes the strategic planning context and the key issues and demands that have influenced the need for, and development of, Inland Rail, and the proposal as part of the wider Inland Rail project. A summary of the need for Inland Rail and the proposal is provided.

5.1 Strategic planning context

5.1.1 The existing situation

There is no direct continuous inland rail link between Melbourne and Brisbane, with interstate rail freight travelling between Melbourne and Sydney via Albury, and then between Sydney and Brisbane, generally along the coast. About 70 per cent of the freight between Melbourne and Brisbane is carried by road, principally the Newell Highway in NSW, and connecting highways in Victoria and Queensland (Transport for NSW, 2015).

The idea for extending the Australian rail network to provide an inland railway between Melbourne and Brisbane has been around for at least one hundred years (Inland Rail Implementation Group, 2015). In the last decade, the concept of an inland railway between Melbourne and Brisbane has been subject to significant analysis for the following reasons (ARTC, 2010):

- The existing north–south coastal railway will reach capacity in the medium term, and additional capacity will be required to service future demands for interstate and regional rail freight.
- The efficiency and service quality associated with the existing coastal route is currently impacting on freight productivity and transport costs.
- Road freight transport has a competitive advantage over rail, making it difficult for rail to increase its market share.
- Road freight is associated with the potential for safety, congestion and environmental costs as a result of the movement of heavy vehicles on roads.
- Rail paths on the coastal route through Sydney are shared between passenger and freight trains, impacting on the reliability of rail freight, and constraining opportunities for the expansion of passenger services.

Two major studies have been undertaken in relation to the development of an inland rail route between Melbourne and Brisbane. The first study, the *North–South Rail Corridor Study* (Department of Transport and Regional Services, 2006) considered potential corridors for the rail line. This study is described in Section 6.1.3. As an outcome of the study the ‘far-western sub-corridor’, via Parkes, Moree and Toowoomba, was identified as the preferred corridor for a Melbourne-Brisbane inland railway.

In 2008, the then Minister for Infrastructure, Transport, Regional Development and Local Government announced a study to determine the optimum alignment, as well as the economic benefits and likely commercial success, of a new standard gauge inland railway between Melbourne and Brisbane. This study, the *Melbourne–Brisbane Inland Rail Alignment Study* (ARTC, 2010) developed the current Inland Rail alignment (as shown in Figure 5.1).

The conclusions of the *Melbourne–Brisbane Inland Rail Alignment Study* include:

- There is demand for an inland railway.
- The route for an inland railway would be more than 100 kilometres shorter than the existing coastal route.
- The preferred alignment could achieve an average Melbourne to Brisbane transit time (terminal to terminal) of less than 24 hours, compared to a transit time on the existing coastal route of about 27 hours and 30 minutes.
- The inland railway would free up rail and road capacity through Sydney.
- The inland railway would achieve a positive economic net present value between 2030 and 2035, and if demand volumes grow more strongly than forecast, viability could be reached sooner.

Figure 5.1 Proposed alignment for Inland Rail

In November 2013, the Minister for Infrastructure and Regional Development announced that the Australian Government had committed $300 million to enable development of Inland Rail to commence, starting with pre-construction activities such as detailed corridor planning, environmental assessments, and community consultation. The Minister also announced that a high-level Implementation Group would be formed to drive the project. The alignment identified by the *Melbourne–Brisbane Inland Rail Alignment Study* (ARTC, 2010) was endorsed by the Implementation Group as the base case for further work (Inland Rail Implementation Group, 2015).

In 2014, the Implementation Group tasked ARTC to develop a business case and a 10-year delivery plan for Inland Rail. Planning and design work for the two projects in NSW is under way:

- Narrabri to North Star (the proposal)
- Parkes to Narromine (subject to a separate application).

ARTC has also commenced planning work on the priority development project in Queensland:

- Gowrie to Helidon – consisting of 26 kilometres of new dual gauge track including a 6.4 kilometre long tunnel.

Further information on the options and alternatives considered is provided in Chapter 6.

5.1.2 Consistency with Australian, State and regional strategic planning

The strategic context of the proposal is influenced by the outcomes of a number of strategic plans for transport, development, and freight that have been prepared at the national, state, and regional levels. Key national and state strategies, policies, and plans have also informed and influenced the vision, objectives, and development of the proposal.

The proposal, as part of Inland Rail, is consistent with the following relevant strategies:

National

- *Australian Infrastructure Plan: Priorities and reforms for our nation's future* (Infrastructure Australia, 2016) (Australian Infrastructure Plan)
- *State of Australia's Cities 2014-2015* (Department of Infrastructure and Regional Development, 2015)
- *Urban Transport Strategy* (Infrastructure Australia, 2013)
- *National Land Freight Strategy: A place for freight* (Standing Council on Transport and Infrastructure, 2013)
- *National Ports Strategy* (Infrastructure Australia, 2011b).

NSW

- State Priorities: NSW Making it Happen – announced by the NSW Premier on 14 September 2015
- *Newell Highway Corridor Strategy* (NSW Government, 2015)
- *Rebuilding NSW – State Infrastructure Strategy* (NSW Government, 2014a)
- *NSW Freight and Ports Strategy* (NSW Government, 2013)
- *NSW Road Safety Strategy 2012-2021* (Transport for NSW, 2012a)
- *NSW Long Term Transport Master Plan* (Transport for NSW, 2012b).

Regional/local

- *New England North West Regional Plan 2036* (Department of Planning and Environment, 2017)
- *Economic Development Strategy for Regional NSW* (Department of Trade and Investment, Regional Infrastructure and Services, 2015)
- *A Plan for Growing Sydney* (NSW Government, 2014b)
- *NSW Central West Regional Transport Plan* and the *New England North West Transport Plan* (Transport for NSW, 2013a and b)
- *NSW Central West Freight Study* (Regional Development Australia Central West, 2014)
- *Strategic Regional Land Use Plan New England North West* (Department of Planning and Infrastructure, 2012).

Further information on these strategies and their relationship to Inland Rail and the proposal in provided in Appendix E.

5.2 Summary of key issues and demands

A summary of the key issues and demands relevant to the development of, and need for, Inland Rail (including the current proposal) is provided below. A detailed analysis of the issues and project drivers is provided in the Programme Business Case (ARTC, 2015) and in the *Inland Rail Implementation Group Report* (Inland Rail Implementation Group, 2015).

5.2.1 Growth in freight demand

In 2011, the domestic rail freight task totalled 261.4 billion tonne kilometres, accounting for approximately 46 per cent of total domestic freight. This represents an increase of 91 per cent since 2000–01 (Infrastructure Australia, 2015).

The *Australian Infrastructure Audit* (Infrastructure Australia, 2015) notes that:

- The national land freight task is expected to grow by 80 per cent between 2011 and 2031.
- Demand for freight rail infrastructure is projected to grow, in particular for resource bulk commodity haulage in WA, Queensland and NSW.
- Freight rail will need to play a growing role in the movement of goods between ports and inland freight terminals, and in the movement of containerised and general freight over longer distances.

The Melbourne to Brisbane corridor is one of the most important general freight routes in Australia, supporting key population and employment precincts along the east coast and inland NSW. The non-bulk and complementary volumes moving within the corridor are currently estimated at 21 million tonnes per annum. This is expected to grow to over 40 million tonnes per annum by 2050 (Infrastructure Australia, 2016a).

The eastern states of Australia comprise 18 million residents (79 per cent of Australia's population), nine million jobs (78 per cent of Australia's national employment) and contributes $1.1 trillion in gross state product (75 per cent of gross domestic product). Interstate freight transport is projected to increase by 70 per cent between 2015 and 2030, to 140 billion tonne kilometres. The Melbourne to Brisbane corridor already supports 17 per cent of these interstate movements (ARTC, 2015).

With the population of the eastern states forecast to increase by 60 per cent over the next 40 years, the need for efficient and effective freight transport will continue to increase. Strong forecast population growth, accompanied by comparable growth in employment, is likely to place significant pressure on existing infrastructure and services (ARTC, 2015).

Without the increased use of rail, the growth in freight demand is likely to result in increasing pressure on the road network and associated issues, increased freight costs, and a loss of economic opportunity.

5.2.2 Existing freight capacity and infrastructure issues

As the demand for regional and interstate freight transport grows, rail and road infrastructure in the north–south corridor will face progressive challenges in meeting future demand. There will be increasing pressure on freight capacity between capital cities and from the regions to export ports and urban freight destinations.

Freight trains travelling along the Melbourne to Brisbane corridor currently travel through the Sydney metropolitan rail network, often experiencing significant delays. Travel time reliability is poor, as a result of the priority given to passenger services, freight transit curfews in the Sydney metropolitan area, and substandard rail alignments elsewhere. Limited capacity during morning and afternoon passenger peaks restricts freight movements at these times (NSW Government, 2013).

The Australian Infrastructure Plan (Infrastructure Australia, 2016) notes that the existing north–south rail corridor between Melbourne and Brisbane does not provide a service offering that is competitive with road transport. This is largely the result of 19th century alignments leading to low travel speeds and reliability, and major bottlenecks, most notably in the Sydney metropolitan area.

Infrastructure Australia (2016) notes that the demand for urban transport infrastructure is projected to increase significantly. Without action, the cost to the wider community of congestion on urban roads could rise to more than $50 billion each year by 2031. Demand for many key urban road and rail corridors is projected to significantly exceed current capacity by 2031.

The *National Land Freight Strategy* identifies a number of existing challenges facing road and rail freight in general, including:

- Congestion from increasing numbers of passenger vehicles, and the priority given to passenger vehicles over freight vehicles in urban transport, can adversely impact on the efficiency of freight vehicle movement.
- The encroachment of urban development on freight routes and precincts as cities grow in size and density leads to an increased potential for amenity, environmental and interface issues.

The *Melbourne–Brisbane Inland Rail Alignment Study* (ARTC, 2010) indicated that:

- There are likely to be capacity constraints on the existing coastal railway unless significant capital works are undertaken.
- The coastal railway between Sydney and Brisbane would reach capacity around 2052.

The issues associated with the existing regional rail systems also include the fact that much of the infrastructure is old and has maintenance and renewal issues. Poor maintenance of rail lines leads to more freight being transported by road, imposing additional maintenance burdens on the affected councils (Infrastructure Australia, 2015).

5.2.3 Assessment of demands for Inland Rail

Continued growth in freight volumes is giving rise to a range of increasingly complex challenges for government, industry and the community. Over the last four decades, the Australian freight task (that is, the amount of freight transport, usually measured in tonnes or tonne-kilometres) has quadrupled, with major increases evident in road and rail transport. Forecasts indicate that the total freight task will continue to grow, and is estimated to nearly double by 2030 based on 2010 levels (Commonwealth of Australia, 2012).

The Programme Business Case (ARTC, 2015) provides a detailed description of the potential demand for Inland Rail. The demand projections have been used to:

- estimate the potential revenue of Inland Rail
- assess the economic benefits arising from mode shift from road and the coastal route to Inland Rail
- determine the appropriate capacity of Inland Rail
- determine appropriate service frequency and the impact of this on capacity utilisation, railway and train operating costs.

The main categories of freight that are expected to comprise the market for Inland Rail are non-bulk manufactured products, including bulk steel, paper, coal and grain. The demand analysis indicates that (ARTC, 2015):

- Inland Rail is expected to increase rail's share of the Melbourne to Brisbane freight market from the current 26 per cent to 62 per cent by 2049-50. Similarly, it is estimated that Inland Rail would increase rail freight's share of the Adelaide to Brisbane market by 28 per cent and Brisbane to Perth's share by seven per cent.
- Better connections to the Port of Brisbane would result in an estimated two million tonnes of freight shifting from road to rail by 2049–50, particularly grain and cotton from New England, as well as grain on both rail and road from the Darling Downs to the Port of Brisbane. In NSW, a significant tonnage of grain (about 7.5 million tonnes) would also use Inland Rail on its way to NSW ports.
- Inland Rail would induce an increase in freight, such as coal in the Surat and Clarence-Moreton Basins, which would increase from the current eight million tonnes to 19.5 million tonnes.

5.3 Need for the proposal

5.3.1 Need for Inland Rail

As noted in the *National Land Freight Strategy* (Standing Council on Transport and Infrastructure, 2013) 'The efficient movement of land freight is crucial for Australia's productivity and competitiveness, and affects the lives of every Australian'. The existing rail mode share of freight between Melbourne and Brisbane (averaging the two directions) varies between approximately 22 to 27 per cent for non-bulk freight, to 60 to 90 per cent for commodities transported in bulk (ARTC, 2010).

The *National Land Freight Strategy* notes that the infrastructure supporting the movement of land freight, such as road, rail and ports, must be sufficient for the significant projected growth in demand for freight transport (described in Section 5.2.1).

Rail is generally the most productive and efficient mode for freight travelling from regional areas to export ports and urban destinations. Rail has traditionally dominated the freight market for mining and agricultural commodities, particularly iron ore, coal, grains, rice, cotton, and sugar for processing or export (ARTC, 2015). As noted by the Minister for Infrastructure and Regional Development (2013), 'an efficient rail freight network is the key to effective supply chains, national productivity and competitiveness'.

Inland Rail is needed to improve the efficiency of freight moving between Melbourne and Brisbane. Inland Rail would bypass the Sydney metropolitan area, it would substantially cut the overall journey time to less than 24 hours, and increase the reliability of services between Melbourne and Brisbane (Infrastructure Australia, 2016). This is expected to increase the competitiveness of rail transport relative to road transport (ARTC, 2015).

As noted by the *Australian Infrastructure Audit* (Infrastructure Australia, 2015) 'Rail offers an alternative to road transport and societal benefits in terms of lower emissions, reduced road congestion and increased safety per tonne kilometre, particularly over longer distances or when carrying heavy goods.'

In summary, Inland Rail is needed to respond to the growth in demand for freight transport (as described in Section 5.2.1), and address existing freight capacity and infrastructure issues (described in Section 5.2.2). The analysis of demand undertaken by ARTC indicated that there would be sufficient demand for Inland Rail (described in Section 5.2.3).

With respect to the need for the proposal, the Inland Rail Implementation Group (2015) found that:

- Without Inland Rail, the amount of freight travelling by road between Melbourne and Brisbane in 2050 will be approximately 7.1 million tonnes, 2.3 million tonnes more than what would be on the road with Inland Rail.
- Key transport links are experiencing increasing capacity constraints and congestion due to inadequate infrastructure.
- Current investment in road and rail is insufficient to address Australia's future freight task.
- Further population and freight growth along the north-south corridor will increase the demand for transport services at a local, state and national level, placing freight corridors under severe pressure and compounding the inefficiencies that already exist.
- If capacity constraints and congestion resulting from inadequate infrastructure are not overcome, national productivity and economic growth will be constrained with environment and safety outcomes also becoming increasingly sub-optimal.

5.3.2 Need for the proposal

Inland Rail consists of 13 geographically based projects, involving:

- building sections of new or 'greenfield' route
- upgrading sections of existing secondary lines to meet Inland Rail's performance specification
- enhancing sections of existing main lines, mainly to improve vertical clearances between infrastructure above the rail corridor and the tracks themselves, to enable trains with double stacked containers to pass safely beneath.

The proposal involves upgrading an existing secondary rail line to meet Inland Rail's performance specification. Development of both the proposal and the Parkes to Narromine project is required to enable implementation of Inland Rail to align with funding availability.

6. Alternatives and proposal options

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

6.1 Inland Rail alternatives

6.1.1 Strategic alternatives - alternative freight transport solutions

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

Strategic options assessment

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

- progressive road upgrades
- upgrading the existing east coast railway
- an inland railway.

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

- capacity to serve east coast future inter-capital regional/bulk freight market needs
- foster economic growth through improved freight productivity and service quality (including improved reliability and resilience)
- optimise environmental outcomes
- alleviate urban constraints
- enable regional development
- ease of implementation
- cost-effectiveness.

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

Review of alternatives

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

- maritime freight
- air freight
- road freight
- rail solutions.

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

Maritime shipping

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

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

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

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

Air freight

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

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

Road freight

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

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

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

The report concluded that:

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

Rail solutions

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

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

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

The report concluded that:

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

Summary of findings

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

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

6.1.2 The 'do nothing' alternative

Not developing Inland Rail would result in continued growth in the use of road for freight transport between Melbourne and Brisbane, particularly along the Newell Highway. The issues associated with using road transport alone to address Australia's freight needs into the future are considered in Section 6.1.1. In addition, road transport will be unlikely to meet the longer term needs for Australia's freight task alone unless substantial additional investment is made (Inland Rail Implementation Group, 2015).

6.1.3 Alternative locations/route options for Inland Rail

Alternative routes for Inland Rail have been considered by the following two studies:

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

The results of the studies are summarised below.

North–South Rail Corridor Study

The *North–South Rail Corridor Study* (Department of Transport and Regional Services, 2006) considered potential corridors for the rail line to determine which route would deliver the best economic and financial outcome.

Options identified

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

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

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

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

Analysis of options

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

- operating efficiency
- infrastructure requirements
- market demand
- environmental constraints
- financial and economic viability.

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

Melbourne–Brisbane Inland Rail Alignment Study

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

Options identified

The *Melbourne–Brisbane Inland Rail Alignment Study* short-listed and analysed a number of route options. The stages of route analysis involved:

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

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

- Melbourne to Parkes – two main options:
    - Via Albury, using existing track from Melbourne to Parkes (with a possible new direct line from Junee or Illabo to Stockinbingal by-passing Cootamundra).
    - Via Shepparton, using the existing broad gauge Mangalore–Tocumwal line via Shepparton, the disused standard gauge line to Narrandera, and a new direct connection through to near Caragabal, before rejoining the existing line to Parkes.

- Parkes to Moree – four main options:
  - Parkes to Moree via Werris Creek, using existing track (with a new section of track at Binnaway and Werris Creek to avoid reversals).
  - Parkes to Moree via Binnaway and Narrabri, using existing track to Binnaway, and then a new section connecting to the existing track near Emerald Hill or Baan Baa.
  - Parkes to Moree via Curban, Gwabegar and Narrabri, using existing track to Narromine, predominately new track between Narromine and Narrabri, and existing track from Narrabri to Moree.
  - Parkes to Moree via Burren Junction, using existing track to Narromine, and predominately new track via Coonamble and Burren Junction to Moree.
- Moree to Brisbane - two main options:
  - The Warwick route – a new 'greenfield' route via Warwick to the existing standard gauge Sydney–Brisbane line.
  - The Toowoomba route – a new corridor direct from Inglewood to Millmerran and Oakey, near Toowoomba, and then a new alignment down the Toowoomba range, and use of the proposed Southern Freight Rail Corridor from Rosewood to Kagaru.

Analysis of options

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

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

- environmental and land issues
- railway operations considerations
- engineering assessments
- capital cost estimates.

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

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

6.2 Proposal option development

6.2.1 Approach to the option development and design process

Option development has been an integral part of the overall design process for the proposal. An iterative process of option selection, design development, and evaluation has been undertaken to define the proposal to date. Further to the strategic and initial planning studies for Inland Rail, as described in Section 5.1, the design process for the proposal involves the following general phases:

- phase 1 – concept design
- phase 2 – feasibility design
- phase 3 – detailed design.

The proposal as described in this EIS is based on the outcomes of the feasibility design. The detailed design would take into account the outcomes of the feasibility design phase; the findings of this EIS, including the mitigation measures detailed in Chapters 9 to 26 (and summarised in Chapter 27); and any conditions of approval (if the proposal is approved).

The design has, and will continue to, evolve over these phases as a result of engineering, traffic, financial, economic and environmental considerations. The option selection and design process has also taken into account issue raised during consultation with relevant stakeholders (refer to Chapter 4) and the findings of preliminary environmental investigations.

6.2.2 Option assessment process

Options assessments have been undertaken for the following features of the proposal:

- track upgrading
- crossing loops
- bridges over Croppa Creek and the Gwydir and Mehi rivers
- level crossings
- Newell Highway overbridge
- Camurra hairpin curve upgrade
- Moree options.

A summary of the outcomes of the options assessments for these features is provided in the following sections.

In general, the assessments involved the following steps:

- Task 1 – confirming requirements
- Task 2 – identifying options to be assessed
- Task 3 – reviewing potential impacts, constraints, risks and opportunities associated with each option
- Task 4 – agreeing on evaluation criteria
- Task 5 – assessing the options against the criteria using a multi-criteria analysis
- Task 6 – identifying the preferred option
- Task 7 – reporting.

6.3 Options considered for proposal features

6.3.1 Track upgrading

Within the existing rail corridor, the existing track and formation needs to be upgraded/replaced to meet the operational requirements for Inland Rail, in particular, for the types and speeds of trains that would use Inland Rail.

Options considered

The track consists of the rails, fasteners, sleepers and ballast. The formation consists of the foundation material beneath the ballast and above the sub-grade. It is comprised of structural fill but may also include a capping layer. Three options for upgrading the track and/or formation were considered:

- track reconstruction – replacing the existing track and formation
- skim reconditioning – using the existing track ballast and sub-ballast as structural capping on the existing consolidated subgrade
- skim plus reconditioning – a combination of skim reconditioning and track reconstruction.

Assessment

Geotechnical investigations were undertaken along the existing rail corridor to provide a preliminary quantification of the extent of each potential treatment option. The results of this investigation were tested against the key parameters for each option.

Preferred option

All three options would be implemented as required, depending on the existing track and formation conditions. The track would be reconstructed in areas where the subgrade strength is inadequate, the existing formation has failed, and/or there is insufficient quality material in the existing track to be retained. Skim reconditioning would be used in areas where the existing ballast and sub-ballast is suitable for reuse. Skim plus reconditioning would be used in areas where there is not enough existing ballast.

6.3.2 Crossing loops

Initial options

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

Crossing loops are positioned along a rail line using a network modelling methodology. This identifies locations to provide the maximum number of possible 'train paths' on the network. The number of potential train paths on a network represents the capacity of that network. For Inland Rail, a crossing loop is required around every 25 kilometres.

Assessment

A multi-criteria analysis was undertaken to determine the location of crossing loops as part of the proposal, based on network capacity requirements and taking into account local constraints. Considerations included:

- future train lengths
- minimising impacts on level crossings
- existing structures currently recommended to be retained
- distance to a receiver (noise)
- earthwork cut and fill volumes
- access
- geometry.

Preferred option

Based on this assessment, five new crossing loop locations were selected to allow trains to pass safely – at Bobbiwaa, Waterloo Creek, Tycannah Creek, Coolleearllee, and Murgo.

6.3.3 Bridges over Croppa Creek and the Gwydir and Mehi rivers

The existing rail bridges over Croppa Creek and the Gwydir and Mehi rivers are large span steel bridges, ranging in length from 75 to 150 metres, which span over rivers with high and steep river banks. The bridges over the Mehi and Gwydir rivers are listed heritage items on ARTC's Section 170 register and the bridge over Croppa Creek has local heritage significance (described in Chapter 18).

A review of the existing structures with Inland Rail requirements determined that there were a number of issues associated with the existing bridges including:

- the existing steel truss girders are not compatible with Inland Rail vertical clearance requirements
- there are a number of structural defects in the existing bridges associated with timber degradation
- the existing piers would be unable to handle Inland Rail design loadings.

An assessment of the potential options to upgrade the bridges were considered as part of the design process. The following options were identified and assessed:

- Base case – this option would involve a combination of partial demolition and upgrade of the existing structure. A retrofitted ballast top superstructure would be fitted on to the existing piers.
- Option 1 - Offline: this would involve building a new bridge approximately 10 metres to the east of the existing bridge. The rail track would be realigned for a distance of about 250 metres to 280 metres on each side of the bridge, to meet the new bridge approach spans. The existing bridge would be removed once construction and commissioning of the new bridge is complete
- Option 2 - Online: this option would involve building a new bridge in the same location as the existing bridge, and upgrading the rail tracks and formation along the existing alignment. The existing bridge would be removed prior to construction of the new infrastructure. The new bridge would be wider than the existing bridge.

Assessment

A multi-criteria analysis of the options was undertaken. The following criteria were used:

- relative cost
- construction complexity
- property impacts
- environmental impact.

Table 6.1 lists the advantages and disadvantages associated with each option, which provided the basis for assessing the options.

Table 6.1 Advantages and disadvantages of bridge options

Option	Advantages	Disadvantages
Base case	▸ Some level of retention would provide heritage reference. ▸ No property acquisition would be required. ▸ Limited vegetation removal would be required. ▸ The impact on Aboriginal objects/sites would be minimised (Mehi River bridge only - refer to Chapter 17).	▸ The existing piers would require substantial strengthening. ▸ The time for reconstruction of the approach embankments and shutdown of the rail line would be significant, which would also increase the potential for flooding during works. ▸ There would be high design and construction costs. ▸ A unique Super T span would be required to match the pier locations.
Option 1	▸ The new structure would not clash with the existing pier foundations. ▸ The risk to program is the lowest of all options. ▸ Lower risk from a constructability perspective when compared to the base case and option 2. ▸ A standard Super T and rail girder configuration could be utilised.	▸ Some property acquisition and vegetation clearance would be required. ▸ The hydraulics of flood flow would change. This would need to be considered during detailed design. ▸ An increased amount of earthworks would be required, when compared to the other options. ▸ The impact on Aboriginal objects/sites would be increased due to the increase in earthworks (Mehi River bridge only – refer to Chapter 17).
Option 2	▸ No property acquisition and minimal vegetation clearance would be required. ▸ Lower cost and constructability risk when compared to base case. ▸ The potential for impact on Aboriginal objects/sites would be less than option 2. ▸ A standard Super T and rail girder configuration could be utilised.	▸ It may require removal of the existing pier substructure to substantial depth. ▸ The hydraulics of flood flow would change. This would need to be considered during detailed design.

Options 1 and 2 also entail the complete demolition of the existing structures. From an engineering and safety perspective, this was considered necessary because:

- Retention of the existing structures would be a safety risk to the community as the structures continue to degrade with time and could collapse. The risk would be to ARTC personnel or members of the public who seek unauthorised access to the bridge.
- Retention of the existing structures would require ongoing maintenance costs and would increase the potential for vandalism and graffiti.
- If the existing piers were retained (in addition to the construction of new piers), there would be the potential for an increase in local flooding extent and frequency and associated scour issues.
- If the existing piers were retained additional bridge spans would be required which would result in increased costs.

Preferred option

The assessment concluded that option 2 (the online option) is the preferred option, as it scored highest as an outcome of the multi-criteria assessment. This option has the benefits noted above, and would involve the complete demolition of the existing structures. With regards to the existing structures ARTC will explore opportunities to reuse the existing truss structures elsewhere on their network.

6.3.4 Level crossings

A total of 86 level crossings are located along the proposal site. Of these, 45 are located on public roads (a number of which are Crown roads providing access to a single property), and 41 crossings are located on private roads or maintenance access tracks.

The majority of level crossings along the proposal site have passive forms of control, consisting of give way or stop signs (82 crossings). The remaining four crossings have active controls (either signage with flashing lights, or signage with flashing lights and boom gates).

Initial options and assessment

ARTC is applying the Inland Rail level crossing strategy for the proposal. The level crossing strategy involves reviewing all crossings along the proposal site to determine the works required to meet relevant crossing standards, guidelines, and Inland Rail operational criteria. The level crossing strategy consists of two stages:

- Stage 1 - identify options for level crossings and the preferred approach.
- Stage 2 - consult with relevant stakeholders (including landowners and road owners) to confirm the preferred treatment, and finalise the strategy.

Stage 1 of the level crossing strategy involved:

- identifying all level crossings across the proposal site
- initial field assessment of crossings
- review existing crossings with regard to Australian and ARTC level crossing design standards
- consulting with stakeholders about the use of crossings
- identifying preferred works and consolidation options for further stakeholder consultation as part of stage 2.

The following options were considered for each level crossing:

- retain existing crossing controls
- upgrade the level of control at the crossing
- construct a gated crossing with administrative controls, such as a requirement to phone train control prior to use
- consider crossing consolidation based on he outcomes of further investigation and stakeholder agreement.

Preferred option

The preferred option for level crossings across the proposal site is listed in Table 6.2.

Table 6.2 Summary of preferred option for level crossings

Action	Number of crossings affected		
	Private	Public	Total
Consider crossing consolidation based on the outcomes of further investigation	2	6	8
Upgrade crossing from existing passive protection (Give Way sign) to Stop sign	3	0	3
Retain existing passive protection (Stop sign)	19	26	45
Upgrade from passive to active pedestrian level crossing	3	0	3
Retain existing active protection (railway crossing flashing signal and boom)	4	0	4
Upgrade from Give Way sign to flashing lights and boom barriers	3	0	3
Upgrade from Stop sign to flashing lights and boom barriers	7	0	7
Construct a gate and require call access to open	0	13	13
Total	**41**	**45**	**86**

The next stage

The next stage in the level crossing strategy involves:

- consulting with stakeholders regarding the preferred option
- reviewing the proposed works for each crossing in detail, taking into account input from stakeholders
- reviewing consolidation options in accordance with the requirements of the *Transport Administration Act 1998*
- preparing detailed designs for works
- stakeholder consultation on the detailed designs
- finalise the detailed designs for each crossing, taking into account the results of consultation.

As noted in Section 3.4.3, any closure of level crossings needs to be undertaken in accordance with the requirements of the *Transport Administration Act 1998*. Private level crossings cannot be closed unless there is an alternative means of legal access to the property. Further information on the requirements of the *Transport Administration Act 1998* in relation to level crossings is provided in Section 3.4.3.

6.3.5 Newell Highway overbridge

Initial options

As described in Chapter 2, the Newell Highway passes over the existing rail corridor via an existing overbridge located about 3 kilometres north of Bellata, near the Tookey Creek rest area (located about 46 kilometres south of Moree). There are a number of issues associated with the existing bridge, including the width of the bridge and its clearance above the rail corridor. An assessment of the potential options to upgrade the existing Newell Highway overbridge were considered as part of the design process.

The objectives of the upgrade are to:

- provide sufficient height to meet the Inland Rail performance requirements and cater for double stacked freight trains to clear the crossing of Newell Highway (at least 7.1 metres from top of rail to base of bridge)
- be consistent with the Newell Highway Corridor Strategy (NSW Government, 2015)
- provide adequate room for any future widening of the rail corridor in this location
- minimise environmental impacts
- minimise property impacts
- minimise disruption to road users.

The following options were identified and assessed:

- Option 1.1 – involves a new 1.5 kilometres long highway deviation to the south, and a new three span bridge.
- Option 1.2 – similar to option 1.1 with a higher embankment.
- Option 2 – involves a new 2 kilometres long highway deviation to the north, and a new single span bridge structure.
- Option 3.1 – is an unmodified base case (that is, the 'do nothing' option).
- Option 3.2 – is an improved base case, which involves lowering the rail track by excavating a distance of 2.5 metres underneath the existing overbridge for a distance of one kilometre.

The location of options 1.1, 1.2 and 2 is shown in Figure 6.1.

Assessment

A multi-criteria analysis of the options was undertaken to assist in weighting the value of various risks and opportunities associated with each of the options. The following criteria were used for the assessment:

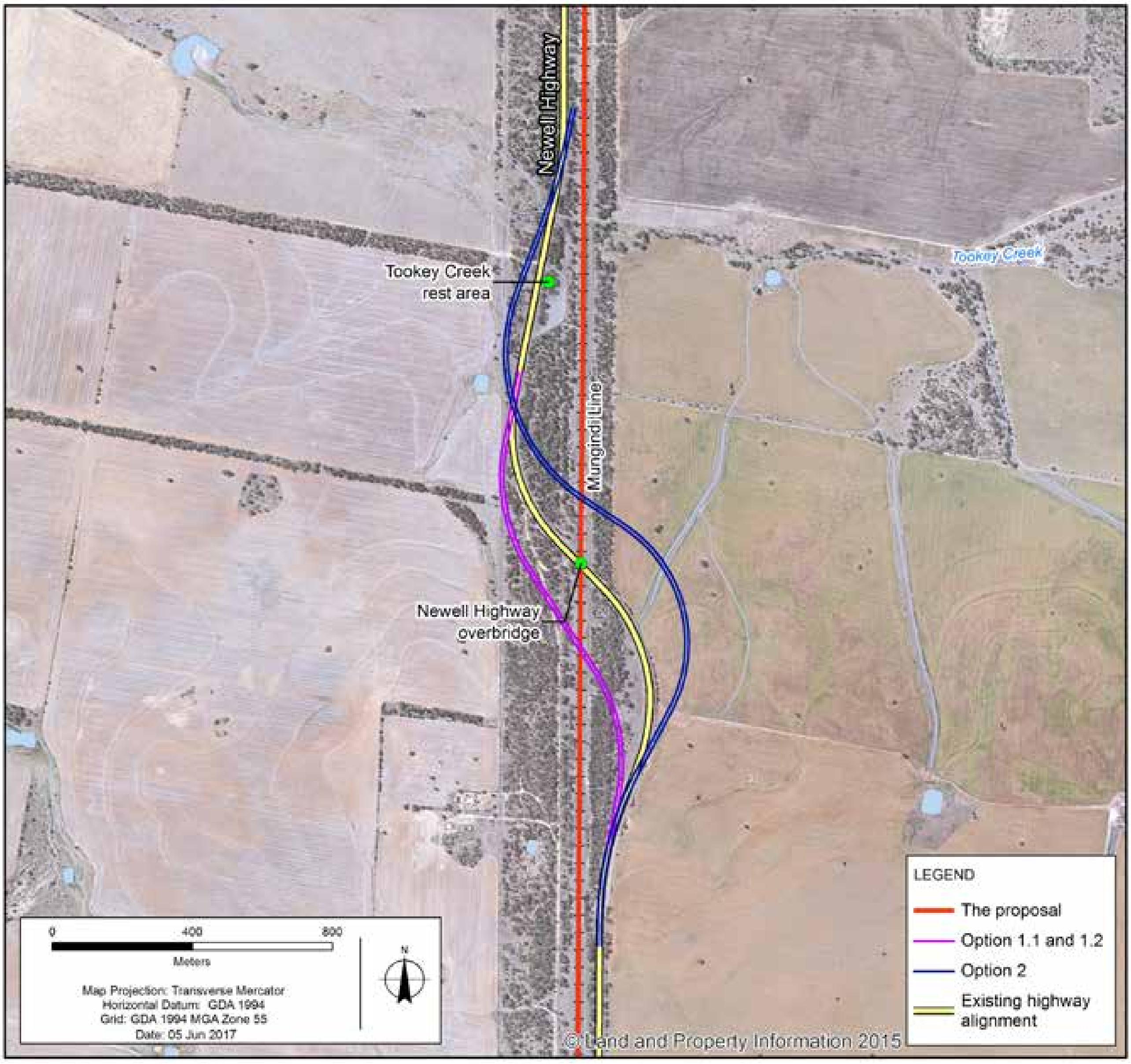
- corridor compliance
- cut-to-fill balance
- construction staging
- structures size
- property impacts
- utilities/services impact
- environmental impact.

The assessment of options considered the design criteria listed in Table 6.3, which incorporates the requirements of the Roads and Maritime Services corridor strategy, where relevant.

Table 6.3 Newell Highway overbridge design criteria

Design criteria	Basis of design
Barrier performance	Medium
Lane width	3.5 m
Footpath	n/a
Shoulder width	2 m
Sign posted speed	100 km/h
Design speed	100 km/h
Bridge clearance	7.4 m

Figure 6.1 Newell Highway overbridge upgrade options



The multi-criteria assessment also took into consideration the following potential constraints:

- the impact on the travelling stock route currently located to the west of the rail track
- a large cut to fill imbalance exists therefore fill would need to be imported
- safety barrier requirements would need to be considered given the significant embankment heights
- the truck rest area located to the north of the overbridge (the Tookey Creek rest area) is an important stop due to the high volume of heavy vehicles which travel along the Newell Highway.

Preferred option

The assessment concluded that option 1.2 (a new 1.5 kilometres long highway deviation to the south, and a new three span bridge) was the preferred option, as it scored highest as an outcome of the multi-criteria assessment, best meets the objectives of the upgrade, and has the following benefits:

- the width of the bridge and road formation complies with Roads and Maritime Services standards
- it ties into the existing alignment to the south of the truck rest area which means it can continue to be utilised unaffected
- there are no impacts to the existing highway except for the tie-in works
- there would be minimal property impacts
- minimal clearing would be required close to the road corridor
- there is minimal potential for noise impacts – there is only one resident to the west
- there would be minimal impacts to existing traffic – it would enable access along Newell Highway to be maintained during construction, as it would be constructed 'offline'.

6.3.3 Camurra bypass

Initial options

As described in Chapter 2, the existing rail corridor includes a tight 'hairpin' curve near the locality of Camurra, which is about 10 kilometres north-east of Moree. At Camurra, the proposal site enters the corridor for the existing Boggabilla Line at the hairpin curve. This curve does not meet the required performance specifications for Inland Rail. An assessment of the potential options to upgrade the rail line is this location, and bypass the existing hairpin curve, was undertaken as part of the design process.

The objectives of the bypass are to:

- improve the alignment to achieve a 115 kilometre per hour design speed
- minimise environmental impacts
- minimise property impacts
- minimise infrastructure impacts.

The following options were identified and assessed:

- Option 1 – existing situation.
- Option 2 – involves 1.6 kilometres of new track to the east of the existing turn, with an 800 metre radius curve.
- Option 3 – involves 2.6 kilometres of new track further to the east of the existing turn, with a 1,000 metre radius curve.
- Option 4 – involves 2.4 kilometres of new track further to the east of the other options.

The locations of the options are shown in Figure 6.2.

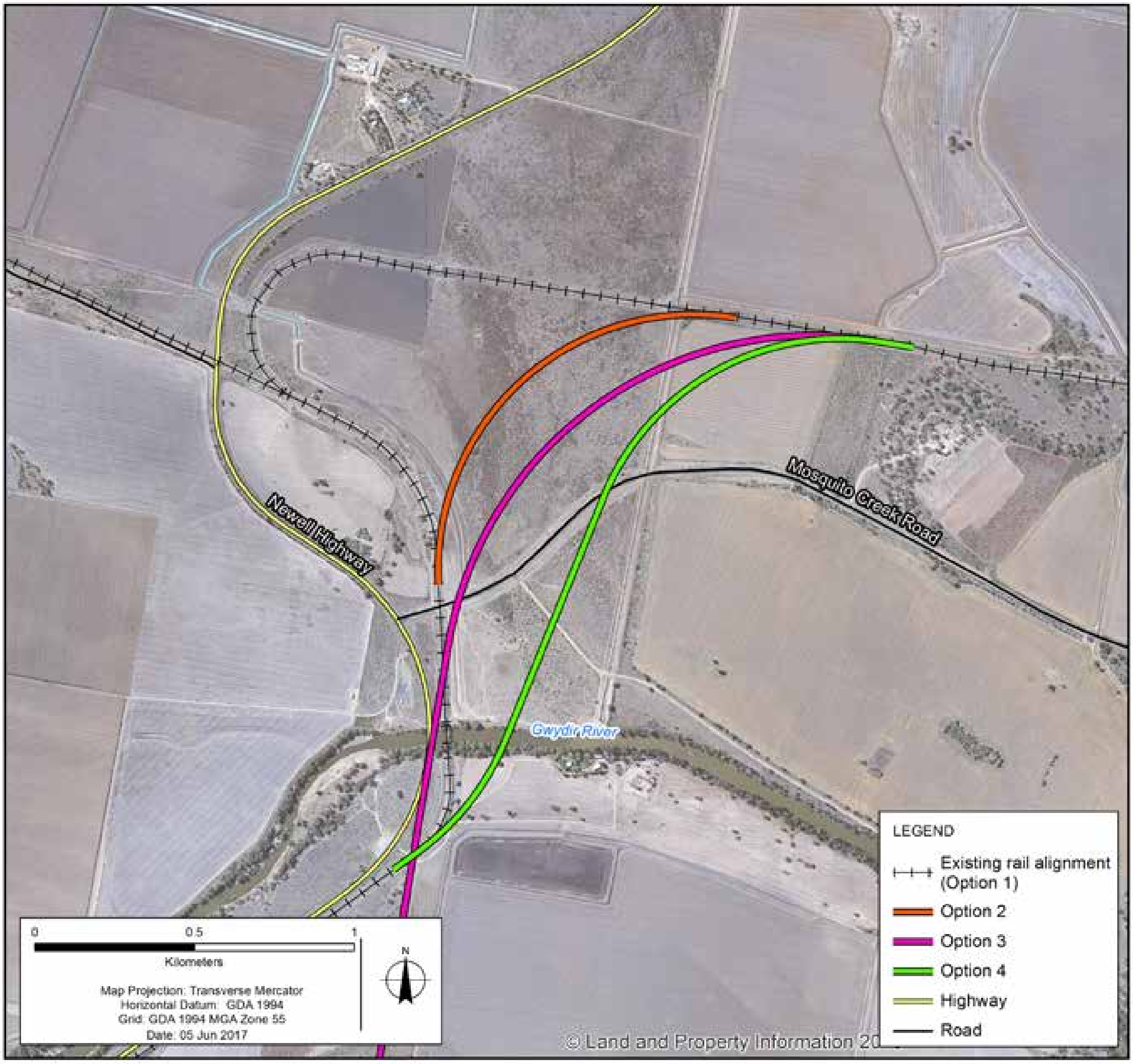
Assessment

A multi-criteria analysis of the options was undertaken to assist in weighting the value of various risks and opportunities associated with each of the options.

The following criteria were used for the assessment:

- operational benefits
- safety (operational/public/emergency response)
- maintenance
- utility impacts
- roads impacts
- environmental impacts
- property impacts
- track
- civil and geotechnical
- capital cost (based on quantities).

Figure 6.2 Camurra bypass options



Preferred option

The assessment concluded that option 2 was the preferred option, as it scored highest as an outcome of the multi-criteria analysis, best meets the objectives of the bypass, and has the following benefits:

- least impact on Mosquito Creek Road
- least impact on the existing irrigation channel
- requires the shortest length of new track to be constructed.

6.3.7 Moree options

As shown in Figure 6.5, the existing rail corridor passes through the south-eastern part of Moree for a distance of about 3.7 kilometres. The proposal would result in an increase in the number of trains travelling through Moree Station, from two to three trains per day (existing rail traffic) to about 12 trains per day in 2025, and about 21 trains per day in 2040.

In Moree Plains Shire Council's submission to the Department of Planning and Environment during preparation of the SEARs, they expressed concerns about the potential impacts of the proposal on Moree, including impacts on connectivity between the areas of the town located on either side of the current railway alignment, and the effect that increased train volumes would have on this. Consequently, the SEAR specifically required consideration of an eastern deviation around the Moree urban area, as an alternative to upgrading the existing rail corridor.

Moree options identification

In accordance with the SEARs, an assessment of options to minimise the potential impacts of the proposal on Moree was undertaken during the design process. The objective of the assessment was to consider options to minimise the impacts of the proposal on the Moree community. The options considered opportunities to improve vehicular, pedestrian, cyclist, and emergency vehicle access between the areas of Moree on either side of the existing rail corridor and included an examination of an eastern deviation around the Moree urban area.

In addition to the do nothing option, the following options were assessed:

- Moree connectivity options – alternative connectivity solutions linked to the upgrade of the existing rail corridor (described below).
- Moree bypass options – alternative alignments to the east of Moree were assessed and a concept design developed of the optimum alignment (described below).

Moree connectivity options assessment

The alternative connectivity solutions assessed to upgrade the existing rail corridor were:

- Level crossing upgrades – level crossing upgrades to enable greater ease for pedestrians and cyclists to safely cross the rail corridor. As the two main level crossings in Moree currently have active protection (lights and boom gates), the required upgrades to these level crossings would be minimal.
- Footbridge(s) – a footbridge at Jones Avenue that spans the rail corridor and Moree Bypass (road), enabling pedestrians to cross from east to west.
- Emergency vehicle access – if a train breakdown was to occur on the section of track within Moree, existing emergency vehicle access routes could be blocked as a result of the length of the trains. A dedicated point of emergency-vehicle-only access to cross the rail line with an alternate access route could be provided adjacent to Blueberry Road.
- Gwydir Highway detour – due to the predicted increase in train numbers, there is a possibility of increased delays at existing road crossings, including the Gwydir Highway. This option involves a detour of the Gwydir Highway to the south, using existing local roads, with the provision of a new level crossing. This option involves a nine kilometre long road detour using existing local roads, which would enable access from Moree east to west, even if a train were to block the two level crossings within Moree.
- Gwydir Highway bypass – this option involves a bypass of the Gwydir Highway to the south of Moree, including an overbridge over the rail corridor, and a major bridge crossing at the Mehi River. This would involve a six kilometre long new road alignment for the Gwydir Highway, which would be comparable to the existing Gwydir Highway alignment that traverses Moree. This option would provide continued access for Gwydir Highway traffic during any rail stoppages, and would divert highway traffic from Moree.
- Moree town overbridges – this option involves constructing new road bridges over the rail corridor within Moree, with various location options considered (described below).

Engagement with Moree Plains Shire Council and local emergency services identified that the provision of a road bridge over the rail corridor (a road overbridge) was the preferred solution to connectively issues. Council and local emergency services considered that the time to travel to the proposed alternate level crossings posed too great a safety risk in emergency situations.

Three options were assessed:

- Option 1 – Jones Avenue overbridge – involves a three span bridge between Jones Avenue and Tycannah Street; spanning the rail corridor, Gosport Street, and the Moree Bypass (Newell Highway).
- Option 2 – Newell Highway (Frome Street) to Tycannah Street overbridge – involves a six span bridge between the Newell Highway/Frome Street and Tycannah Street; spanning the rail corridor for both the Mungindi and Inverell lines, Gosport Street, and the Moree Bypass (Newell Highway).
- Option 3 – Newell Highway (Frome Street) to Bullus Drive overbridge – involves an overbridge located off a new intersection at the Newell Highway, tying into the existing road alignment at the western end of Bullus Drive.

The Moree overbridge options are shown in Figure 6.3.

The following criteria were used for the assessment of each of the options:

- existing infrastructure interface: considers impacts and upgrades required to existing structures and roads
- traffic: considers impacts to road and rail traffic
- construction: considers impacts, such as noise
- community: considers improvements to community connectivity
- property: considers property numbers and impacts.

The assessment concluded that option1 - the upgrade of existing level crossings and provision of emergency access across the corridor via a new overbridge at Jones Avenue was the optimum outcome.

Details of the proposed structure at Jones Avenue is shown in Figure 6.4.

Moree bypass options assessment

Five possible options were identified for a rail corridor bypass to the east of Moree. Analysis of these options involved an assessment of constraints, impacts and opportunities around the following criteria:

- operations and maintenance: considers operational benefits and safety
- technical elements: considers track, civil, utilities, road interface and constructability
- environment: considers biodiversity, noise, flooding and heritage
- community response, land use and property impacts
- capital costs: considers construction quantities and construction methodology.

The five options are described below and are shown in Figure 6.5:

- Option 1 – The proposed alignment is 20.7 kilometres of new track following a direct route across the floodplain bypassing approximately 26 kilometres of the existing alignment including the existing Camurra hairpin curve.
- Option 2 – The proposed alignment is 17 kilometres of new track including the Camurra bypass. It provides a relatively direct route across the floodplain crossing the Mehi and Gwydir rivers at its narrowest point, and bypasses approximately 18 kilometres of the existing alignment.
- Option 3 – The proposed alignment is 14.6 kilometres of new track including the Camurra bypass. It provides a direct route across the floodplain and bypasses approximately 15 kilometres of the existing alignment.
- Option 4 – A derivative of option 3, this option is 13.7 kilometres of new track including the Camurra bypass. Option 4 follows a similar alignment to option 3, however provides a less direct alignment to minimise property severance.
- Option 5 – The proposed alignment is 12.4 kilometres of new track including the Camurra bypass. Of all proposed alignment, it is the shortest in length and the closest to the Moree township.

Figure 6.3 Moree overbridge options

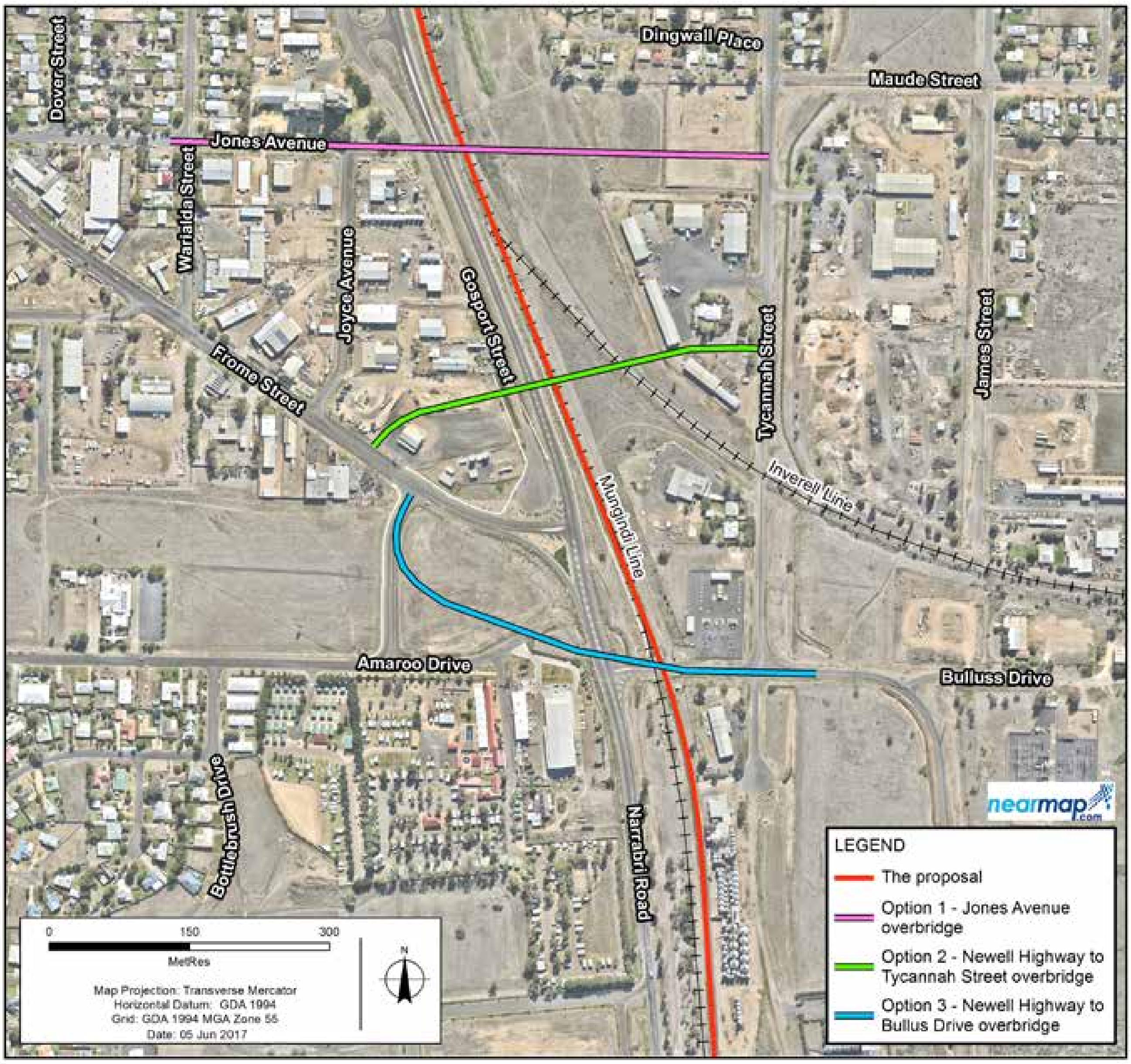
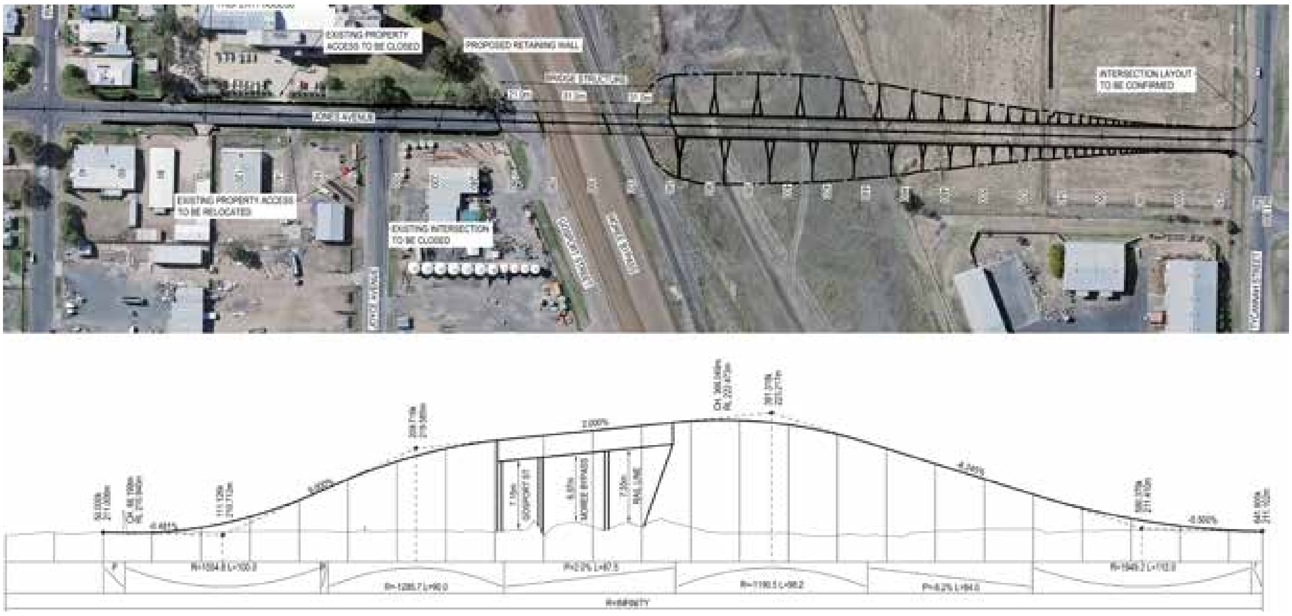


Figure 6.4 Jones Avenue overbridge



The multi-criteria analysis of the Moree bypass options determined that the optimum alignment is option 5.

A concept design of the optimum Moree bypass option was developed to determine the solutions extent of culverts, bridges, road and rail crossings. The concept design alignment is shown in Figure 6.6.

Overall preferred Moree option

To ensure a consistent approach to the 'like for like' comparison of all alternative route options, a multi-criteria analysis was undertaken. The following broad ranges of qualitative and quantitative criteria were used to compare the optimum Moree connectivity option (including Jones Avenue overbridge) with the optimum Moree bypass alignment:

- technical viability: considers the alignment, impact on public utilities, geotechnical conditions, impacts on existing road and rail networks, flood immunity and hydrology and future proofing
- safety assessment: considers construction safety, operational safety, public safety, road safety interfaces and emergency response
- operational approach: considers the impact on travel time, reliability and availability, and network interoperability and connectivity including interfaces with rail terminals and network
- constructability and schedule: considers construction duration, access, and complexity, resources, interface with operational railway and staging opportunities
- environmental impacts: considers the ecological impacts (flora, fauna and habitats), visual impacts, noise and vibration impacts, flooding and waterway impacts and the effect on air quality and greenhouse gas emissions
- community and property impacts: considers property impacts, Aboriginal and non-Aboriginal heritage, heritage, impact on community, community response and current and future land use and links to economic impacts
- approvals and stakeholder engagement: considers planning and approval requirements, State and Australian Government agency buy-in, local government buy-in, other statutory and regulatory approvals and service authorities, such as utilities
- construction costs: considers costs of trackwork and crossings, earthworks and fencing, utilities, culverts, bridges, noise walls, environmental issues, contractor costs and client costs.

The multi-criteria analysis concluded the Moree connectivity option (including the Jones Avenue overbridge) was the overall preferred option.

Figure 6.5 Moree bypass options

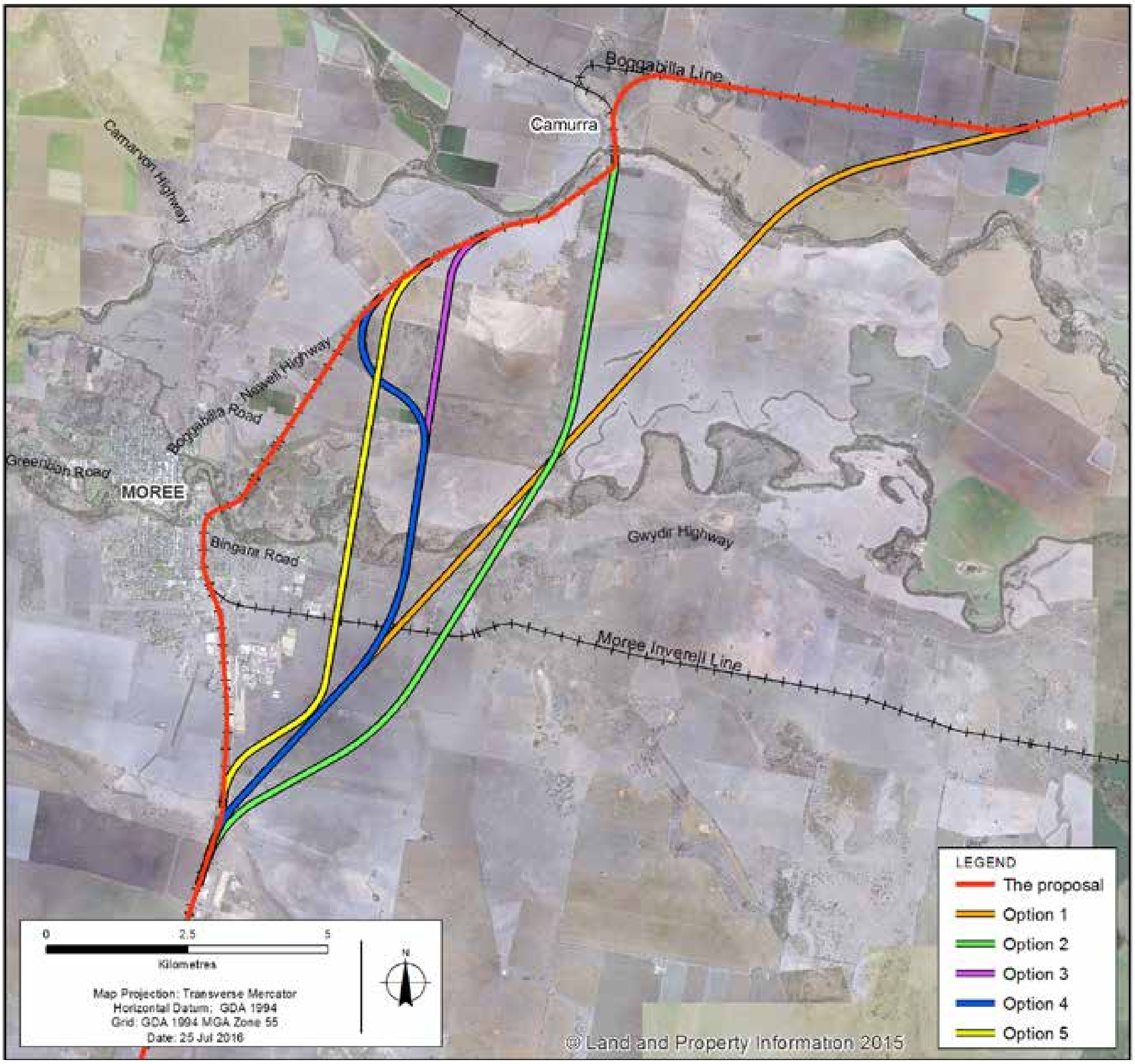
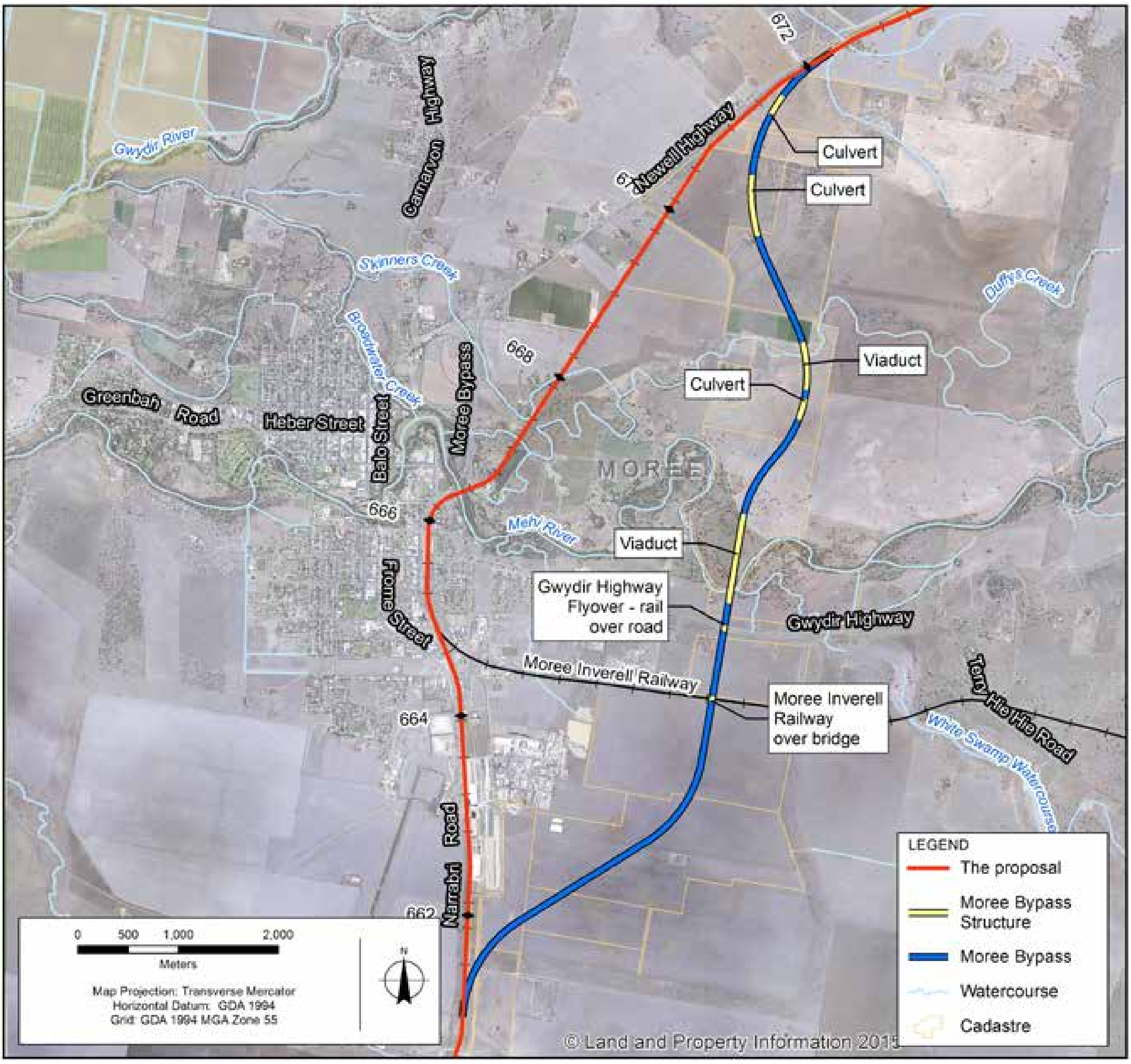


Figure 6.6 Concept design of optimum Moree bypass alignment



7. Proposal features and operation

This chapter provides a description of the proposal's features and operation for the purposes of the EIS. It includes a description of the approach to avoiding/minimising impacts during the design of the proposal, the infrastructure proposed, land acquisition likely to be required, and how the proposal would operate. The proposed approach to construction of the proposal is described in Chapter 8.

7.1 Overview

7.1.1 The proposal

The key features of the proposal, which are shown in Figure 1.2, are as follows:

- upgrading the track, track formation, culverts and underbridges within the existing rail corridor, for a distance of 188 kilometres, between Narrabri and North Star via Moree
- realigning the track within the existing rail corridor at Bellata, Gurley, and Moree stations to conform with required platform clearances for Inland Rail trains
- providing five new crossing loops within the existing rail corridor at Bobbiwaa, Waterloo Creek, Tycannah Creek, Coolleearllee and Murgo
- providing a new section of rail line at Camurra about 1.6 kilometres long, to bypass the existing hairpin curve ('the Camurra bypass')
- removing the existing bridges and providing new rail bridges over the Mehi and Gwydir rivers and Croppa Creek
- realigning about 1.5 kilometres of the Newell Highway near Bellata, and providing a new road bridge over the existing rail corridor ('the Newell Highway overbridge')
- providing a new road bridge over the existing rail corridor at Jones Avenue in Moree ('the Jones Avenue overbridge').

The key features of the proposal are described in Sections 7.2 and 7.3.

Ancillary work would include works to level crossings, signalling and communications, signage, fencing, and services and utilities. Ancillary works are described in Section 7.4.

The Mungindi line, and a short section of the former Inverell line, are existing operational rail lines that join the proposal around Moree. These lines will continue to operate following construction of the proposal. Accordingly, only the relevant direct impacts on these existing lines, as described in Section 2.5, form part of the proposal. Any associated maintenance works and other minor works, undertaken by ARTC in accordance with existing ARTC procedures and processes and under relevant State legislative requirements on these existing lines, do not form part of the proposal.

7.1.2 Approach to avoiding or minimising impacts

The approach to design development (shown in Figure 7.1) has included a focus on avoiding and/or minimising the potential for impacts during all key phases of the process.

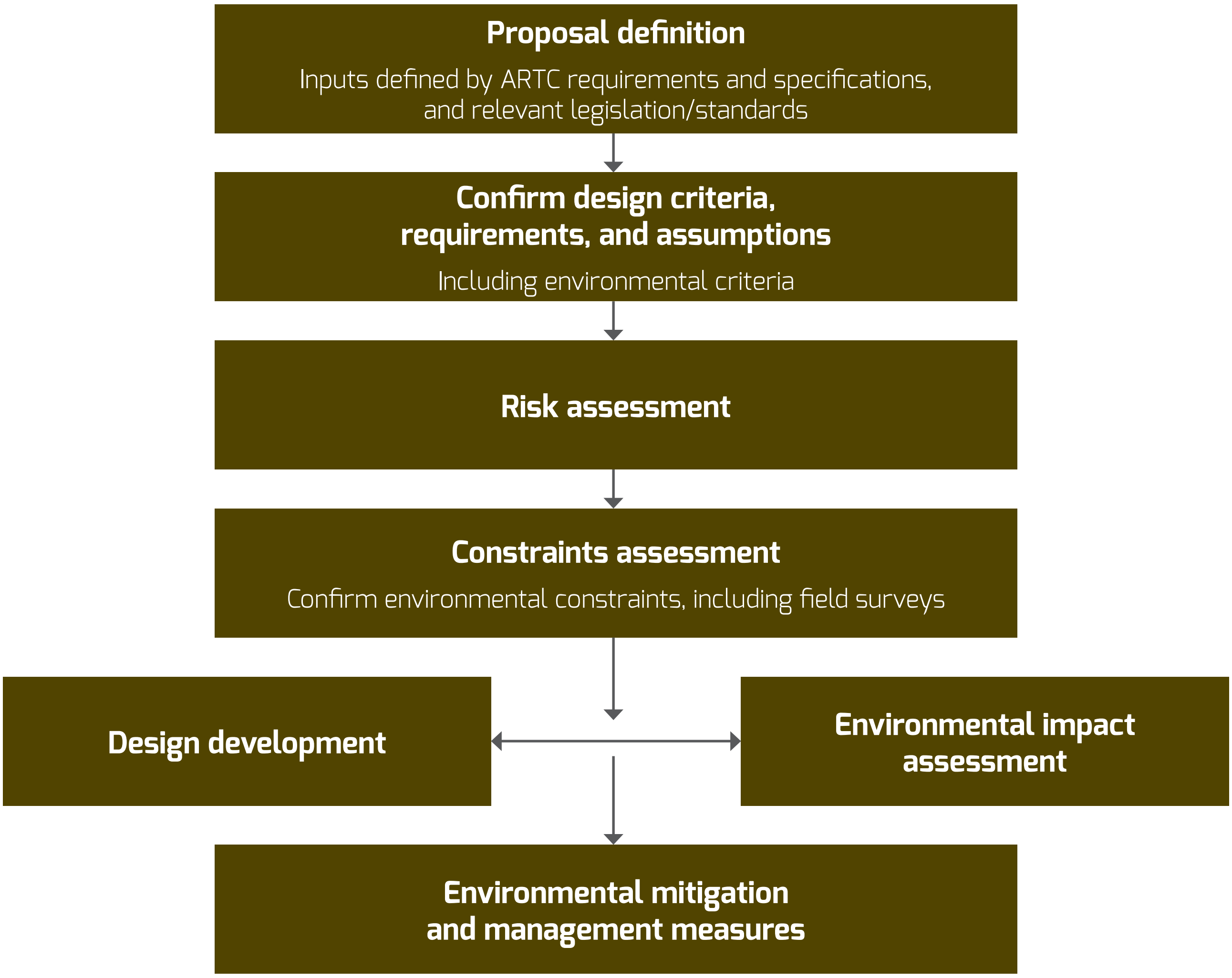
As described in Chapter 6, the multi-criteria assessments undertaken during the option selection and design process for key pieces of infrastructure included consideration of environmental and social impacts. Various options assessments have been undertaken, and the preferred option chosen based on the outcome of the assessments. The options assessment process also included assessment of opportunities and risks.

Examples of approaches to minimising the potential impacts of the proposal are described below.

Reuse of material

Track upgrade works make up a large part of the overall proposal. The design involves removing some of the existing material and replacing it with 'structural' and 'capping' materials. These materials are specification controlled, and are therefore generally required to be imported onto a site from a quarry or other suitable location. Importing material and exporting spoil requires truck movements.

Figure 7.1 Approach to avoiding and minimising impacts during the design process



For the proposal, the track works have been designed to reuse as much existing material as possible. Geotechnical investigations have been undertaken to identify what materials are contained within the proposal site. This has enabled the proposal to include reuse of as much existing material as possible via a site-specific formation design.

By undertaking this approach, import quantities have been reduced, and spoil quantities have been minimised.

Culvert design

Replacement culverts have been designed to ensure they take into account local constraints and existing flood flows. If the existing water flow situation was ignored and substantial changes made to the track structure, significant increases in the areas inundated during flood inundation events could eventuate.

Heritage items

Moree Station is listed on the Moree Plains LEP 2011 and Railcorp's section 170 heritage register. To minimise the potential impacts of the proposal on this item, options to realign the existing track would be explored further during detailed design. One option involves moving the track further away from the platform (up to about 1.5 metres from the existing platform) than currently proposed, to avoid potential impacts to the platform during track works.

7.2 Description of key proposal features within the existing rail corridor

This section describes those features of the proposal that would be located within the existing rail corridor.

7.2.1 Track upgrading

The existing track would be upgraded within the existing rail corridor for a distance of about 188 kilometres. All of the existing track would be upgraded in some way. As noted in Section 6.3.1, this would involve a combination of:

- track reconstruction
- skim reconditioning
- skim plus reconditioning.

Track reconstruction would involve replacing the existing track and formation. An indicative design for this form of treatment is provided in Figure 7.2.

Skim reconditioning would involve using the existing track ballast and sub-ballast as structural capping on the existing consolidated subgrade. An indicative design for this form of treatment is shown in Figure 7.3.

Skim plus reconditioning would involve a combination of skim reconditioning and track reconstruction. This form of treatment seeks to reuse as much existing material as possible. An indicative design for this form of treatment is shown in Figure 7.4.

7.2.2 Track realignment

At Bellata, Gurley, and Moree stations the rail line would be reconfigured within the existing rail corridor to conform with required platform clearances for Inland Rail trains. The location of the proposed realignment works are shown in Figure 7.5 to Figure 7.7.

At Bellata Station, the realignment works would involve reconfiguring the existing crossing loop to allow trains on the main rail line to bypass the platform with sufficient clearance.

At Gurley and Moree stations, the realignment works would involve moving the existing track about 125 millimetres away from the existing station platform to allow Inland Rail trains to pass the station platform. As described in Section 7.1.2, the detailed design of the realignment at Moree Station would consider the heritage significance of the station, and options to further minimise the potential impacts of the proposal on the station would be explored during detailed design.

In addition, the eastern side of the platform at Moree Station may need to be upgraded to allow passengers to join or alight from the Xplorer passenger service.

Additional works near Moree Station involve upgrading the existing pedestrian level crossing at the northern end of the station to include gates with lights and bells to alert passengers of approaching trains.

Figure 7.2 Track reconstruction

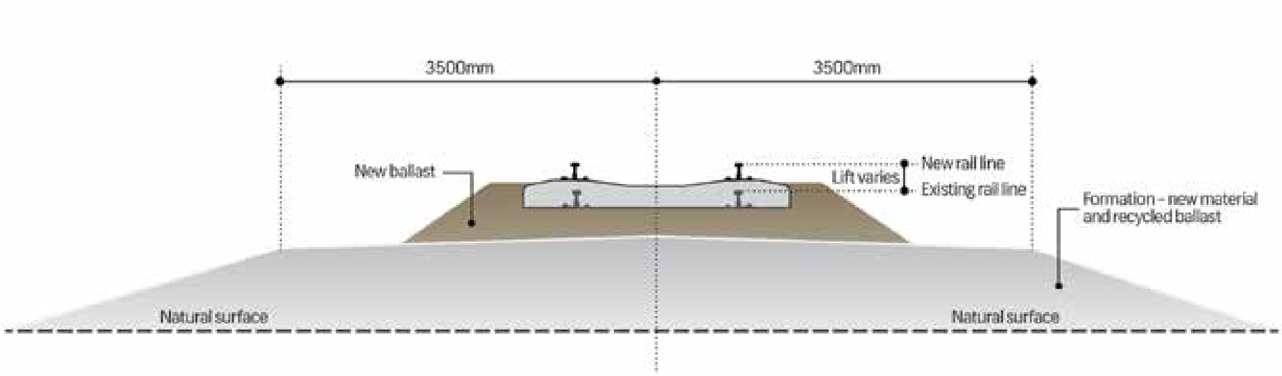


Figure 7.3 Skim reconditioning

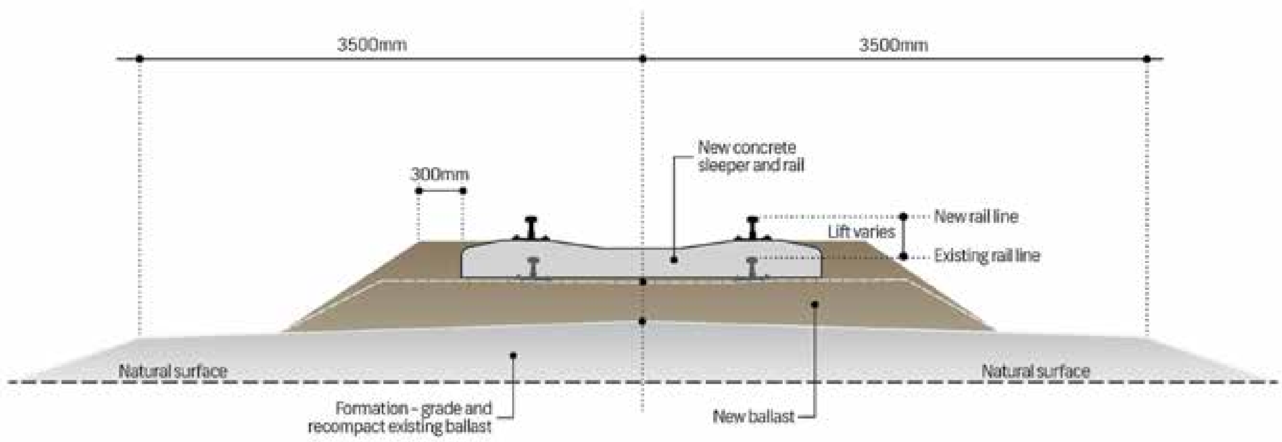


Figure 7.4 Skim plus reconditioning

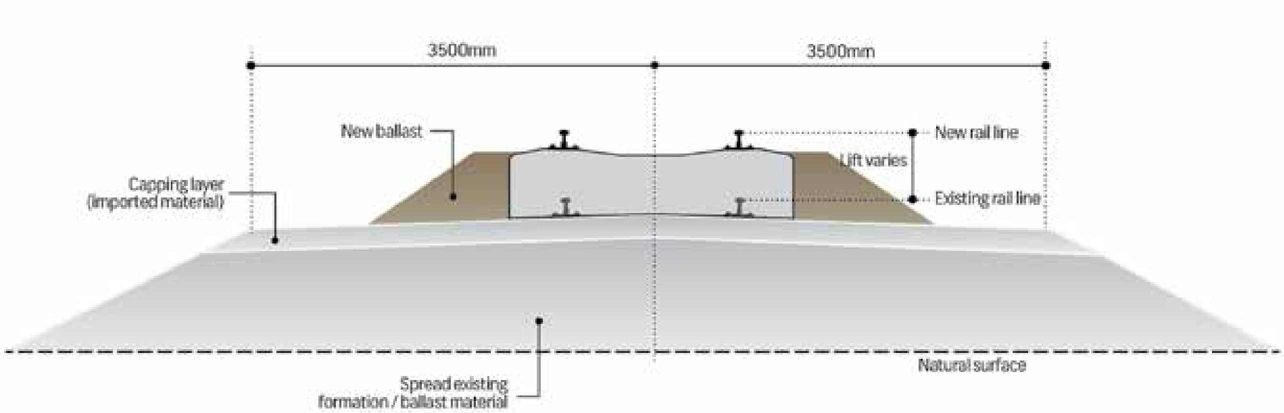


Figure 7.5a Bellata Station track realignment

Figure 7.5b Bellata Station track realignment

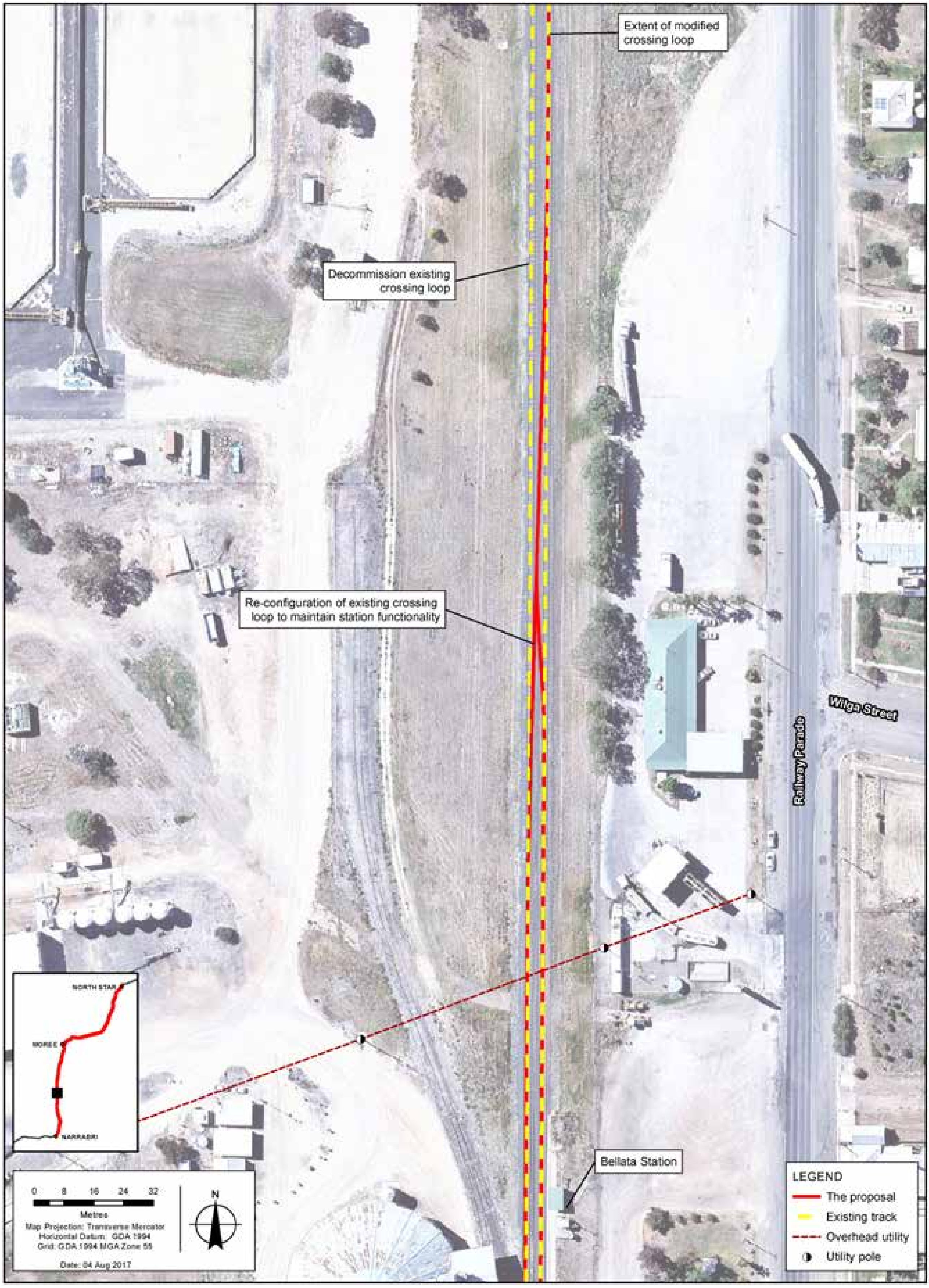


Figure 7.6 Gurley Station track realignment

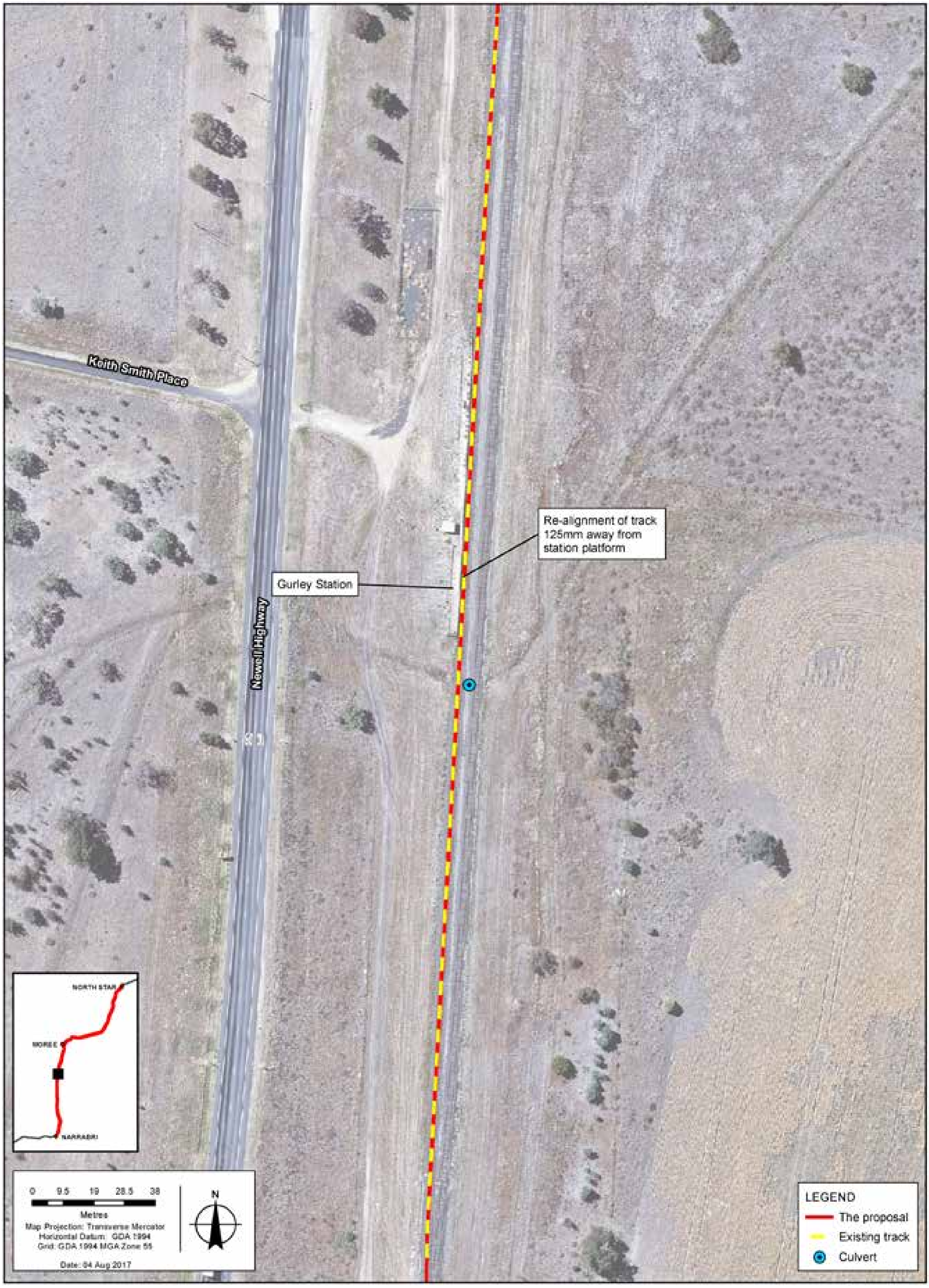


Figure 7.7 Moree Station track realignment

7.2.3 Culverts and underbridges

There are 211 culverts of varying types and sizes and 17 underbridges along the proposal site. Culverts are structures that allow water (in a watercourse or drain) to pass under the rail line. Like culverts, underbridges also allow water to pass under the rail line, however their span is longer and they are constructed differently. The majority of these structures (187 culverts) need to be replaced as part of the proposal to meet Inland Rail operational requirements. The remaining 24 culverts are proposed to be either retained or extended, pending further assessment.

Seven new culverts would also be built along the new alignment at the Camurra bypass. The location of the new culverts along the Camurra bypass has been selected to maintain the existing flow paths and minimise the potential impacts to flood depths upstream and downstream of the culverts. The culverts under the existing Camurra hairpin curve would be retained (four in total). Although it is likely that these culverts would experience a slight reduction in flow compared with the existing situation. The proposal does not include decommissioning the existing Camurra hairpin curve and as such, it is expected that ponding will occur between the existing and proposed Inland Rail alignment. The inundation is expected to be very similar to pre-development conditions.

The design of new/replacement culverts and underbridges has been informed by a hydrologic and hydraulic assessment of the proposal site, a geotechnical assessment, and a preliminary assessment of the existing structures. An assessment of flooding events has been undertaken for each structure. The target design condition for the new structures is the one per cent annual exceedance probability (AEP) flood event, where reasonably practicable.

The new structures have been designed to:

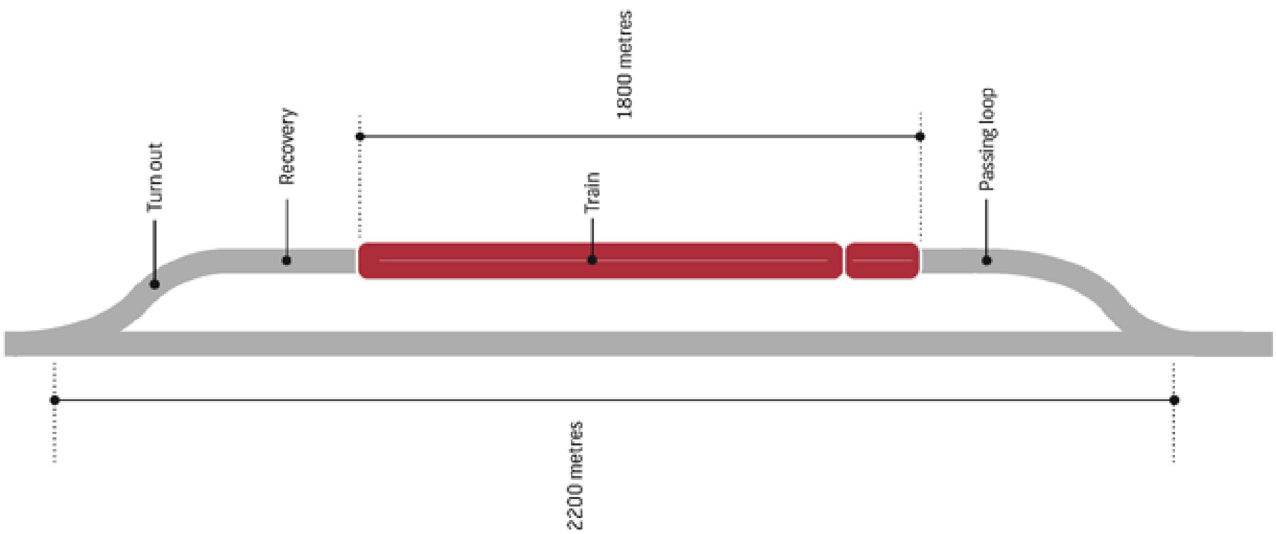
- take into account local constraints and flooding/hydrological conditions (described in Chapter 15)
- permit an appropriate flow and minimise the potential for adverse flooding impacts, by:
  - locating culverts at low points along the proposal site to prevent upstream water ponding
  - ensuring that the inside base of the culverts and underbridges match the natural surface level
  - retaining (at a minimum) the existing flow
  - minimising the potential for increases in the area of flood inundation
  - ensuring that sizes and capacities are as close to the existing situation as practicable, to minimise impacts on adjacent land and infrastructure
- meet ARTC design standards
- ensure that the flooding situation is no worse than the existing situation.

Culverts would be constructed of concrete, and would consist of three types:

- low level culvert consisting of twin cells, with approximate dimensions for each cell of 300 millimetres high by 755 millimetres wide
- mid level culvert consisting of a single cell with approximate dimensions of 700 millimetres high by 2.6 metres wide
- high level culvert consisting of a single cell with approximate dimensions of 1.5 metres high by 2.5 metres wide.

Underbridges would be constructed of reinforced concrete with a ballast top.

Figure 7.8 Indicative crossing loop design



7.2.4 Crossing loops

Five new crossing loops are proposed at Bobbiwaa, Waterloo Creek, Tycannah Creek, Coolleearllee, and Murgo. The loops would be constructed as new sections of track roughly parallel to the existing track. They would each be 2,200 metres long, to fit the design length of the train (1,800 metres). The existing rail corridor is of sufficient width to accommodate the new crossing loops.

An indicative crossing loop design is shown in Figure 7.8. The loops are shown in Figure 7.9 to Figure 7.13.

7.2.5 Turnouts

Turnouts allow the train to be guided from one track to another. The proposal involves replacing some existing turnouts, and providing new turnouts, as described in the following subsections.

New turnouts

Turnouts would be provided at the beginning and end of each crossing loop (10 in total) as well as at Bellata Station (an additional two to allow for reconfiguration of the existing crossing loops as described in Section 7.2.2).

Replacement turnouts

Eighteen turnouts would also be replaced at existing siding locations. All siding turnouts are maintained by ARTC under agreement with the siding owner. Although still within the proposal site, some sections of these turnouts may be partially located outside the existing rail corridor.

Figure 7.9 Bobbiwaa crossing loop

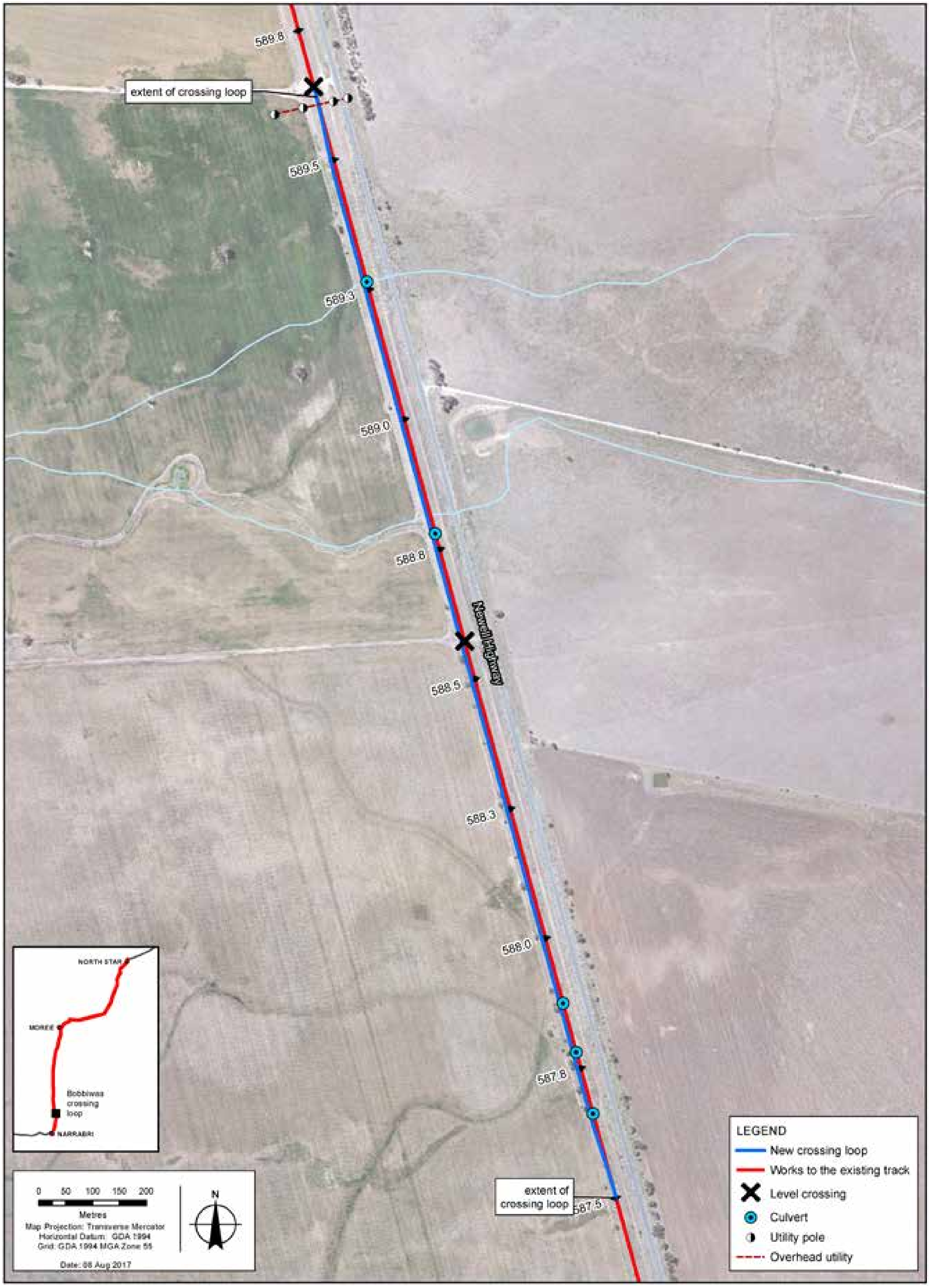


Figure 7.10 Waterloo Creek crossing loop

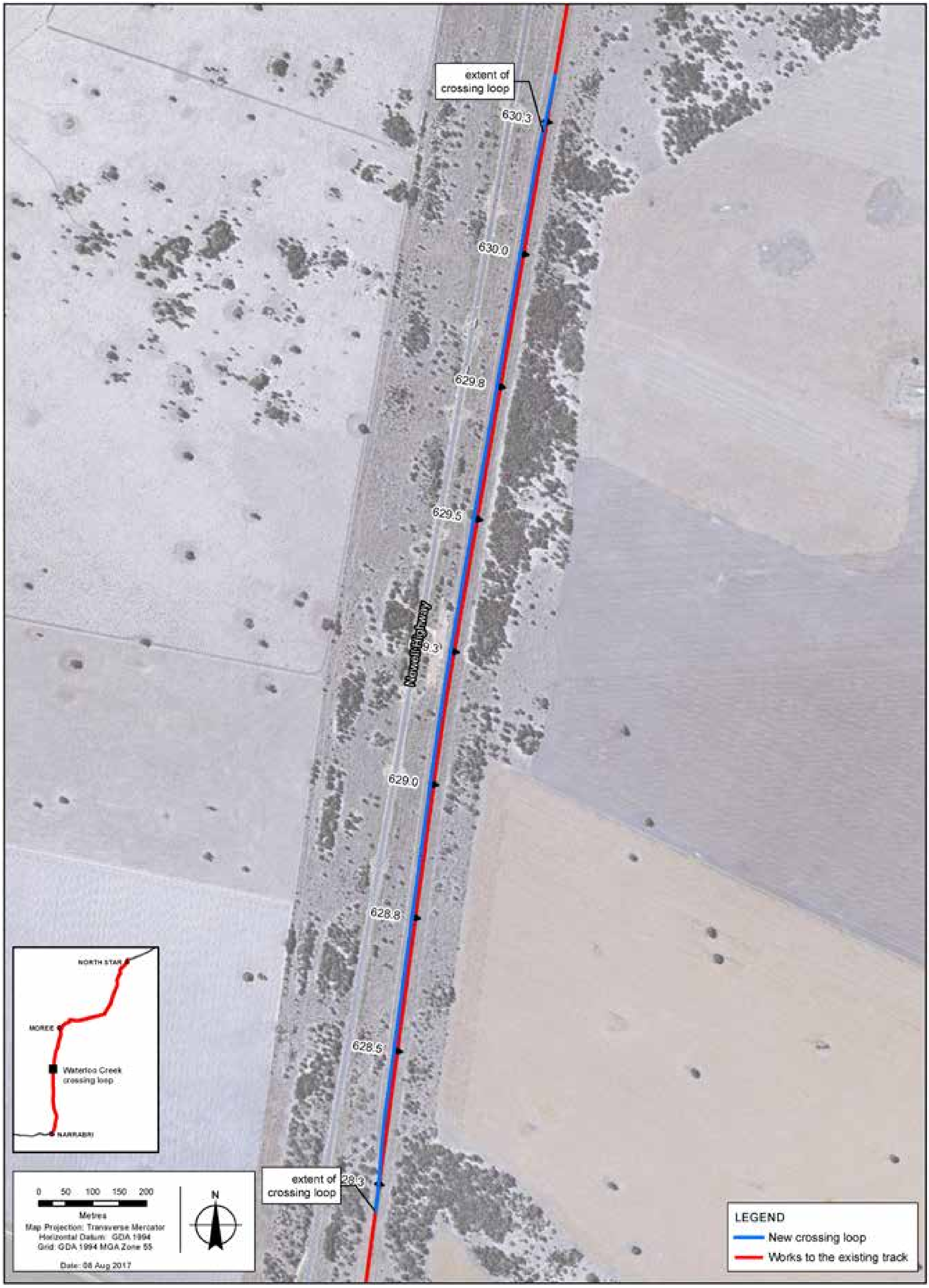


Figure 7.11 Tycannah Creek crossing loop

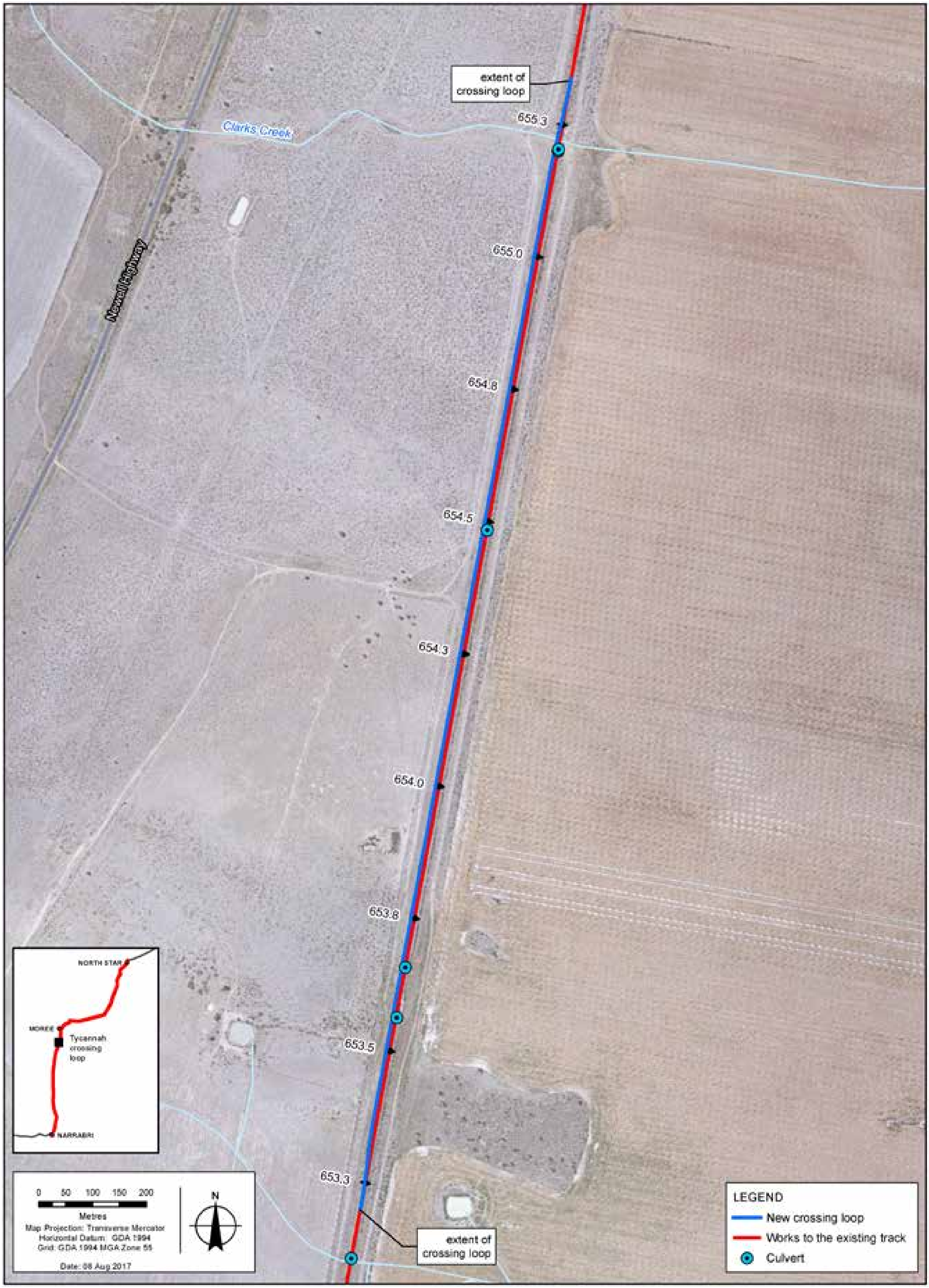


Figure 7.12 Coolleearllee crossing loop

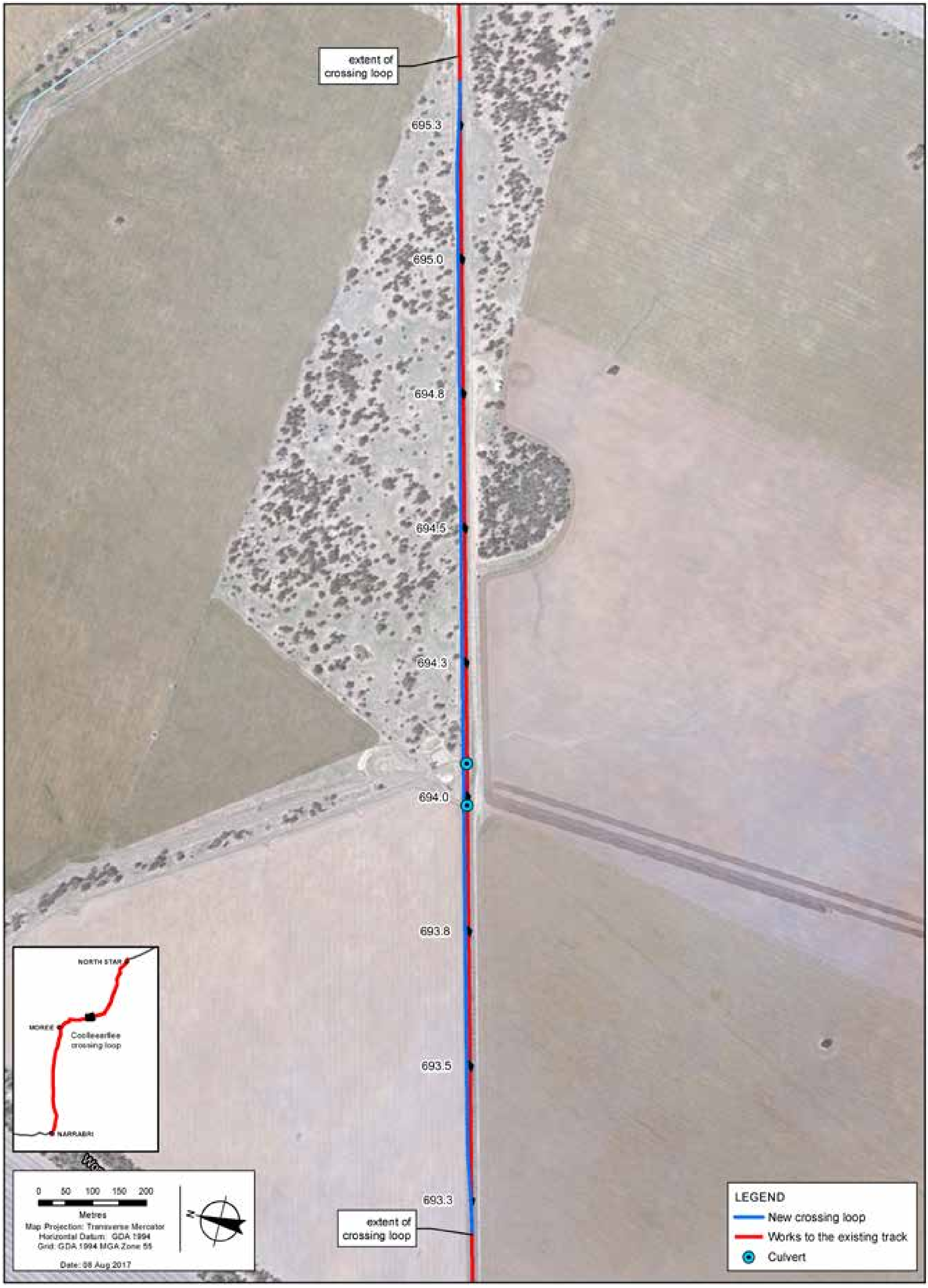
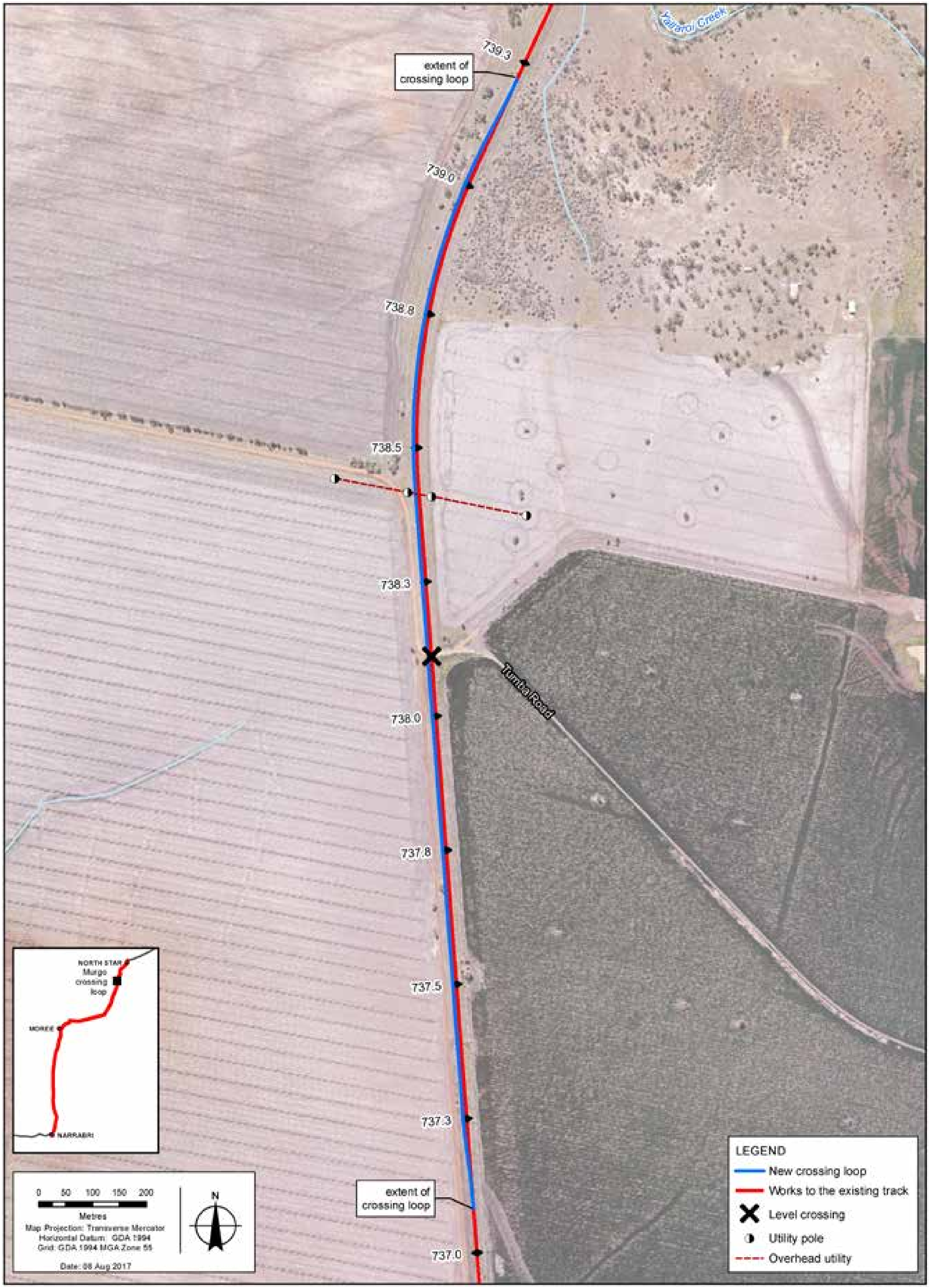


Figure 7.13 Murgo crossing loop



7.2.6 New bridges

New bridges are proposed to replace the existing bridges over Croppa Creek and the Gwydir and Mehi rivers as the existing bridges do not meet Inland Rail requirements. The locations of the existing and replacement bridges are shown in Figure 7.14 to Figure 7.16.

The existing bridges would be removed prior to construction to allow construction of the new bridges on the same alignment. The replacement bridges would consist of a bridge foundation based on bored piles and reinforced concrete blade piers, and 0.7 metres high ballast walls on each side of the structure.

Key features of the replacement bridges include:

- Mehi River bridge:
  - 152 metres long
  - 12 section/span bridge structure
  - height of about 6 metres from the river bed to the top of rail.
- Gwydir River bridge:
  - 126 metres long
  - nine section/span bridge structure
  - height of about 5 metres from the river bed to the top of rail.
- Croppa Creek bridge:
  - 75 metres long
  - three section/span bridge structure
  - height of about 13 metres from the river bed to the top of rail.

7.3 Description of key proposal features outside the existing rail corridor

This section describes those features of the proposal that would be located outside the existing rail corridor.

7.3.1 Newell Highway overbridge

A new road overbridge is proposed to enable the Newell Highway to pass above the rail corridor with sufficient clearance for double stacked Inland Rail trains to pass beneath. The overbridge would consist of about 1.5 kilometres of new two-lane road with a design speed of 100 kilometres per hour and a maximum grade of four per cent, and would include a bridge structure and two tie-ins.

Key features of the overbridge are described below and are shown in Figure 7.17.

Figure 7.14 Mehi River bridge

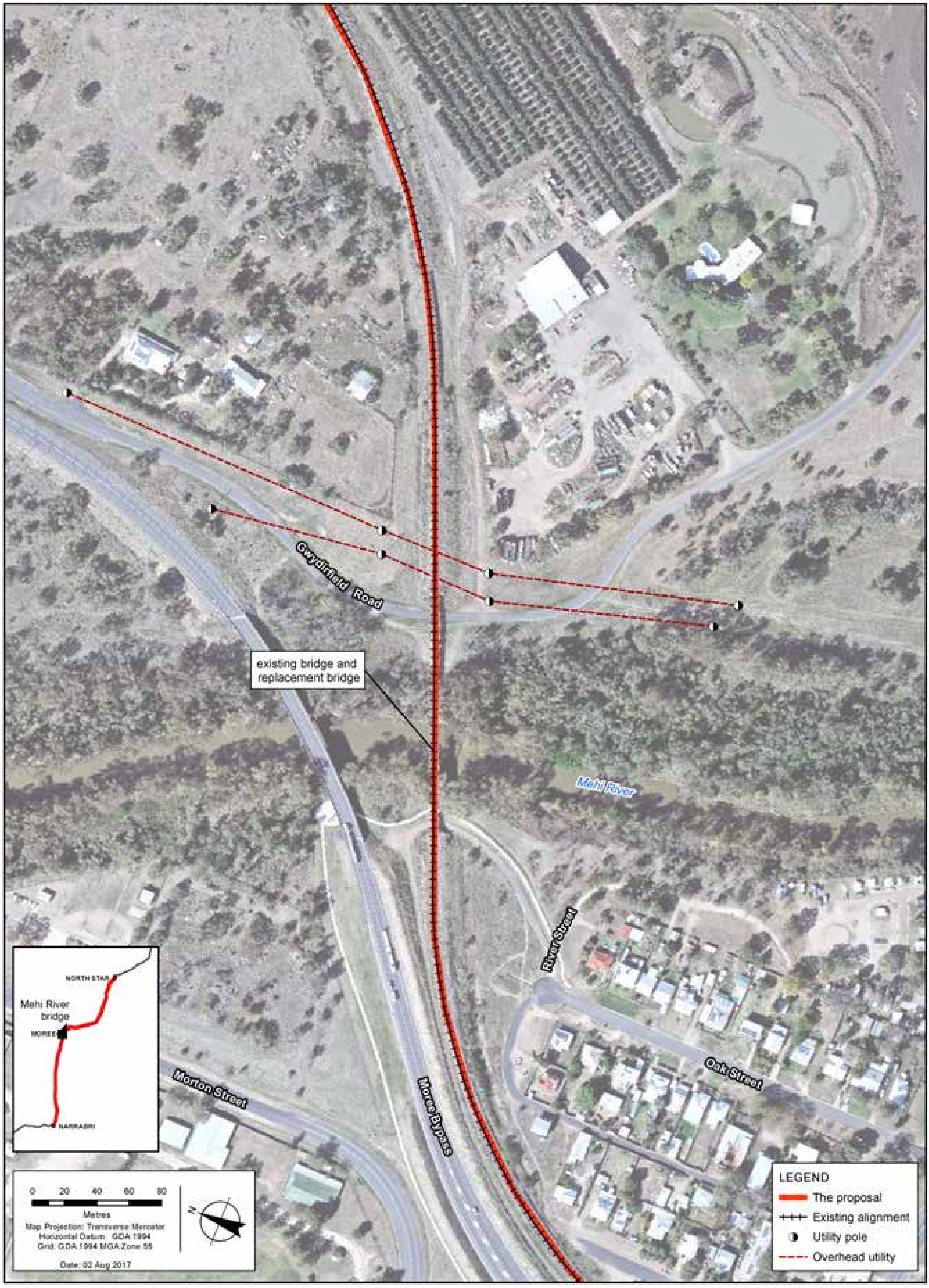


Figure 7.15 Gwydir River bridge

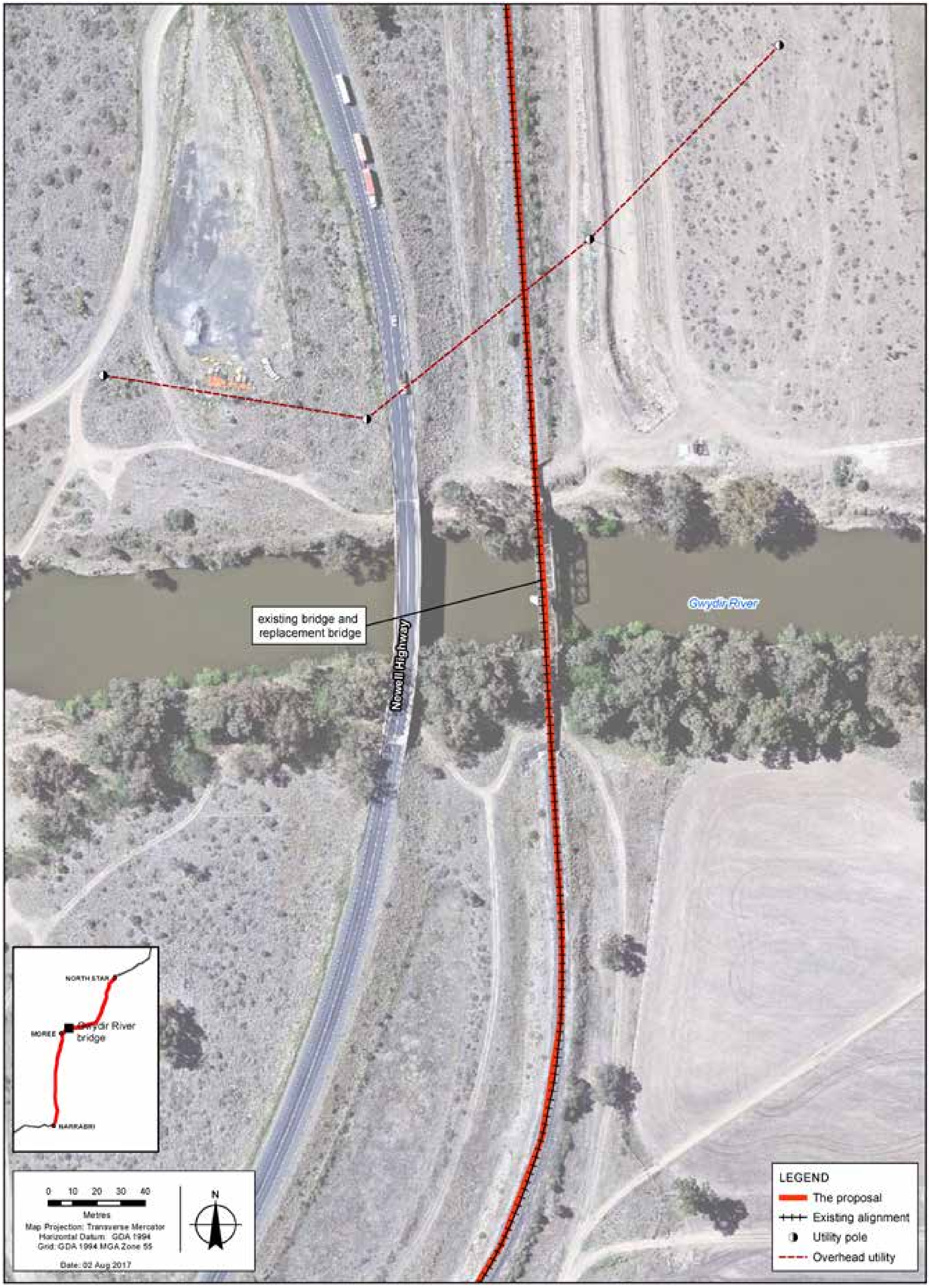


Figure 7.16 Croppa Creek bridge

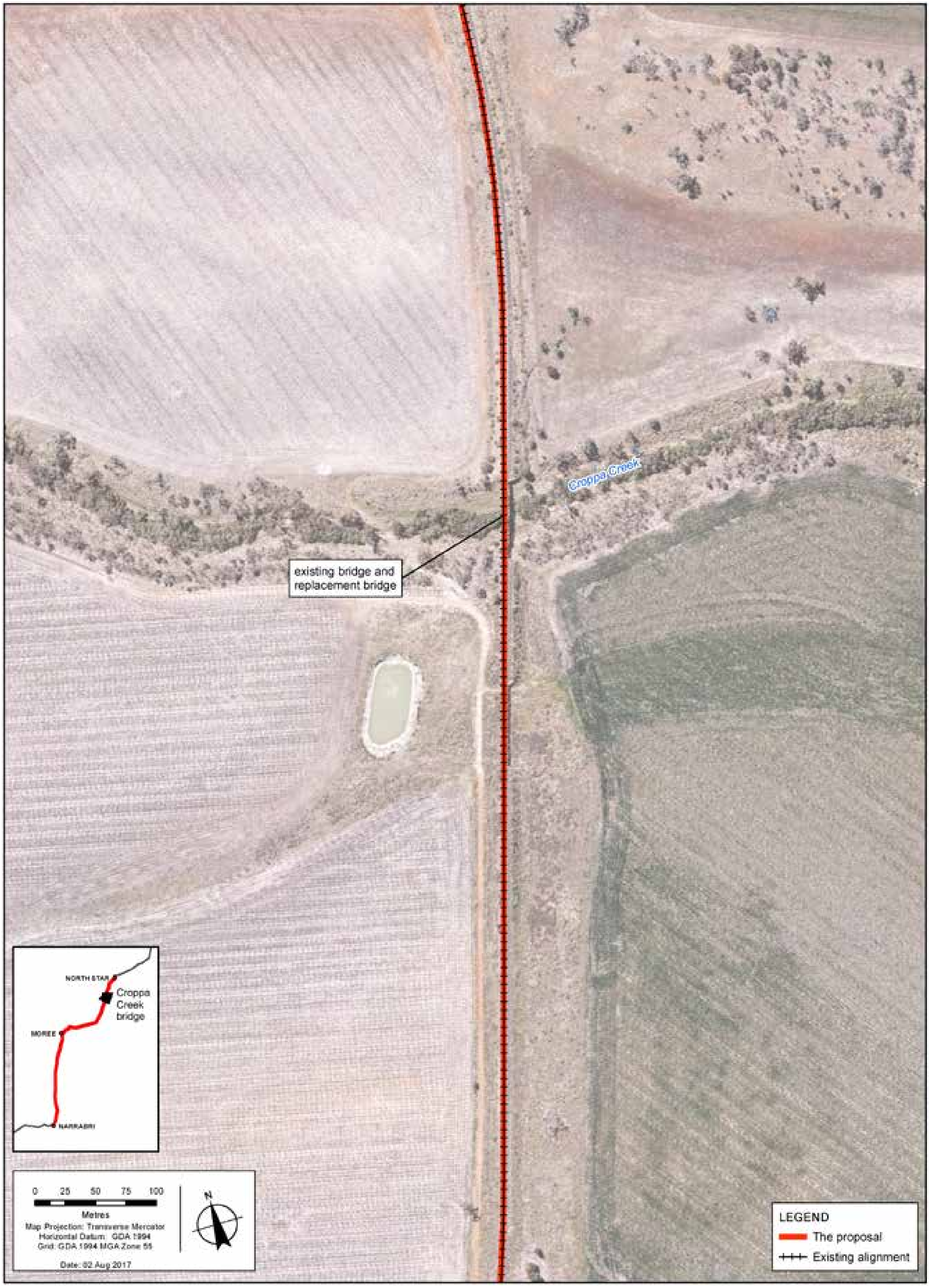
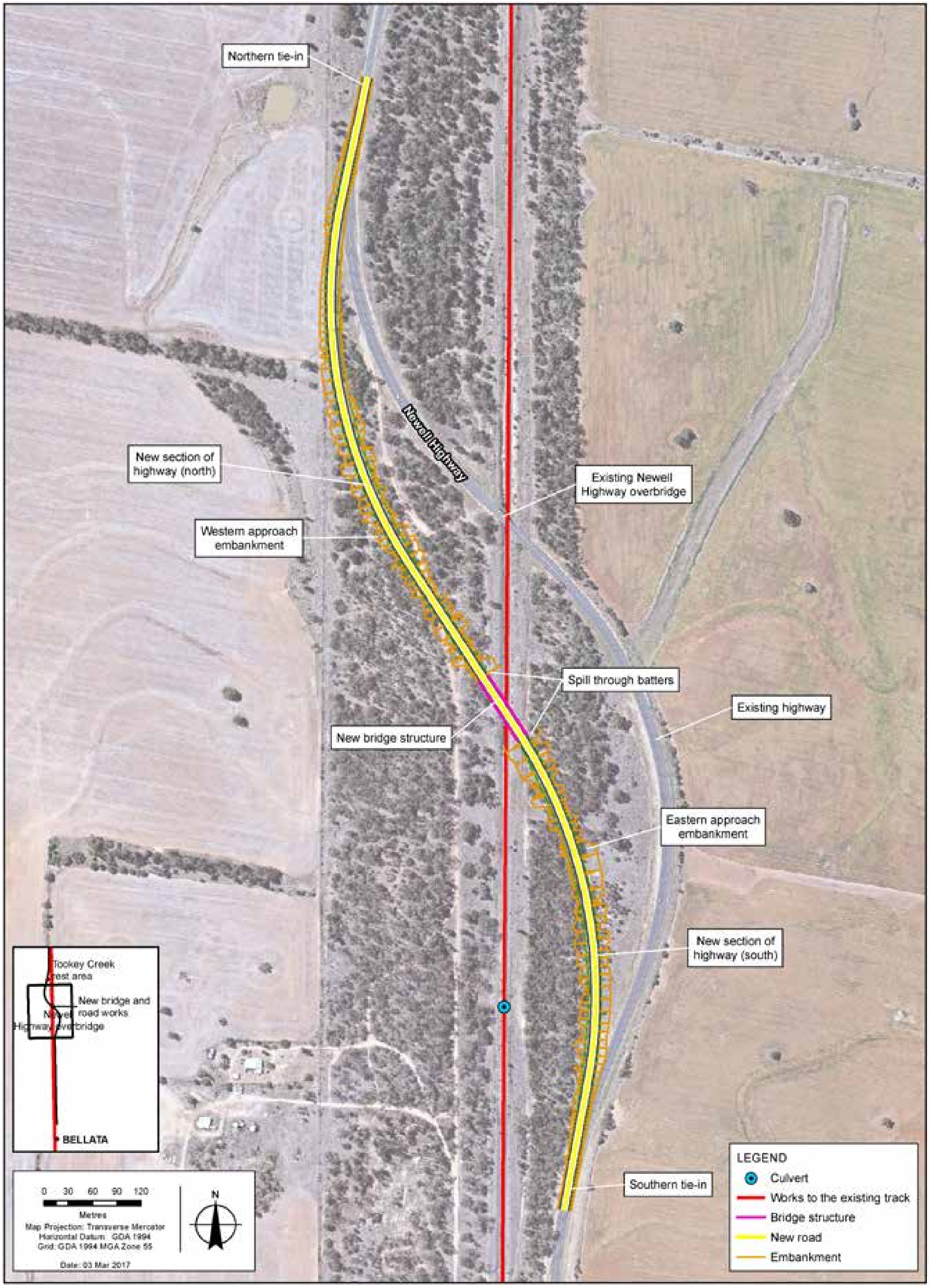


Figure 7.17 Newell Highway overbridge



Bridge structure

The bridge structure would consist of:

- a new 83 metre long three span super T girder bridge structure, supported on cast insitu reinforced concrete piers/abutments, and founded using reinforced concrete bored piles
- road pavement consisting of two lanes with a width of 3.5 metres each, and two shoulders with a width of 2 metres each
- reinforced soil wall abutments with a maximum height of 10 metres
- spill through batters at the eastern and western abutments
- a bridge clearance height of 7 metres.

Tie-ins

New sections of road (known as 'tie-ins') would be constructed at the northern and southern ends of the overbridge to connect the bridge to the existing section of Newell Highway. The tie-ins would be about 600 metres long on the southern side, and about 790 metres long on the northern side. They would include a 350 metre long eastern approach embankment and a 500 metre long western approach embankment. The tie-ins would consist of two lanes with a width of 3.5 metres each, and two shoulders with a width of 2 metres each.

7.3.2 Camurra bypass

A new section of track would be built at Camurra outside of the existing rail corridor to allow trains to bypass the existing hairpin curve (shown in Figure 7.18). The Camurra bypass involves:

- 1.6 kilometres of new track to the east of the existing turn, with an 800 metre radius
- constructing seven culverts
- connections to the existing rail lines to the east and west
- property acquisition, including 50 metres of irrigation channel and a portion of a travelling stock reserve.

7.3.3 Jones Avenue overbridge, Moree

The proposal involves providing a road overbridge and road connections between Jones Avenue to the west of the rail corridor (between Warialda Street and Joyce Avenue), and Tycannah Street to the east of the road corridor (a distance of about 710 metres). The overbridge would enable road traffic to pass over Gosport Street, the Moree Bypass (Newell Highway) and the rail corridor. Truck access to the industrial area south of Jones Avenue would be maintained or appropriate alternative access routes created. The overbridge would consist of about 620 metres of new road with a design speed of 50 kilometres per hour, and would include a bridge structure and two tie-ins.

Key features of the overbridge are described below and are shown in Figure 7.19.

Figure 7.18 Camurra bypass

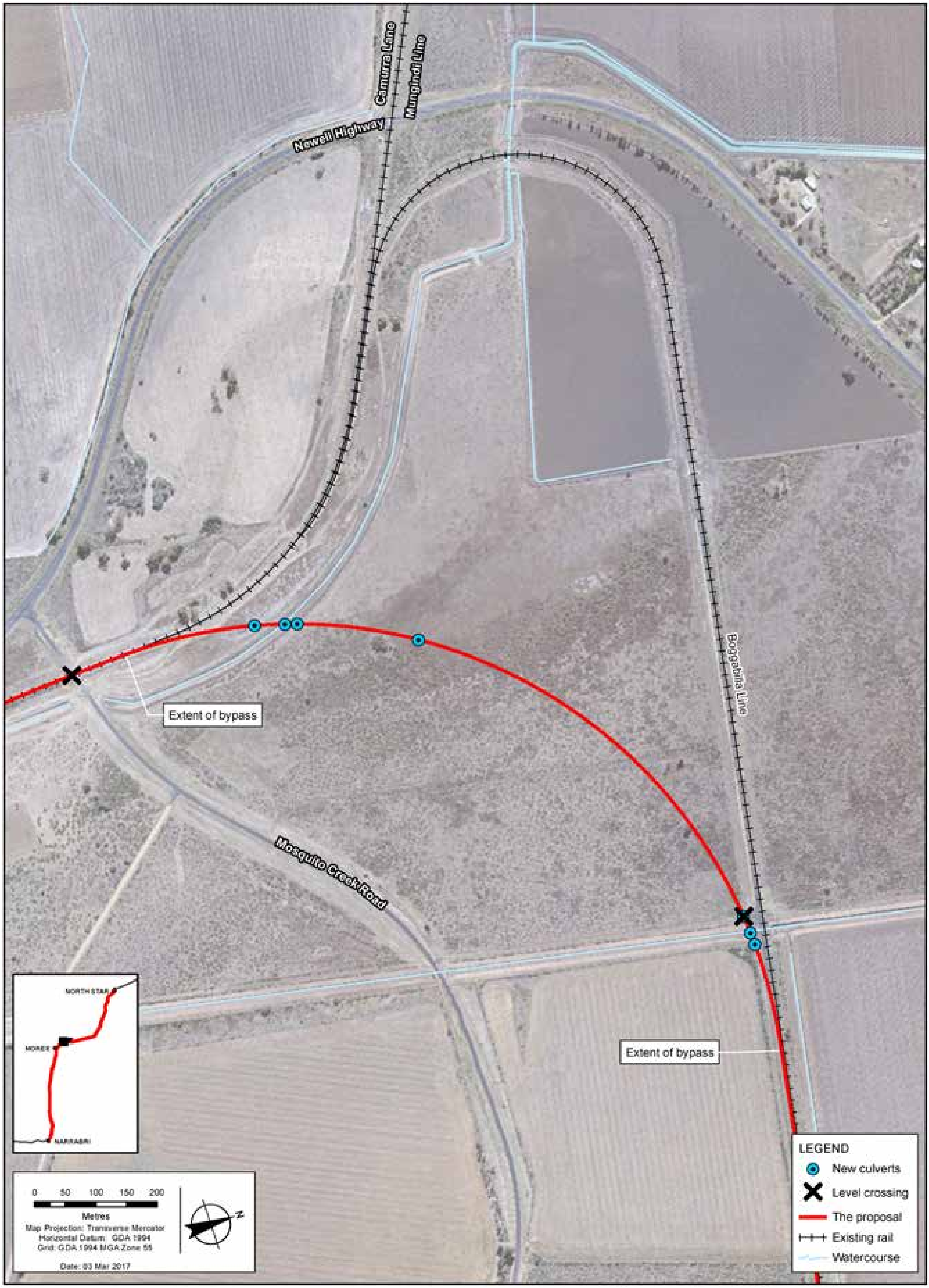
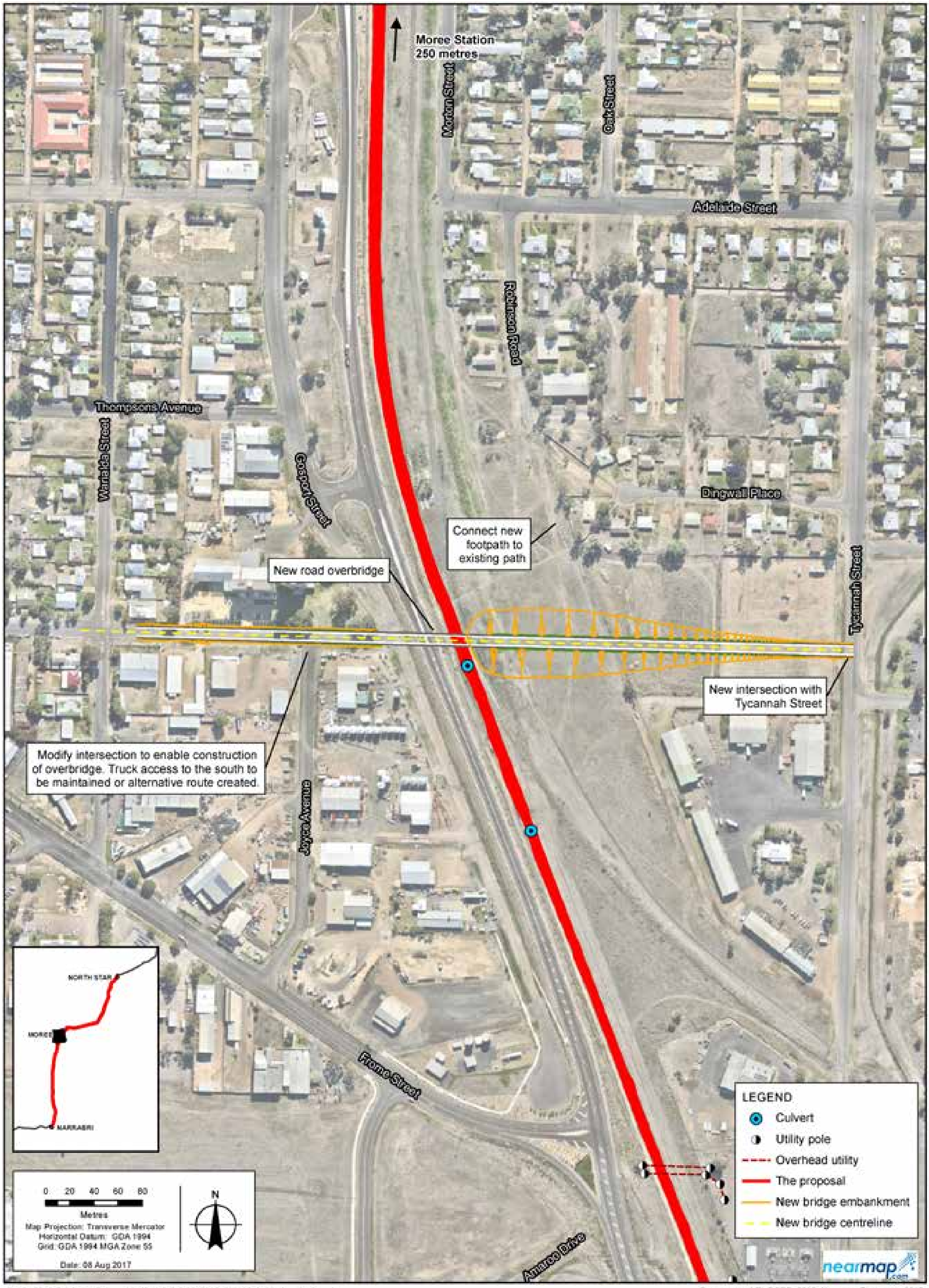


Figure 7.19 Jones Avenue overbridge



Bridge structure

The bridge structure would consist of:

- a new 89.5 metre long three span super T girder bridge structure, supported on cast insitu reinforced concrete piers/abutments, and founded using reinforced concrete bored piles
- road pavement consisting of two lanes with a width of 3.5 metres each, two shoulders with a width of 1.0 metre each and one 1.5 metre wide shared pedestrian/cycle path with kerb separation on the northern side of the bridge
- 10 metre high embankments east and west of the bridge
- throw screens on both sides of the bridge
- bridge clearance of 7.1 metres.

Tie-ins

New sections of road would be constructed at the western end of the overbridge to connect the bridge to the existing section of Jones Avenue and at the eastern end to create a road intersection with Tycannah Street. The tie-ins would be about 200 metres long on the western end and include a retaining wall, and would be about 250 metres long on the eastern side consisting of an approach embankment. The tie-ins would be about 11.7 metres wide, and would consist of two lanes with a width of 3.5 metres each, and two shoulders with a width of 1.0 metre each and one 1.5 metre wide shared pedestrian/cycle path.

Road modifications

Construction of the road overbridge would involve modifications to the intersection of Joyce and Jones avenues (west of the rail corridor). All property access would be maintained along Joyce and Jones avenues.

7.4 Ancillary works and infrastructure

7.4.1 Track drainage

Drainage in the form of a cess drain would be installed within the rail corridor adjacent to the track. Cess drains are surface drains located to the side of the tracks, used to remove water that percolates through the ballast and flows along the capping layer towards the outside of the track formation. Cess drains are used to protect the track formation by keeping it dry.

As the proposal site is relatively flat, cess drains are proposed where the upstream catchment has an area of 5,000 square metres or greater, and is within 25 metres of the rail line.

The cess drains would be positioned towards the outer limit of the rail corridor, with the surrounding earthworks shaped to shed water towards its location.

7.4.2 Spoil mounds

Excess material resulting mainly from the excavation of track formation and cess drains would be stockpiled along the rail corridor. The stockpiles would be located as close as possible to the source of the excavated material and would be formed into permanent spoil mounds, spread out to minimise height. Spoil mounds would be designed to have a maximum height of 2 metres (about one metre above the top of the rails), and in some cases, may need to be located on both sides of the rail track. The mounds would be stabilised as required.

Gaps in the spoil mounds would be provided to allow water to drain away from the formation. The location, sizing and design of the mounds would be determined during the detailed design phase, with consideration given to the results of hydraulic modelling and sight distances. Mounds would not be located in areas where they would impact on flooding or drainage.

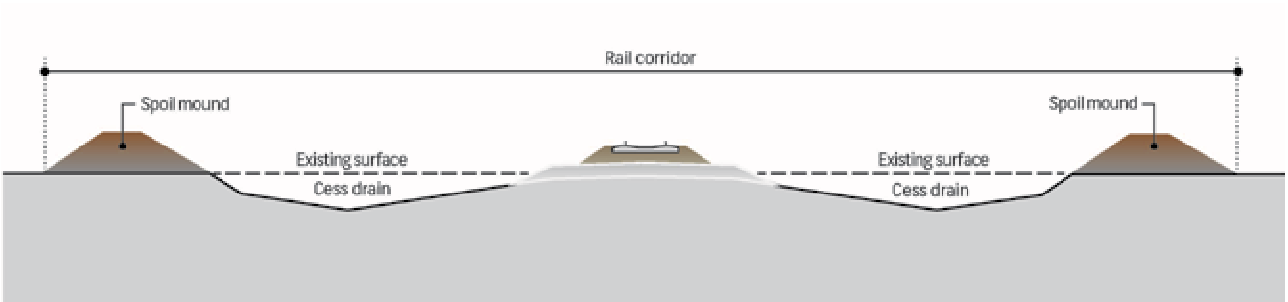
An indicative cross section of the proposal with spoil mounds is shown in Figure 7.20.

7.4.3 Level crossings

Works at the majority of the 86 level crossings along the proposal site are required to ensure crossings meet relevant Australian and ARTC level crossing design standards. The preferred option for level crossings, developed as an outcome of stage 1 of the level crossing strategy, involves a mix of retaining/refurbishing existing crossings, considering the consolidation of some crossings, upgrading the level of control, or installing a gated crossing.

ARTC is currently undertaking stage 2 of the level crossing strategy, which involves consulting with relevant stakeholders (including landowners and road owners) to confirm the preferred approach, and finalising the designs for the works at each crossing.

Figure 7.20 Indicative spoil mound cross-section



Where an existing access to or within a property is proposed to be removed, altered or severed, additional works to reinstate access to the property would be undertaken. This may require works outside the rail corridor.

Further information on the level crossing strategy is provided in Section 6.3.4.

Upgrading signalling and communications

Signalling and communications would be upgraded as part of the level crossing works, to enable any level crossings with active controls to tie into the rail network.

ARTC's Advanced Train Management System (ATMS) would be implemented to manage signalling and communications for the wider rail network. ATMS is a communication based train management system, which communicates via both voice and data between Network Control Centres and locomotives operating on ARTC's rail network.

7.4.4 New fencing

Existing fencing along the rail corridor would be replaced as required. Where the corridor abuts a public road, fencing would be installed on the field side only. The fencing would consist of a standard stock fence (1.2 metres high).

Along sections of the rail line in Moree noise attenuation structures would be constructed instead of fencing. Preliminary noise treatment locations have been identified utilising noise modelling and the location of sensitive receivers relative to the rail line. Key locations include near Moree Station and the proposed Jones Avenue overbridge. The location of the noise attenuation structures would be confirmed during detailed design but generally they would be located towards the outer edge of the rail corridor to improve the effectiveness of the attenuation structures.

7.4.5 Signage

Signage would be provided/replaced where required.

7.5 Land acquisition

The existing rail corridor is owned by the NSW Government (Transport for NSW). The majority of the proposal would be undertaken within the existing rail corridor or on land for which ARTC has existing access agreements.

A limited amount of property acquisition would be required, as summarised in Appendix G. The extent of property impacts would be refined and confirmed during detailed design in consultation with property owners. For partial acquisitions, property adjustment plans would be developed in consultation with the property owner.

Leasing requirements are unknown at this stage. Consultation regarding agreements would be undertaken with landowners prior to works commencing.

All acquisitions would be undertaken in accordance with the requirements of the *Land Acquisition (Just Terms) Compensation Act 1991.*

7.6 Operation of the proposal

7.6.1 Train operations

The proposal would form part of the rail network managed and maintained by ARTC. Train services would be provided by a variety of operators. The existing operation of the Mungindi line (described in Section 2.5.2) would continue prior to, during, and following construction of the proposal. Inland Rail as a whole would be operational once all 13 sections are complete, which is estimated to be in 2025.

Inland Rail would involve operation of a single rail track with crossing loops, to accommodate double stacked freight trains up to 1.8 kilometres long and 6.5 metres high. Train speeds would vary according to axle loads, and range from 80 to 115 kilometres per hour, except through Moree where the maximum train speed would be 65 kilometres per hour due to track geometry.

It is estimated that the operation of Inland Rail would involve an annual average of about 10 trains per day travelling north of Moree (between North Star and Moree) and 12 trains per day travelling south of Moree (between Moree and Narrabri) in 2025. This would increase to about 19 trains per day north of Moree (between North Star and Moree) and 21 trains per day south of Moree (between Moree and Narrabri) in 2040. This rail traffic would be in addition to the existing rail traffic using the Narrabri to North Star line.

The Inland Rail trains would be a mix of grain, bulk freight, and other general transport trains. Total annual freight tonnages would be about 11.8 million tonnes in 2025, increasing to about 19 million tonnes in 2040 (from the existing two million tonnes of grain per year).

The Xplorer passenger train would continue to stop at Moree and Bellata stations. Train stop locations for Inland Rail trains would be confirmed during detailed design.

7.6.2 Maintenance activities

Standard ARTC maintenance activities would be undertaken during operations. Typically, these activities include minor maintenance works, such as bridge and culvert inspections, rail grinding and track tamping, through to major maintenance, such as reconditioning of track and topping up of ballast as required.

8. Construction of the proposal

This chapter provides an outline of the indicative construction activities likely to be used to construct the proposal. It includes a summary of the proposed timing, an indicative construction methodology, likely resources, and proposed access arrangements. This information is preliminary only, and is based on the current stage of the design. The construction methodology would be refined as the design of the proposal progresses, and once the construction contractor is engaged.

8.1 Overview of construction scope and approach

Construction of the proposal would commence once all necessary approvals are obtained, and the detailed design is complete. It is anticipated that construction would take about 24 months, commencing in mid-2018, and concluding in mid-2020.

The construction methodology, sequencing and durations would be confirmed once a possession strategy has been agreed with affected train operators, track stakeholders and relevant government departments. The possession strategy would define the times that rail traffic would not be permitted to operate along the existing rail corridor. An indicative possession strategy and approach to rail traffic management during construction is provided in Table 8.1.

Construction along the existing rail corridor would depend on the possession strategy however, it is anticipated that works would commence north of Moree, then move north of Narrabri in stages, as follows:

- stage 1 – Camurra to North Star
- stage 2 – Narrabri to Bellata
- stage 3 – Bellata to Moree South
- stage 4 – Moree South to Camurra.

Construction of the Newell Highway overbridge, the Camurra bypass, and the Jones Avenue overbridge would be undertaken in parallel with the above stages.

For each stage, the timing of construction along the existing rail corridor would depend on the possession strategy. Further information on working hours is provided in Section 8.3.

8.1.1 Approach to avoiding or minimising impacts during construction

Mitigation and management measures applicable to the design, pre-construction and construction stages would be implemented to avoid or minimise the construction impacts described in Chapters 9 to 26. Mitigation measures are provided in each chapter in Part C, and are summarised in Chapter 27. The measures include preparing and implementing a construction environmental management plan (CEMP) including detailed sub-plans.

The CEMP would be prepared for the construction phase of the proposal by the responsible construction contractor. The CEMP would provide a centralised strategy through which all potential environmental impacts would be managed during construction, and would include detailed management measures to avoid or minimise potential impacts. The requirements for the CEMP are described in Chapter 27. An outline of the CEMP, including the required sub-plans, is provided in Appendix K.

8.2 Indicative construction methodology

For each stage, construction would typically involve:

- site establishment (described in Section 8.2.1)
- main construction works (described in Sections 8.2.2 to 8.2.8)
- testing and commissioning (described in Section 8.2.9)
- finishing works (described in Section 8.2.10).

The construction methodology would be further developed and confirmed during detailed design.

8.2.1 Site establishment

Site establishment would generally involve:

- consult landowners/occupants where required
- install site environment management and traffic controls in accordance with the CEMP
- establish site compounds and facilities
- clear vegetation
- erect temporary fencing
- establish site access roads where required
- utility relocations as required
- deliver and stockpile materials including rail, sleepers, ballast, culverts and structural fill.

8.2.2 Track works

Track upgrading

A general methodology for the main proposed forms of track upgrading is provided below:

- Track reconstruction:
  - remove fastenings, rail and sleepers and stockpile to one side of the rail corridor
  - excavate the existing ballast and earth formation
  - place new earth and recycled ballast into the excavated area and compact
  - place new ballast on top of the earth formation and compact
  - place concrete sleepers and rail tracks on prepared ballast bed and weld up rails
  - place new ballast on top of the sleepers
  - tamp and profile the ballast around the sleepers and line to a smooth alignment.
- Skim reconditioning:
  - remove fastenings, rail and sleepers and stockpile to one side of the rail corridor
  - trim and level the existing ballast bed and compact
  - place concrete sleepers and rail track on prepared ballast bed and weld up rails
  - place new ballast on top of the sleepers
  - tamp and profile the ballast around the sleepers and line to a smooth alignment.
- Skim plus reconditioning:
  - remove fastenings, rail and sleepers and stockpile to one side of the rail corridor
  - trim and level the existing ballast bed and compact
  - place new capping material on top of compacted ballast
  - place concrete sleepers and rail track on prepared ballast bed and weld up rails
  - place new ballast on top of the sleepers
  - tamp and profile the ballast around the sleepers and line to a smooth alignment.

Track realignment works

Track realignment works at Bellata, Gurley, and Moree stations would involve:

- excavate and remove existing track and formation
- construct new track as described above
- weld and adjust track to interface back into existing track alignment.

In addition, the eastern side of the platform at Moree Station may need to be upgraded to allow passengers to join or alight from the Xplorer passenger service. This would be confirmed during detailed design.

Culverts/underbridges

Where required, culverts and underbridges would be removed and replaced as described below. Culvert and underbridge replacement would be undertaken online (the structure would be replaced in the same location). Culverts would be pre-cast off-site, and installed along the proposal site as the track upgrading works progress.

Culvert replacement

- remove existing culvert structure (either concrete or steel pipes)
- excavate to the required depth
- place and compact bedding material
- place pre-fabricated culvert structures on the new formation area and fasten together
- place ballast, sleepers and rail on top of the culverts and tamp and profile the ballast under and around the sleepers and weld up tracks.

Underbridge replacement

- install substructure components including bored/ precast concrete/ steel piles beneath the existing structure
- during a track possession remove existing superstructure (including girders) and substructure components (abutments and piers) and store at nominated locations within the rail corridor
- install any new substructure precast concrete components on the new substructure/ piles
- place new girders (concrete) on the new concrete substructures
- place ballast, sleepers and rail on top of the new bridge and tamp and profile the ballast under and around the sleepers and weld up tracks
- install guard rails as required.

Crossing loops

The general methodology for constructing crossing loops is as follows:

- excavate beside the existing track for the length of the crossing loop
- place and compact formation material
- place ballast, sleepers and rail tracks on top of the new formation
- install signal equipment and associated equipment
- testing and commissioning.

Turnouts

The general methodology for constructing turnouts is as follows:

- cut existing track, remove and dispose of existing turnout (at existing sidings only)
- undertake formation improvement works as required
- install ballast, sleepers and rails
- install control mechanisms (points motor, power supply etc)
- testing and commissioning.

Drainage

The general methodology for drainage construction is as follows:

- prepare survey control points for planned excavation of cess drains
- excavate earth material from the side of the existing track formation, and trim and compact base and sides of the drain
- form spoil mounds.

8.2.3 Level crossings

The general methodology for level crossings is as follows:

- Upgrading controls:
  - remove existing controls, excavate to a suitable depth as required, place new formation material and ballast, replace track and surface panel as required
  - install new controls
  - provide standard road signs and road markings.
- Consolidating level crossings:
  - complete road works and appropriate road signage to redirect traffic
  - remove level crossing signs and road markings
  - upgrade tracks as described in Section 8.2.2.

The pedestrian level crossing at Moree Station would be upgraded as follows:

- remove existing pedestrian crossing
- construct pedestrian footpath and pedestrian maze
- install relevant track circuitry for active crossing control
- line marking and installation of signage.

8.2.4 New bridges

Construction of the new bridges over the Mehi and Gwydir rivers and Croppa Creek would generally involve the following:

- install substructure components including bored/ precast concrete/ steel piles alongside the existing bridge
- install any new substructure precast concrete components on the new substructure/ piles
- remove existing bridge superstructure and demolish the existing visible substructure (piers only) as far as required
- place new girders (concrete) on the new concrete substructures
- construct new earth formation to connect between the existing track alignment and the new bridge alignment
- place ballast, sleepers and rail on top of the new bridge and tamp and profile the ballast under and around the sleepers and weld up tracks
- install guard rails as required.

Demolition of the existing bridges over the Mehi and Gwydir rivers and Croppa Creek would generally involve the following:

- establish a crane pad for an appropriately sized crane (probably at least one on each side of the river bank)
- demolish the steel superstructure (lifting sections onto trucks to be reused elsewhere on ARTC network or disposed of at nearby recycling facility)
- demolish the visible existing brick or concrete piers
- dispose of waste material off-site.

8.2.5 Newell Highway overbridge construction

Construction of the Newell Highway overbridge would generally involve the following:

Bridge works

- construct cast-in-place piles at abutments and piers
- construct spill through abutments, column extensions and pier headstocks
- install pre-stressed concrete girders and construct reinforced concrete deck
- construct reinforced concrete approach slabs
- install expansion joints and steel traffic barrier railing
- install waterproof membrane and asphalt.

Embankment and pavement works

- place bulk general fill to construct approach embankments
- if identified as necessary during detailed design, install a culvert suitable for the travelling stock route
- construct new pavement, including placing and compacting select fill, sub base and asphalt wearing surface
- tie into the existing Newell Highway.

Finishing and landscaping

- rehabilitate disturbed areas and landscape in accordance with the rehabilitation strategy
- line marking and sign posting
- final site clean-up
- switch traffic
- demolish the existing bridge.

8.2.6 Camurra bypass

Construction of the Camurra bypass would involve the following:

- excavate to a depth determined by geotechnical investigations and design
- place imported formation material into the excavated area and compact using vibratory compaction rollers
- place bottom ballast
- place skeletonised track consisting of fastenings, rail and sleepers on bottom ballast
- place ballast on top of the track
- tamp and profile the ballast around the sleepers and line to the design's vertical and horizontal alignment
- construct cess drainage as described in Section 8.2.2
- construct tie-ins to the existing alignment and install turnouts.

8.2.7 Jones Avenue overbridge construction

Construction of the Jones Avenue overbridge would generally involve the following:

Bridge works

- construct cast-in-place piles at abutments and piers
- construct spill through abutment on eastern side and reinforced soil wall abutment on western side
- construct column extensions and pier headstocks
- install girders and construct reinforced concrete deck
- install pedestrian footpath
- construct reinforced concrete approach slabs
- install throw screens
- install expansion joints and steel traffic barrier railing
- install waterproof membrane and asphalt.

Embankment and pavement works

- place bulk general fill to construct approach embankments
- construct new pavement, including placing and compacting select fill, sub base and asphalt wearing surface
- construct pedestrian walkway down the side of the embankments to be *Disability Discrimination Act 1992* compliant
- tie into existing Jones Avenue.

Finishing and landscaping

- rehabilitate disturbed areas and landscape in accordance with the rehabilitation plan
- line marking and sign posting
- modify existing Joyce Avenue intersection with Jones Avenue
- relocate property accesses for affected properties
- final site clean-up.

8.2.8 Earthworks

Earthworks would be required:

- where upgrades to the formation are required
- to widen existing embankments and cuttings to meet design requirements
- to construct the new crossing loops
- to construct the Newell Highway and Jones Avenue overbridges and Mehi River, Gwydir River and Croppa Creek bridges
- to construct the Camurra bypass
- to construct culverts and underbridges.

Minor earthworks would also be required to construct the ancillary infrastructure and undertake the ancillary works associated with the proposal.

8.2.9 Testing and commissioning

Testing and commissioning (checking) of the rail line and communication/signalling systems would be undertaken to ensure that all systems and infrastructure are designed, installed, and operating according to ARTC's operational requirements.

8.2.10 Finishing works/ reinstatement

All construction sites, compounds and access routes would be returned to the same or better condition than prior to construction commencing.
Site reinstatement and rehabilitation would be undertaken progressively during the works and would include the following activities:

- demobilise site compounds and facilities
- remove all materials, waste and redundant structures from the works sites
- forming, and stabilising of spoil mounds
- decommission all temporary work site signs
- remove temporary fencing
- establish permanent fencing
- decommission site access roads that are no longer required
- restoration of disturbed areas as required, including revegetation where required.

Site rehabilitation would be undertaken in accordance with the rehabilitation strategy; the requirements of which would be incorporated into the CEMP (described in Chapter 27).

8.3 Timing, staging and working hours

8.3.1 Timing and staging

An indicative construction program is shown in Figure 8.1. As described in Section 8.1, construction along the existing rail corridor would be undertaken in four stages, subject to agreement with relevant stakeholders. The stages are shown in Table 8.1. For each stage, rail traffic would be interrupted as described in Table 8.1.

Construction of the key features outside the existing rail corridor would be undertaken as follows:

- Newell Highway overbridge – offline construction would be undertaken in parallel with stages 1 to 4 would take about 10 months to complete.
- Offline construction of the Jones Avenue overbridge and the Camurra bypass, would be undertaken in parallel with stages 1 to 4, and would take about six to eight months each to complete.

For the works along the existing rail corridor, it is anticipated that it would take about eight to 10 weeks to construct a 4.5 to 5 kilometre section of track. This does not include location specific works such as culverts and underbridges or the relocation of services and utilities.

Figure 8.1 Indicative construction program

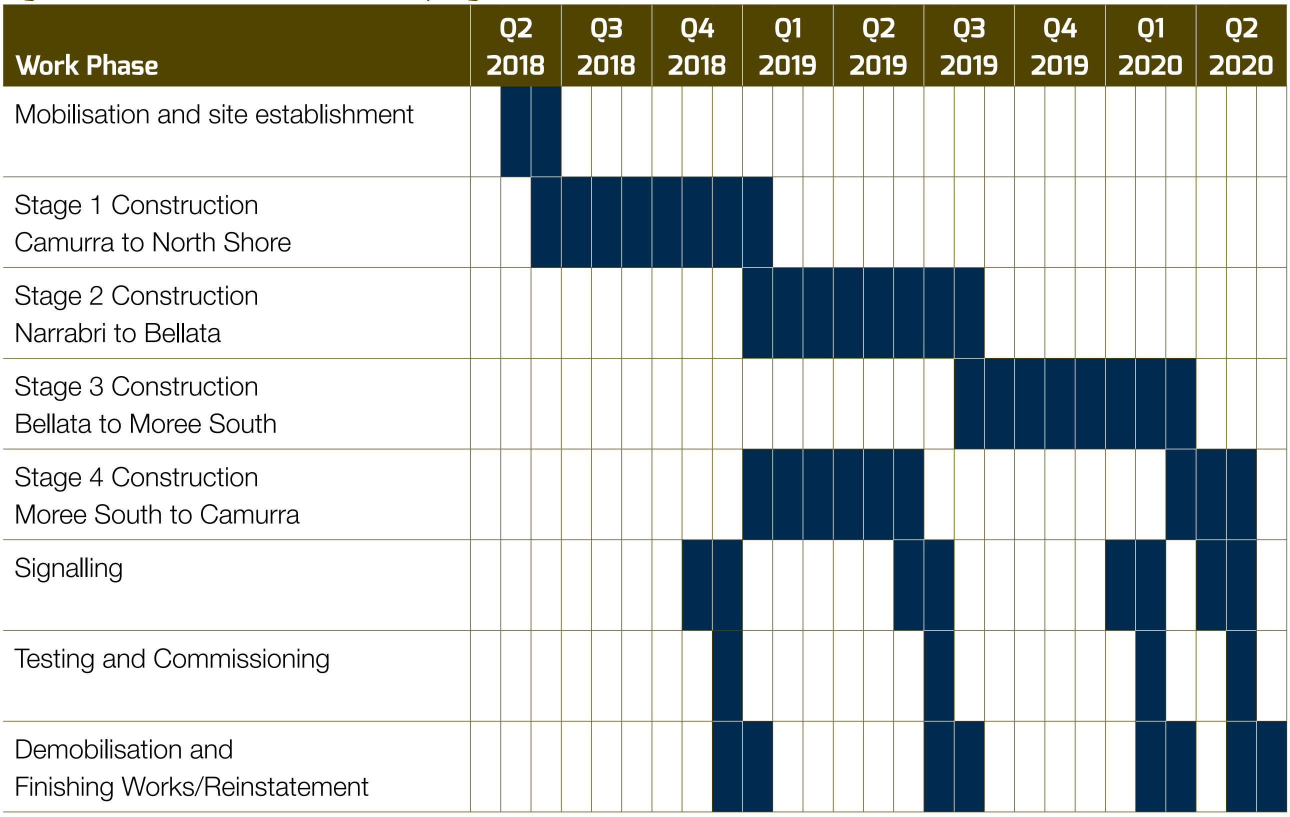


Table 8.1 Rail traffic management during construction

Stage	Location	Distance (km)	Rail traffic	Possession descriptions
1 – Camurra to North Star	Located at the northern end of the proposal site (described in Section 2.2) and stopping about 15 km north of Moree.	81	Between Camurra and North Star the existing line is closed, requiring a seven day advanced notice, and is only used periodically for grain trains. Full closure possessions are proposed for construction of this stage, where road haulage or grain storage solutions may replace rail traffic.	Full closure possession means the railway would be closed for construction for periods longer than 16 days. The timing and duration of the possessions would be agreed with affected train operators, track stakeholders, and relevant government departments.
2 – Narrabri to Bellata	Located between Narrabri and including the Bellata grain siding at the southern end of the proposal site (described in Section 2.2).	52	Roster possessions are proposed, where grain would be stockpiled or road haulage would replace rail traffic during possessions. Passenger rail would be replaced by bus services.	Roster possessions means that, in a 21 day period, the railway would be closed for construction for 16 days, and open for rail traffic for 5 days. The timing and duration of the possessions would be agreed with affected train operators, track stakeholders, and relevant government departments.
3 – Bellata to Moree South	Located between Bellata and Moree South including the Inverell spur line in the middle of the proposal site (described in Section 2.2).	35	Roster possessions are proposed, where grain would be stockpiled or road haulage would replace rail traffic during possessions. Passenger rail would be replaced by bus services.	As above
4 – Moree South to Camurra	Located at Moree and including the Camurra bypass about 10 km north of Moree (described in Section 2.2).	20	Roster possessions are proposed, where grain would be stockpiled or road haulage would replace rail traffic during possessions.	As above

8.3.2 Working hours

Construction working hours

Construction work would be undertaken during the following primary proposal construction hours:

- Monday to Friday: 6:00 am to 6:00 pm
- Saturday: 6:00 am to 6:00 pm
- Sundays and public holidays: 6:00 am to 6:00 pm.

Works would also be undertaken during 24 hour possessions, where required. Work undertaken outside of the *Rail Infrastructure Noise Guideline* (NSW EPA, 2013) standard hours would be in accordance with the Inland Rail NSW Construction Noise and Vibration Management Framework.

Work during possessions

Some works may also be undertaken during scheduled rail corridor possession periods. This could include, for example, the connection of the tracks at either end of each stage, and some finishing works. During possessions, works may need to be undertaken on a 24 hour basis.

8.4 Construction compounds

Two types of compound areas are proposed; minor compound/storage areas and larger compound sites.

Minor compounds/storage areas are areas that would be used for the assembly of adjacent infrastructure such as culverts and turnouts. These compounds would be located within the rail corridor.

Larger compound sites would be established for general construction activities associated with each stage of work. For the purposes of the EIS, it is assumed that temporary compounds would be sited outside the existing rail corridor every 4.5 to 5 kilometres (one for each work area described in Section 8.3.1). Indicative compound locations are shown in Figure 8.2.

Each larger compound site would contain:

- stockpiles
- track infrastructure laydown area
- bunded refuelling area
- fencing as required
- office area including parking, offices and ablutions
- mobile plant and equipment
- hazardous material storage.

The design of the proposal has been developed so that infrastructure would either be constructed in place (for example, welding of track) or prefabricated structures would be used (for example, culverts). Therefore, activities undertaken at compound sites would include the following:

- site office operations
- delivery and stockpiling of various construction materials including rail, sleepers, ballast, culverts and structural fill
- movement of plant and equipment
- maintenance of site environmental management controls
- operation of mobile concrete batching plants (where present).

Not all of the above activities would be undertaken at every compound site.

The location of compounds would be determined based on the following criteria:

- at least 50 metres from watercourses and outside the five per cent AEP flood zone
- where no or only minor clearing would be required, and not within areas identified as threatened communities or species habitat
- no significant impacts to utilities, primarily gas and electricity
- at least 1.0 kilometre from the nearest residence or other noise sensitive receiver where possible
- not on or near sites with known Aboriginal or non-Aboriginal heritage value
- minimise use of private land
- where safe access to the road network and rail corridor can be provided
- relatively flat land.

Figure 8.2a Construction work areas

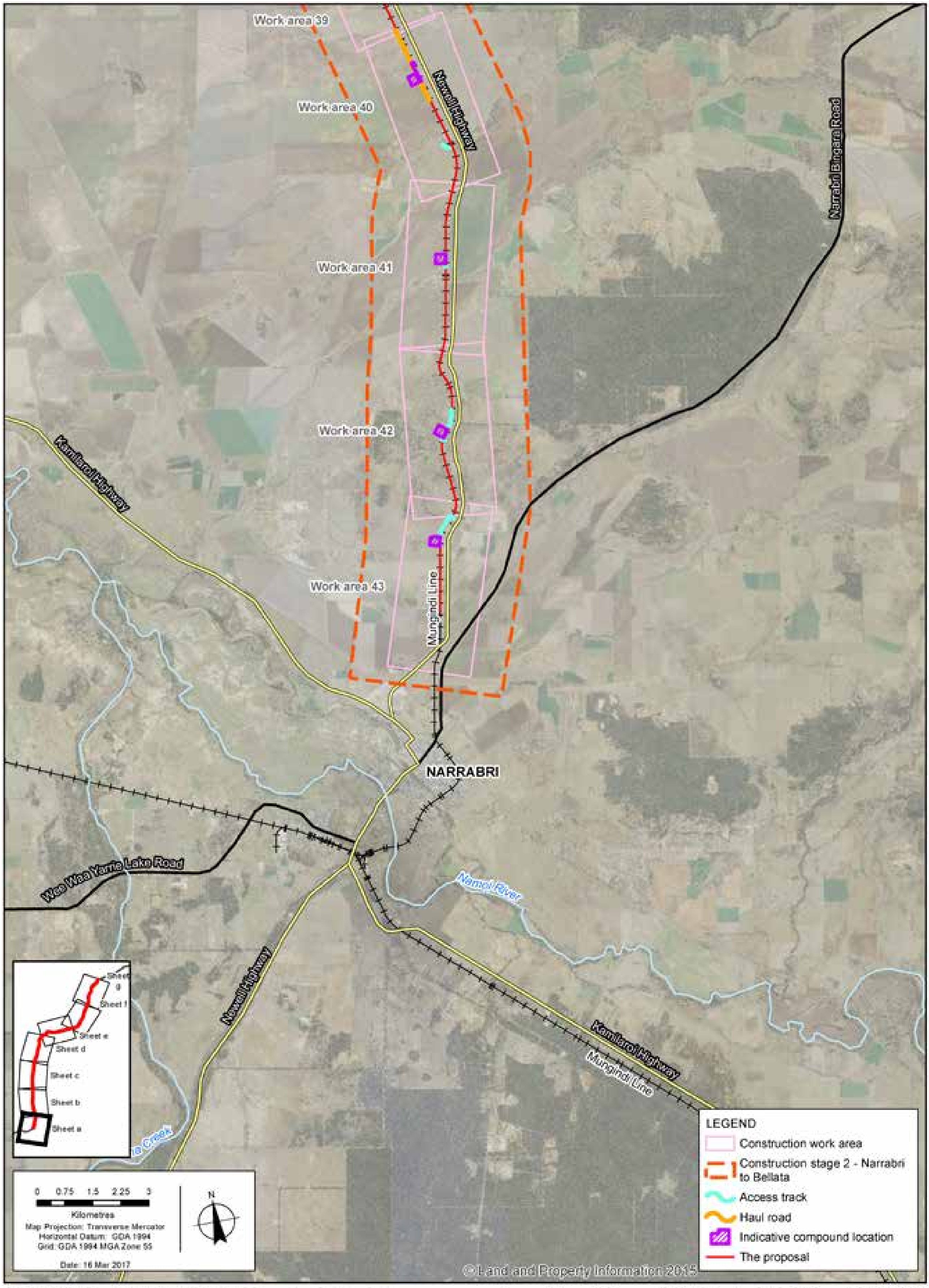


Figure 8.2b Construction work areas

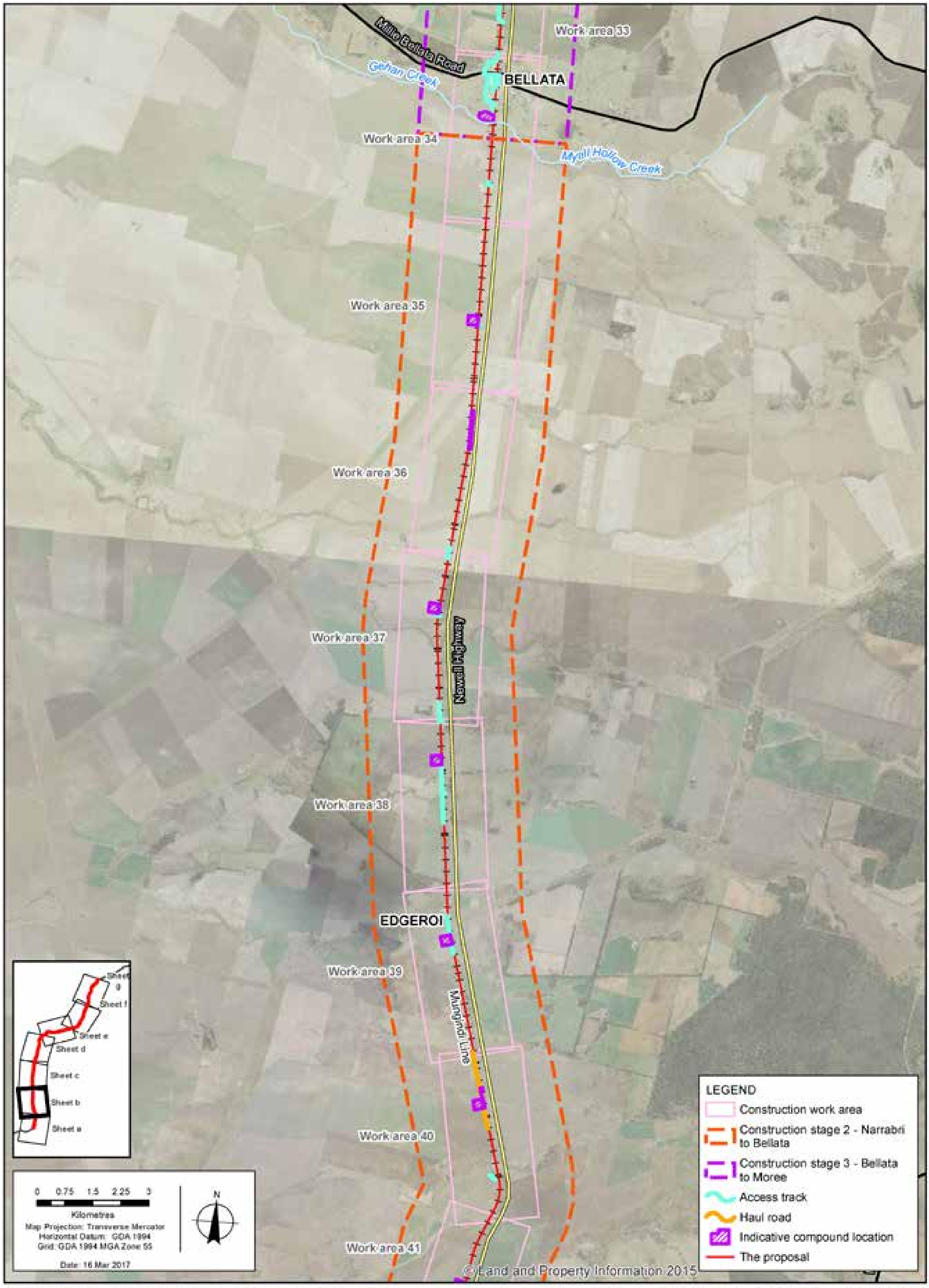


Figure 8.2c Construction work areas

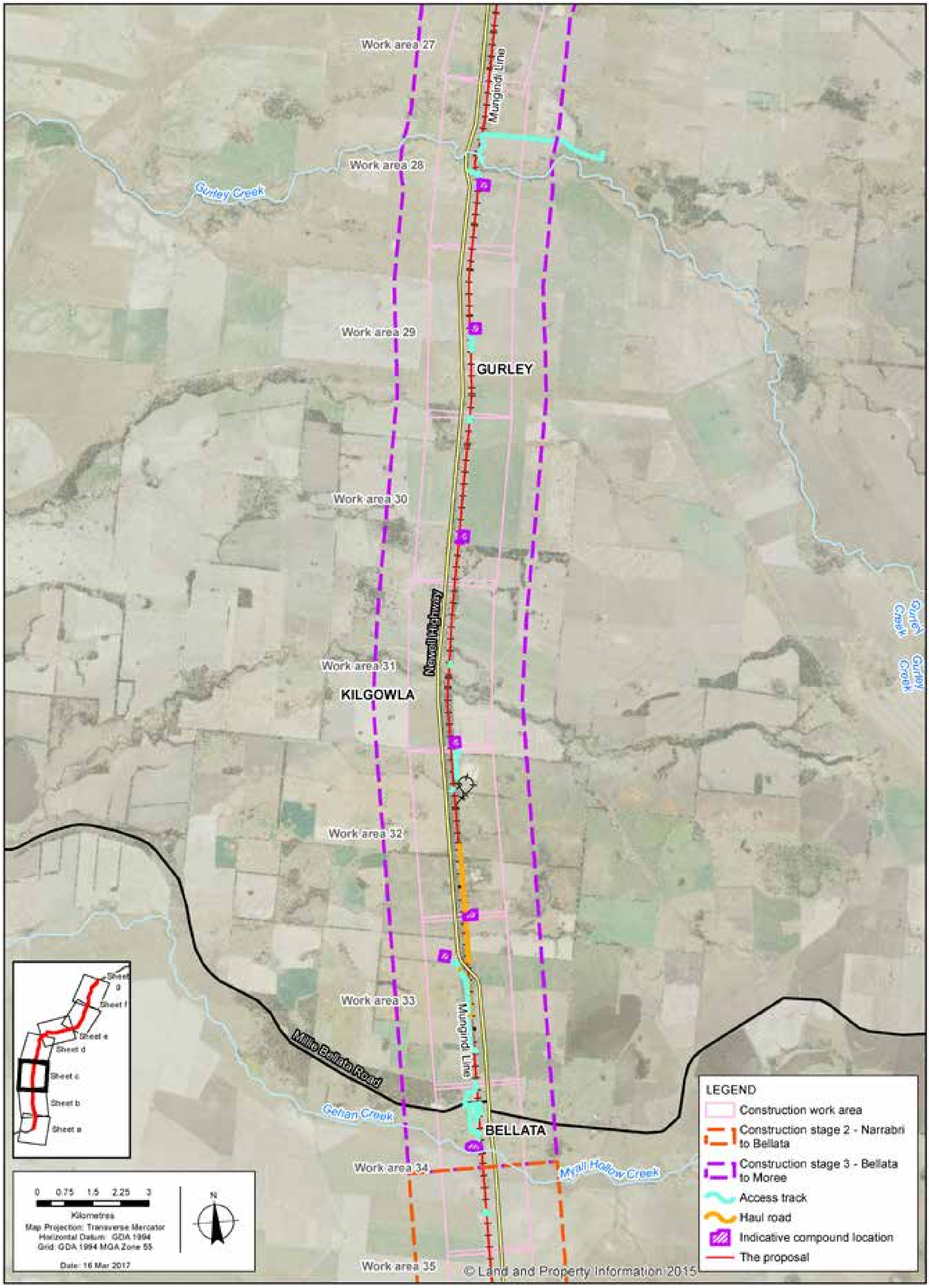


Figure 8.2d Construction work areas

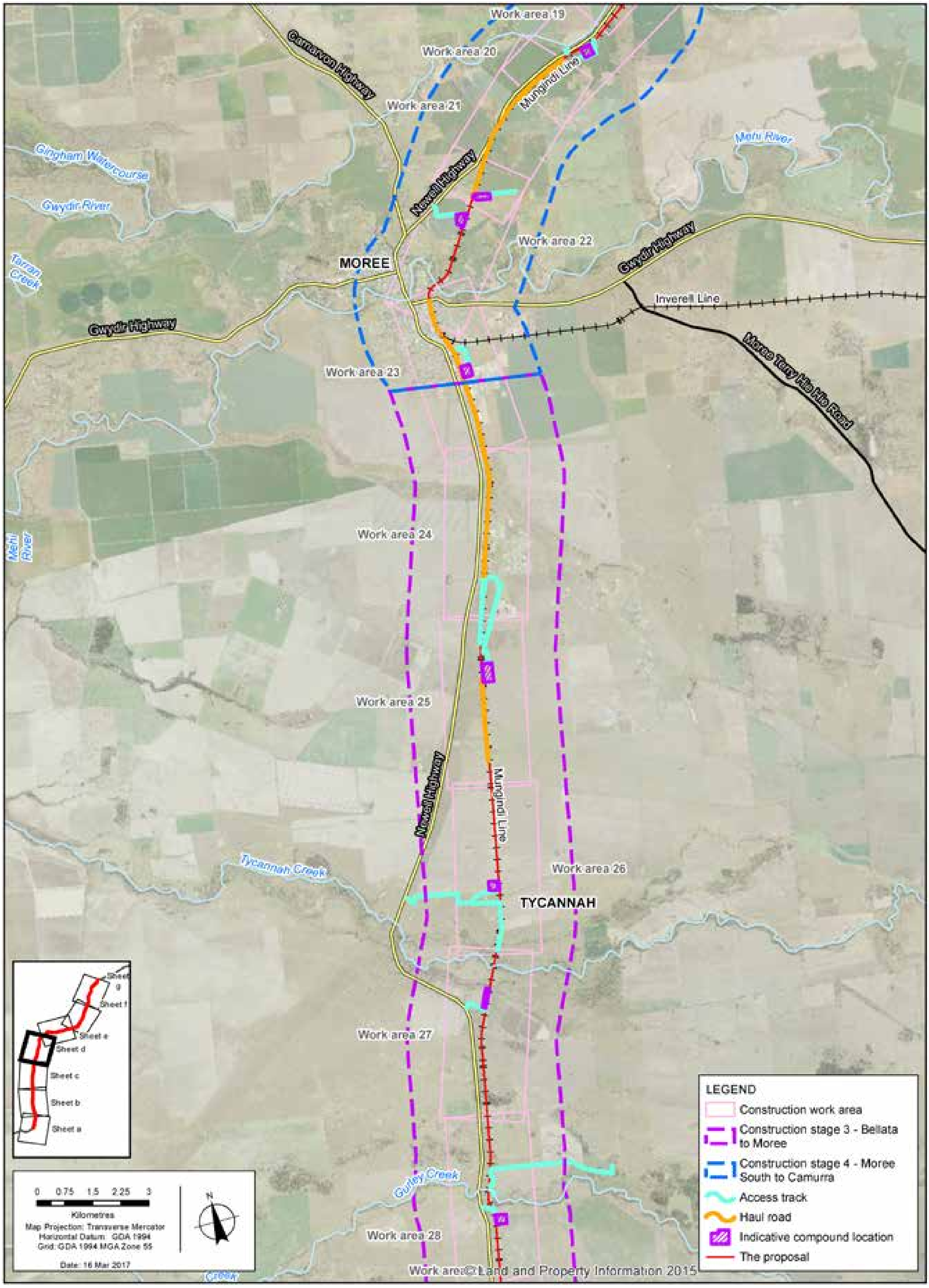


Figure 8.2e Construction work areas

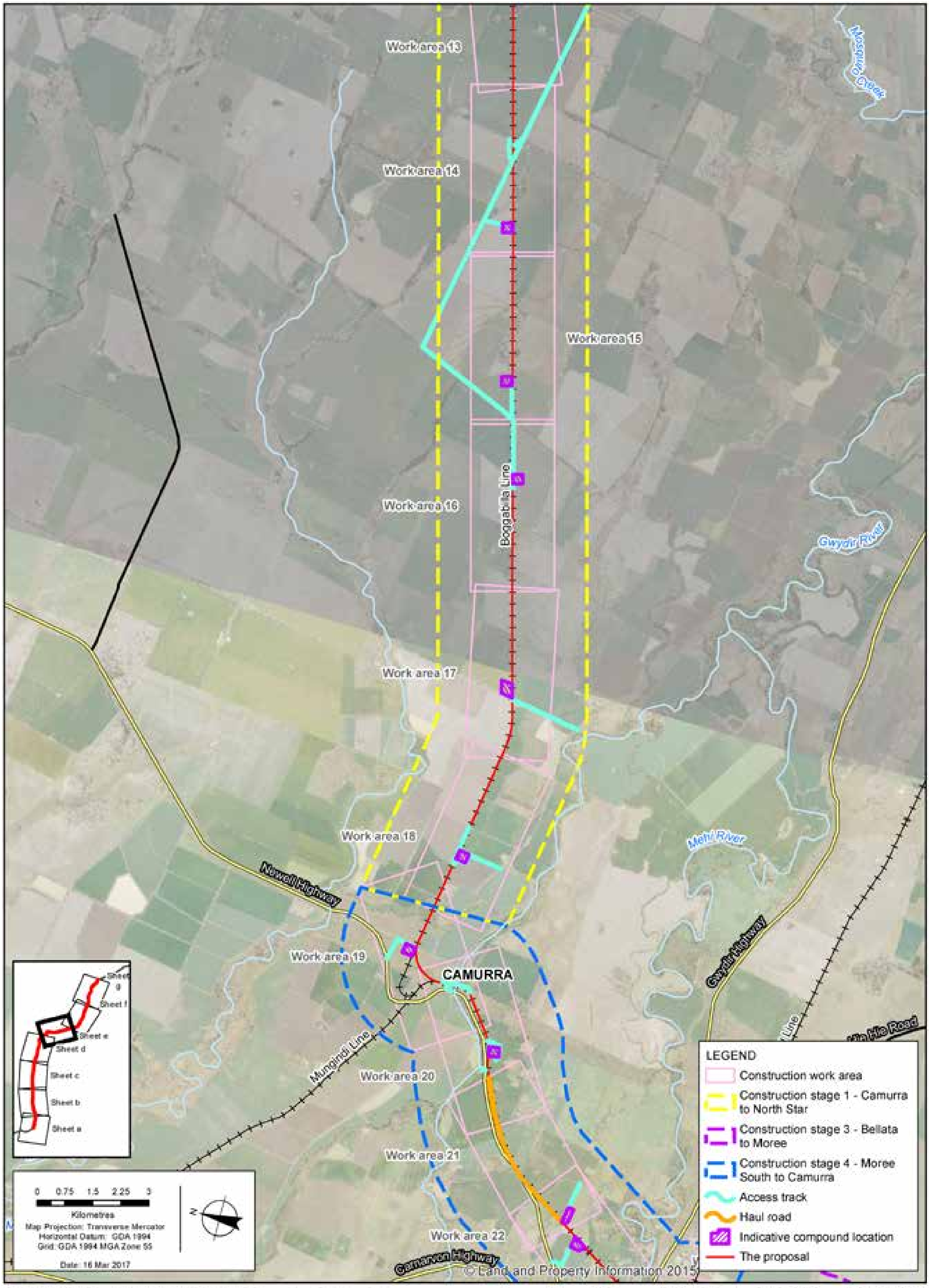


Figure 8.2f   Construction work areas

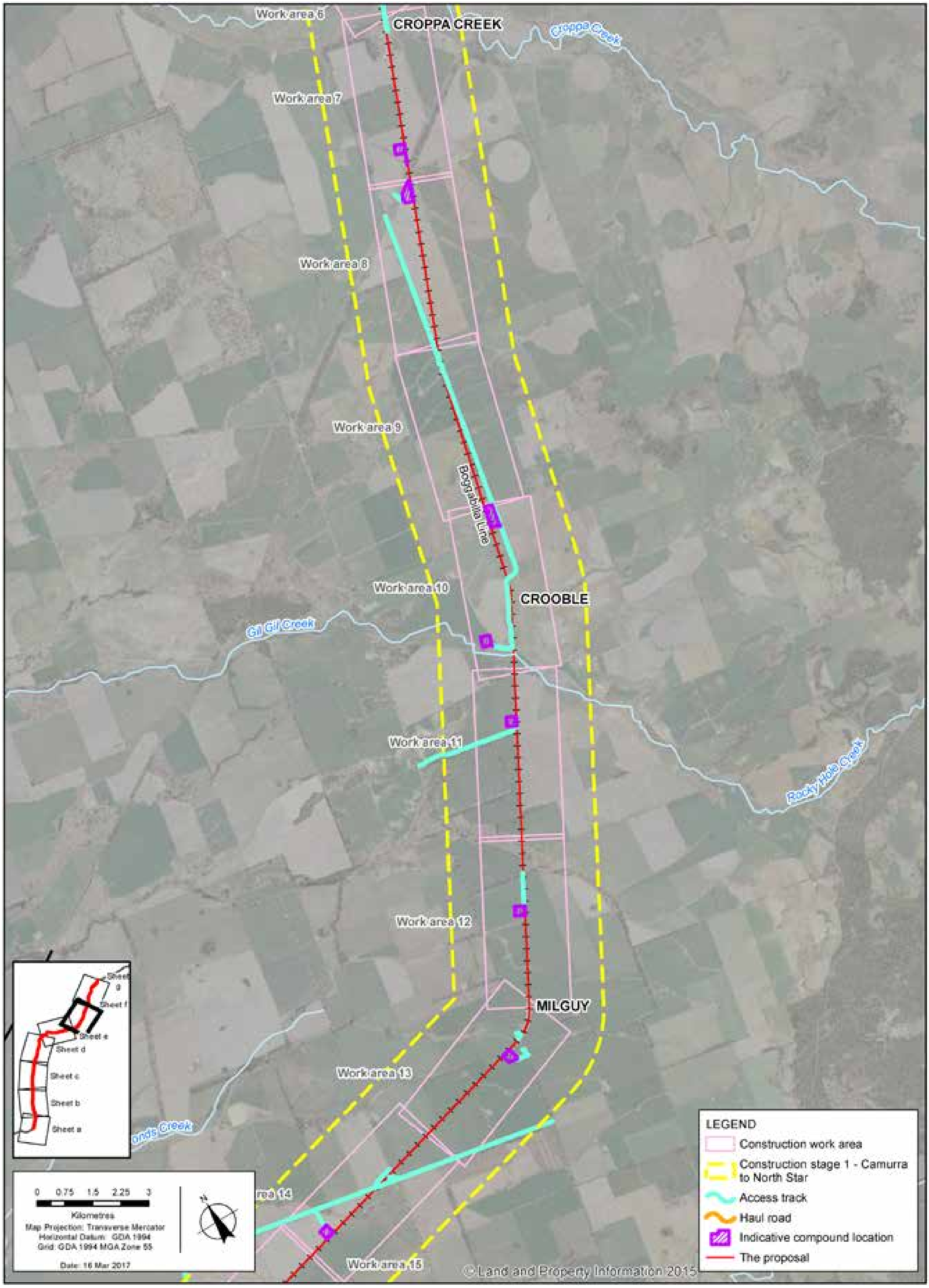
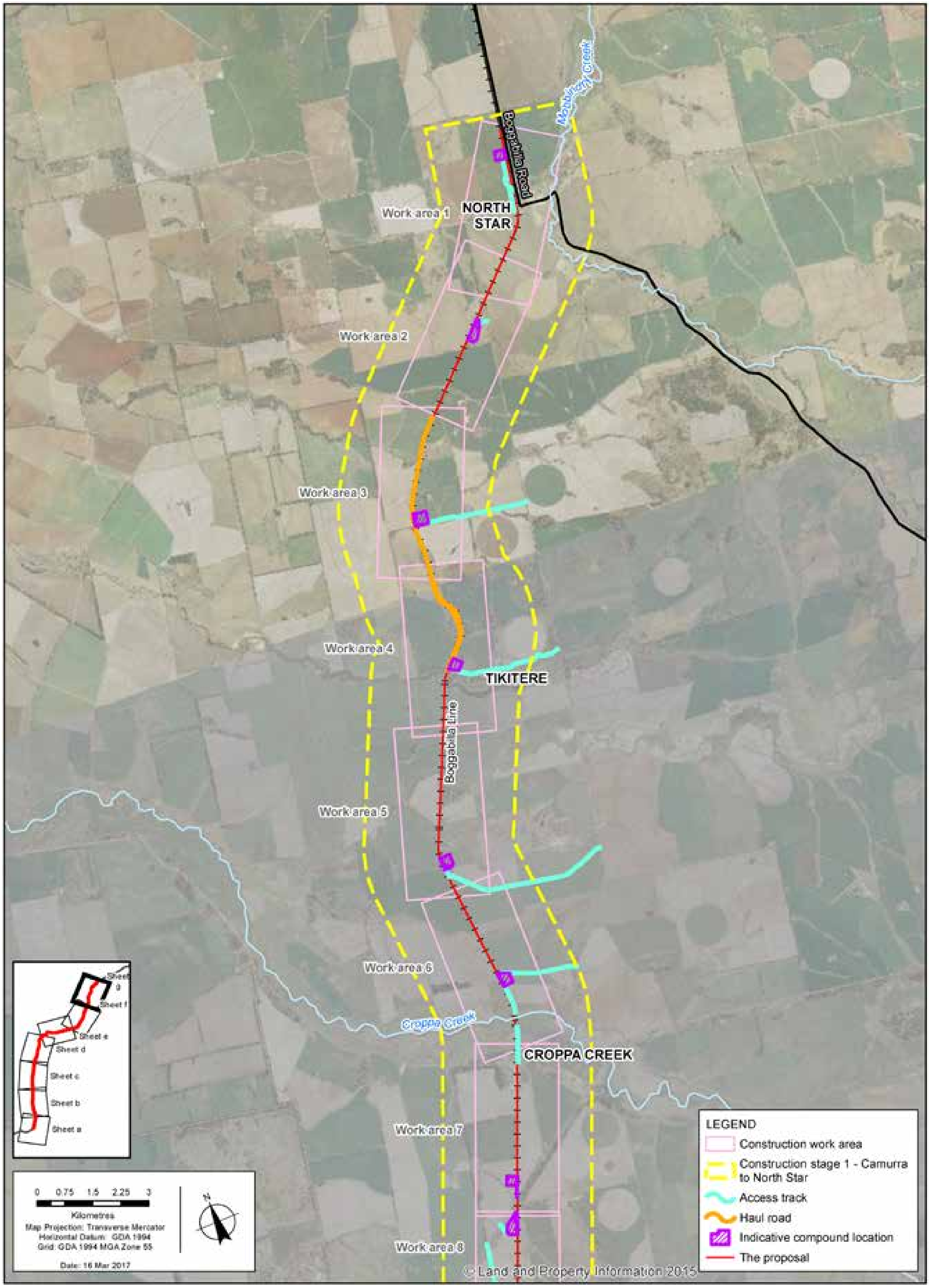


Figure 8.2g Construction work areas



8.5 Construction resources

8.5.1 Workforce

For the majority of the construction period, the workforce would average about 180 people. For some limited items of work an additional short-term workforce may be required.

8.5.2 Materials

The proposal would require quantities of various materials including fill, ballast, concrete sleepers, rail, precast concrete units, ready mix concrete and water. The majority of these materials would be used during track formation works, with the exception of precast concrete units and ready mix concrete, which would be used for construction of concrete structures including culverts and bridges.

Subject to confirmation and the gaining of any necessary approvals, the following local quarries are proposed to be used for structural fill, capping and ballast (ballast would be delivered by train, other materials by truck):

- Runnymede quarry in Milguy
- Narrabri quarry
- Wave Hill quarry in Narrabri.

In addition, subject to the gaining of any necessary approvals, the following greenfield sites may be used as quarry sites for the proposal:

- Oonoonba, located about 9 kilometres east of Bellata
- Tikitere, located adjacent to the existing alignment about 10.5 kilometres south-west of North Star.

This would be further investigated and confirmed during detailed design.

8.5.3 Plant and equipment

A range of plant and equipment would be used during construction. The final equipment and plant requirements would be identified by the construction contractor. An indicative list of plant and equipment that would be used for each construction stage is provided in Table 8.2.

Table 8.2 Indicative construction plant and equipment

Construction phase	Plant and equipment	
Establishment	▸ trucks ▸ cranes	▸ clearance equipment such as chainsaws and chippers
Utility relocations and property adjustments	▸ excavators ▸ rigid and articulated trucks ▸ jackhammers ▸ cranes ▸ concrete pumps ▸ welding equipment	▸ concrete saws ▸ light vehicles ▸ concrete trucks ▸ generators ▸ oxy-cutting equipment
Earthworks and drainage	▸ excavator ▸ jackhammers ▸ rigid and articulated trucks ▸ compactors ▸ water carts ▸ generators	▸ bulldozers ▸ boring machines ▸ graders ▸ profilers ▸ vibrating rollers ▸ trucks and trailers
Track works	▸ 25-30 tonne excavators ▸ 40 tonne dump truck ▸ vibratory roller ▸ water cart ▸ crane ▸ trucks and trailers	▸ graders ▸ bulldozer ▸ lighting ▸ skid steer loader ▸ front end loader
Road overbridges, underbridges and pavement works	▸ excavators ▸ rigid and articulated trucks ▸ drilling rigs and boring machines ▸ cranes ▸ concrete trucks and pumps ▸ generators ▸ welding equipment ▸ trucks and trailers	▸ compactors ▸ graders ▸ paving machines ▸ slip-forming machines ▸ vibrating rollers ▸ water carts ▸ road marking machine
Finishing and landscaping	▸ milling machines ▸ piling machines ▸ trucks ▸ rollers	▸ generators ▸ oxy-cutting equipment ▸ sprayers ▸ trucks

Mobile concrete batching plant

In addition to the plant and equipment listed in Table 8.2 the use of mobile concrete batching plants, to supplement supply from existing readymix plants, is proposed for the following construction works:

- earthworks and drainage
- road overbridges and underbridges.

The size of the plant would be about 15 metres by 10 metres, and up to eight metres high. The plant and ancillary features would have a footprint of about 100 metres by 150 metres to account for a water tanker, concrete trailer and storage of materials including aggregate and sand. The location of the plant would be wholly within the proposal site and would be subject to the same criteria as per that for the construction compounds, described in Section 8.4.

The combined total output from mobile batch plants is estimated to be less than 10,000 metres cubed per annum.

8.5.4 Site servicing requirements

Utilities and services such as water, sewer, electricity and telecommunications would need to be supplied to each of the work and compound sites for use in site offices and amenities. Where these utilities are located close to the sites, opportunities to connect to existing sources would be explored with relevant providers, particularly for electricity. Where connections are not available, power would be provided by generators.

Water would be required for dust control, site compaction and reinstatement during construction. A number of potential water sources have been investigated, including extraction of groundwater or surface water, private bores and watercourses. This would be further explored prior to construction in consultation with local councils and landowners. Where water is not available, it would be transported to the site via tanker truck and stored in temporary storage tanks. Potable water for human consumption would be supplied via bottled water or potable water tanks. Non-potable wash water would be supplied by the use of trailer-mounted storage tanks.

Portable toilet facilities would be used where existing infrastructure is unavailable and sewage pump out services utilised to remove waste off-site.

8.6 Transport, access and haulage arrangements

8.6.1 Access to construction work areas

Access to the construction work areas would mainly be from public roads or existing access routes which are located within the rail corridor. An access track runs parallel to the rail line along the majority of the alignment.

Potential access routes to each construction work area are listed in Table 8.3. Generally, access to construction stage 2 would be from Narrabri, access to construction stage 3 and stage 4 would be from Moree and access to construction stage 1 would be from Moree and North Star. Some areas would have two access points, and some would have alternative routes available, depending on the origin.

Table 8.3 Potential construction access routes to construction work areas

Construction work area (as shown in Figure 8.2)	Primary Route	Secondary Route	Tertiary Route
1 - 9	Newell Highway	-	-
10	Newell Highway	Millie Road	-
11-16	Newell Highway	Gurley Creek Road	Access track
17	Newell Highway	Gurley Creek Road	Access track
	Newell Highway	Gurley Settlers Road	-
18-19	Newell Highway	Access track	-
20-21	Newell Highway	Tapscott Road	-
22	Newell Highway	Bullus Drive	-
23-24	Newell Highway	Access track	-
	Newell Highway	Gwydirfield Road	Access track
25	Newell Highway	-	-
26	Newell Highway	Mosquito Creek Road	-
27	Newell Highway	Mosquito Creek Road	Roydon Road
28-29	Newell Highway	Mosquito Creek Road	Wongabindie Road
	Newell Highway	Croppa Creek Road	Wongabindie Road
30	Gwydir Highway	County Boundary Road	Calimpa Road
	Newell Highway	Croppa Creek Road	Wongabindie Road → Calimpa Road
31	Gwydir Highway	County Boundary Road	-
32	Gwydir Highway	County Boundary Road	Alma Lane
33	Gwydir Highway	County Boundary Road	Gil Creek Road
	Newell Highway	Croppa Moree Road à County Boundary Road	Gil Creek Road
34-35	Newell Highway	Croppa Moree Road	-
	Gwydir Highway	County Boundary Road	Gil Creek Road → Crooble Road → Access Road
36-37	Newell Highway	Croppa Moree Road	Buckie Road
	Newell Highway	Buckie Road	-
	Newell Highway	Croppa Moree Road	Croppa Creek Road → Access Road
38	Newell Highway	Croppa Moree Road	Croppa Creek Road → Tumba Road
	Newell Highway	Buckie Road	Croppa Creek Road → Tumba Road
	Gwydir Highway	County Boundary Road	Croppa Creek Road → Tumba Road

Construction work area (as shown in Figure 8.2)	Primary Route	Secondary Route	Tertiary Route
39-40	Newell Highway	Croppa Moree Road	Croppa Creek Road → Access Road
	Newell Highway	Buckie Road	Croppa Creek Road → Access Road
	Gwydir Highway	County Boundary Road	Croppa Creek Road → Access Road
41	Newell Highway	I B Bore Road	Croppa Creek Road
	Newell Highway	I B Bore Road	Croppa Creek Road
	Gwydir Highway	I B Bore Road	Croppa Creek Road
42-43	Newell Highway	I B Bore Road	-

8.6.2 Access to compounds

Access routes to compounds would be determined based on the following criteria:

- provision of a suitability wide road to achieve a single lane, two-way access
- provision of adequate turning circles for crane and heavy vehicles - at least a 25 metre turning radius capability
- minimal property impacts by using access alignments within and adjacent to the rail corridor and existing agreed property access roads as far as practicable
- provision of more than one access point where possible to allow access from either road direction.

8.6.3 Alternative public transport arrangements

As described in Section 2.5.2 an existing passenger service train (the Northern Tablelands Xplorer) travels between Sydney and Moree, and stops at Bellata and Moree stations within the proposal site.

During construction at Bellata and Moree, buses would be used in place of trains to transport passengers to the nearest active station. The location of the bus stops would take into consideration the safe access of passengers, and proximity to the construction impact zone. The train patronage levels using these stations are low, and therefore delays incurred due to the works are expected to be minimal. Works would be staged where possible to further minimise impacts to passengers.

8.6.4 Haul routes

While a detailed haulage program has not yet been developed, it is expected that some of the proposal's components would be delivered by rail. Other transport would be undertaken by heavy vehicles using the Newell Highway, Gwydir Highway / Alice Street and Kamilaroi Highway and then local roads and existing access roads along the rail corridor.

It is likely that rail components, including sleepers, ballast, and track, would be transported to the work areas via dedicated rail trains; while pre-fabricated concrete units, fill and equipment deliveries would most likely be via road from suppliers or town centres.

8.6.5 Construction traffic numbers

Construction vehicle movements would comprise both heavy and light vehicles as listed in Table 8.4.

Table 8.4 Vehicle movements for each stage of construction

Vehicle type		Numbers on-site per day	Movements per day	Indicative peak hour movements (one-way)
Light vehicles	Cars and utilities	75	170	75
	Total light vehicles	**75**	**170**	**75**
Heavy vehicles	Light trucks	8	24	8
	25 seater buses	5	10	5
	Haulage and delivery trucks	28	200	28
	Total heavy vehicles	**41**	**234**	**41**

Light vehicle movements would largely be based on the amount of construction workers travelling to site each day. Based on an average workforce of 180 people, up to 180 private vehicles could travel to and from the proposal site per day. However, given the remote nature of many of the construction work areas, buses would be provided for construction workers. Workers are likely to use a combination of buses and light vehicles to travel to the proposal site.

8.7 Public utilities

Consultation with public utility authorities is being undertaken as part of the design process to identify and locate existing utilities, and incorporate utility authority requirements for relocations and/or adjustments.

Preliminary investigations have indicated that a number of utilities would need to be relocated or adjusted as part of the proposal. This would be undertaken in consultation with the utility authorities during detailed design.

Desktop review of 'Dial Before You Dig' data indicated that the proposal would impact on a number of services. The number and length of interactions with services within the rail corridor is listed in Table 8.5. Additional services investigations would be undertaken during detailed design. Consultation has commenced with the various utility providers regarding their requirements for relocation or protection of the services impacted by the proposal.

Table 8.5 Services crossings and length

Service type	Number of crossings	Approximate length of service in the corridor (km)
Electricity (Essential Energy)	64	8
Communications (Telstra/Soul/Nextgen)	385	139
Sewer (Moree Plains Shire Council and Narrabri Shire Council)	3	0.1
Water (Moree Plains Shire Council and Narrabri Shire Council)	18	1.2
Stormwater (Moree Plains Shire Council)	1	0.1

Part C: **Environmental Impact Assessment**

Image: Newell Highway north of Narrabri, NSW

9. Traffic, transport and access

This chapter provides a summary of the traffic, transport, and access impact assessment undertaken or the proposal. It describes the existing transport and traffic environment, assesses the impacts from construction and operation of the proposal, and provides recommended mitigation and management measures. The full Traffic, Transport and Access Assessment report is provided as Technical Report 1.

9.1 Assessment approach

9.1.1 Methodology

The traffic, transport, and access assessment involved:

- reviewing the concept design for the proposal
- reviewing existing road features, traffic, transport services, pedestrian and cyclist facilities, and available traffic survey data
- estimating the traffic that would be generated during construction
- assessing the potential impacts of construction, including impacts to the operation of the local rail and road network, pedestrians, cyclists, and public transport
- assessing the potential impacts to the road network during operation
- assessing the potential travel time impacts at level crossings based on the expected train lengths, travel speeds and closure times
- assessing potential operational impacts on the wider transport network, including impacts to cyclists, pedestrians, and public transport
- providing mitigation measures to manage the potential impacts on traffic, transport and access.

Traffic modelling was undertaken for level crossings and key intersections. SIDRA modelling of intersections in Moree were based on traffic counts provided by Moree Plains Shire Council, and the operating characteristics of the intersections and adjacent level crossings. The level crossing model was based on the train characteristics (length and speed) and the volume of road traffic from which road traffic delays at level crossings could be identified.

9.1.2 Legislative and policy context to the assessment

The traffic and transport assessment was undertaken with reference to the following guidelines:

- *Guide to Traffic Management – Part 3 Traffic Studies and Analysis* (Austroads, 2007)
- *Guide to Traffic Generating Developments* Version 2.2 (Roads and Traffic Authority of NSW, 2002)
- *Cycling Aspects of Austroads Guides* (Austroads, 2014)
- *NSW Bicycle Guidelines* Version 1.2 (Roads and Traffic Authority of NSW, 2005)
- *Planning guidelines for walking and cycling* (Department of Infrastructure, Planning and Natural Resources, 2004)
- *Construction of New Level Crossing Policy* (Transport for NSW, no date)
- *Policy: Railway crossings* (Office of the National Rail Safety Regulator, 2016).

The Traffic, Transport and Access Assessment report (Technical Report 1) describes the legislative and policy context for the assessment in detail, including the policy and standards specifically related to level crossings.

9.2 Existing environment

9.2.1 Road network

The road network in the study area is described below and shown in Figure 9.1.

Main roads

Newell Highway

The Newell Highway, which runs generally in a north–south direction through the study area, stretches 1,060 kilometres through NSW between the Victorian border town of Tocumwal and the Queensland border town of Goondiwindi. The Newell Highway, which is managed by Roads and Maritime Services, is part of the national highway network. The importance of this highway is recognised by the *Newell Highway Corridor Strategy* (NSW Government, 2015). Further information on the strategy and the highway overall is provided in Technical Report 1.

Within the study area, the Newell Highway runs generally parallel to the rail line. The proposal site crosses the Newell Highway twice, at about 3 kilometres north of Narrabri Station and 4 kilometres north of Bellata. At both these locations the rail line passes under the highway.

Outside of built-up areas, the Newell Highway has a posted speed limit of 110 kilometres per hour, and generally comprises a single lane of travel in each direction on a single carriageway. Overtaking lanes are provided in some locations.

At Moree, the Moree Bypass provides a limited access route through the eastern edge of Moree urban area. The northern part of this bypass, north of the Gwydir Highway, was opened in April 2012 and the southern part opened in August 2015. The bypass has a single lane of through traffic in each direction, with a posted speed limit of 60 kilometres per hour.

Gwydir Highway/Alice Street

The Gwydir Highway runs generally east-west and connect the Castlereagh Highway at Walgett to the Pacific Highway at Grafton. The Gwydir Highway passes through Moree as Alice Street and crosses the rail line at a level crossing. Within Moree, Alice Street has a single lane in each direction, with a 50 kilometre per hour speed limit.

Kamilaroi Highway

The Kamilaroi Highway runs generally in an east-west direction through Narrabri. It connects Walgett in the west to Gunnedah in the east. It joins the Newell Highway in the north of Narrabri as Wee Waa Road and continues from the south of Narrabri via a roundabout off the Newell Highway. Within Narrabri it has a single lane in each direction, with a 50 kilometre per hour speed limit. Outside of Narrabri speed limits range from 80 to 100 kilometres per hour.

Local roads

The study area includes a network of local roads and private access roads through properties. The local road network provides direct access to properties and to the main road network. Local roads that cross the proposal site are listed (from south to north) in Table 9.1. Intersections in the vicinity of the proposal site are described below. The location of roads is shown in Figure 9.1.

Table 9.1 Local roads crossing the proposal site

Road Name	Surface type	Shoulders	Line marking
Tarlee Road	Unsealed	No	No
Galathera Lane	Unsealed	No	No
The Clump Road	Unsealed	No	No
Ten Mile Lane	Unsealed	No	No
Millie Road	Sealed	No	No
Penneys Road	Sealed/Unsealed	No	Yes/No
Kanimbla Road	Unsealed	No	No
Gurley Creek Road	Sealed	No	No
Bellata Street	Unsealed	No	No
Gurley Settlers Road	Unsealed	No	No
Tapscott Road	Sealed	No	Yes
Burrington Road	Sealed	No	No
Bullus Drive	Sealed	No	Yes
Jones Avenue	Sealed	No (some kerb and gutter)	No
Gwydir Highway/Alice Street	Sealed	No (kerb and footpath)	Yes
Gwydirfield Road	Sealed	No	No
Mosquito Creek Road	Sealed	No	Yes
Roydon Road	Unsealed	No	No
Wongabindie Road	Unsealed	No	No
Calimpa Road	Unsealed	No	No
County Boundary Road	Sealed	No	No
Alma Lane	Unsealed	No	No
Gil Gil Creek Road	Sealed/Unsealed	No	No
Crooble Road	Unsealed	No	No
Croppa Moree Road	Sealed	No	No
Buckie Road	Sealed	No	No
Tumba Road	Unsealed	No	No
Boonery Park Road	Unsealed	No	No
Croppa Creek Road	Sealed	No	No
I B Bore Road	Sealed	No	No

Figure 9.1a Road network

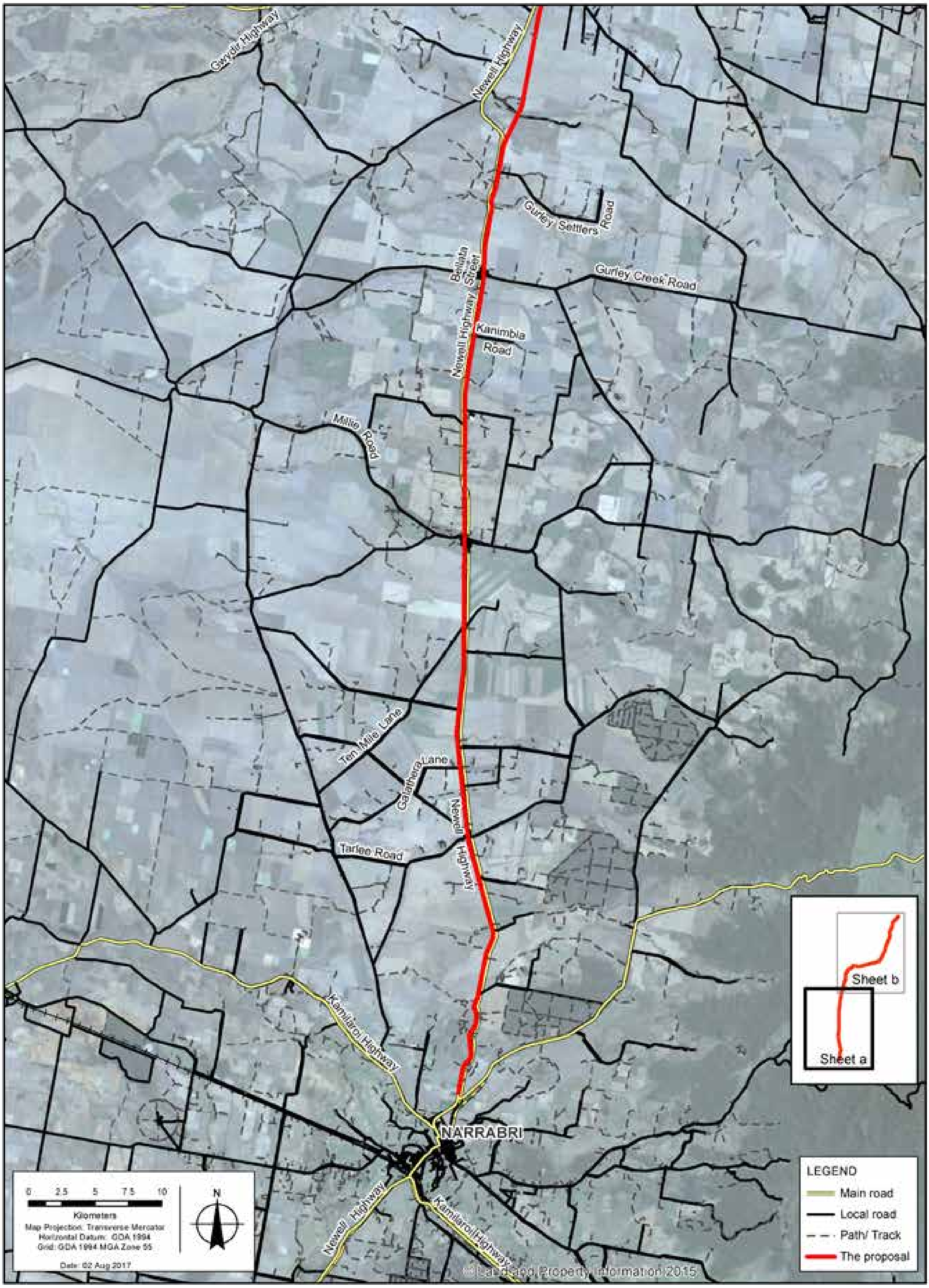
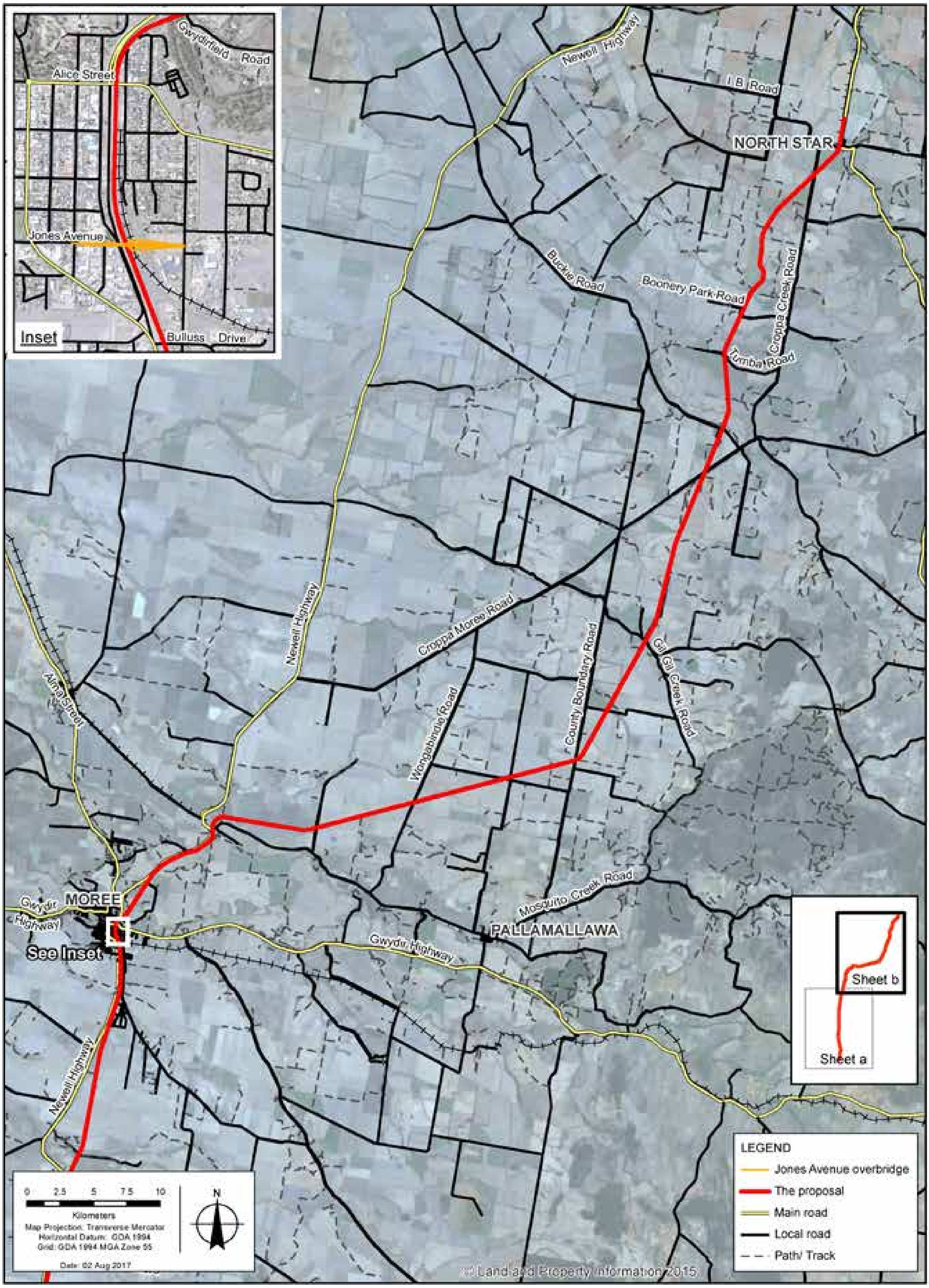


Figure 9.1b Road network



Intersections

The proposal site is located near three intersections, which may be impacted by the proposal and the operation of level crossings.

Alice Street/Moree Bypass

The Alice Street/Moree Bypass intersection is a four-leg signalised intersection that incorporates the railway level crossing into the traffic signals. This allows some movements, such as the through movement on the Moree Bypass, to continue while a train is crossing the road. Eastbound traffic from Alice Street, and the turns from the Moree Bypass onto the Gwydir Highway (east), are stopped to allow trains to cross Alice Street.

Capacity at this intersection is good, with level of service C in both the morning and afternoon peak periods for 2016 and forecast 2040 traffic volumes.

Bullus Drive/Newell Highway

The Bullus Drive/Newell Highway intersection is priority controlled, with right and left turn lanes provided for vehicles turning off the highway. Regular and frequent gaps in Newell Highway traffic flow allow traffic to turn into and out of Bullus Drive with generally minimal delay. The intersection operates at level of service A, with average delays for all turning vehicles of less than 10 seconds. Due to the priority arrangements, no delays are experienced by Newell Highway traffic.

Burrington Road/Newell Highway

The Burrington Road/Newell Highway intersection is priority controlled, with a left turn lane provided for vehicles turning off the highway and a short passing lane provided to allow through traffic on the highway to pass traffic turning right. Regular and frequent gaps in Newell Highway traffic flow allow traffic to turn into and out of Burrington Road with generally minimal delay.

Other intersections

There are a number of intersections located near the level crossings that form part of the proposal. These are generally priority controlled intersections with low traffic volumes on the side roads, and relatively low through movements. The performance of these intersections was not quantified as part of the assessment, however, as a result of the low traffic volumes, it is expected that there would be little to no delay.

Within the main settlement areas there are a number of intersections located near the proposal site, as listed in Table 9.2. The performance of these intersections was not quantified as part of the assessment, however, as a result of the low traffic volumes, it is expected that there would be little to no delay.

Table 9.2 Key intersections located near the proposal site

Locality	Intersecting road	Intersecting road
Narrabri	Newell Highway	Killarney Gap Road
Edgeroi	Newell Highway	Couradda Road / Tarlee Road
Bellata	Newell Highway	The Clump Road
Bellata	Newell Highway	Berrigal Road
Bellata	Newell Highway	Millie Road
Gurley	Newell Highway	Gurley Creek Road / Moloney Road
Gurley	Newell Highway	Tyrone Road
Moree	Newell Highway	Blueberry Road
Moree	Newell Highway	Tapscott Road
Moree	Moree Bypass	Frome Street (the old Newell Highway)
Moree	Moree Bypass	Boggabilla Road
Camurra	Newell Highway	Mosquito Creek Road
Camurra	Newell Highway	Croppa Moree Road
Camurra	County Boundary Road	Croppa Moree Road
Croppa Creek	Croppa Moree Road	Buckie Road

Level crossings

As noted above, the proposal site is crossed by a number of local roads. It is also crossed by a number of private roads/driveways, which provide access to and/or within properties surrounding or located close to the proposal site. A total of 86 level crossings are located along the proposal site. Of these, 41 are public crossings located on the local road network and 45 are private crossings.

The majority of level crossings along the proposal site have passive forms of control, consisting of give way or stop signs (82 crossings). The remaing 4 crossings have active controls (either signage with flashing lights, or signage with flashing lights and boom gates).

The duration of any delay at a level crossing is mainly related to train length and speed. For Inland Rail trains at crossings with active control, a minimum pre-train warning time of 45 seconds, and a minimum five seconds once the train has passed, results in a total maximum delay under existing conditions of 122 seconds (with the exception of Alice Street). Further information on level crossings is provided in Section 6.3.4.

Rail corridor access track

An internal access track used by maintenance vehicles runs along (within) the rail corridor for most of its length in the proposal site. Access to this track is provided off the local road network in a number of locations in the study area. Use of this track is restricted to authorised ARTC maintenance vehicles. The surface of this access track is unsealed.

Parking

There is no formal parking provided around the proposal site, with the exception of some on-street parking along Alice Street just east of the level crossing.

Rest areas are provided at various locations along the Newell Highway. Between Narrabri and Camurra, there are four rest areas designated for heavy and light vehicles, and a further four suitable for light vehicles only. There are three passenger train stations along the proposal site (Narrabri, Bellata and Moree) which have formal parking areas.

9.2.2 Traffic volumes, level of service and safety

Traffic volumes

Limited traffic volume data is available for most roads in and around the study area. Where volumes are available it is under 300 vehicles per day for lower order roads. Traffic counts (Roads and Maritime Services, 2008) indicate that average annual daily traffic volumes on the Newell Highway are as follows:

- 3,100 vehicles per day Newell Highway/Moree Bypass just north of Narrabri comprising:
  - 39 per cent heavy vehicles
  - peak volumes of around 220 vehicles per hour (two-way) at 9:00 am and 3:00 pm, relatively consistent throughout the day
- 2,400 vehicles per day Newell Highway/Moree Bypass between Bellata and Gurley (south of Moree) comprising:
  - 45 per cent heavy vehicles
  - peak volumes of around 160 vehicles per hour (two-way), relatively consistent throughout the day
- 2,200 vehicles per day Newell Highway/Moree Bypass between Croppa Moree Road and Buckie Road (north of Moree) comprising:
  - 46 per cent heavy vehicles
  - peak volumes of around 150 vehicles per hour (two-way), relatively consistent throughout the day.

Data provided by Moree Plains Shire Council indicates average weekday volumes for the following roads:

- 9,000 vehicles per day for Alice Street, west of the Moree Bypass:
  - peak volumes are around 350 vehicles per hour (two-way)
  - westbound traffic experiences a short peak in the morning, in the afternoon the eastbound peak runs between 3:00 pm and 6:00 pm
- 2,800 vehicles per day for Bullus Drive, Moree:
  - 8 per cent heavy vehicles
  - peak volumes are around 134 vehicles per hour (westbound) and 103 vehicles per hour (eastbound) in the afternoon peak.

Based on the dominant rural/agricultural land uses of the study area, traffic volumes on the road network are likely to increase during harvesting season. Harvest of winter crops in the study area can begin in late October and continue through until January in higher rainfall areas (Australian Grain Magazine, July 2016). Key winter crops in the study area include wheat, barley, oats and cereal rye. During this season, heavy vehicle usage on local and main roads in the study area increases as trucks transport grain and tractors and harvesters move between properties. Farming machinery is generally much larger and slower than other vehicles using the roads.

Level of service

The performance of the road network is largely dependent on the operating performance of intersections which form critical capacity control points in the road network. Level of service is the standard measure used to assess the operational performance of the network and intersections. There are six levels of service, ranging from level of service A to level of service F. Level of service A represents the best performance, and level of service F the worst. A level of service of D or better is generally considered to be an acceptable level of service. Level of service E may also be acceptable during peak periods. Levels of service E or F generally refer to intersections operating at, or close to capacity.

A level of service assessment was undertaken for the Newell Highway, using the methodology outlined in the *Guide to Traffic Management – Part 3 Traffic Studies and Analysis* (Austroads, 2007) for two-lane, two-way roads. The busiest section of the highway, just north of Narrabri, has a peak direction volume of 220 vehicles per hour with 39 per cent heavy vehicles. At this location the Newell Highway currently operates at Level of Service A. An allowance for traffic growth since 2008 does not alter the calculated level of service.

Road safety

The five year crash history (2009-2013) for roads in the study area was obtained from the Transport for NSW Centre for Road Safety. Data for key roads in the study area is listed in Table 9.3.

The majority of crashes occurred on the Newell Highway, which is to be expected given the higher volumes of traffic along the highway compared to other roads. The high proportion of serious and moderate injury crashes is also noted, and is likely to be a factor of higher vehicle speeds on rural roads.

Table 9.3 Crash history 2009-2013

Road	Fatal	Serious	Moderate	Minor	Total
Newell Highway[1]					
Narrabri - Bellata	0	7	2	7	16
Bellata – Moree	0	4	7	3	14
Moree – Camurra	1	3	2	0	6
Camurra – North Star (I B Bore Rd)	3	9	7	10	29
Newell Highway total	**4**	**23**	**18**	**20**	**65**
Jones Avenue	0	1	0	0	1
Alice Street	0	0	2	1	3
Gwydir Highway	0	1	0	0	1
Millie Road	0	1	0	0	1
Mosquito Creek Road	0	1	0	0	1
Croppa Moree Road	0	1	0	1	2

Note 1: excludes Newell Highway data within Moree as crash trends will have changed significantly since the Moree Bypass was opened in 2015.

9.2.3 Other transport facilities

Public transport

In addition to the passenger train services (described in Section 2.5.2), there are some buses that operate within the study area. A regional coach service travels between Moree and Grafton along the Gwydir Highway, with connections to Tenterfield, Armidale and Tamworth. Moree has a local bus service which provides routes around Moree, including along Alice Street across the proposal site.

School services also operate on various routes across the study area, including:

- Croppa Moree Road
- County Boundary Road
- Gwydir Highway/Alice Street
- Gurley Creek Road
- Tarlee Road
- Millie Road
- Buckie Road.

Existing rail infrastructure and train movements

Existing rail traffic using the Narrabri to North Star line includes the Northern Tableland Xplorer (a daily passenger service), freight services on an as-need basis (twice daily on average) and occasional maintenance related movements. The existing rail infrastructure and train movements in the study area are described further in Section 2.5.

Pedestrians and cyclists

Pedestrian and cyclist activity is low adjacent to the proposal site, with no facilities for pedestrians or cyclists provided along the Newell Highway (south of Moree) or Moree Bypass. Pedestrian crossings of the Moree Bypass and adjacent rail line are provided at Alice Street and at Moree Station. Pedestrian paths are provided along both sides on Alice Street.

9.3 Impact assessment

9.3.1 Risk assessment

Potential impacts

The environmental risk assessment for the proposal (provided in Appendix B) included an assessment of the potential risks associated with traffic, transport and access. Potential risks are considered according to the impacts that may be generated by the construction and/or operation of the proposal. The likelihood, consequence and overall risk level of each potential risk were assessed, and avoidance and management measures were defined for each potential risk. Further information on the risk assessment, including the approach, methodology, and the full results, is provided in Appendix B.

The assessed risk level for the majority of potential risks to traffic and transport was between low and high. Risks with an assessed level of medium or above are as follows:

- construction traffic impacts, including temporary delays to local and regional traffic
- loss of parking spaces and loading zones in towns near construction areas
- impacts to emergency services through delays in access due to works
- impacts on access to private properties
- impacts to rural roads unsuitable for construction traffic
- increase in travel times due to increase in level crossing closure with increasing length and frequency of trains.

How potential impacts have been and would be avoided

Potential impacts on traffic, transport and access would continue to be avoided by:

- designing, constructing and operating the proposal to minimise the potential for impacts outside the rail corridor
- managing the potential impacts on traffic, transport and access in accordance with relevant design, legislative, and policy requirements, including those described in Section 9.1.2
- implementing the traffic, transport and access mitigation measures provided in Section 9.4.3.

Level crossings not impacted by the proposal would continue to operate as normal, with warning devices and other controls installed in accordance with ARTC's *Level Crossing Design* (ARTC, 2012) standard.

Interactions between vehicles on the road network would continue to be defined by road rules and the physical configuration of the road. In most cases all construction activities would be located clear of the existing road network. Any short-term impacts associated with construction vehicle access or works at particular sites would be governed by a construction traffic management plan implemented by the construction contractor.

9.3.2 Construction impacts

Traffic and road network impacts

Traffic impacts

Construction would generate additional vehicle movements, including light and heavy vehicles. Light vehicles would generally be generated by construction workers moving to and from the construction work areas and/or compounds. Heavy vehicle movements would generally be trucks delivering materials. The estimated amount of construction traffic generation is described in Section 8.6.

Daily traffic generation would be about 170 light vehicle movements per day and about 234 heavy vehicle movements per day – or about 404 total vehicle movements per day. The peak hour for traffic generation would occur at the beginning and end of each shift, with up to 116 movements (one way) including around 41 heavy vehicle movements.

The Newell Highway is the busiest of the roads likely to be used for construction access. It has a peak hourly volume of about 130 vehicles in one direction. An additional 116 vehicles per hour would bring the total directional volume to almost 250 vehicles per hour. This would be a 89 per cent increase, noting that trucks have a disproportionate impact compared to light vehicles. At this volume, the Newell Highway is forecast to operate at level of service B or better. A similar level of service is anticipated for all roads expected to be used for construction access.

Proposed works on level crossings may also result in disruptions to local traffic and temporary access restrictions to private property. Where this occurs, alternative access arrangements would be provided and/or appropriate traffic controls implemented. However, the total expected peak hour flows would be within the nominal capacity of the roadway, remaining at level of service B or better.

The proposed Newell Highway overbridge would be constructed off-line to minimise impacts to traffic during construction. There would be some increase in traffic due to construction vehicles, however the impacts of this would be less than that of other rail works, as discussed above.

There would be some disruption to local traffic on Jones Avenue in Moree, as the overbridge is constructed. All materials would be imported to site resulting in an increase in heavy vehicle traffic in the area.

Measures to manage the potential for construction traffic impacts are provided in Section 9.4.3.

Road network impacts

The surrounding road network is not expected to be significantly impacted by construction traffic. This is because the roads have sufficient capacity to absorb the increased traffic, and delays or closure at crossings and intersections would have a localised impact only due to the low volumes on affected roads. During the peak construction activity, a level of service B is expected to be achieved on all affected roads.

It is expected that construction vehicle movements would be spread out across the day, particularly delivery trucks. This would also assist in minimising any additional delays for vehicles turning from side roads at intersections along the construction access routes.

Some construction transport would require the use of oversize and over-dimension vehicles. Movement of these vehicles would be subject to route-specific planning, with approvals as required by Roads and Maritime Services and the relevant local council.

Measures to manage the potential for impacts on the road network during construction are provided in Section 9.4.3.

Parking impacts

Light vehicle parking for construction workers would be provided within construction compounds, and within the rail corridor, and would not impact surrounding roads or properties. Provision of buses for workers for some construction work areas would reduce the number of light vehicles that would need to travel to individual construction sites. Parking would be adequate to accommodate the peak demands associated with construction including parking for buses where necessary. Based on the worker numbers detailed in Section 8.6, parking may be required for up to 7 buses per work area. If buses are not used, car parking demand may be up to 120-160 vehicles. Parking locations would be detailed in the traffic, transport and access management sub-plan of the CEMP.

Access impacts

A description of the indicative construction methodology is provided in Chapter 8. Construction would move progressively along the proposal site. Given the length of the proposal site, the access routes that would be used for construction traffic would vary depending on the origin of construction vehicles and the location of each construction work site.

As described in Section 8.6.1, construction vehicle access to work areas would be via the existing road network as far as possible and the existing access track within the rail corridor, but would use new temporary access tracks in some locations.

Access points from the public road network would be selected such that adequate sight distance and a safe access path are available. Further investigation of access locations would be undertaken during detailed design. All construction site access points would be designed in accordance with relevant standards and the requirements of the road owner, with adequate sight lines to ensure they operate in a safe and efficient manner. In addition, where possible, access would be provided from secondary roads to minimise the potential disruptions to the arterial road network.

For the southern sections of the proposal site, where the rail line is in close proximity to the Newell Highway there are limited alternative access routes. For these areas, specific traffic management measures would be put in place reflecting the prevailing conditions.

Encroachment of construction works into existing road reserves is not anticipated. Some compound sites may be fenced during construction although there are no anticpated impacts associated with this. Construction activities would be managed such that access to private properties and necessary access for livestock would be maintained, or where this is not possible, alternative access provided.

Measures to manage the potential for impacts to access are provided in Section 9.4.3.

Other transport impacts

Public transport impacts

There may be short-term delays to some coach and local bus services operating in the surrounding area which use level crossings in the proposal site, while construction works are underway.

As with other traffic, public and school buses may be impacted by the increase in traffic on the road network. However, given the relatively small number of bus services in the area combined with the limited traffic impact generally, this would be a minor impact.

Construction would involve temporary track closures between Narrabri and Moree that would disrupt passenger trains. Disruptions would be managed in a similar manner to track work at other times with coach services transferring passengers between affected stations and other measures such as establishment of temporary bus stops in appropriate locations.

Impacts to freight train paths

Construction activities would result in temporary impacts on existing rail freight operations. The construction methodology, sequencing and durations would be confirmed once a possession strategy has been agreed with affected train operators, track stakeholders and relevant government departments.

Pedestrian and cyclist impacts

The main locations where pedestrian and cyclist safety issues may arise include:

- construction site access and egress points where construction vehicles would interface with pedestrians using surrounding footpaths
- locations where footpath widths are reduced around the construction sites or haul roads.

Given the low volume of pedestrian and cyclist activity in around the majority of the proposal site, there is not expected to be any significant impacts to pedestrian and cyclists. The introduction of additional heavy vehicles to the network has the potential to increase safety risks for pedestrians and cyclists, especially where there is an increased likelihood for interaction.

During construction within Moree, where there is potential for higher pedestrian volumes, specific pedestrian management measures would be put in place. These would be subject to site specific planning, and reflect the nature of the works underway and the impacts on the existing pedestrian and cycle network.

9.3.3 Operation impacts

Traffic and road network impacts

Traffic impacts

During operation, some maintenance/operational traffic would be generated. However, this would be minimal, and is estimated to comprise about two to three trips to the proposal site per week. Occasionally there may be larger maintenance efforts required. The potential for significant traffic impacts is unlikely.

As described in Chapter 5, the need for the proposal has been driven by continued growth in both road and rail freight volumes. Operation of the proposal would have a positive impact on the road network, particularly along major transport routes such as the Newell Highway, by decreasing the amount of heavy vehicles on the road. This has the potential to reduce travel times for road users and improve road safety.

Overall, the proposal is expected to have a positive impact on traffic, by relocating some of the road freight task to rail, thereby reducing the number of heavy vehicles on main roads.

Level crossings

The proposed works at level crossings involve a mix of retaining/refurbishing existing crossings, consolidation of some crossings, upgrading the level of control, or installing a gated crossing. At this stage of the planning process, eight crossings have been identified as requiring further investigation and consultation in relation to consolidation options. These are mainly private crossings where alternative access is available, or access is no longer required. Further information on the level crossing strategy, including the next steps, is provided in Section 6.3.4.

The main traffic impact of the proposal would be impacts on travel time as a result of increased train activity at level crossings. Table 9.4 lists the estimated duration of delays at Alice Street and Bullus Drive, which have the greatest predicted traffic volumes. The delays shown would increase only if the maximum length of trains increase, and may actually reduce if train speeds increase.

Table 9.4 Level crossing delays per train

Level crossing location	Year	Maximum delay at crossing (sec)
Alice Street[1]	Existing year	143
	2040	143
Bullus Drive[1]	Existing year	143
	2040	143

1 Assuming 1,800 metre train at 70 kilometres per hour

The frequency of trains, and therefore likelihood of delays, would also increase over time as the number of trains using Inland Rail increases. Given the local nature of most affected roads, this impact is expected to affect a small volume of cars and have a localised impact only. The potential for queued vehicles to impact on adjacent intersections is considered to be very low.

The peak hour operation of the Alice Street/Moree Bypass intersection without the impact of a train arrival has been measured as level of service C. An assessment of intersection operation with a train arriving during the peak hour was also undertaken. Level of service is reduced to a level of service E in both morning and afternoon peak hours. This is however, based on average delays over the peak hour, so while substantial delays may be experienced while a train is crossing the road, this occurs for only a small proportion of the peak hour.

Peak hour modelling of Bullus Drive/Newell Highway with a train arrival indicates that level of service A is maintained. Level crossings during high traffic times such as peak hour vehicles may require vehicles to queue at turning lanes on Newell Highway. The predicted queue length is similar to the existing case despite increases in background traffic as a result of the increased train speed. As such, the proposal is not expected to substantially alter existing conditions.

Newell Highway overbridge

The proposed overbridge would be constructed to a higher standard than the existing overbridge, and would comply with Roads and Maritime Services' Newell Highway corridor design criteria and Austroads design standards. Operationally, there would be no change from the existing overbridge in terms of traffic and the road network.

Jones Avenue overbridge

The main potential traffic impacts of the overbridge would be on Jones Avenue and Tycannah Street, where increases in traffic volumes are expected as vehicles divert from Alice Street and Bullus Drive. The overbridge would be restricted to light vehicles, emergency services, and public transport only, and therefore no increase in heavy vehicle traffic is expected on these streets.

Table 9.5 lists the predicted daily traffic volumes on various streets surrounding the Jones Avenue overbridge for current conditions, 2019 (predicted year of opening) and 10 years after opening.

The greatest increase in traffic would occur on Jones Avenue east of the old Newell Highway (Frome Street) where there are currently very low volumes of around 300 vehicles per day, increasing to around 1,500 vehicles per day with the overbridge. It is expected that there would be about 120 to 150 vehicles in the peak hour. This volume is well within the capacity of the road, and within the environmental goal for a local or collector street according to the environmental capacity performance standards on residential streets provided by the Roads and Maritime Services' *Guide to Traffic Generating Developments* (Roads and Traffic Authority of NSW, 2002).

Traffic volumes on Tycannah Street are expected to increase to around 2,800 vehicles per day by 2029. The peak hour volume is expected to be around 225 to 280 vehicles per hour. This is within the environmental goal for a collector street.

Modifications may be required at the connection of Joyce Avenue with Jones Avenue, requiring all traffic to use the Frome Street to access Joyce Avenue. Joyce Avenue is a short (300 metre) street and the truncation is expected to cause only minor impacts on some trip distances and times. No significant change in performance is expected at the Frome Street intersection as a result of the modifications.

The proposed overbridge would have benefits for all road users by improving connectivity across the rail line. This is particularly important for emergency vehicles as it would remove the risk of being delayed at a level crossing and would be critical in the event of any train breakdown within Moree.

Table 9.5 Daily traffic volumes as a result of the Jones Avenue overbridge

	Without overbridge			With overbridge		
Road	**2016**	**2019**	**2029**	**2019**	**2029**	**Change[1]**
Alice Street east of Moree Bypass	4,863	5,009	5,495	4,298	4,715	-14%
Alice Street west of Moree Bypass	5,158	5,313	5,829	4,602	5,049	-13%
Jones Avenue overbridge	na	na	na	1,136	1,247	na
Jones Avenue east of old Newell Highway	303	312	342	1,448	1,589	+264%
Jones Avenue west of old Newell Highway	2,718	2,800	3,071	3,027	3,321	+8%
Bullus Drive	2,824	2,909	3,191	2,483	2,724	-14%
Tycannah Street south of overbridge	1,791	1,845	2,024	2,270	2,491	+23%
Tycannah Street north of overbridge	1,791	1,845	2,024	2,556	2,804	+39%

Note 1: percentage change in future years with and without the overbridge.
na – Not applicable

Parking impacts

The proposal does not require removal of any existing parking provision, and is expected to generate minimal demand for parking around train stations given that no change is forecast to passenger train services. Therefore, no impacts to parking are expected as a result of the proposal.

Access impacts

Road crossings

Access impacts during operation would include persistence of impacts related to the closure of level crossings during construction as discussed in Section 9.3.2. Delays at intersections as a result of the operation of level crossings are discussed above.

Newell Highway overbridge

The Newell Highway overbridge would be functionally similar to the existing bridge and is therefore not predicted to affect access during operation.

Jones Avenue overbridge

The Jones Avenue overbridge would provide access across the proposal site in addition to the existing level crossings in the vicinity, and is therefore considered to improve access.

Access to the rail corridor

During operation, minimal impacts to access are anticipated as access to the rail corridor would be via existing corridor access points. These access points would be chosen such that adequate sight distance and a safe access/egress path is available.

Consolidation of level crossings may cause access impacts to landowners where the level crossings provide access points for vehicle and livestock movements. Further consultation would be undertaken with potentially affected landowners prior to consolidation, as described in the level crossing strategy in Section 6.3.4.

Other transport impacts

Public transport impacts

There would be no negative impacts to passenger train services as a result of the proposal.

Bus services which cross the rail line may experience a small increase in delays at level crossings due to the increased rail use, in line with other road users on these roads.

The Jones Avenue overbridge provides an opportunity for a new local bus connection across the rail line, subject to further investigation.

Impacts to operation of freight trains

The proposal is not expected to affect existing freight train paths during operation and may allow for optimisation of freight train movements through increased maximum speeds.

Proposed freight train speeds would vary according to axle loads, and range from 80 kilometres per hour (30 tonne) to 115 kilometres per hour (21 tonne). This is an improvement on existing train speeds that are limited to a maximum of 90 to 100 kilometres per hour (80 kilometres per hour between Moree and North Star) and with local speed restrictions due to existing track condition.

Pedestrian and cyclist impacts

Given the low volume of pedestrian and cyclist activity in the study area, there is not expected to be any significant impacts to pedestrian and cyclists as a result of the proposal.

Pedestrians and cyclists using the Alice Street and Moree Station pedestrian crossings may experience some additional delay as a result of increased frequency and length of trains.

The Jones Avenue overbridge would improve pedestrian and cyclist accessibility by providing an additional crossing of the rail line that would not be disrupted by train movements.

9.4 Mitigation and management

9.4.1 Approach to mitigation and management

A traffic, transport and access management sub-plan would be prepared as part of the CEMP, and construction of the proposal would be undertaken in accordance with this plan.

All operational activities would be undertaken in accordance with ARTC's standard operating procedures and the environment protection licence relevant to the proposal.

9.4.2. Consideration of the interactions between mitigation measures

All mitigation measures for the proposal would be consolidated and described in the CEMP. The plan would identify measures that are common between different aspects. Common impacts and common mitigation measures would be consolidated to ensure consistency and implementation.

9.4.3 Summary of mitigation measures

To manage and mitigate the potential for traffic, transport and access impacts, the mitigation measures outined in Table 9.6 would be implemented.

Table 9.6 Traffic, transport and access - summary of mitigation measures

Stage	Impact	Mitigation measures
Detailed design/ pre-construction	Traffic, transport and access	Detailed design would minimise the potential for impacts to the surrounding road and transport network, and property accesses. Where any legal access to a property is permanently affected and a property has no other legal means of access, alternative access to and from a public road would be provided to an equivalent standard, where feasible and practicable. Where an alternative access is not feasible or practicable, and a property is left with no access to a public road, negotiations would be undertaken with the relevant property owner for acquisition of the property in accordance with the provisions of the *Land Acquisition (Just Terms Compensation) Act 1991*.
	Consultation	Input would be sought from relevant stakeholders (including Narrabri Shire Council, Moree Plains Shire Council, Gwydir Shire Council, and Roads and Maritime Services) prior to finalising the detailed design of those aspects of the proposal that impact on the operation of the road and transport infrastructure under the management of these stakeholders.
	Level crossings	Level crossings would be provided with warning signage, line marking, and other relevant controls, in accordance with the relevant national and ARTC standards.

Stage	Impact	Mitigation measures
Construction/ pre-construction	General impacts of construction activities on traffic, transport, access, pedestrians and cyclists	A traffic, transport and access management sub-plan would be prepared and implemented as part of the CEMP. It would include measures to minimise the potential for impacts on the community and the operation of the surrounding road and transport environment. It would address all the aspects of construction relating to the movement of vehicles, pedestrians and cyclists, and the operation of the surrounding road network, including: - construction site traffic control, parking and access arrangements - construction material, equipment and spoil haulage, including arrangements for oversize vehicles - road pavement and access road condition management - management of impacts to public transport, including school buses, pedestrian and cyclist access, and safety - management of impacts to access for surrounding residents and business owners/operators - arrangements for level crossings during construction - road and driver safety. The traffic, transport and access management sub-plan would be developed in consultation with (where relevant) Narrabri Shire Council, Moree Plains Shire Council, Gwydir Shire Council, Roads and Maritime Services, and public transport/bus operators.
Construction	Access	Access to individual residences, services and businesses, and access for livestock across the rail corridor, would be maintained during construction. Where alternative access arrangements need to be made, these would be developed in consultation with affected property owners/occupants.
	Emergency vehicle access	Access for emergency vehicles would be maintained along key emergency access routes throughout the construction period, with suitable alternative access arrangements provided where required.
	Rail traffic diversions	Diversions of existing rail traffic would be undertaken in consultation with relevant stakeholders, and alternative arrangements would be provided.
	Consultation	Consultation with relevant stakeholders would be undertaken regularly to facilitate the efficient delivery of the proposal and to minimise congestion and inconvenience to road users. Stakeholders would include the relevant local council, bus operators, Roads and Maritime Services, emergency services, affected property owners/occupants. The community would be notified in advance of any proposed road and pedestrian network changes through signage, the local media, and other appropriate forms of communication. Where changes to access arrangements are required, ARTC would advise property owners/occupiers and consult with them in advance regarding alternate access arrangements.
Operation	Level crossings	The operation of the level crossings that have been subject to changes as part of the proposal would be reviewed after the proposal commences operation to confirm: - that the level of protection continues to be appropriate - that the infrastructure is appropriate for the traffic conditions.

10. Biodiversity

This chapter provides a summary of the biodiversity impact assessments undertaken for the proposal by Umwelt (Australia) Pty Limited (Umwelt). It describes the existing biological environment (both terrestrial and aquatic), assesses the biodiversity impacts from construction and operation of the proposal, and provides recommended mitigation and management measures. The biodiversity assessments include the terrestrial Biodiversity Assessment report (prepared in accordance with the Framework for Biodiversity Assessment (OEH, 2014b)) (full report is provided as Technical Report 2) and the Aquatic Ecology Assessment (full report is provided as Technical Report 3).

The chapter also considers the potential impacts of the proposal on EPBC Act matters. The full assessment is provided in the assessment of Commonwealth Matters Assessment report (Technical Report 4).

10.1 Assessment approach

10.1.1 Methodology

The impacts of the proposal on biodiversity were assessed using the methodology in the *Framework for Biodiversity Assessment* (OEH, 2014b) (for terrestrial ecology) and relevant aquatic ecology guidelines. The *Framework for Biodiversity Assessment* methodology also includes consideration of fauna connectivity impacts when generating species credits for offsetting The biodiversity assessments involved desktop literature reviews of flora and fauna listed as occurring or potentially occurring in the study area, supported by detailed field surveys and assessment. The methodology used is described in detail in Technical Reports 2 and 3, and is summarised below.

Literature and database review

Existing information on the terrestrial and aquatic biodiversity of the study area was obtained from a range of sources, including databases, aerial photographs and maps, previous studies carried out in the locality, and consultation with representatives of relevant government agencies/organisations and landowners.

Previous documents and reports relevant to the study area were reviewed, including regional and sub-regional vegetation mapping reports, site-specific monitoring surveys, ecological surveys, and relevant ecological database searches.

Digital aerial photography was reviewed to identify spatial patterns in vegetation, land use, and landscape features.

Searches were undertaken of species databases to identify listed threatened species and ecological communities listed under the *Threatened Species Conservation Act 1995* (TSC Act), *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), and the *Fisheries Management Act 1994* (FM Act), known or likely to occur within the search area (a radius of 10 kilometres around the existing rail corridor). The following databases were searched:

- OEH Threatened Species Profile Database for known/predicted threatened ecological communities (TECs) and threatened species in the Northern Basalts, Northern Outwash and Castlereagh-Barwon Interim Biogeographic Regionalisation of Australia (IBRA) subregions, accessed between April and July 2016.
- PlantNET (Royal Botanic Gardens Sydney) database search for Rare or Threatened Australian Plant species within the Narrabri, Moree Plains and Gwydir LGAs, accessed in June 2016.
- The Protected Matters Search Tool for known/predicted TECs and species listed under the EPBC Act, accessed in April 2016 and March 2017.
- OEH BioNet Atlas of NSW Wildlife database and mapping tool, accessed April 2016.
- Vegetation Information System Classification Database, accessed between April and July 2016.
- NSW Department of Primary Industries – Fishing and Aquaculture – Threatened and protected species record viewer, accessed May 2016.

Field surveys

Field surveys were undertaken across a range of seasons and years. The survey design considered seasonality issues associated with maximising the opportunity of identifying threatened species with the potential to be impacted by the proposal. Surveys were undertaken on the following dates.

- 25 to 29 September 2014
- 1 to 2 July 2015
- 7 to 16 December 2015
- 3 to 12 February 2016
- 20 to 24 April 2016.

Surveys were undertaken in the proposal site and the additional assessment areas, as described in Section 2.2. Survey effort and habitat assessments focused on known or potential habitat locations for threatened ecological communities, and potential habitat for threatened flora and fauna species. Surveys involved quadrats, plots, transects, random meanders, and rapid surveys. Further information on the surveys, including the locations of survey sites, is provided in Technical Reports 2 and 3.

Analysis and reporting

Vegetation mapping was undertaken using best-practice techniques to delineate plant communities. The BioBanking Credit Calculator Version 4.1 was applied in accordance with the *BioBanking Assessment Methodology* (OEH, 2014a) to identify the biodiversity credits that would be required to offset the impacts of the proposal. Potential fish habitats were classified in accordance with the *Policy and guidelines for fish habitat conservation and management* (Department of Primary Industries, 2013).

As described in Section 2.2.1, the biodiversity assessment considers the potential impacts of the proposal on biodiversity in the proposal site and, to provide flexibility for the design (particularly in relation to culvert and level crossing upgrades), it also considers additional assessment areas outside the proposal site, including:

- an approximate 60 metre buffer around culverts/underbridges and the new bridges over the Mehi and Gwydir rivers and Croppa Creek
- an approximate 120 metre buffer around the locations of level crossings.

As described in Section 2.2.1, the need for works in these areas would be determined during detailed design. Calculations undertaken using the BioBanking Credit Calculator were based on the biodiversity assessment area (that is, the proposal site plus the additional assessment areas).

10.1.2 Legislative and policy context to the assessment

The main legislation relevant to the assessment are the TSC Act, FM Act, *Noxious Weeds Act 1993* and EPBC Act. These acts provide the statutory basis for listing threatened species and communities, and/or assessment requirements in relation to impacts to biodiversity.

The main policy relevant to biodiversity assessments for State significant development and infrastructure in NSW is the *NSW Biodiversity Offsets Policy for Major Projects* (OEH, 2014c) (Major Projects Offsets Policy), which provides guidance in relation to biodiversity offsetting for major project approvals. A key principle underpinning the policy is that offset requirements should be based on a reliable and transparent assessment of biodiversity losses and gains. The offsets policy is underpinned by the *Framework for Biodiversity Assessment*, which sets out the process for assessing biodiversity impacts as a result of a development, and determining the biodiversity offset requirements for those impacts.

The BioBanking Credit Calculator is a web tool that is used in conjunction with the *Framework for Biodiversity Assessment* to apply the *BioBanking Assessment Methodology*.

As noted in Section 3.5, the proposal is a controlled action under the EPBC Act, with the controlling provision being 'listed threatened species and communities', specifically in relation to the potential for impacts to/removal of:

- *Natural grasslands on basalt and fine-textured alluvial plains of northern NSW and southern Queensland* critically endangered ecological community (CEEC)
- known foraging habitat for the koala (*Phascolarctos cinereus*).

As part of the overall approval process for the proposal, the proposal will be assessed by the NSW Department of Planning and Environment in accordance with the Bilateral Agreement made under section 45 of the EPBC Act relating to environmental assessment (between the State of NSW and the Commonwealth of Australia) (Bilaterial Agreement). The assessment and approval requirements under the EPBC Act are described in Section 3.5.

The biodiversity assessment requirements are specified in the SEARs that are provided in Appendix A.

10.2 Existing environment

10.2.1 General ecological context

The study area for the biodiversity assessment is typical of the Border Rivers/Gwydir and Darling Riverine Plains bioregions. The study area is in the Namoi River, the Gwydir River, and the Macintyre River basins. The major river systems in the study area (and crossing the proposal site) are the Namoi River and Gwydir River (including the Mehi River), which are perennial systems. The proposal site also crosses a number of ephemeral watercourses. Further information on the hydrological context of the proposal site is provided in Chapters 15 and 16.

The majority of the study area has been heavily modified by past and ongoing disturbances associated with the active rail corridor and surrounding rural and agricultural activities. Clearance and maintenance of the rail corridor has resulted in fragmentation, a high level of disturbance, and degradation of vegetation communities within the rail corridor. The majority of the proposal site (69 per cent or about 1,080 hectares) is cleared or consists of non-native vegetation. Patches of native vegetation exist sporadically within and near the proposal site, and are typically associated with travelling stock reserves, road reserves, or farm woodland remnants. These patches generally comprise a woodland community, with the dominant canopy species including bimble box (*Eucalyptus populnea* subsp. *bimbil*), belah (*Casuarina cristata*), silver-leaved ironbark (*Eucalyptus melanophloia*), and white cypress pine (*Callitris glaucophylla*). Extensive areas of natural grasslands also exist around the proposal site.

10.2.2 Terrestrial biodiversity

Communities, habitats and species identified during field surveys

Plant communities

Nine native plant community types across 10 condition classes were identified during field surveys. These communities are listed in Table 10.1 and are shown on Figure 10.1. The most common native vegetation community is the Queensland Bluegrass +/- Mitchell Grass grassland community. All of these communities have the potential to be impacted by the proposal.

With regards to proposal features located outside of the rail corridor the following is noted:

- The Camurra bypass – the location of the Camurra bypass has been mapped as plant community type 52 (Queensland Bluegrass +/- Mitchell Grass grassland community), which conforms to the EPBC Act listed *Natural grassland on basalt and fine-textured alluvial plains of northern NSW and southern Queensland* CEEC.
- The Newell Highway overbridge – the location of the Newell Highway has been mapped as plant community type 56, which does not conform to any listed community.
- The Jones Avenue overbridge – the area surrounding the Jones Avenue overbridge location has been mapped as cleared/non-native vegetation which is consistent with its urban setting.

Table 10.1 Plant communities

Plant community type (PCT)	PCT[1] reference code	Condition	Total area (hectares)	Conservation status[2]	General description
Weeping Myall open woodland of the Darling Riverine Plains Bioregion and Brigalow Belt South Bioregion	PCT 27	Moderate to good	6.95	State: Conforms to the TSC Act listed *Myall Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain, Murray-Darling Depression, Riverina and NSW South western Slopes bioregions* endangered ecological community (EEC). 2.61 ha conforms Commonwealth: to the EPBC Act listed *Weeping Myall Woodlands* EEC	Occurs as several small remnant or regenerating patches throughout the biodiversity assessment area occupying plains and low rises on alluvial clays and loams. Although widespread, patches are relatively isolated due to historic clearing.
Brigalow - Belah open forest / woodland on alluvial often gilgaied clay from Pilliga Scrub to Goondiwindi, Brigalow Belt South Bioregion	PCT 35	Moderate to good	4.75	State: Conforms to the TSC Act listed *Brigalow within the Brigalow Belt South, Nandewar and Darling Riverine Plains Bioregions* EEC Commonwealth: Conforms to the EPBC Act listed *Brigalow (Acacia harpophylla dominant and co-dominant)* EEC	Mainly occurs in the southern portion of the biodiversity assessment area between Bellata and Gurley, with occurrences in the north towards North Star. This community mainly occurs on gilgaied clay and loams on alluvial plains and valley flats.

Plant community type (PCT)	PCT[1] reference code	Condition	Total area (hectares)	Conservation status[2]	General description
Coolabah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion	PCT 39	Moderate to good	1.19	State: Conforms to the TSC Act listed Coolibah - *Black Box Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain and Mulga Lands Bioregions* EEC Commonwealth: Conforms to the EPBC Act listed *Coolibah – Black Box Woodland of the Darling Riverine Plains and the Brigalow Belt South Bioregion* EEC	Occurs as small, isolated patches due to historic clearing, located on alluvial loams and clays of drainage depressions and streambanks.
Queensland Bluegrass +/- Mitchell Grass grassland on cracking clay floodplains and alluvial plains mainly the northern-eastern Darling Riverine Plains Bioregion	PCT 52	Moderate to good	268.64	Commonwealth: Conforms to the EPBC Act listed *Natural Grassland on Basalt and Fine-textured Alluvial Plains of northern NSW and southern Queensland* CEEC	Mainly occurs south of Moree between Gurley and Bellata, with isolated occurrences between Moree and North Star. Limited to alluvial loams and clays on alluvial plains and floodplains.
Poplar Box - Belah woodland on clay-loam soils on alluvial plains of north-central NSW	PCT 56	Moderate to good	71.95	Not listed	Mainly occurs on alluvial plains consisting of red clay loams.
		Derived native grasslands	108.20	Not listed	Typically lacks an upper storey and mainly occurs on alluvial plains consisting of red clay loams. Often adjacent to Poplar Box - Belah woodland.

Plant community type (PCT)	PCT[1] reference code	Condition	Total area (hectares)	Conservation status[2]	General description
Carbeen - White Cypress Pine - River Red Gum - bloodwood tall woodland on sandy loam alluvial and aeolian soils in the northern Brigalow Belt South Bioregion and Darling Riverine Plains Bioregion	PCT 71	Moderate to good	0.04	State: Conforms to the TSC Act listed *Carbeen Open Forest community in the Darling Riverine Plains and Brigalow Belt South Bioregions* EEC	This vegetation zone occurs as one remnant patch. The community is found on Aeolian sediments as well as alluvial clay loams on floodplain flats and gentle rises.
River Red Gum riparian tall woodland / open forest wetland in the Nandewar Bioregion and Brigalow Belt South Bioregion	PCT 78	Moderate to good	14.70	Not listed	Occurs on alluvial loam soils mainly along the banks of watercourses and on adjoining alluvial flats.
Coobah - Western Rosewood low open tall shrubland or woodland mainly on outwash areas in the Brigalow Belt South Bioregion	PCT 135	Moderate to good	3.79	Not listed	Mainly occurs as linear patches on the black loam soils, including basalt derived soils, on the low hills near Bellata.
Silver-leaved Ironbark - White Cypress Pine - box dry shrub grass woodland of the Pilliga Scrub - Warialda region, Brigalow Belt South Bioregion	PCT 413	Moderate to good	2.59	Not listed	Occurs as small remnant patches throughout the biodiversity assessment area. The community occupies red sandy loam and clay loam soils on slight rises and low hills.

Notes 1: Plant community types are as per the NSW Vegetation Information System database
2: Conservation status indicates conformity to threatened ecological communities (TECs) listed by the TSC Act and/or the EPBC Act. EEC – endangered ecological community, CEEC – critically endangered ecological community.

Figure 10.1a Vegetation communities in proposal site

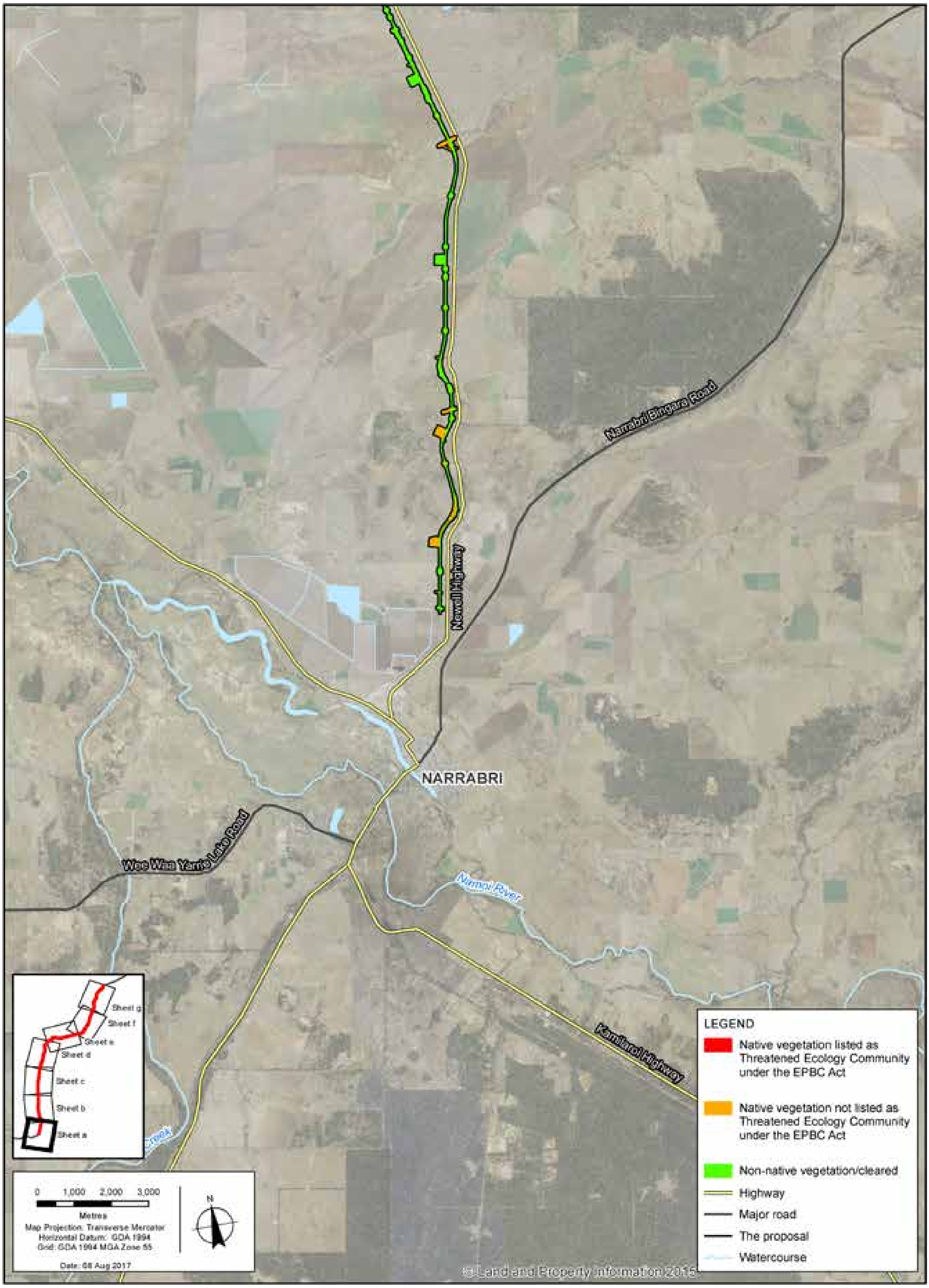


Figure 10.1b Vegetation communities in proposal site

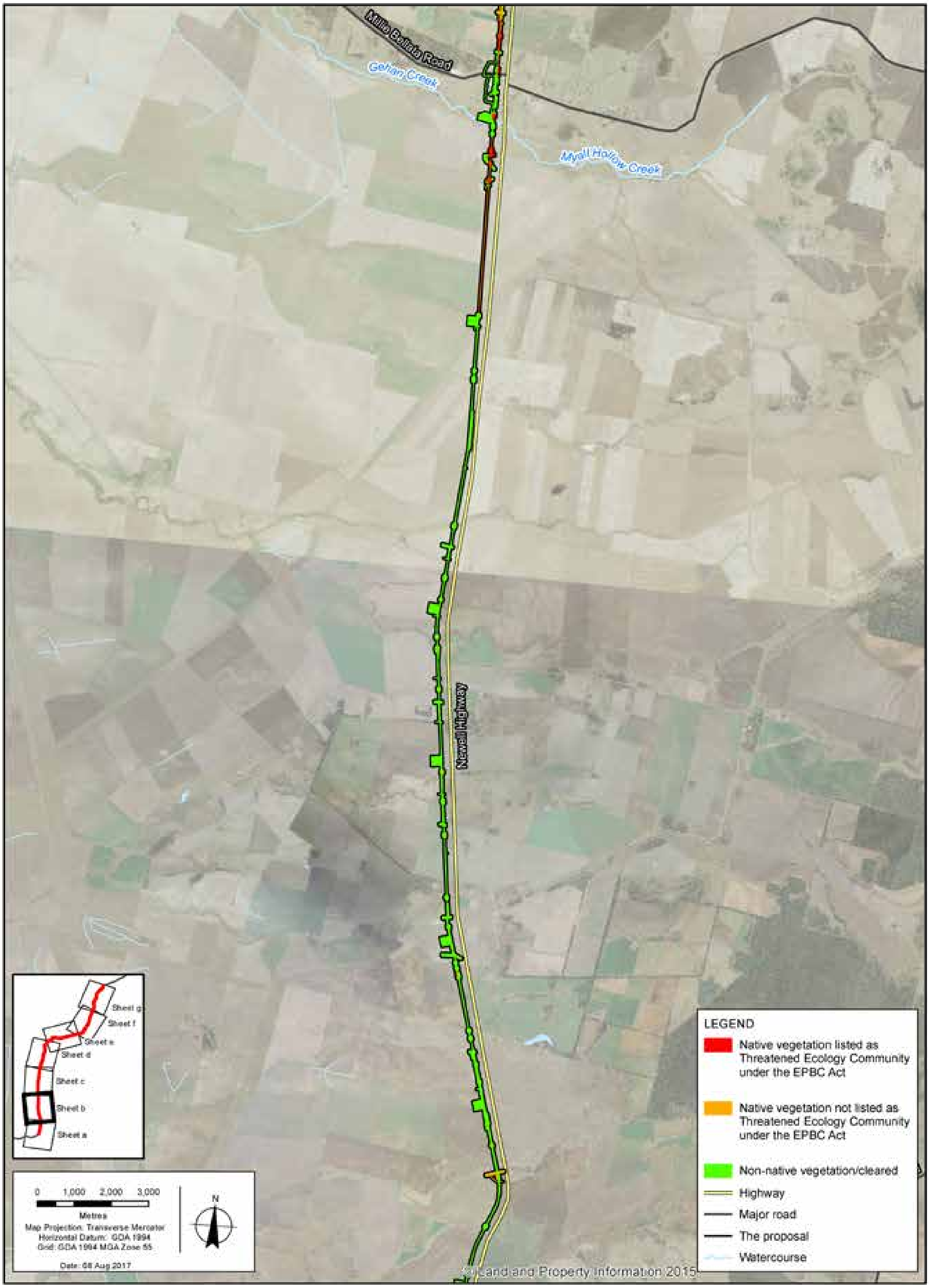


Figure 10.1c Vegetation communities in proposal site

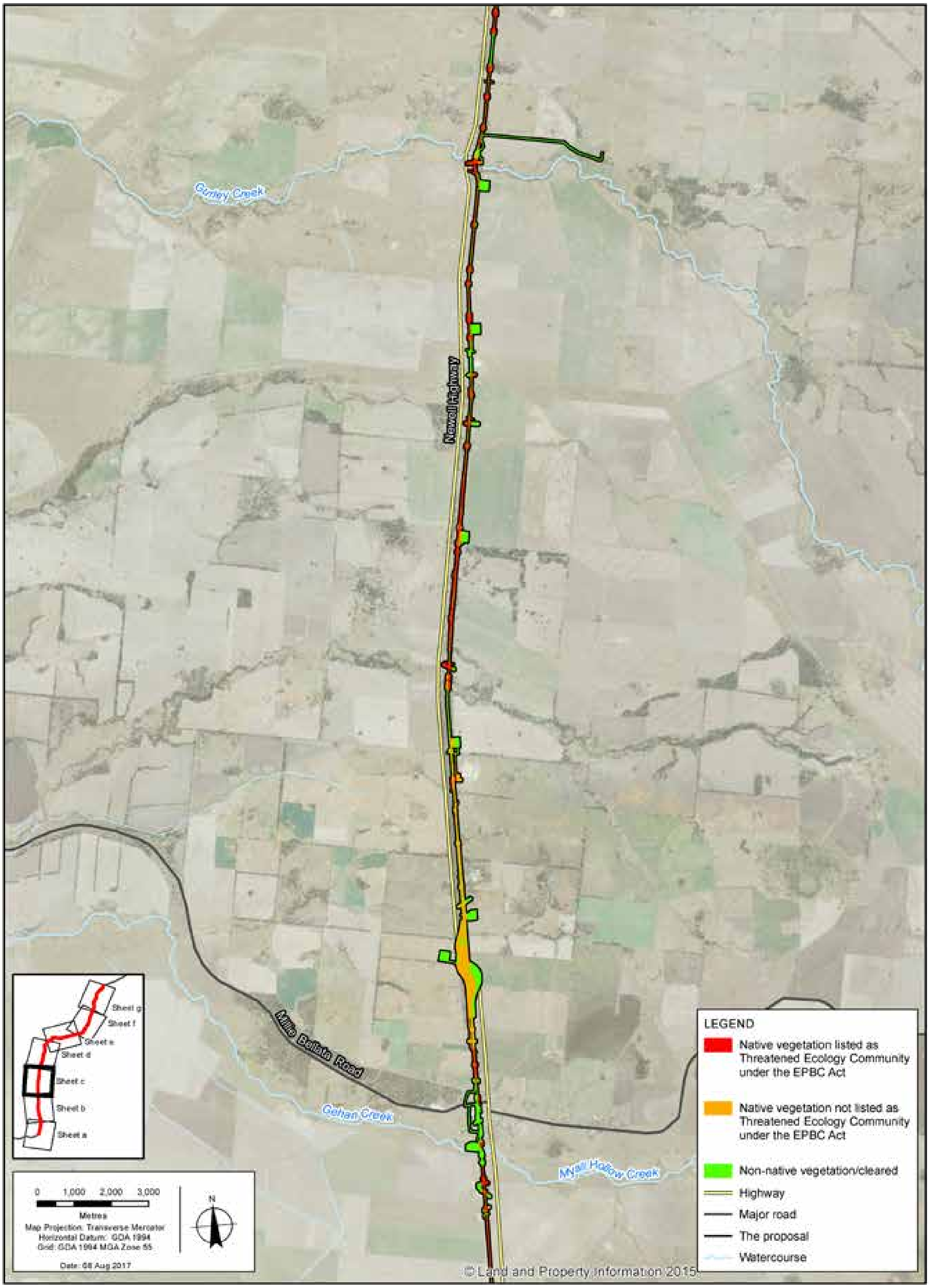


Figure 10.1d Vegetation communities in proposal site

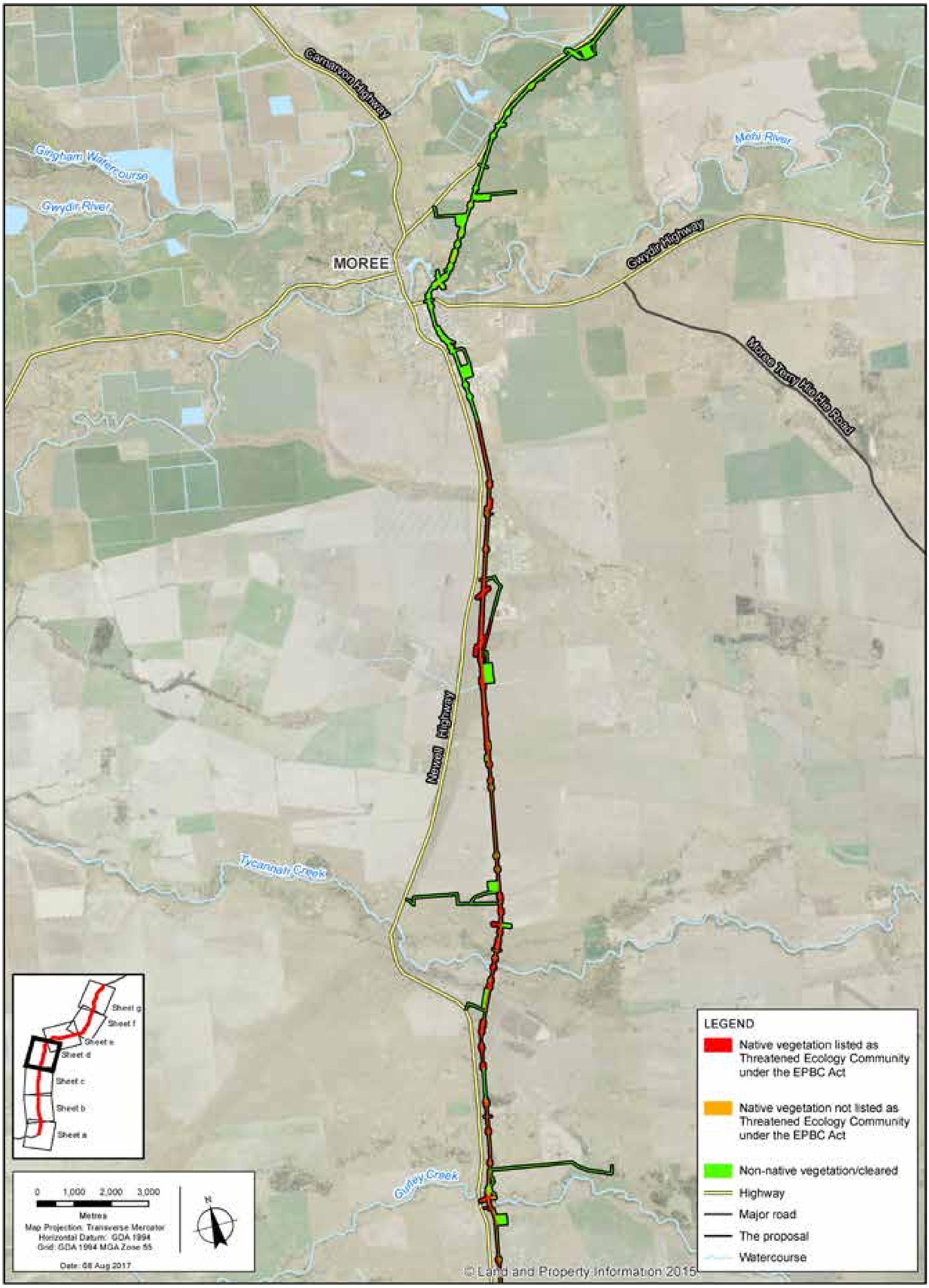


Figure 10.1e Vegetation communities in proposal site

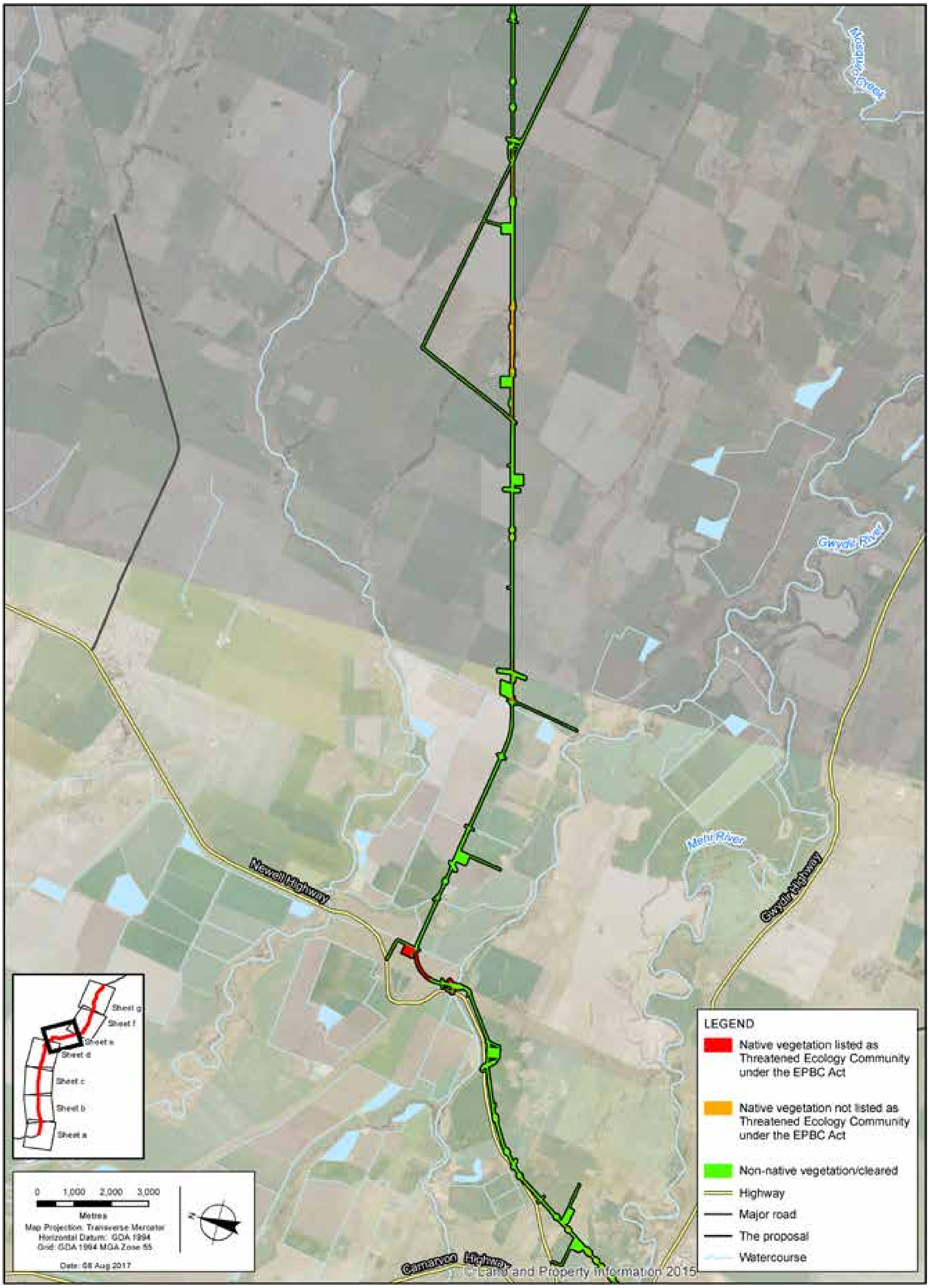


Figure 10.1f Vegetation communities in proposal site

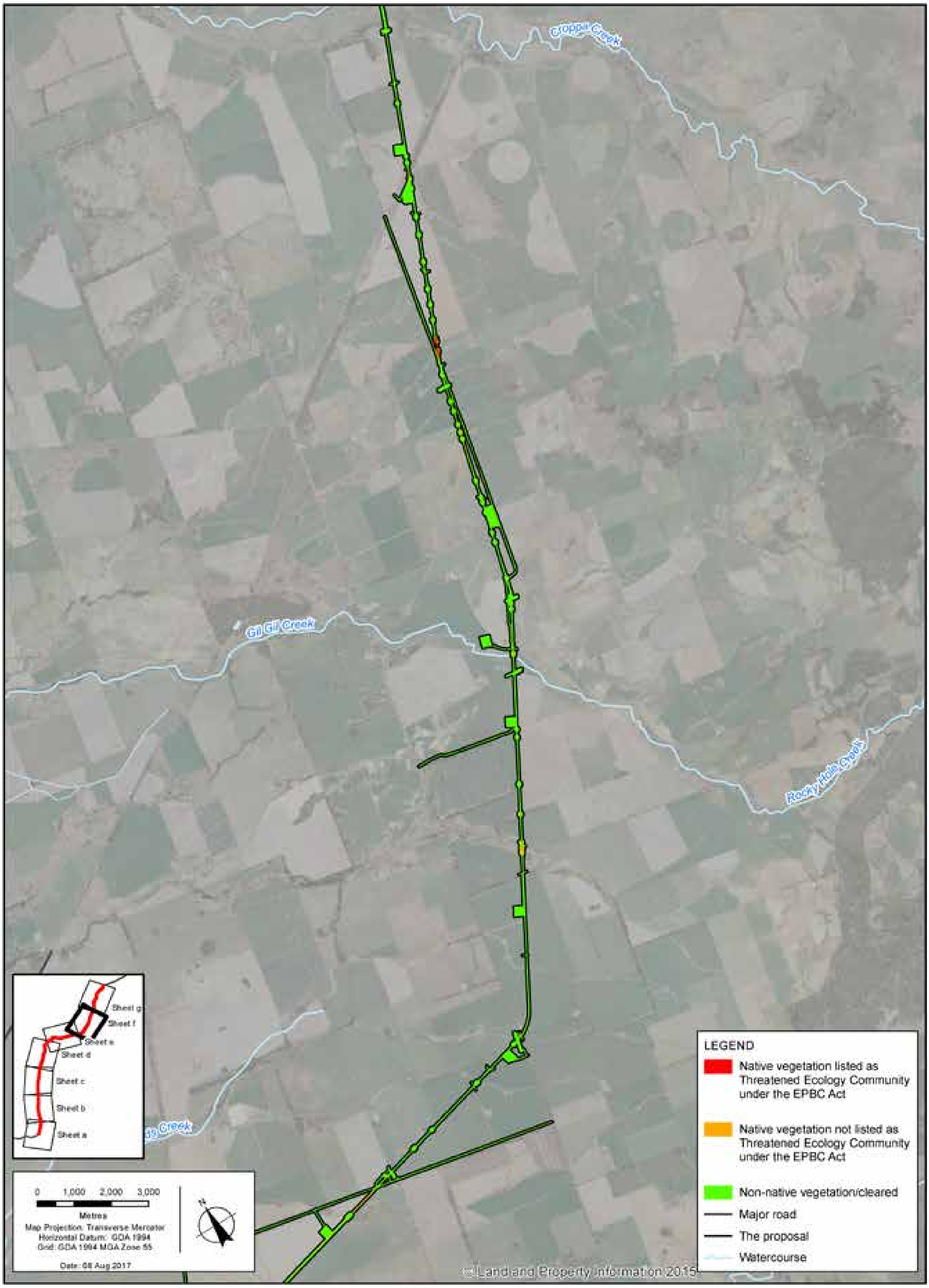
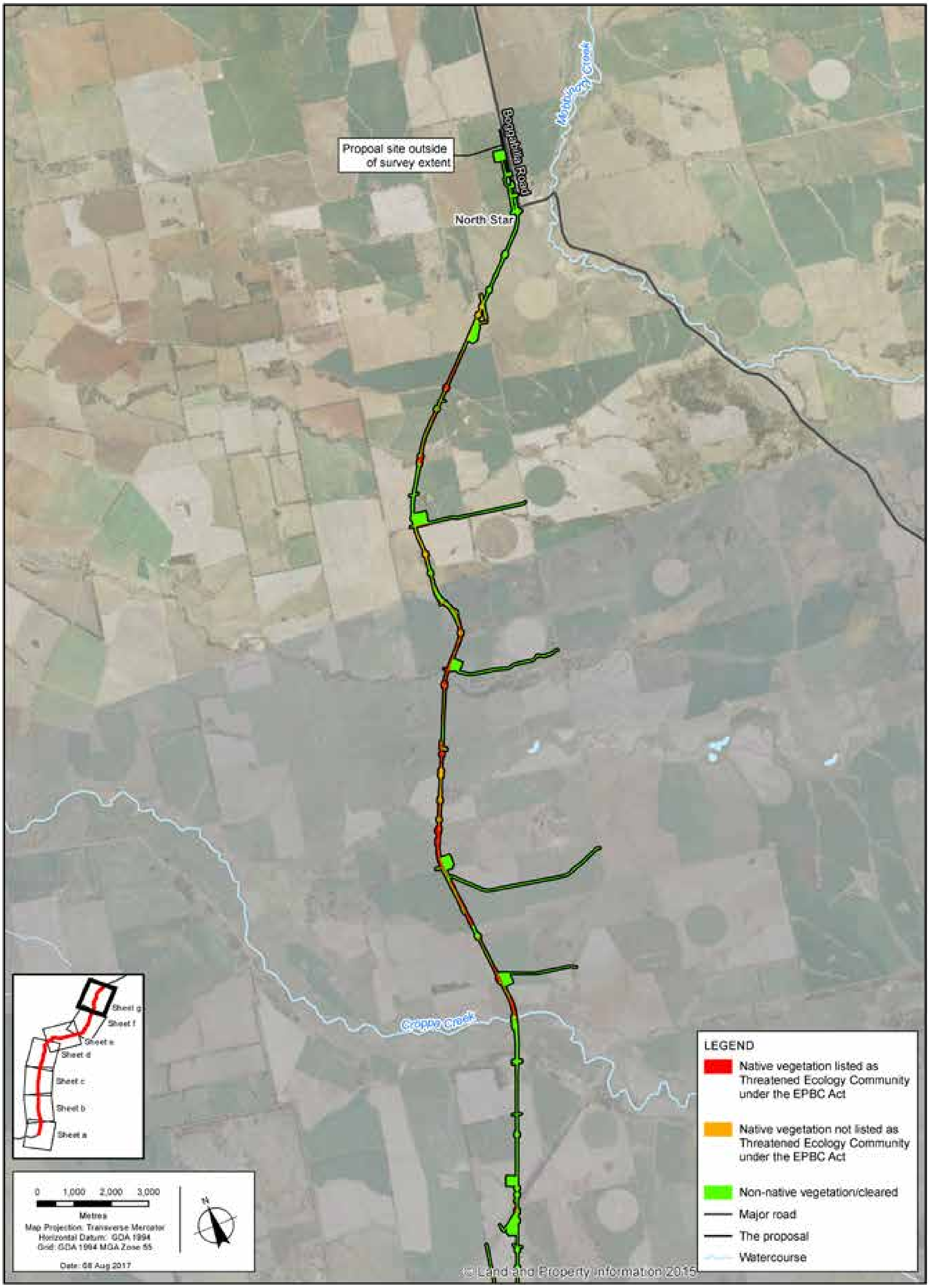


Figure 10.1g Vegetation communities in proposal site



Flora species

A total of 330 flora species were recorded during field surveys. Of the recorded species, 82 (25 per cent) are non-native/exotic species (discussed further below). A full list of recorded species is provided in Technical Report 2.

Fauna habitats

The biodiversity assessment area occurs in a landscape that is dominated by crop land and introduced pastures, and contains only a small proportion of woodland and scattered tree cover. Patches of native woodland habitat exists sporadically and are typically associated with road verges or small woodland patches on farmland. As such, native fauna habitats within the biodiversity assessment area are minimal.

Several general fauna habitat types were identified during field surveys. Each of these habitat types has a range of characteristics that influence the habitat value, and the range of fauna species that are likely to be identified. Sparse woodland areas may provide nesting resources for small birds or hollow resources for micro-bat species. Open grassland may provide a foraging resource for macropods and likely foraging and refuge habitat for reptile species. The broad habitat types recorded within the biodiversity assessment area consist of grasslands, scattered woodland, and riparian and aquatic habitat. Aquatic ecology is described in Section 10.2.3.

Fauna species

Ninety-three (93) fauna species were recorded during field surveys. This included 61 bird species, 4 amphibian species, 4 reptile species, and 24 species of mammal. Commonly recorded species included eastern grey kangaroo (*Macropus giganteus*), magpie lark (*Grallina cyanoleuca*) and noisy miner (*Manorina melanocephala*).

Of the fauna species recorded, six were introduced species, being feral pig (*Sus scrofa*), red fox (*Vulpes vulpes*), cat (*Felis catus*), brown hare (*Lepus capensis*), house mouse (*Mus musculus*) and sheep (*Ovis aries*).

A full list of recorded species is provided in Technical Report 2.

TSC Act protected matters

Threatened Flora

Three threatened flora species, listed as endangered under the TSC Act, were recorded in the biodiversity assessment area during field surveys:

- Belson's panic (*Homopholis belsonii*): a total of 73 individuals were recorded at four locations on alluvial clay soils in the understorey of weeping myall open woodlands
- creeping tick-trefoil (*Desmodium campylocaulon*): 2,559 individuals were recorded within and immediately adjacent to the biodiversity assessment area in naturally-occurring native grasslands
- finger panic grass (*Digitaria porrecta*): 28 individuals were recorded in naturally-occurring native grasslands.

Threatened Fauna

Seven threatened fauna species, listed as vulnerable under the TSC Act, were recorded in the biodiversity assessment area during field surveys:

- grey-crowned babbler (*Pomatostomus temporalis temporalis*)
- varied sittella (*Daphoenositta chrysoptera*)
- koala (*Phascolarctos cinereus*)
- grey-headed flying-fox (*Pteropus poliocephalus*)
- eastern bentwing-bat (*Miniopterus schreibersii oceanensis*)
- little pied bat (*Chalinolobus picatus*)
- yellow-bellied sheathtail-bat (*Saccolaimus flaviventris*).

Threatened ecological communities

Four of the vegetation communities in the biodiversity assessment area (listed in Table 10.1) conform to threatened ecological communities listed under the TSC Act, comprising:

- *Myall Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain, Murray-Darling Depression, Riverina and NSW South Western Slopes Bioregions* (EEC)
- *Brigalow within the Brigalow Belt South, Nandewar and Darling Riverine Plains Bioregions* (EEC)
- *Coolibah - Black Box Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain and Mulga Lands Bioregions* (EEC)
- *Carbeen Open Forest community in the Darling Riverine Plains and Brigalow Belt South Bioregions* (EEC).

No critical habitat listed under the TSC Act occurs within the biodiversity assessment area.

EPBC Act protected matters

Threatened Flora

One threatened flora species listed as vulnerable under the EPBC Act was recorded during field surveys - Belson's panic. A total of 73 individuals were recorded at four locations within alluvial clay soils within the understorey of weeping myall open woodlands within the biodiversity assessment area.

Threatened Fauna

Two threatened fauna species, listed as vulnerable under the EPBC Act, were recorded during field surveys – the koala, and the grey-headed flying-fox.

Koalas were recorded at six locations during the surveys conducted for this assessment. Within the proposal site, potential woodland habitat is restricted to small linear patches and scattered trees, sometimes with adjoining woodland areas. The proposal site contains 2.18 hectares of higher quality koala habitat within riparian communities that contain primary koala food trees [river red gum (*Eucalyptus camaldulensis*) and coolabah (*Eucalyptus coolabah*)]. The proposal site contains 13.44 hectares of moderate koala habitat in communities where bimble box, a secondary koala food tree, is a dominant canopy species. Remnant vegetation associated with rivers and creeks are likely to provide important corridors for the species within the highly modified and fragmented landscape. The biodiversity assessment area contains three known koala food tree species and 62.77 hectares of koala habitat.

A grey-headed flying-fox was recorded on one occasion within the biodiversity assessment area. The nearest known roost camp site of the grey-headed flying-fox to the biodiversity assessment area is at Blair Athol, near Inverell, about 120 kilometres south-east of the biodiversity assessment area. No breeding habitat (camp sites) occur within the biodiversity assessment area.

Potential habitat exists within the biodiversity assessment area for a number of additional threatened species that are listed under the EPBC Act – the swift parrot (*Lathamus discolour*), regent honeyeater (*Anthochaera phrygia*), painted honeyeater (*Grantiella picta*), squatter pigeon (*Geophaps scripta scripta*), five-clawed worm-skink (*Anomalopus mackayi*), pink-tailed worm skink (*Aprasia parapulchella*), border thick-tailed gecko (*Uvidicolus sphyrurus*), pilliga mouse (*Pseudomys pilligaensis*), large-eared pied-bat (*Chalinolobus dwyeri*), and the south-eastern long-eared bat (*Nyctophilus corbeni*). None of these species were recorded during the surveys undertaken in the biodiversity assessment area.

Migratory species

No migratory species listed under the EPBC Act were considered to have the potential to be impacted by the proposal, as little or no suitable habitat is present within the biodiversity assessment area.

Threatened ecological communities

Four of the plant community types listed in Table 10.1 conform to threatened ecological communities listed under the EPBC Act as endangered or critically endangered, where condition thresholds are met:

- *Weeping Myall Woodlands* (endangered)
- *Brigalow (Acacia harpophylla dominant and co-dominant)* (endangered)
- *Coolibah - Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions* (endangered)
- *Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland* (critically endangered).

Weeds of national significance and exotic species

The majority of the biodiversity assessment area is cleared or contains non-native vegetation. Non-native vegetation in the biodiversity assessment area is characterised by a predominantly dense understorey of non-native grasses, forbs and herbs. Dominant non-native grasses typically include Johnson grass (*Sorghum halepense*), paspalum (*Paspalum dilatatum*), bearded oats (*Avena barbata*), *Setaria parviflora* and urochloa grass (*Urochloa panicoides*). Dominant non-native forbs and herbs typically include paddy's lucerne (*Sida rhombifolia*), Cobblers pegs (*Bidens pilosa*), *Centaurium tenuiflorum*, flaxleaf fleabane (*Conyza bonariensis*), cat-head (*Tribulus terrestris*), Bathurst burr (*Xanthium spinosum*), spiked malvastrum (*Malvastrum americanum*), tiger pear (*Opuntia aurantiaca*), and prickly pear (*Opuntia stricta*).

Weeds of national significance that occur in the biodiversity assessment area include African boxthorn (*Lycium ferocissimum*) and tiger pear (*Opuntia aurantiaca*). Weeds of national significance are weeds that have been prioritised by Australian governments based on their potential for spread, their invasiveness, and their social and economic impacts.

10.2.3 Aquatic ecology

General description of aquatic flora and fauna habitat

Watercourses that cross and/or are located near the proposal site are described in Chapter 15. Most are either cleared or contain non-native vegetation. The majority of watercourses are first order or second order streams with intermittent flow following rain events, little or poorly defined channels, and no aquatic flora species. The watercourses have been modified by crossing structures for rail, road, and agricultural land practices, with minimal native vegetation retained along the banks.

The Mehi and Gwydir rivers are defined as 'class 1 key fish habitat'. The location of key fish habitat is described in Section 10.2.4. A full list of recorded species is provided in Technical Report 3.

Threatened species

The database searches identified a number of threatened species, endangered populations and aquatic matters of national environmental significance listed under the FM Act, TSC Act and/or EPBC Act in the study area. Only the FM Act listed eel-tailed catfish (*Tandanus tandanus*), and the EPBC Act listed Murray cod (*Maccullochella peelii*), are considered to have the potential to occur within watercourses in and around the proposal site.

Threatened ecological communities

The proposal site does not contain any threatened aquatic ecological communities. However, it occurs within the mapped distribution of one endangered ecological community under the FM Act – the *Aquatic Ecological Community in the Natural Drainage System of the Lowland Catchment of the Darling River*.

Groundwater dependent ecosystems

Groundwater dependent ecosystems are ecosystems in which species composition and ecological processes are determined by groundwater (Department of Land and Water Conservation, 2002). Ephemeral waterways are likely to be fed by both surface and groundwater, and the associated riparian vegetation is therefore likely to be dependent, at least in some part, on groundwater.

The Gwydir subregion contains a range of groundwater dependent ecosystems, including wetlands, terrestrial vegetation, and instream ecosystems fed by baseflow, and springs focused on the Gwydir wetlands and floodplain systems.

A review of the Australian Government's Atlas (Bureau of Meteorology) *Groundwater Dependent Ecosystems* identified the following groundwater dependent ecosystems in the study area:

- watercourses and riparian vegetation along Gurly Creek, Gehan Creek, Mehi River, Gwydir River and Croppa Creek
- riparian vegetation along Gil Creek is identified as having a low potential for groundwater dependent ecosystems, while upstream of the biodiversity assessment area there is a higher potential for groundwater dependent ecosystems
- floodplain waterbodies associated with Tycannah Creek upstream and downstream of the biodiversity assessment area are mapped as groundwater dependent ecosystems
- the Gwydir River wetlands.

10.2.4 Protected and sensitive lands

Protected areas

No protected areas, defined as areas/reserves managed by OEH and/or DPI NSW Fisheries under the *National Parks and Wildlife Act 1974* (NPW Act), are located near the proposal site. The nearest reserve is the Killarney State Conservation area, located approximately 2 kilometres to the east of the proposal site at the closet point.

Key fish habitat

Table 10.2 lists the areas of key fish habitat within/around the proposal site. These are areas classified as class 3 (minimal key fish habitat) or above, in accordance with the *Policy and guidelines for fish habitat conservation and management* (Department of Primary Industries, 2013).

Critical habitat

No land or waters identified as critical habitat under the TSC Act, FM Act, or EPBC Act are located in the biodiversity assessment area.

Biobank sites, private conservation lands and other lands identified as offsets.

No BioBank sites, private conservation land, or other lands identified as offsets, are located in or in the vicinity of the biodiversity assessment area.

Table 10.2 Key fish habitat

Watercourse	Strahler Order	Habitat sensitivity type[1]	Classification of watercourse for fish passage[1]
Spring Creek	Fourth order	Type 3 - Minimally	Class 3 - Minimal
Bobbiwaa Creek	Fifth order	Type 2 - Moderate	Class 2 - Moderate
Ten Mile Creek	Fifth order	Type 2 - Moderate	Class 2 - Moderate
Bulldog Creek	Third order	Type 3 - Minimally	Class 3 - Minimal
Boggy Creek	Third order	Type 3 - Minimally	Class 3 - Minimal
Gehan Creek	Fourth order	Type 3 - Minimally	Class 3 - Minimal
Unnamed	Third order	Type 3 - Minimally	Class 3 - Minimal
Tookey Creek	Third order	Type 3 - Minimally	Class 3 - Minimal
Waterloo Creek	Fourth order	Type 3 - Minimally	Class 3 - Minimal
Waterloo Creek	Fourth order	Type 3 - Minimally	Class 3 - Minimal
Gurly Creek	Fifth order	Type 2 - Moderate	Class 2 - Moderate
Tycannah Creek	Third order	Type 2 - Moderate	Class 2 - Moderate
Mehi River	Fifth order	Type 1 - Highly	Class 1 - Major
Mehi River	Fifth order	Type 2 - Moderate	Class 3 - Minimal
Duffys Creek	Third order	Type 2 - Moderate	Class 3 - Minimal
Skinners Creek	Third order	Type 3 - Minimally	Class 3 - Minimal
Gwydir River	Fifth order	Type 1 - Highly	Class 1 - Major
Croppa Creek	Fifth order	Type 3 - Minimally	Class 3 - Minimal
Yallaroi Creek	Fourth order	Type 2 - Moderate	Class 2 - Moderate
Tackinbri Creek	Third order	Type 3 - Minimally	Class 3 - Minimal
Mungle Creek	Third order	Type 3 - Minimally	Class 3 - Minimal

Note 1: As per the Policy and guidelines for fish habitat conservation and management (Department of Primary Industries, 2013)

10.3 Impact assessment

10.3.1 Risk assessment

Potential impacts

The environmental risk assessment for the proposal (provided in Appendix B) included an assessment of the potential risks of the proposal in relation to biodiversity. The assessed risk level for the majority of potential risks to biodiversity was between low and medium. Risks with an assessed level of medium or above are as follows:

- clearing of native vegetation resulting in loss of fauna habitat, habitat fragmentation and loss of connectivity
- direct impacts on terrestrial threatened species and endangered populations and communities from clearing
- direct impacts on aquatic threatened species and endangered populations and communities from clearing
- increased potential for the occurrence and spread of pest plants and animals during construction and maintenance from movement of vehicles, machinery and materials in and out of the site, particularly in greenfield sections such as the Camurra bypass
- indirect impacts due to increased dust, sedimentation and erosion, noise and light
- disturbance to aquatic habitats and reduced water quality as a result of fugitive sediments and altered hydrology
- alterations to surface water flow regimes and interruptions to fish passage
- fauna mortality from vehicle strikes.

The SEARs identified a likely significant impact on the following EPBC Act matters:

- *Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland* CEEC
- known foraging habitat for the koala (*Phascolarctos cinereus*).

The SEARs also included the following additional EPBC Act matters as having potential to be impacted by the proposal and requiring assessment for impacts:

- *White Box Yellow Box Blakely's Red Gum Grassy Woodland and Derived Native Grassland* CEEC
- regent honeyeater (*Anthochaera phrygia*)
- squatter pigeon (*Geophaps scripta scripta* (southern))
- painted honeyeater (*Grantiella picta*)
- swift parrot (*Lathamus discolor*)
- superb parrot (*Polytelis swainsonii*)
- Murray cod (*Maccullochella peelii*)
- Pilliga mouse (*Pseudomys pilligaensis*)
- *Androcalva procumbens*
- ooline (*Cadellia pentastylis*)
- bluegrass (*Dichanthium setosum*)
- *Tylophora linearis*
- five-clawed worm-skink (*Anomalopus mackayi*)
- pink-tailed worm-lizard (*Aprasia parapulchella*)
- border thick-tailed gecko (*Uvidicolus sphyrurus*).

Additionally Attachment B of the SEARs identified eight threatened ecological communities, two fauna species, one insect and ten flora species, which required further consideration.

The SEARs provide the requirements for the assessment of the potential impacts on these matters (listed in Table A.3 of Appendix A). Further information on relevant statutory requirements under the EPBC Act is provided in Section 3.5.1.

How potential impacts have been avoided

The option development and assessment process for the Inland Rail location/route options is summarised in Chapter 6. As noted in Chapter 6, the shortlist of route options was subject to a detailed assessment, and the proposed alignment was refined based on evaluation of key considerations, including environmental impacts. The majority of Inland Rail (about 65 per cent) would be located on upgraded track in existing rail corridors, minimising as far as practicable the potential for biodiversity impacts.

The proposal minimises the potential for direct impacts, as the majority of works would be undertaken within areas subject to existing disturbance within the rail corridor. For works outside the corridor (including the Newell Highway overbridge and the Camurra bypass), environmental impacts were included in the list of selection criteria used for the analysis of options (summarised in Chapter 6).

Potential impacts on biodiversity would continue to be avoided by:

- designing, constructing and operating the proposal to minimise the potential for impacts outside the rail corridor
- managing the potential impacts on biodiversity in accordance with relevant legislative and policy requirements, as outlined in Section 10.1.2
- implementing the biodiversity mitigation measures provided in Section 10.4, including the biodiversity offset strategy
- implementing the soils, water, noise and air quality management and mitigation measures provided in Chapters 11, 13, 14 and 16.

10.3.2 Construction impacts – terrestrial ecology

Potential impacts on terrestrial biodiversity during construction include:

- direct impacts as a result of permanent removal (clearing) or temporary disturbance of vegetation in the proposal site to enable the proposal to be constructed
- indirect impacts on flora and fauna located outside the proposal site as a result of activities within the proposal site.

Impacts on vegetation

Direct impacts include the removal of vegetation for the location of permanent infrastructure. Clearing of vegetation would be required to construct and locate the infrastructure. Direct impacts also include temporary disturbance of vegetation. Vegetation has the potential to be temporarily disturbed for construction facilities such as compounds and temporary access tracks. Native vegetation occurring in these areas is not expected to be fully impacted (that is, not cleared), but would be subject to some disturbance, and is expected to recover. While the vegetation and habitats in these areas would be impacted in the short-term, it is expected that these areas would regenerate following completion of construction and rehabilitation undertaken in accordance with the proposed rehabilitation strategy (described in Section 10.4). As a result, these temporary impacts are not included in the calculation of biodiversity credits.

The assumptions used to calculate the potential impacts on terrestrial biodiversity are provided in Technical Paper 2. This impact assessment is based on calculating potential vegetation removal using a conservative worst-case scenario. The actual amount of vegetation with the potential to be directly impacted would be subject to further refinement during detailed design. The estimate of potential clearing would continue to be refined as the design of the project progresses, with the aim of reducing the potential clearing required.

The estimated areas of vegetation (according to plant community types) that would be directly impacted by the proposal are listed in Table 10.3. In summary, it is estimated that the proposal would result in:

- permanent removal or modification of about 411 hectares of native vegetation
- temporary disturbance of about 72 hectares of native vegetation.

Table 10.3 Estimated area of each plant community type that would be impacted

Plant community type[1]		Permanent disturbance area (ha)	Temporary disturbance area (ha)
Listed threatened ecological communities (under the TSC and/or EPBC acts)			
Weeping Myall open woodland of the Darling Riverine Plains Bioregion and Brigalow Belt South Bioregion		5.05	1.90
Brigalow - Belah open forest / woodland on alluvial often gilgaied clay from Pilliga Scrub to Goondiwindi, Brigalow Belt South Bioregion		3.54	1.21
Coolabah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion		1.19	0.0
Queensland Bluegrass +/- Mitchell Grass grassland on cracking clay floodplains and alluvial plains mainly the northern-eastern Darling Riverine Plains Bioregion		237.41	31.23
Carbeen - White Cypress Pine - River Red Gum - bloodwood tall woodland on sandy loam alluvial and aeolian soils in the northern Brigalow Belt South Bioregion and Darling Riverine Plains Bioregion		0.04	0.0
Area impacted - listed communities		**247.23**	**34.34**
Non-listed communities			
Poplar Box - Belah woodland on clay-loam soils on alluvial plains of north-central NSW	*Moderate to good*	55.07	16.88
	Derived native grasslands	87.87	20.34
River Red Gum riparian tall woodland / open forest wetland in the Nandewar Bioregion and Brigalow Belt South Bioregion		14.59	0.10
Coobah - Western Rosewood low open tall shrubland or woodland mainly on outwash areas in the Brigalow Belt South Bioregion		3.57	0.22
Silver-leaved Ironbark - White Cypress Pine - box dry shrub grass woodland of the Pilliga Scrub - Warialda region, Brigalow Belt		2.29	0.30
Area impacted – non-listed communities		**163.39**	**37.84**
Total area impacted		**410.62**	**72.18**

The largest areas of permanent impacts (more than 10 hectares removed) on native vegetation would occur within the following native vegetation communities:

- Queensland Bluegrass +/- Mitchell Grass grassland
- Poplar Box - Belah woodland
- River Red Gum riparian tall woodland / open forest wetland.

Threatened ecological communities – TSC Act

The proposal would result in direct impacts to the following TSC Act listed threatened ecological communities:

- *Myall Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain, Murray-Darling Depression, Riverina and NSW South western Slopes Bioregions* EEC
- *Brigalow within the Brigalow Belt South, Nandewar and Darling Riverine Plains Bioregions* EEC
- *Coolibah - Black Box Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain and Mulga Lands Bioregions* EEC
- *Carbeen Open Forest community in the Darling Riverine Plains and Brigalow Belt South Bioregions* EEC.

The area impacted is listed in Table 10.3.

None of the communities in the biodiversity assessment area are considered to consist of an 'important area' of the EEC or CEEC as defined by the *Framework for Biodiversity Assessment*. An important area comprises an area of a CEEC or EEC that is necessary for the community's long-term persistence and recovery. The areas of EECs within the biodiversity assessment area with the potential to be impacted by the proposal are unlikely to be necessary for the long-term persistence and recovery of the EECs overall. These areas occur as fragmented and disturbed patches, and they do not constitute a large area in comparison with other stands of the EEC.

While the proposal would result in an increase in the level of fragmentation of the EECs at the local scale, the increase in fragmentation is considered to be negligible, given the already highly fragmented nature of the EECs in the study area.

To mitigate the potential impacts to biodiversity as a result of the proposal, biodiversity offsets would be provided in accordance with the Major Projects Offsets Policy, as detailed in Table 10.4 and in Section 10.4.1.

Threatened ecological communities – EPBC Act

The proposal would result in the following permanent impacts to EPBC Act listed threatened ecological communities:

- *Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland* CEEC – 146.7 hectares would be permanently impacted
- *Weeping Myall Woodlands* EEC – all of the 0.43 hectares that meets the definition of the EPBC Act threatened ecological community would be permanently impacted
- *Brigalow (Acacia harpophylla dominant and co-dominant)* EEC – 0.6 hectares would be permanently impacted
- *Coolibah - Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions* EEC – 1.19 hectares would be permanently impacted.

The reduction in the extent of the *Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland CEEC* within the proposal site of 146.7 hectares is likely to result in a significant impact on this threatened ecological community. The proposal is unlikely to result in a significant impact on *Weeping Myall Woodland, Brigalow (Acacia harpophylla dominant and co-dominant)* and *Coolibah - Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions* endangered threatened ecological communities given the small areas of impact associated with each community.

To mitigate the potential impacts to biodiversity as a result of the proposal, biodiversity offsets would be provided, as described in Table 10.5 and Section 10.4.1.

Flora species

Species listed under the TSC Act

The proposal will have an impact on three threatened flora species listed under the TSC Act that occur within the biodiversity assessment area:

- Belson's panic (*Homopholis belsonii*): a total of 73 individuals were recorded at four locations on alluvial clay soils in the understorey of weeping myall open woodlands
- creeping tick-trefoil (*Desmodium campylocaulon*): 2,559 individuals were recorded within and immediately adjacent to the biodiversity assessment area in naturally-occurring native grasslands
- finger panic grass (*Digitaria porrecta*): 28 individuals were recorded in naturally-occurring native grasslands.

No other species-credit flora species are considered likely to be adversely impacted by the proposal.

To mitigate the potential impacts to threatened plants as a result of the proposal, biodiversity offsets would be provided in accordance with the Major Projects Offsets Policy, as detailed in Table 10.4 and in Section 10.4.1.

Species listed under the EPBC Act

One threatened flora species (Belson's panic), listed as vulnerable under the EPBC Act, was recorded during the surveys undertaken for this assessment.

Given the relatively small number of individuals recorded in the proposal site (73), the highly disturbed and fragmented nature of the proposal site and the reasonable number of records of this species outside the proposal site at this locality according to the OEH Atlas of NSW Wildlife, it is unlikely that a key source population either for breeding or dispersal, a population that is necessary for maintaining genetic diversity or a populations that is near the limit of its known range occurs within the proposal site. Therefore the individuals of Belson's panic within the proposal site are not considered to form part of an important population. Therefore the proposal is unlikely to result in a significant impact on an important population of Belson's panic.

To mitigate the potential impacts to Belson's panic as a result of the proposal, biodiversity offsets would be provided, as described in Table 10.4 and Section 10.4.1.

Fauna species

Species listed under the TSC Act

Removal of the vegetation communities described above would impact on fauna habitats in the biodiversity assessment area. Fauna habitat resources that would be removed include foraging and shelter resources. Threatened fauna species recorded in the biodiversity assessment area are described in Section 10.2.2. As per the *Framework for Biodiversity Assessment* methodology:

- The grey-headed flying-fox, eastern bentwing-bat, and little pied bat are species-credit species for breeding habitat only. No breeding habitat for these species were identified in the biodiversity assessment area, and none is considered likely to occur.
- The grey-crowned babbler, varied sittella, and yellow-bellied sheathtail-bat are ecosystem-credit species predicted by the landscape features of the biodiversity assessment area. Therefore, they do not generate any species credits.
- 1,632 species credits for koala would require offsetting as a result of the permanent impacts of the proposal.
- While the proposal would result in an increase in the level of fragmentation of threatened species habitat at the local scale, the increase in fragmentation is considered to be negligible, given the already highly fragmented nature of the fauna habitats across the biodiversity assessment area.

Temporary construction compounds and work sites will be bounded by temporary fauna exclusion fencing, where appropriate, to prevent mortality of fauna species during construction.

Species listed under the EPBC Act

Although the proposal would result in the removal of 15.62 hectares of known habitat for the koala, it is unlikely to modify, destroy, remove, isolate, or decrease the availability or quality of habitat to the extent that the species would be likely to decline. However, the Department of the Environment and Energy has determined the proposal is likely to result in a significant impact on the koala. Pre-clearing surveys and other mitigation measures are likely to reduce the risk of adverse impacts on this species.

The koala is a species credit species and potential impacts resulting from habitat removal in the biodiversity assessment area will be offset through the retirement of species credits as detailed in Table 10.4 and Table 10.5.

One grey-headed flying-fox was recorded within the proposal site. There are no records of grey-headed flying-fox on the OEH Atlas of NSW Wildlife within 10 kilometres of the proposal site. There are no camp sites or breeding habitat for this species within the proposal site and therefore, it is unlikely to be a key source population either for breeding or dispersal or comprise a population that is necessary for maintaining genetic diversity. The species is not near the limits of its known range within the proposal site. Therefore, any potentially occurring population of grey-headed flying-fox within the proposal site would not be considered to be an important population. The proposal is therefore unlikely to result in a significant impact on an *important population* of the grey-headed flying-fox.

Ten vulnerable EPBC Act listed fauna species were found to have known or potential habitat within the biodiversity assessment area– koala, squatter pigeon, painted honeyeater, Murray cod, Piliga mouse, five-clawed worm-skink, pink-tailed worm lizard, border thick-tailed gecko, south-eastern long-eared bat, and grey-headed flying-fox.

Potential habitat exists within the biodiversity assessment area for a number of additional threatened species that are listed under the EPBC Act – the swift parrot (*Lathamus discolour*), regent honeyeater (*Anthochaera phrygia*), and large-eared pied-bat. The assessment undertaken has concluded that the proposal is unlikely to have a significant impact on these threatened fauna species given:

- the highly modified, fragmented and disturbed nature of the proposal site
- intensive and targeted field surveys failed to detect the species or ecological communities
- characteristic or potential habitat is absent or represents minimal areas in the proposal site
- the proposal site is outside the known species ranges and there are no nearby records, and/or
- important populations, using the definition in the EPBC Act Policy Statement 1.1 – Significant Impact Guidelines – Matters of National Environmental Significance (Department of the Environment, 2013), are not present within the proposal site as the area is not considered to contain key source populations either for breeding or dispersal, populations that are necessary for maintaining genetic diversity, and/or populations that are near the limit of the species range.

Biodiversity offsets provided for native vegetation loss, as described in Table 10.4 and Section 10.4.1 will mitigate impacts associated with habitat loss for these threatened fauna species.

Migratory species

No migratory species were considered to have the potential to be significantly impacted by the proposal, as there is little or no suitable habitat is present within the biodiversity assessment area. No migratory species listed under the EPBC Act would be significantly impacted by the proposal.

Biodiversity offsets

The number and type of biodiversity credits required to offset the impacts of the proposal have been calculated in accordance with the *Framework for Biodiversity Assessment*, and are listed in Table 10.4. The TSC Act and EPBC Act listed threatened ecological communities that these plant community types conform to are listed in Table 10.1. The ecosystem credits required for offsetting incorporate the offsets for the threatened ecological communities recorded, required as a result of the clearing of native vegetation. Species credits are required for offsetting impacts on the finger panic grass, creeping tick-trefoil, Belson's panic and the koala under the provisions of the NSW *Framework for Biodiversity Assessment* and Major Projects Offsets Policy.

Biodiversity offsets are required for significant residual impacts of the proposal on matters of national environmental significance under the provisions of the EPBC Act Offset Policy. Biodiversity offset is therefore required for impacts of the proposal on *Natural grassland on basalt and fine-textured alluvial plains of northern NSW and southern Queensland* CEEC and the koala. Like-for-like credit retirement will be undertaken for these matters of national environmental significance affected by the proposal in accordance with the NSW *Framework for Biodiversity Assessment* as indicated in Table 10.5. The final application of offset credits for relevant matters of national environmental significance following the like-for-like principal will be determined during detailed design.

Biodiversity offsets for impacts on the remaining EPBC Act-listed EECs of relevance to the proposal, where there will not be a significant residual impact, while not required under the EPBC Act Offset Policy, will be provided through the offset contribution for native vegetation loss required by the NSW *Framework for Biodiversity Assessment* as indicated in Table 10.5. Similar considerations apply for Belson's panic, which although unlikely to be significantly impacted, will be offset via the offset contribution required by the NSW *Framework for Biodiversity Assessment* and Major Projects Offsets Policy.

Table 10.4 Credits required for offsetting impacts

Community/species	Credits required
Ecosystem credits	
PCT 27 Weeping Myall open woodland of the Darling Riverine Plains Bioregion and Brigalow Belt South Bioregion	254
PCT 35 Brigalow - Belah open forest / woodland on alluvial often gilgaied clay from Pilliga Scrub to Goondiwindi, Brigalow Belt South Bioregion	250
PCT 39 Coolabah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion	63
PCT 52 Queensland Bluegrass +/- Mitchell Grass grassland on cracking clay floodplains and alluvial plains mainly the northern-eastern Darling Riverine Plains Bioregion	11,046
PCT 56 Poplar Box - Belah woodland on clay-loam soils on alluvial plains of north-central NSW	6,303
PCT 71 Carbeen - White Cypress Pine - River Red Gum - bloodwood tall woodland on sandy loam alluvial and aeolian soils in the northern Brigalow Belt South Bioregion and Darling Riverine Plains Bioregion	2
PCT 78 River Red Gum riparian tall woodland / open forest wetland in the Nandewar Bioregion and Brigalow Belt South Bioregion	675
PCT 135 Coobah - Western Rosewood low open tall shrubland or woodland mainly on outwash areas in the Brigalow Belt South Bioregion	133
PCT 413 (BR346, NA348) Silver-leaved Ironbark - White Cypress Pine - box dry shrub grass woodland of the Pilliga Scrub - Warialda region, Brigalow Belt South Bioregion	100
Total ecosystem credits required for offsetting	**18,826**
Species credits	
Finger panic grass (*Digitaria porrecta*)	364
Creeping tick-trefoil (*Desmodium campylocaulon*)	2,607
Belson's panic (*Homopholis belsonii*)	1,898
Koala (*Phascolarctos cinereus*)	1,632
Total ecosystem credits required for offsetting	**6,501**

Table 10.5 Summary of the offset requirements for relevant matters of national environmental significance

Matters of national environmental significance	Like for like offset in accordance with NSW FBA
Natural grassland on basalt and fine-textured alluvial plains of northern NSW and southern Queensland	Subject to the revision of credits as part of the detailed design process, 11,046 ecosystem credits will be retired to offset impacts to this critically endangered threatened ecological community, in accordance with the biodiversity offset strategy and the NSW *Framework for Biodiversity Assessment*.
Koala	Subject to the revision of credits as part of the detailed design process, 1,632 species credits will be retired to offset impacts on this threatened species, in accordance with the biodiversity offset strategy and the NSW *Framework for Biodiversity Assessment*.

Indirect impacts

Indirect impacts could include the following:

- edge effects – can occur in adjoining or adjacent areas of vegetation and habitat as a result of weed growth, increased noise and light, erosion and sedimentation, and can result from vegetation clearance, where a new edge is created between vegetation and cleared areas, or from widening or extending of cleared easements through existing vegetation
- light and noise – could impact breeding, foraging and roosting activities where fauna are located close to construction activities
- erosion and sedimentation - uncontrolled erosion of topsoil, including wind erosion, from excavated areas and exposed soils and deposition into native vegetation can cause weed problems, reduce habitat values and stifle plant growth
- weeds - dispersal of weed propagules (seeds, stems and pollen) into areas of native vegetation through erosion (wind and water) and the movement of workers and vehicles
- plant pathogens - potential spread of soil-borne pathogens of native plants (for example, Phytophthora (*Phytophthora cinnamomi*) spread on machinery
- disease - potential spread of Chytrid fungus into local native frog populations, through soil and water on machinery and through human contact
- fauna injury and mortality – as a result of vegetation clearing (particularly hollow-bearing trees), boulder removal and excavations.

These impacts can be readily managed through the implementation of standard construction soil and water management measures (listed in Chapters 14 and 16) and the other mitigation measures listed in Section 10.4. With the implementation of these measures, no significant indirect impacts on biodiversity are predicted.

Summary of potential impacts on biodiversity values not covered by the Framework for Biodiversity Assessment

Biodiversity values not considered under the *Framework for Biodiversity Assessment* include marine mammals, wandering sea birds and biodiversity that are endemic to Lord Howe Island. None of these biodiversity values occur or have the potential to occur within the biodiversity assessment area, and as do not require further consideration.

In addition, the *Framework for Biodiversity Assessment* does not assess the direct impacts of a proposal that are not associated with clearing of vegetation. The main impact related to the proposal would be vehicle (train) strike during operation (considered in Section 10.3.4).

The impacts on potentially groundwater dependent ecosystems are summarised in Section 10.3.3. As the proposal does not involve substantial excavations are that likely to interfere with groundwater, the risk of impacts to groundwater and groundwater dependent ecosystems is low.

The impacts on aquatic ecology are provided in Technical Report 3 and summarised in Section 10.3.3.

Summary of potential impacts on the EECs, threatened species and/or populations as listed in Attachment B to the SEARs

EECs

The proposal would impact on the EECs specifically identified in the SEARs. The impacts to EECs are summarised in Table 10.3. It is unlikely that the proposal would impact these communities in such a way as to change the characteristic and functionally important species, impact their quality and integrity, or fragment an important area of the community in the study area.

Table 5.4 of Technical Report 2 provides detailed information for the threatened ecological communities identified in the SEARs as requiring further consideration.

To mitigate the potential impacts to EECs as a result of the proposal, biodiversity offsets would be provided in accordance with the Major Projects Offset Policy, as described in Section 10.4.1.

Threatened fauna species

None of the threatened fauna species identified in the SEARs as requiring further consideration were recorded during field surveys. However, it is acknowledged that these species have the potential to occur. Table 5.5 of Technical Paper 2 provides detailed information for the threatened fauna species identified in the SEARs as requiring further consideration.

Threatened flora species

Ten threatened flora species were identified in the SEARs as requiring further consideration. Of those species, the following were recorded within the biodiversity assessment area during field surveys:

- finger panic grass
- Belson's panic
- creeping tick-trefoil.

Additionally, while not recorded in the biodiversity assessment area, bluegrass (*Dichanthium setosum*), which is listed as vulnerable under the TSC Act and EPBC Act, may occur due to suitable habitat and nearby records.

The proposal would impact these species and their habitats by temporary and permanent disturbances and increasing fragmentation. However, it is unlikely that the proposal would impact these species in such a way as to modify habitat importance, or substantially impact these species' pollination cycles, seedbanks, recruitment, or interactions with other species.

The proposal is likely to impact the local population of creeping tick-trefoil, permanently disturbing an estimated 237.41 hectares of habitat for this species. Table 5.6 of Technical Paper 2 provides detailed information for the threatened flora species identified in the SEARs as requiring further consideration.

To mitigate the potential impacts to these species as a result of the proposal, biodiversity offsets would be provided in accordance with the Major Projects Offsets Policy, as described in Section 10.4.1.

Potential impacts on biodiversity values that require further consideration

Under the *Framework for Biodiversity Assessment*, certain impacts on biodiversity values may require further consideration by the consent authority. These are impacts that are considered to be complicated or severe and include:

- impacts on landscape features
- impacts on native vegetation that are likely to cause the extinction, or significantly reduce the viability, of an EEC/CEEC from an IBRA subregion
- impacts on critical habitat or on threatened species or populations that are likely to cause the extinction of a species or population from an IBRA subregion or significantly reduce its viability.

The proposal would not result in any of the above severe impacts.

Key threatening processes

The proposal is not classified as a key threatening process. The proposal may contribute to the following key threatening processes through clearing and edge effects:

- aggressive exclusion of birds by noisy miners (*Manorina melanocephala*)
- clearing of native vegetation
- loss of hollow-bearing trees
- removal of dead wood and dead trees
- competition and grazing by the feral European rabbit (*Oryctolagus cuniculus*)
- predation by the European red fox
- invasion of native plant communities by exotic perennial grasses.

The mitigation and management of the impacts of the proposal, including measures to mitigate contributions to the above key threatening processes where appropriate, are discussed in Section 10.4.

10.3.3 Construction impacts – aquatic ecology

Potential impacts on aquatic ecology include:

- removal of riparian vegetation on the banks of watercourses to build the new bridges over the Mehi and Gwydir rivers and Croppa Creek, and to replace some of the culverts
- temporary obstruction of fish passage associated with bridge and culvert works, and any vehicle access across watercourses
- removal of in-stream vegetation
- impacts to fish within any semi-permanent pools within the proposal site
- any impacts to water quality during construction (described in Chapter 16) has the potential to impact on aquatic ecology in receiving watercourses.

As noted in Section 10.2.3, some of the watercourses crossed by the proposal site (including the Mehi and Gwydir rivers) comprise important aquatic ecosystems and key fish habitat. These watercourses would be subject to temporary construction impacts as noted above. However, the temporary construction impacts would occur in discrete areas where the rail corridor crosses the watercourses, and only a very small proportion of the aquatic habitat associated with the watercourses would be impacted. Assuming the implementation of appropriate construction mitigation and management measures, no long-term impacts are predicted.

These potential impacts would be minimised by the implementation of appropriate design features to minimise watercourse impacts (described in Chapters 15 and 16), the soil and water mitigation measures provided in Chapters 14 to 16, and the mitigation measures provided in Section 10.4.

As described in Section 10.2.3, the proposal site is located within the mapped distribution of an aquatic threatened ecological community, and an endangered aquatic population. Assessments of significance of the potential impact on these matters were undertaken as part of the aquatic ecology assessment provided in Technical Report 3. The assessments concluded that the proposal is unlikely to have an adverse impact, assuming the adoption of appropriately designed fish friendly crossing structures and other mitigation measures to further reduce impacts.

The proposal is not expected to significantly change local surface water flow regimes, and would not require extraction of groundwater. Clearance of riparian vegetation for the upgrading of watercourse structures may occur where it is not possible to undertake works within the existing disturbance area. However, works to watercourse crossings are not expected to adversely alter local surface or groundwater flow regimes and the proposal is not expected to impact on groundwater dependent ecosystems.

10.3.4 Operation impacts

Increased rail movements may result in adverse impacts on locally occurring fauna species, particularly terrestrial mobile species as a result of vehicle strikes. Although there would be an increase in the number of trains using the operational rail line, no significant vehicle strike impacts are predicted.

Permanent fauna exclusion fencing of the rail corridor is not proposed. The barrier that fauna exclusion fencing would create is considered likely to result in an adverse effect on the connectivity of habitat along the rail corridor and the movement of fauna species across the landscape, including the koala, would be impeded by such fencing.

It is acknowledged in the biodiversity assessment that there is an increased risk of train strike on fauna species as a result of the proposal. Although the proposal will result in an increased number of trains using the rail line, there will still only be approximately 20 trains per day. The risk of vehicle strike due to the proposal is much lower than for a road project where there may be thousands of vehicle movements per day. The maintenance of movement corridors between remnant vegetation patches within the local area and region is particularly important for the koala. Considering these factors, a permanent fauna exclusion fence is not proposed. Weed species could be inadvertently brought into the proposal site with imported materials, or could invade naturally through removal of native vegetation. Mitigation measures outlined in Section 10.4 would minimise the potential for weed encroachment into surrounding areas around the proposal site.

No other operational activities, such as maintenance inspections or monitoring, are expected to impact on native flora and fauna or other biodiversity values.

10.4 Mitigation and management

10.4.1 Approach to mitigation and management

ARTC is committed to minimising the environmental impact of the proposal and is investigating opportunities to reduce actual impact areas where practicable. The area that would be directly impacted by construction activities would depend on factors such as presence of significant vegetation, constructability, construction management and safety considerations, landform, slopes and anticipated sub-soil structures. Direct impacts would be reduced as far as practicable. The exact amount of clearance (within the proposal site) would be refined during detailed design.

ARTC has, where possible, altered the proposal to avoid and minimise ecological impacts in the proposal planning stage, and a range of impact mitigation strategies have been included in the proposal to mitigate the impact on ecological values prior to the consideration of offsetting requirements. Further refinement will be made during detailed design, where possible, to minimise ecological impacts.

Biodiversity offsets

ARTC is committed to delivering a biodiversity offset strategy for the proposal that appropriately compensates for the unavoidable loss of ecological values as a result of the proposal under the Major Projects Offsets Policy.

The proposal will include the retirement of credits calculated in accordance with the NSW *Framework for Biodiversity Assessment* (provided in Section 10.3.2). This includes all plant community types that would be directly and permanently impacted as a result of the proposal. The retirement of credits associated with the plant community types occurring in the biodiversity assessment area also ensures that the habitat for threatened fauna and flora species are offset as part of the proposal.

In accordance with the *Framework for Biodiversity Assessment*, there are two options, which can be used separately or together to fulfil offset requirements:

- securing like for like offsets to retire credits
- contributing to supplementary measures.

Analysis undertaken to date suggests that potential offsets would be identified within either the subregion in which the proposal site is located, or an adjoining subregion.

Biodiversity offset strategy for the proposal

The Narrabri to North Star biodiversity offset strategy (phase 1) has been developed for the proposal and is provided in Appendix L. The strategy is summarised below.

The approach to biodiversity offsets for the proposal has been developed in accordance with the NSW *Framework for Biodiversity Assessment*, and based on the calculated offset credits described in Section 10.3.2. This will provide for the offset requirements (for both plant community types and species requiring offsets) in accordance with the Major Projects Offsets Policy.

Efforts to secure these credits will continue throughout detailed design. The tasks undertaken and proposed are summarised in Table 10.6.

Table 10.6 Proposal biodiversity offset strategy tasks

Step	Actions
Check for available credits	The OEH biodiversity credits register was checked on 15 December 2016 to determine if ecosystem credits matching the proposal offset requirements have been issued and are available.
Check for expressions of interest	The OEH BioBank site expression of interest register was checked on 16 December 2016 to determine if a landholder may have credits matching the proposal offset requirements, but have not yet issued those credits.
Identify potential like for like offset sites	A desktop analysis was undertaken in December 2016.
Put a request on the credits wanted list	A 'credits wanted' request will be prepared and submitted on the OEH credits wanted register for the approximate number and type of credits required for the proposal once these are confirmed with assessing agencies.
Test landholder interest	If the proposal is approved, contact would be made with shortlisted landholders to determine their interest in entering into a BioBanking agreement and selling credits to ARTC.
Validate offset credits	Potential offset sites would be ground-truthed to validate the presence of ecosystem and/or species credit requirements, and assess overall suitability as an offset. Shortlisted offset properties would then be taken to the next level of assessment.
Investigate options for supplementary measures and estimate costs	The indicative cost of supplementary measures is estimated with similar credits already sold as part of the BioBanking scheme acting as a guide to pricing.

A search of the OEH biodiversity credits register and expression of interest register in December 2016 identified there were no suitable ecosystem credits available for purchase (apart from one expression of interest potentially occurring in an adjacent subregion) that satisfy the *Framework for Biodiversity Assessment* criteria for the proposal. For koalas, there are three offset sites on the OEH credit register for the whole of NSW available for use. Two are classified with a credit status of 'Issued' and have a combined credit number of 1,074 which would meet the proposal's requirements.

To assess offset availability more broadly, a spatial analysis of OEH's vegetation information system database and mapping has been undertaken. The results of the spatial analysis indicate that there are mapped areas of each plant community type requiring offsets within at least one of the impact subregions. In addition, each impacted plant community type has been identified and mapped within at least two of the adjoining subregions that can also be considered for offsetting purposes.

The analysis shows there is opportunity to identify potential offsets for impact plant community types within either the impacted subregion or adjoining subregion.

The biodiversity offset strategy (phase 2) will be submitted post detailed design and prior to commencement of construction activities. Phase 2 will consist of confirmation of the biodiversity credits required, preliminary field inspection outcomes for proposed offset sites, and assessment of condition, key threats and likely management actions of the offset site. Phase 2 of the biodiversity offset strategy has commenced and an offset analysis has been undertaken to identify potential environmental offset sites for the proposal. This approach is consistent with the NSW Offset Delivery Strategy prepared for ARTC and will maximise efficiencies and conservation outcomes when delivering the NSW Inland Rail offset requirements. The GIS criteria and desktop assessment process has followed the requirements of the Major Projects Offsets Policy. Therefore all potential offset sites that will be investigated will follow the rules within the policy, and no formal variations are required. Furthermore, landholder engagement has commenced to finalise interested landholders. Thereafter, ground-truthing and survey will commence.

The biodiversity offset strategy (phase 3) will be prepared and submitted for approval within 12 months post commencement. The phase 3 report will provide in detail the final offset sites proposed, ground-truthed confirmation of plant community types and species credits generated at the offset site/s, completed biodiversity credit calculator output and report and a detailed offset site management plan. It is then proposed that the endorsed offset site/s are legally secured within 2 years post commencement.

10.4.2 Consideration of the interactions between mitigation measures

Mitigation measures to minimise potential impacts associated with noise, air quality, soils, hydrology and water quality would also assist in mitigating the potential impacts to biodiversity. These mitigation measures are detailed in Chapters 11 and 13 to 16. The rehabilitation strategy would also assist in mitigating identified land use, and landscape and visual impacts.

10.4.3 Summary of mitigation measures

To mitigate the potential impacts to biodiversity, the mitigation measures listed in Table 10.7 would be implemented.

Table 10.7 Biodiversity - summary of mitigation measures

Stage	Impact	Mitigation measures
Detailed design/ pre-construction	Biodiversity offset strategy	The biodiversity offset strategy (phase 1) for the proposal would be finalised in accordance with the requirements of the NSW *Framework for Biodiversity Assessment* (OEH, 2014b) and the Major Projects Offsets Policy (OEH, 2014c). The biodiversity offset strategy would be approved by the Department of Planning and Environment prior to the commencement of construction work that would result in the disturbance of relevant ecological communities, threatened species, or their habitat, unless otherwise agreed.
	Direct impacts to biodiversity	Detailed design and construction planning would minimise the construction footprint and avoid impacts to native vegetation as far as practicable.
	Riparian vegetation	Compounds would be located an appropriate distance from riparian vegetation to avoid indirect impacts on aquatic habitat. This includes a minimum of 100 metres for type 1 class 1 watercourses (Mehi River and Gwydir River), 50 metres for type 2 class 2 to 3 watercourses, and 10 to 50 metres for type 3 class 2 to 4 watercourses. Direct impacts to in-stream vegetation and native vegetation on the banks of watercourses would be avoided as far as practicable.
	Fish passage	Detailed design and construction planning would minimise the potential for impacts to fish passage. To ensure that fish passage is maintained, watercourse crossing structures would be designed in accordance with the guideline *Why do fish need to cross the road? Fish passage requirements for waterway crossings* (Fairfull and Witheridge, 2003) and the minimum design requirements specified in Table 5.1 of Technical Report 3.

Stage	Impact	Mitigation measures
Pre-construction construction	General biodiversity impacts	A biodiversity management sub-plan would be prepared and implemented as part of the CEMP. It would include measures to minimise the potential for biodiversity impacts. The sub-plan would address, as outlined below: ▸ a pre-clearance survey and tree-felling procedure ▸ procedures to manage micro-bats ▸ avoiding impacts on surrounding vegetation ▸ weed management ▸ dewatering of standing pools in watercourses ▸ measures to minimise impacts on aquatic ecology.
	Pre-clearing surveys	Pre-clearing surveys would be undertaken prior to construction. The surveys and inspections, and any subsequent relocation of species, would be undertaken in accordance with the biodiversity management sub-plan in the CEMP.
	Rehabilitation	A rehabilitation strategy would be prepared to guide the approach to rehabilitation of disturbed areas following the completion of construction. The strategy would include: ▸ clear objectives and timeframes for rehabilitation works (including the biodiversity outcomes to be achieved) ▸ details of the actions and responsibilities to progressively rehabilitate, regenerate, and/or revegetate areas, consistent with the agreed objectives ▸ identification of flora species and sources ▸ procedures for monitoring the success of rehabilitation ▸ corrective actions should the outcomes of rehabilitation not conform to the objectives adopted.
Construction	Avoidance of impacts	Areas of biodiversity value outside the proposal site would be fenced or signposted, where appropriate, to prevent the unnecessary disturbance during the construction phase.
	Weed management	Noxious weeds would be managed in accordance with the *Noxious Weeds Act 1993*. Weeds of national environmental significance would be managed in accordance with the *Weeds of National Significance: Weed management guides.* Any herbicides would be applied such that impacts on surrounding agricultural properties are avoided.
	Rehabilitation	Rehabilitation of disturbed areas would be undertaken progressively and in accordance with the rehabilitation strategy.
Operation	Fish passage	Culverts would be regularly inspected and maintained to minimise blockage of fish passage.
	Weed management	Annual inspections would be undertaken for weed infestations and to assess the need for control measures. Any outbreak of noxious and/or weeds of national environmental significance would be managed in accordance with the *Noxious Weeds Act 1993*, the *Weeds of National Significance: Weed management guides*, and the requirements of relevant authorities.

11. Noise and vibration (amenity impacts)

This chapter provides a summary of the noise and vibration assessment undertaken for the proposal as it relates to the potential for amenity impacts. It describes the existing environment, assesses the impacts from construction and operation of the proposal, and provides recommended mitigation and management measures. The full Noise and Vibration Assessment report is provided as Technical Report 5.

This chapter focuses on the potential for audible noise impacts and human comfort impacts as a result of vibration. Structural noise and vibration impacts are considered in Chapter 12.

11.1 Assessment approach

11.1.1 Methodology

The noise and vibration assessment:

- identifies noise and vibration sensitive receivers
- identifies existing noise and vibration levels in the study area
- identifies the main potential noise and vibration sources during construction and operation
- establishes amenity-related noise and human comfort vibration criteria/management levels to:
  - provide a basis for assessing the potential for impacts during construction
  - provide a basis for assessing the potential for impacts during operation, based on the current design
  - use as the basis for monitoring during construction and operation
- assesses the potential for noise and vibration to exceed the applicable criteria and impact on the amenity of sensitive receivers
- provides amenity-related noise and vibration mitigation measures.

A summary of the main tasks involved in the assessment is provided in the following sections. Further information is provided in Technical Report 5.

The study area for the noise and vibration assessment is defined as the area that extends about 2 kilometres from the centreline of the proposal site.

Identification of noise and vibration sensitive receivers

Potentially sensitive receivers are those that may be affected by changes in noise and vibration levels within the study area. Noise and vibration sensitive receivers were identified based on the type of land use, the activities undertaken, and the nature of the building, by using aerial imagery and geospatial information. Sensitive receivers are described in Section 11.3.1.

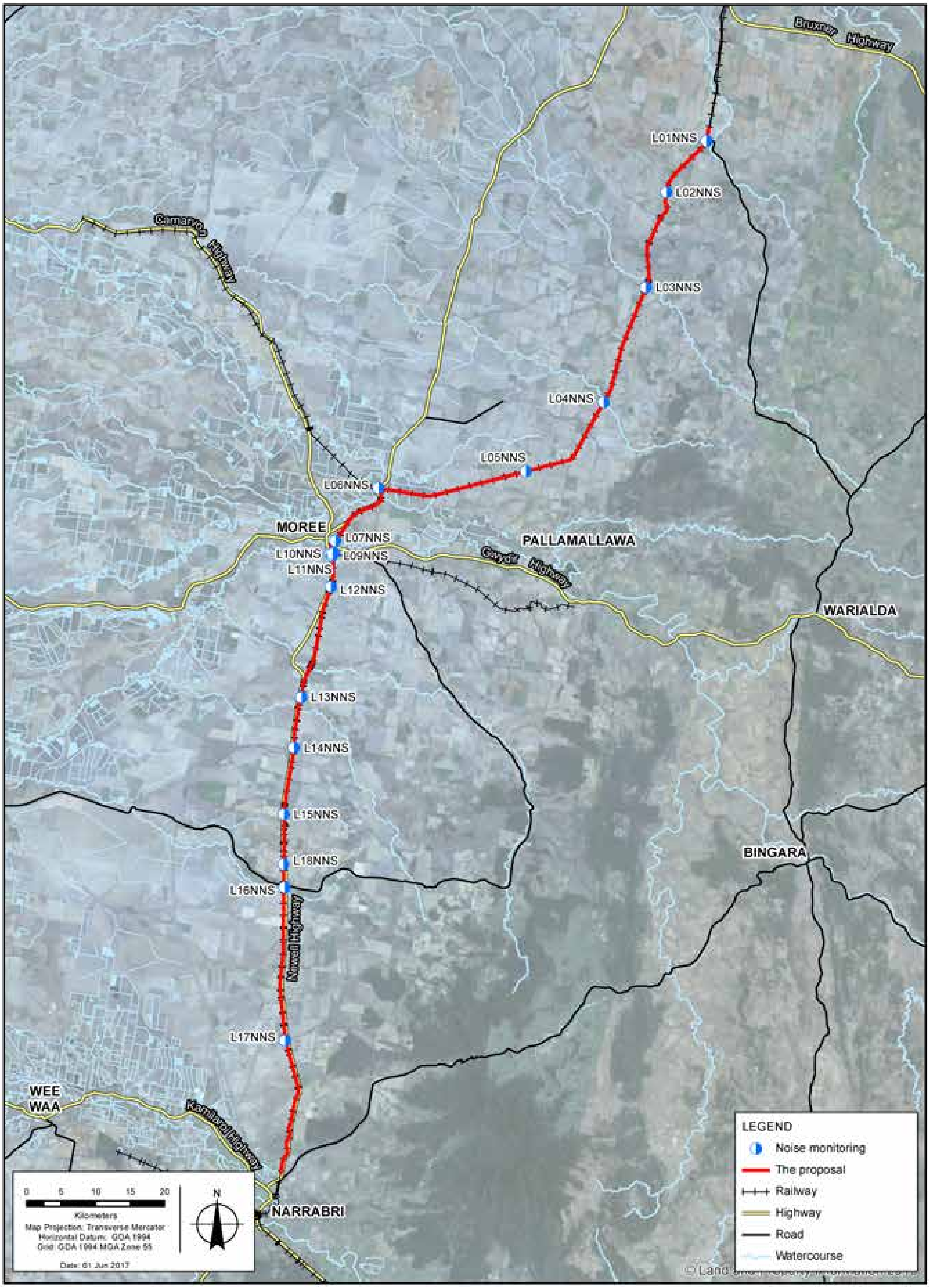
Measuring background noise to determine existing noise levels

Unattended noise monitoring was undertaken at 17 locations considered to be representative of the existing ambient (background) noise environment. Logger locations included sites within the proposal site, residential and commercial locations. Monitoring was undertaken at various times between 1 March 2015 and 7 April 2016. Monitoring locations are shown in Figure 11.1.

Attended noise monitoring was also undertaken at the same locations between 21 March 2016 and 24 March 2016 to supplement the noise logger data and identify dominant noise sources.

Existing train pass-by noise levels were calculated by reviewing and analysing data from the unattended noise loggers located adjacent to the existing rail corridor.

Figure 11.1 Noise monitoring locations



Construction noise

Construction working hours are described in Section 8.3. An assessment of the potential for construction noise (amenity) impacts was undertaken in accordance with the *Interim Construction Noise Guideline* (Department of Environment and Climate Change, 2009). Noise emissions were assessed during both primary proposal construction hours and outside the primary proposal construction hours. The methodology involved the following tasks:

- Construction noise rating background levels were calculated based on monitoring data and were used to establish the construction noise management levels (that is, the construction noise criteria) in accordance with the *Interim Construction Noise Guideline*. Criteria for road traffic noise were established based on the NSW *Road Noise Policy* (Department of Environment, Climate Change and Water, 2011).
- Representative sound power levels for likely construction activities and machinery were obtained from the *Construction Noise Strategy* (Transport for NSW, 2012a) and Australian Standard (AS) 2436-2010 *Guide to noise and vibration control on construction, demolition and maintenance sites* (Standards Australia 2010). Noise propagation calculations were then carried out to assess the potential impacts.

Where noise levels were predicted to exceed the construction noise management levels, mitigation measures were recommended.

Construction vibration

Vibration from construction plant and equipment was predicted and assessed based on:

- *Assessing Vibration: a technical guideline* (Department of Environment and Conservation, 2006a)
- British Standard (BS) 5228-2:2009 *Code of practice for noise and vibration on construction and open sites – Part 2: Vibration* (BS 5228-2:2009)
- BS 6472:1992 *Guide to evaluation of human exposure to vibration in buildings* (BS 6472:1992).

Assessment of vibration levels from intermittent construction sources is described in *Assessing Vibration: a technical guideline*, which is based on BS 6472:1992. The assessment evaluates a Vibration Dose Value (VDV), which incorporates the magnitude of vibration and the length of time the source operates. During construction of a project, the vibration impact on a receiver can be measured and compared directly to the *Assessing Vibration: a technical guideline* VDV criteria for day and night periods and for various receiver types.

The specifics of the construction methodology such as operating duration of vibration generating equipment is not yet known for this proposal. Therefore the estimation of VDV values from construction sources would require a broad range of assumptions to be made. The *Assessing Vibration: a technical guideline* notes that velocity values can be used as a screening method. Further, velocity values are widely available for typical construction equipment and are more likely to be routinely measured based on the more usual concern over potential building damage. Therefore, the Peak Particle Velocity (PPV) was adopted as a screening method to assess human comfort impacts from construction vibration. This was assessed with consideration to guidance contained in BS 5228-2.2009 relating to human response to construction vibration.

Where vibration levels were predicted to exceed the vibration criteria, mitigation measures were recommended.

Operational noise

Operational noise was assessed in accordance with the *Rail Infrastructure Noise Guideline* (Environment Protection Authority, 2013) ('the RING'). Assessment results were presented for the following modelling scenarios:

- no build and build scenarios for the year in which operations commence following construction completion – 2020
- no build and build scenarios when Inland Rail commences operation – 2025
- no build and build scenarios for the 'design year' – 2040.

Operational (airborne) noise goals were derived from the RING. Airborne noise is defined as noise that reaches a receiver through the air. The RING presents non-mandatory noise goals that trigger the need for an assessment to be conducted. If triggered, the operational noise assessment is required to address the potential noise impacts, and consider mitigation measures that may be feasibly and reasonably applied to mitigate the impacts.

The *Environmental Management System Guide: Noise and Vibration from Rail Facilities* (Sydney Trains, 2013) provides guidance on assessment of sleep disturbance based on the *NSW Industrial Noise Policy* (Environment Protection Authority, 2000).

Operational vibration

Assessing vibration: a technical guideline (Department of Environment and Conservation, 2006a) outlines methods of assessing potential impacts and ways to manage vibration from rail operations, such as ground induced vibration
created by train movements.

The ground-borne noise trigger levels in the RING were also used. Ground-borne noise is generally only a potential issue where noise levels are higher than the airborne noise levels, such as for underground railways. As there are no underground sections associated with the proposal, the risk of potential adverse ground-borne noise impacts is considered to be low.

Mitigation measures

Mitigation measures are provided to avoid or minimise identified impacts. These include standard measures used on similar projects which have been shown to be effective in reducing impacts. They also include project-specific measures which would need to be reviewed as the design progresses to determine whether they are feasible and reasonable to be implemented.

The terms 'feasible' and 'reasonable' are defined by the *Interim Construction Noise Guideline* and the RING. A measure is feasible if it can be engineered and is practical to build, given project constraints such as safety and maintenance requirements. Selecting reasonable measures from those that are feasible involves judging whether the overall noise benefits outweigh the overall adverse social, economic and environmental effects (including costs) of the measure.

11.1.2 Legislative and policy context to the assessment

In addition to the guidelines and standards described above, other relevant documents include:

- *Environmental Noise Management Manual* (Roads and Traffic Authority, 2001)
- *NSW Industrial Noise Policy* (EPA, 2000)
- *Construction Noise Strategy* (Transport for NSW, 2012a)
- AS 1055.1-1997 *Acoustics – Description and measurement of environmental noise*
- AS 2436–2010 *Guide to noise and vibration control on construction, demolition and maintenance sites*
- *Transit noise and vibration impact assessment* (USA Federal Transit Administration, 2006)
- *NSW Sustainable Design Guidelines* Version 3.0 (Transport for NSW, 2013c).

11.2 Noise and vibration management levels/ criteria - amenity

11.2.1 Construction noise management levels

Table 11.1 lists the construction noise management levels for the proposal. It is noted that, based on the *Interim Construction Noise Guideline*:

- The 'noise affected' management level represents the level above which there may be some community reaction to noise.
- The 'highly noise affected' management level represents the level above which there may be strong community reaction to noise.

Table 11.1 Construction noise management levels

Receiver	Period	Times	Background level (dB(A)) $L_{A90(period)}$[1]	Management level (dB(A)) $L_{Aeq(15\ min)}$[2]
Residential	Standard hours	Mon-Fri: 7:00am – 6:00 pm Sat: 8:00 am – 1:00 pm Sun/public holidays: no works	30	Noise affected level: 40 Highly noise affected level: 75
	Outside standard hours - evening	Mon-Fri: 6:00 pm – 10:00 pm Sat: 1:00 pm – 10:00 pm Sun/public holidays: 8:00 am – 6:00 pm	30	Noise affected level: 35
	Outside standard hours - night/early morning	Mon-Fri: 10:00 pm – 7:00 am Sat: 10:00 pm – 8:00 am Sun/public holidays: 6:00 pm – 7:00am	30	Noise affected level: 35
Industrial	When in use	-	n/a	75 dB(A)

Source: *Interim Construction Noise Guideline* (Department of Environment and Climate Change, 2009)
Notes 1: *The NSW Industrial Noise Policy,* states that where the rating background level is less than 30 dB(A), then it is set to 30 dB(A)
2: The noise affected management level is the background noise level plus 10 dB(A) during recommended standard working ours and the background noise level plus 5 dB(A) outside recommended standard hours.

Proposal specific construction noise management level

The proposed construction working hours are described in Section 8.3. Construction would be undertaken both during and outside standard construction hours defined by the *Interim Construction Noise Guideline*, in accordance with the Inland Rail NSW Construction Noise and Vibration Management Framework (refer to Section 11.5.1). Individual activities may span across time periods. As a result, the more stringent construction noise management level of 35 dB(A) has been adopted as the proposal specific management level.

11.2.2 Construction traffic noise criteria

Table 11.2 lists the construction road traffic noise criteria for residential land uses, as specified in the *Road Noise Policy* (Department of Environment, Climate Change and Water, 2011).

Table 11.2 Construction road traffic noise criteria (residential land uses)

Road category	Type of proposal/land use	Assessment criteria (dB(A)) (external)[1]	
		Day (7:00 am –10:00 pm)	Night (10:00 pm – 7:00 am)
Freeway/arterial road/sub- arterial roads	Existing residences affected by additional traffic on existing freeways/arterial/sub-arterial roads generated by land use developments	60 $L_{Aeq\ (15\ hour)}$	55 $L_{Aeq\ (9\ hour)}$
Local road	Existing residences affected by additional traffic on existing local roads generated by land use developments	55 $L_{Aeq\ (1\ hour)}$	50 $L_{Aeq\ (1\ hour)}$

Source: *Road Noise Policy* (Department of Environment, Climate Change and Water, 2011)
Note 1: Section 2.4 of the *Road Noise Policy* indicates that, where existing road traffic noise levels already exceed the assessment criteria, an increase of less than 2 dB(A) represents a minor impact that is barely perceptible to the average person.

11.2.3 Operational rail noise criteria

Based on the RING, predicted rail noise levels need to exceed the criteria ('trigger values') listed in Table 11.3 to initiate an assessment of noise impacts and mitigation measures.

For the assessment, the proposal was categorised as follows:

- Redevelopment of an existing heavy rail line – track works
- New rail line development – Camurra bypass.

For residential receivers, the criteria have two components – L_{Aeq} (assessed over the day or night) and L_{Amax} (train pass by events).

Table 11.3 Rail traffic noise criteria – residential land uses

Type of development	Noise criteria (dB(A)) (external) Day (7:00 am –10:00 pm)	Night (10:00 pm – 7:00 am)
Redevelopment of existing rail line	Development increases existing $L_{Aeq(period)}$ rail noise levels by 2 dB or more, or existing L_{Amax} rail noise levels by 3 dB or more, and predicted rail noise levels exceed:	
	65 $L_{Aeq(15h)}$	60 $L_{Aeq(9h)}$
	OR	OR
	85 L_{AFmax}	85 L_{AFmax}
New rail line	Predicted rail noise levels exceed:	
	60 $L_{Aeq(15h)}$	55 $L_{AEq(9h)}$
	OR	OR
	80 L_{AFmax}	80 L_{AFmax}

Source: *Rail Infrastructure Noise Guideline (RING)* (EPA, 2013).

In accordance with the RING, other non-residential sensitive land uses (including hospitals, schools and outdoor recreational areas) have their own specific noise trigger levels for rail redevelopments, applicable when the facility or space is in use. The criteria for other sensitive land uses are listed in Table 11.4.

Table 11.4 Rail traffic noise criteria – non-residential land uses

Land use	New rail line development noise criteria (dB(A)) (when in use)[1]	Redevelopment of existing rail line noise criteria (dB(A)) (when in use)[1]
	Resulting rail noise levels exceed:	Development increases existing $L_{Aeq(period)}$ rail noise levels by 2 dB or more, and resulting rail noise levels exceed:
Schools, educational institutions and child care centres	40 $L_{Aeq(1h)}$ (internal)	45 $L_{Aeq(1h)}$ (internal)
Places of worship	40 $L_{Aeq(1h)}$ (internal)	45 $L_{Aeq(1h)}$ (internal)
Hospital wards	35 $L_{Aeq(1h)}$ (internal)	40 $L_{Aeq(1h)}$ (internal)
Hospitals – other uses	60 $L_{Aeq(1h)}$ (external)	65 $L_{Aeq(1h)}$ (external)
Open space – Passive use	60 $L_{Aeq(15h)}$ (external)	65 $L_{Aeq(15h)}$ (external)
Open space – Active use	65 $L_{Aeq(15h)}$ (external)	65 $L_{Aeq(15h)}$ (external)

Source: *Rail Infrastructure Noise Guideline* (EPA, 2013).

Note 1: The RING allows for an open window to provide ventilation. Noise trigger levels for these receivers are applicable as internal or external levels depending on the land use. As construction materials and the facade acoustic performance of these buildings is unknown and may vary, a conservative 10 dB reduction in noise between the external level and internal level has been assumed.

11.2.4 Sleep disturbance criteria

Sleep disturbance criteria are based on the Road Noise Policy, which suggests that internal noise levels below 50 dB(A) L_{Amax} to 55 dB(A) L_{Amax} are unlikely to cause awakening reactions. One or two events per night, with internal noise levels of 65 dB(A) L_{Amax} to 70 dB(A) L_{Amax} (inside dwellings), are not likely to significantly affect health and wellbeing.

11.2.5 Human comfort vibration criteria

Construction typically generates ground vibration of an intermittent nature. Acceptable vibration levels, defined by *Assessing vibration: A technical guideline*, are listed in Table 11.5 for each type of sensitive receiver.

Table 11.5 Acceptable vibration values for intermittent vibration

Receiver	Daytime[1] ($m/s^{1.75}$)		Night-time[1] ($m/s^{1.75}$)	
	Preferred value	Maximum value	Preferred value	Maximum value
Critical areas[2]	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

Source: *Assessing vibration: A technical guideline* (Department of Environment and Conservation, 2006a)
Notes 1: Daytime is 7:00 am to 10:00 pm, and night-time is 10:00 pm to 7:00 am.
2: Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. These criteria are only indicative, and there may be need to assess intermittent values against the continuous or impulsive criteria for critical areas.

Humans are capable of detecting vibration levels well below those that risk causing damage to a building. The degrees of perception for humans are suggested by the vibration level categories provided in BS 5228-2:2009 *Code of practice for noise and vibration on construction and open sites – Part 2: Vibration*, as listed in Table 11.6.

Table 11.6 Guidance on the effects of vibration levels

Approximate vibration level (mm/s)	Degree of perception
0.14	Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction. At lower frequencies, people are less sensitive to vibration.
0.3	Vibration might be just perceptible in residential environments.
1	It is likely that vibration of this level in residential environments would cause complaint, but can be tolerated if prior warning and explanation has been given to residents.
10	Vibration is likely to be intolerable for any more than a very brief exposure to this level.

Source: BS 5228-2:2009 *Code of practice for noise and vibration on construction and open sites – Part 2: Vibration*

11.3 Existing environment

11.3.1 Sensitive receivers

As described in Chapter 2, the majority of the proposal site passes through rural land. Sensitive receivers are concentrated in the main towns (Moree, Narrabri, Gurley, and Bellata), with scattered residential receivers located on rural properties surrounding the proposal site. Locations of sensitive receivers are shown in Figure 11.2. The closest residential receiver is located about 15 metres from the proposal site.

Non-residential receivers comprise the following:

- 8 places of worship
- 1 hospital ward
- 9 schools
- 16 areas of passive recreational
- 19 areas of active recreational.

A number of commercial and industrial facilities are also located near the proposal site, and are subject to assessment for construction noise only. A total of 2,442 noise sensitive receivers were identified within the study area (2 kilometres either side of the rail corridor). This differs from the operational noise assessment because some construction activities have the potential to impact a wider area than rail operation associated with the proposal.

The baseline noise monitoring results indicate that background noise levels are dominated by natural sounds, usually wind through long grass or trees, with occasional train pass-by noise events.

Further information on sensitive receivers and detailed noise monitoring results are provided in Technical Report 5.

Train pass-by noise levels

The existing rail line includes grain/goods trains and TrainLink's daily Northern Tablelands Xplorer passenger service operating to and from Sydney with stops at Narrabri, Bellata and Moree.

Existing train pass-by noise levels recorded by the noise loggers ranged from a sound exposure level of 80 dB(A) (at a logger located 420 metres from the existing rail corridor) to a sound exposure level of 97 dB(A) (recorded by two loggers located 10 and 35 metres from the corridor). The recorded duration of train pass-by events ranged from 24 to 74 seconds.

11.3.2 Vibration

Vibration levels of about 1.0 to 1.3 millimetres per second were recorded at the vibration logger during train pass-by events. Between pass-by events, background vibration levels were about 0.1 millimetres per second.

11.4 Impact assessment

11.4.1 Risk assessment

The environmental risk assessment for the proposal (Appendix B) included an assessment of the potential amenity risks as a result of noise and vibration. Risks with an assessed level of medium or above included:

- noise impacts on local residents and sensitive receivers from construction activities, particularly during work outside recommended standard working hours
- noise impacts on local residents and sensitive receivers from construction traffic
- noise impacts on local residents and sensitive receivers from the operation of trains.

How potential impacts would be avoided

Potential noise and vibration (amenity) impacts would to be avoided by:

- designing, constructing and operating the proposal to minimise the potential for noise and vibration (amenity) impacts
- implementing the Inland Rail Noise and Vibration Management Strategy and developing specific noise mitigation approaches in accordance with the Inland Rail NSW Construction Noise and Vibration Management Framework, described in Section 11.5.1
- implementation of mitigation measures listed in Section 11.5.

11.4.2 Construction noise

Construction typically requires the use of heavy machinery, which can generate high noise and vibration levels at nearby receivers. The potential impacts may vary greatly depending on the intensity and location of construction activities, the type of equipment used, existing background noise, intervening terrain, and prevailing weather conditions.

Figure 11.2a Sensitive receiver locations and construction exceedances

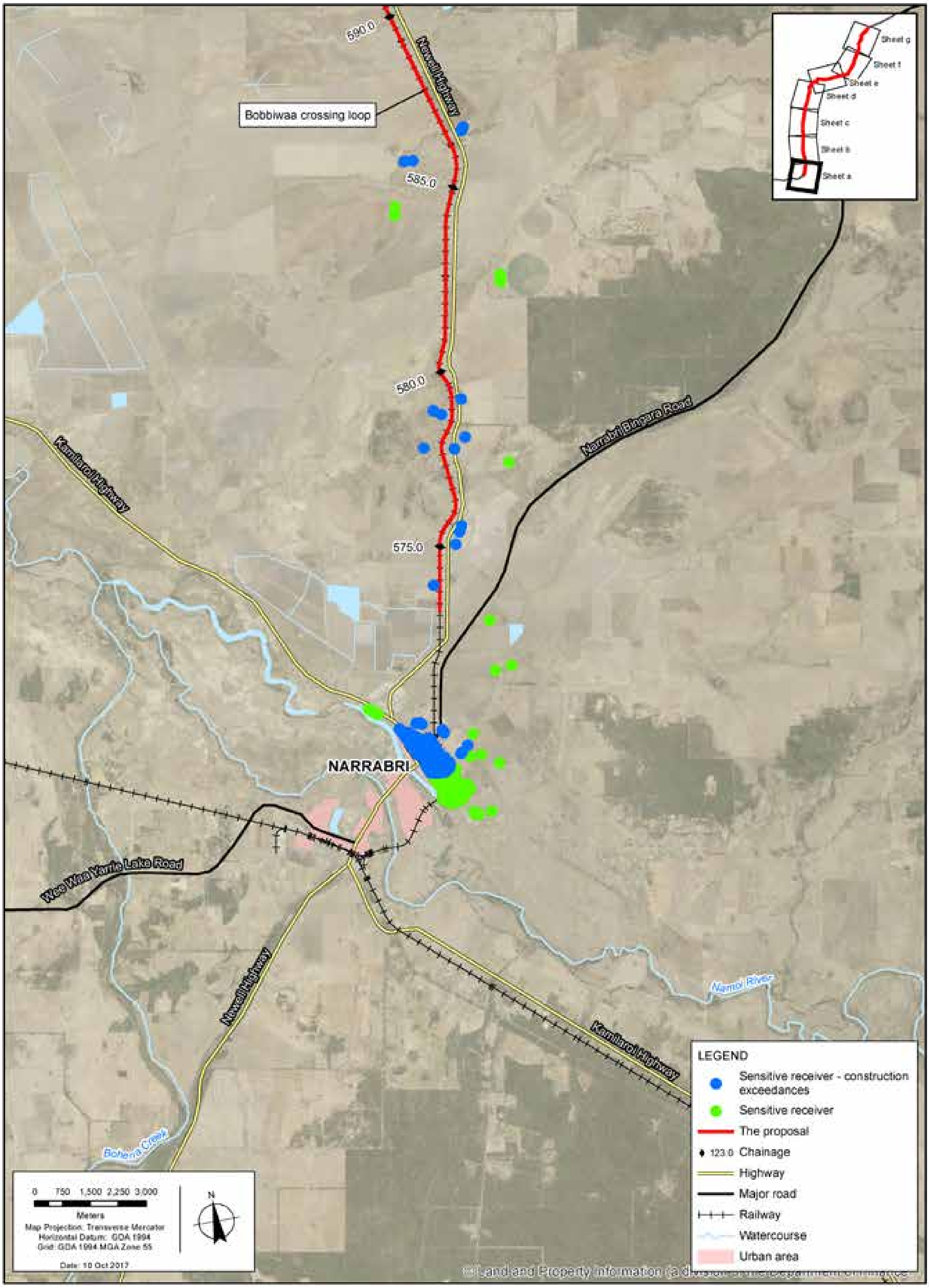


Figure 11.2b Sensitive receiver locations and construction exceedances

Figure 11.2c Sensitive receiver locations and construction exceedances

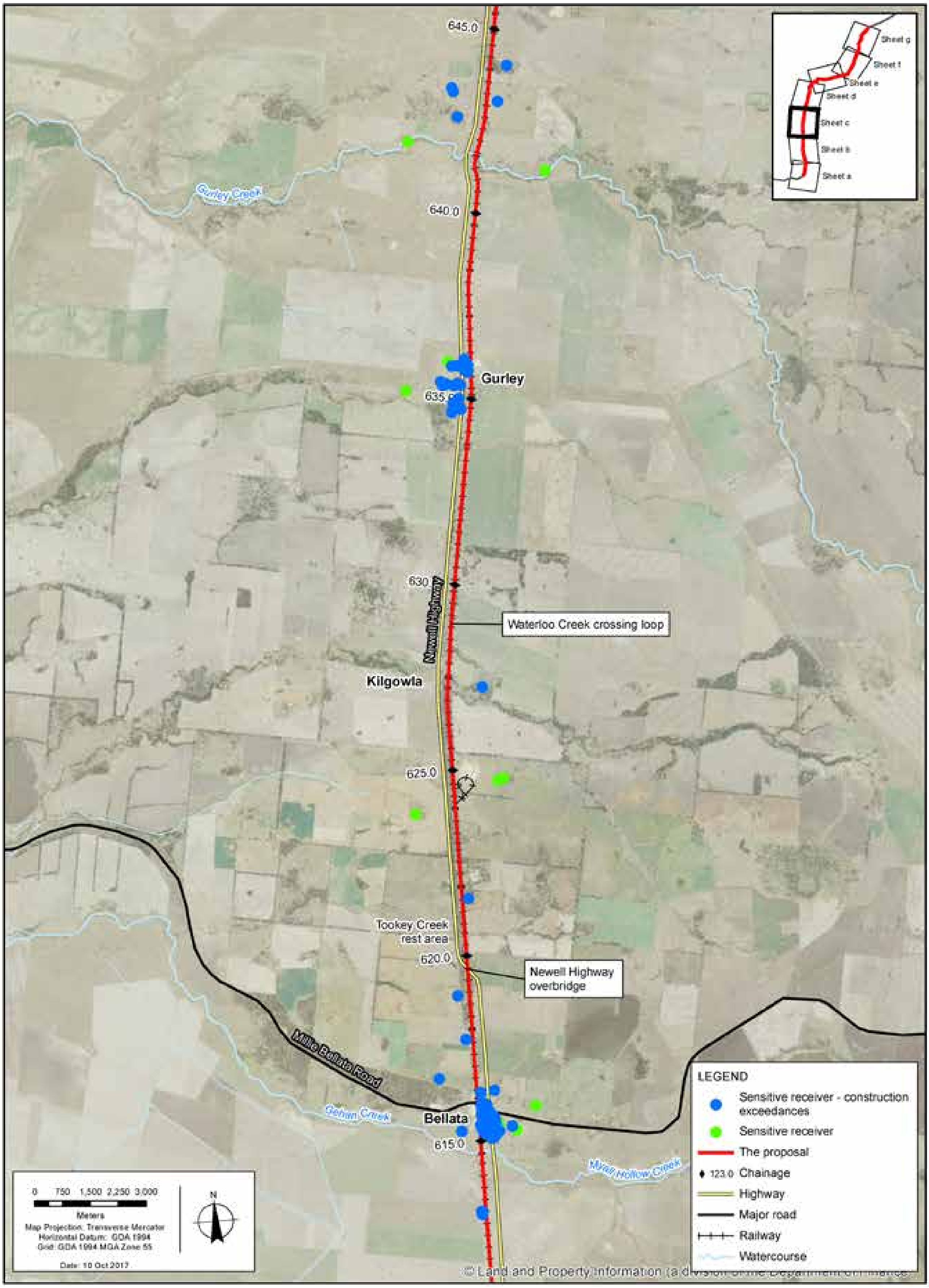


Figure 11.2d Sensitive receiver locations and construction exceedances

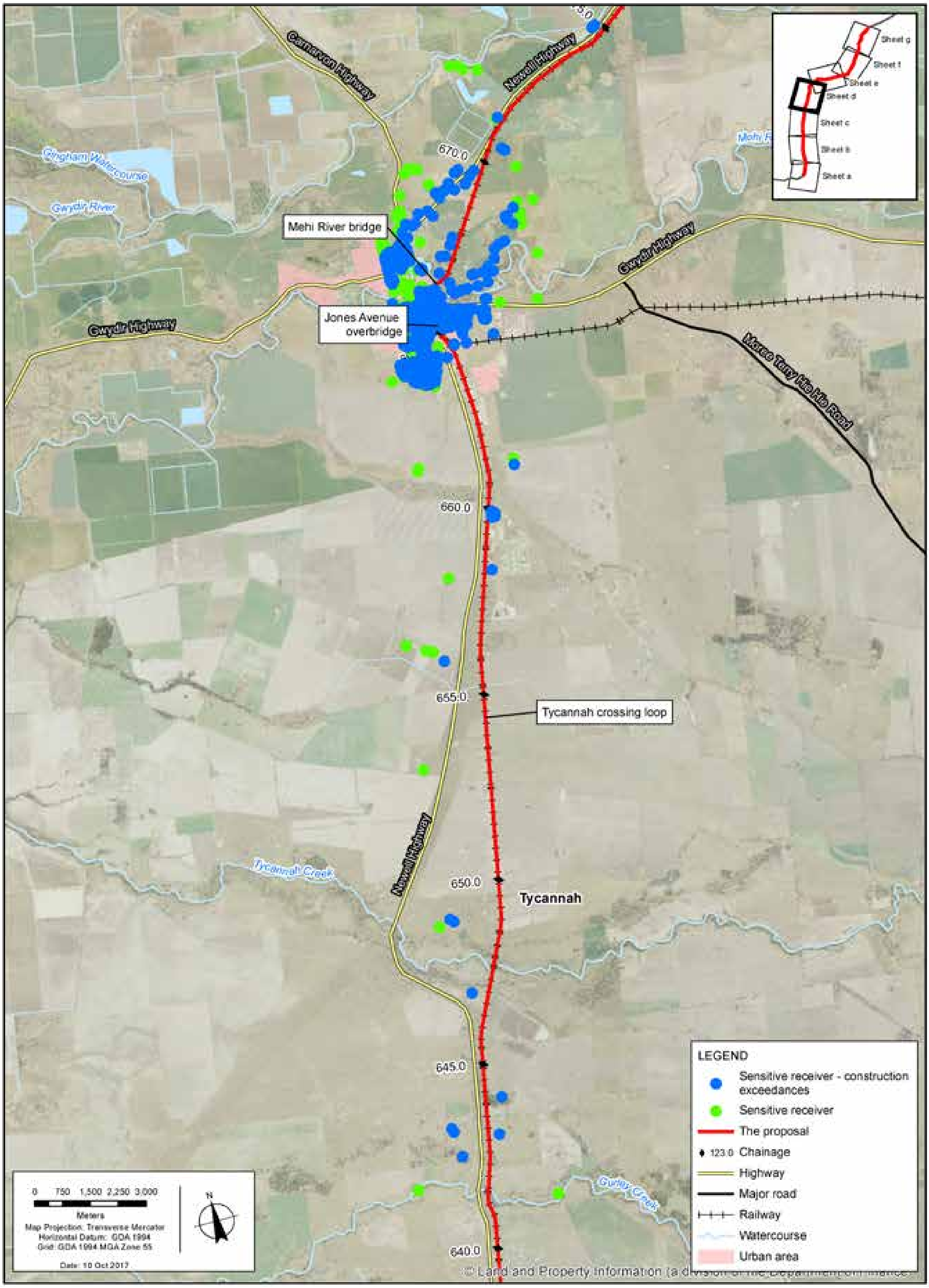


Figure 11.2e Sensitive receiver locations and construction exceedances

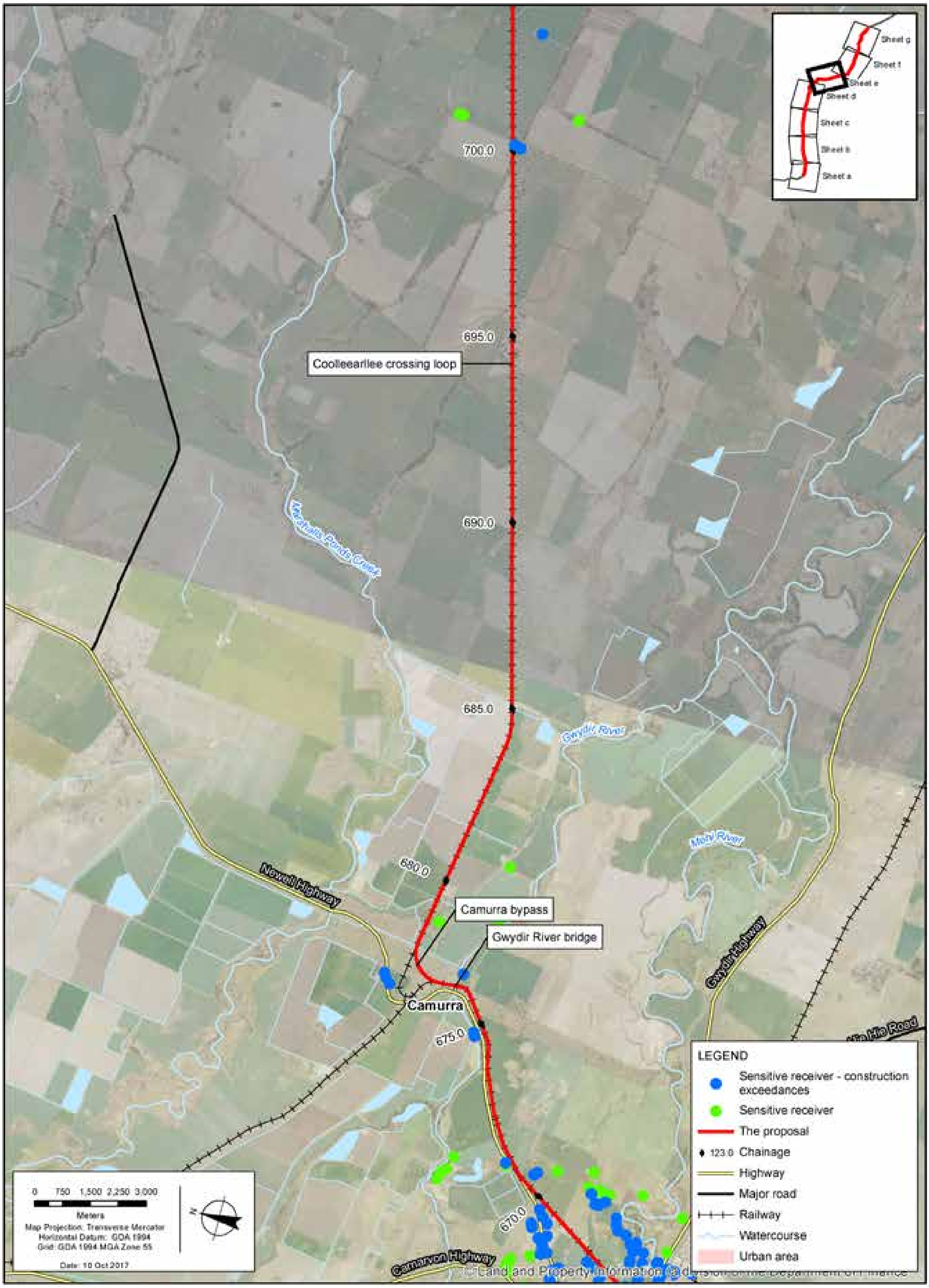


Figure 11.2f Sensitive receiver locations and construction exceedances

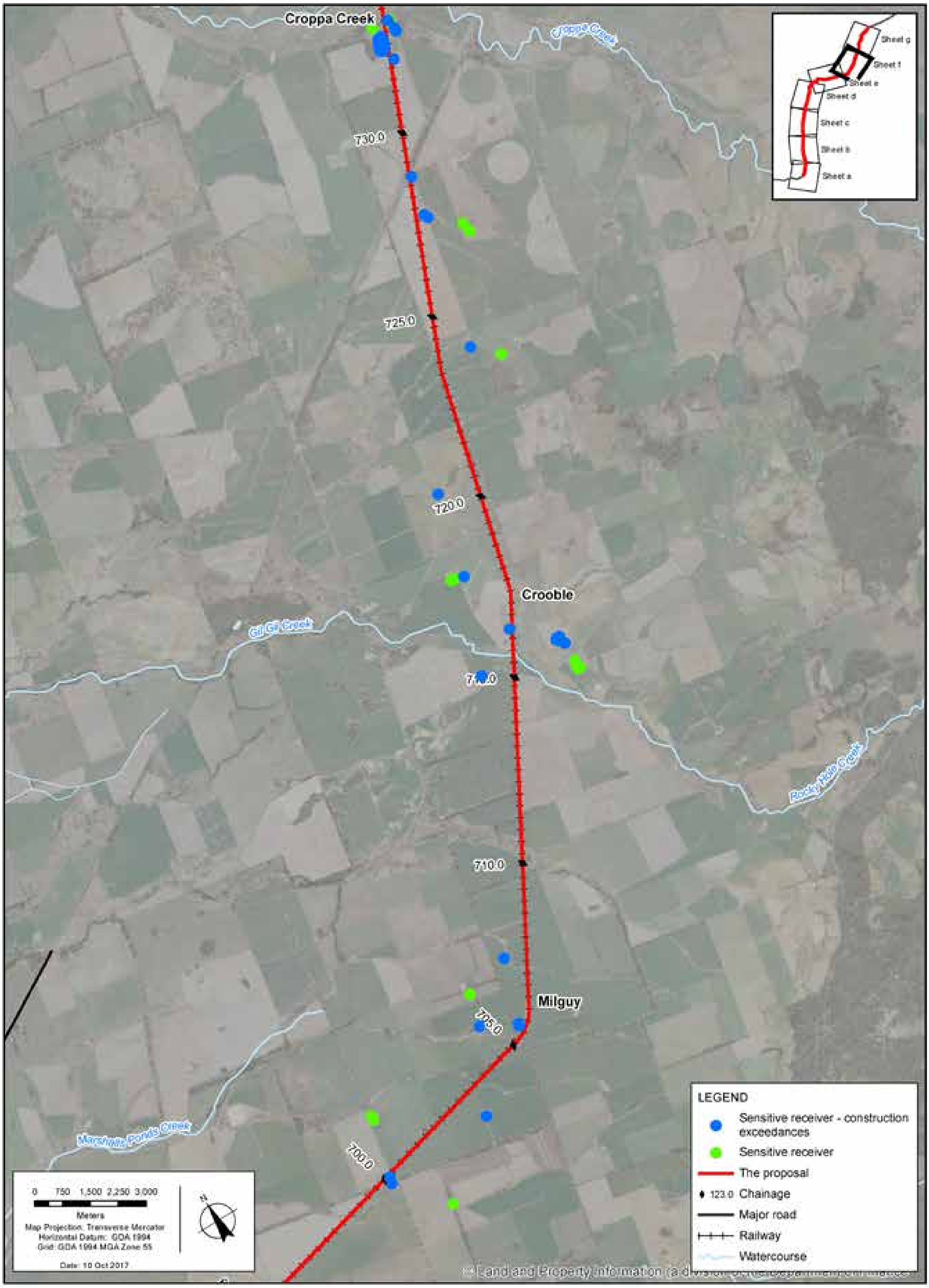
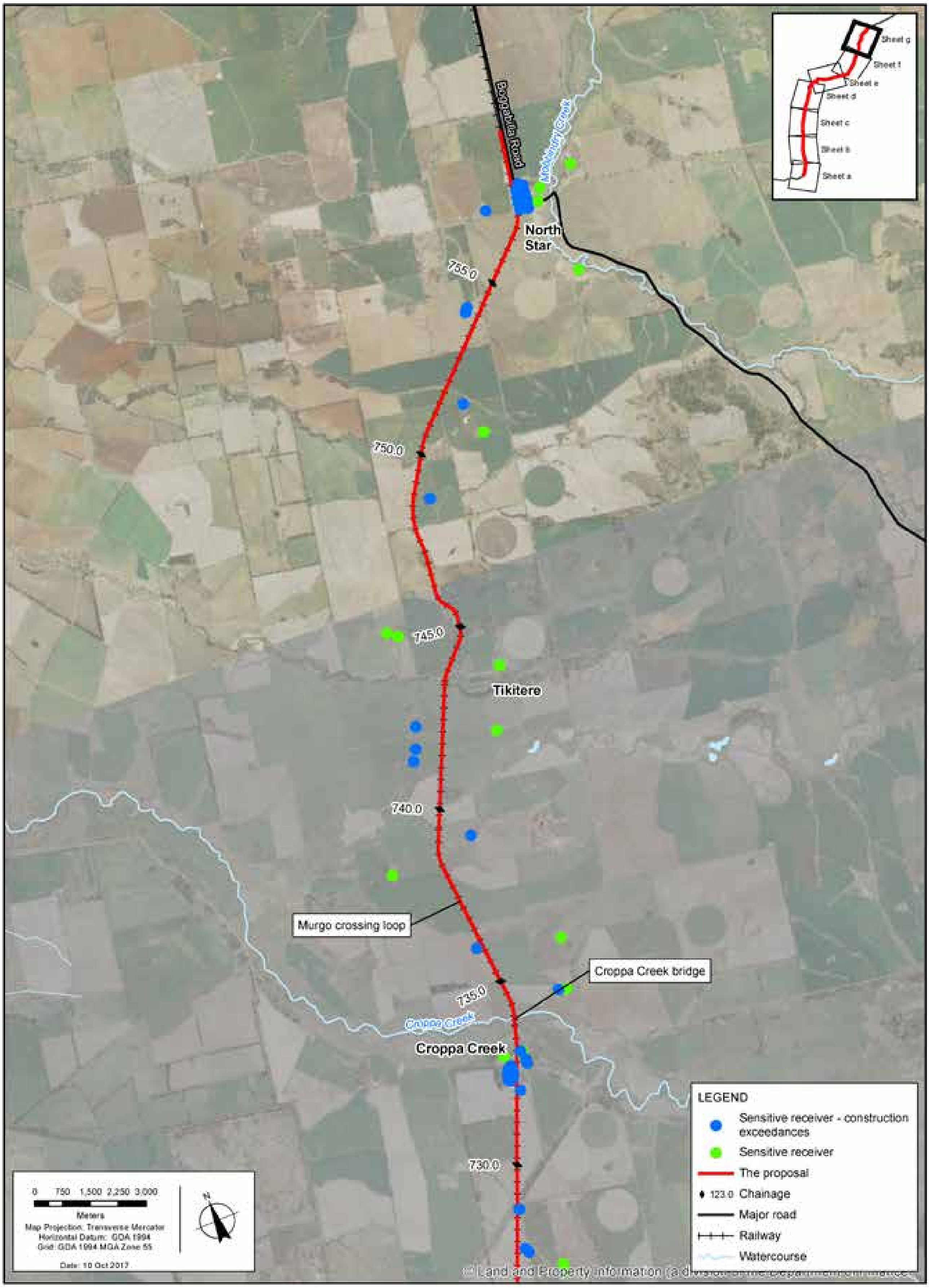


Figure 11.2g Sensitive receiver locations and construction exceedances



In accordance with the assessment guidelines, potential noise impacts were predicted with a focus on those activities with the highest potential to cause noise impacts, and assuming that the loudest two items of plant for each activity operate continuously. As a result, the predictions identify worst-case construction noise levels, which may not be reached, or only reached infrequently.

Potential noise emissions from construction activities were modelled for identified sensitive receivers based on various construction scenarios. The different construction activities represent different equipment noise levels, providing an indication of how noise levels may change across the proposal site. Waste management (excavation, handling, on-site storage and transport) has been considered in each construction scenario, where relevant to that activity. Modelling was undertaken to predict the potential impacts during the primary proposal construction hours.

As a result of the modelling, adopted activity sound power levels were determined. These range from 109 dB(A) (level crossing works) to 118 dB(A) (site establishment works, track upgrading, drainage construction, culvert replacement, crossing loop construction, rail station work and the Camurra bypass). It was estimated that the majority of activities would generate a sound power level of around 115 to 118 dB(A).

Table 11.7 lists the predicted exceedances of the noise management levels for each activity modelled, and the numbers of residential receivers where the 'noise affected' level may be exceeded.

Where noise is above the proposal specific construction noise management level, all feasible and reasonable work practices to minimise noise need to be implemented, and all potentially affected receivers need to be informed. If no quieter work method is feasible and reasonable, consultation with the impacted residence would be undertaken to explain the duration and noise levels of the works and any respite periods that would be provided.

Table 11.7 Construction activity noise management level exceedances

Construction activity	Noise management level exceedances: Maximum predicted level of exceedance above 35 (dB(A))[1]	Noise management level exceedances: Number of receivers with predicted exceedances
Full alignment works	43	1,574
Level crossing upgrades and consolidation	22	275
Culvert works	39	653
Bridge works	24	682
Crossing loops	27	685
Newell Highway overbridge	13	2
Jones Avenue overbridge	41	1,098
Camurra bypass	10	3
Post possession	38	834

Note 1: As defined by Department of Environment and Climate Change, 2009

The location of sensitive receivers with predicted exceedances are shown on Figure 11.2. The results of the construction noise assessment for residential receivers are summarised below.

Impacts of construction of the key proposal features

Track works

Activities that encompass the entire proposal site (i.e. the full alignment), such as site establishment (includes construction compound activities as described in Section 8.4), track works and drainage construction, are predicted to exceed the construction noise management levels:

- in North Star at 37 residential receivers with impacts up to 27 dB and 1 educational facility up to 5 dB
- between Moree and North Star at 70 residential receivers with impacts up to 29 dB
- in Moree at 922 residential receivers with impacts up to 43 dB
- between Bellata and Moree at 48 residential receivers with impacts up to 22 dB
- in Bellata at 71 residential receivers with impacts up to 23 dB and 1 recreational area by up to 6 dB
- between Narrabri and Bellata at 38 residential receivers with impacts up to 24 dB
- in Narrabri at 388 residential receivers with impacts up to 20 dB.

Construction would progress along the route therefore, noise impacts would be experienced for a relatively short-time at most locations.

Level crossing upgrades and consolidation

Construction activities of crossing signalisation, give way crossing upgrades, and level crossing consolidation are predicted to exceed the construction noise management levels:

- in North Star at 22 residential receivers with impacts up to 18 dB
- between Moree and North Star at 9 residential receivers with impacts up to 9 dB
- in Moree at 205 residential receivers with impacts up to 22 dB and 1 recreational receiver by up to 1 dB
- between Bellata and Moree at 24 residential receivers with impacts up to 17 dB
- in Bellata at 11 residential receivers with impacts up to 11 dB and at 1 recreational receiver by up to 7 dB
- between Narrabri and Bellata at 4 residential receivers with impacts up to 12 dB
- no impacts are predicted to sensitive receivers in Narrabri.

Culvert works

Replacement and upgrade of existing culverts and bridges are predicted to exceed the construction noise management levels:

- in North Star at 30 residential receivers with impacts up to 22 dB
- between Moree and North Star at 22 residential receivers with impacts up to 22 dB
- in Moree at 489 residential receivers with impacts up to 39 dB
- between Bellata and Moree at 22 residential receivers with impacts up to 8 dB
- in Bellata at 65 residential receivers with impacts up to 16 dB
- between Narrabri and Bellata at 25 residential receivers with impacts up to 19 dB
- no impacts are predicted to sensitive receivers in Narrabri.

Bridge works

Construction of bridges are predicted to exceed the construction noise management levels:

- between Moree and North Star at 37 residential receivers with impacts up to 15 dB
- in Moree at 639 residential receivers with impacts up to 24 dB
- between Bellata and Moree at 2 residential receivers with impacts up to 4 dB
- no impacts are predicted to sensitive receivers in Bellata or Narrabri
- between Narrabri and Bellata at 4 residential receivers with impacts up to 11 dB
- no impacts are predicted to sensitive receivers in North Star.

Construction of the Mehi and Gwydir river bridges would take about six to eight months each to complete. Construction of the Croppa Creek bridge would take about seven months to complete.

Crossing loops

Construction of crossing loops is predicted to exceed the construction noise management levels:

- in North Star at 36 residential receivers with impacts up to 22 dB
- between Moree and North Star at 24 residential receivers with impacts up to 24 dB
- in Moree at 517 residential receivers with impacts up to 27 dB
- between Bellata and Moree at 29 residential receivers with impacts up to 23 dB
- in Bellata at 69 residential receivers with impacts up to 21 dB
- between Narrabri and Bellata at 10 residential receivers with impacts up to 18 dB
- no impacts are predicted to sensitive receiviers in Narrabri.

Newell Highway overbridge

Construction of the Newell Highway overbridge is predicted to exceed the construction noise management levels:

- between Bellata and Moree at 2 residential receivers with impacts up to 13 dB
- no impacts are predicted for other sensitive receiver areas.

Construction of the Newell Highway overbridge would take about 10 months to complete.

Jones Avenue overbridge

Construction of the Jones Avenue overbridge is predicted to exceed the construction noise management levels:

- in Moree at 1,098 residential receivers with impacts up to 41 dB
- no impacts are predicted for other sensitive receiver areas.

Construction of the Jones Avenue overbridge would take about six to eight months to complete.

Camurra bypass

Construction of the Camurra bypass is predicted to exceed the construction noise management levels:

- between Moree and North Star at 3 residential receivers with impacts up to 10 dB
- no impacts are predicted for other sensitive receiver areas.

Impacts of construction in relation to working hours

Construction working hours, and the activities that would be undertaken during each, are described in Section 8.3. Where exceedances of construction management levels are predicted, reasonable and feasible mitigation measures would be implemented to reduce the significance of impacts.

Impacts of works

The assessment indicates that:

- The highly affected level of 75 dB(A) L_{Aeq} is predicted to be exceeded at about three receivers.
- Rail line redevelopment construction activities are predicted to exceed the noise management level at receivers nearest to the construction footprint. Impacted receivers are within about 700 metres of the works and includes up to 1,574 identified noise sensitive residential receiver locations. Noise levels are predicted to exceed the proposal specific construction management level by up to 43 dB.
- Newell Highway overbridge construction is predicted to exceed the proposal specific construction management level by up to 13 dB at 2 residential receivers.
- Jones Avenue overbridge construction is predicted to exceed the proposal specific construction management level by up to 41 dB at 1,098 residential receivers.
- Construction activities during the primary proposal construction hours have the potential to exceed the noise management level at non-residential sensitive receivers including educational, child care and hospital facilities. Construction noise management levels are applicable as an internal level only when the facilities are in use.
- Construction activities during the primary proposal construction hours have the potential to exceed the noise management level at recreational areas including bushland areas, parks and sporting facilities when these areas are in use.

The noise and vibration mitigation measures detailed in Section 11.5 would be implemented where feasible and reasonable to protect the environment and reduce the potential for noise exceedances at receivers.

Sleep disturbance

The results of modelling indicate that the sleep disturbance criteria is predicted to be exceeded for:

- full alignment works – exceedances at 75 sensitive receivers
- level crossing upgrades and consolidation – exceedances at 2 sensitive receivers
- culvert works – exceedances at 11 sensitive receivers
- bridge works – exceedances at 8 sensitive receivers
- crossing loops – exceedances at 23 sensitive receivers
- Jones Avenue overbridge – exceedances at 43 sensitive receivers
- post construction works – exceedances at 23 sensitive receivers.

The sleep disturbance criteria will not be exceeded at sensitive receivers during the Newell Highway overbridge works.

Construction traffic noise

The increase in noise levels due to construction traffic is estimated to be less than 2 dB, which would not be noticeable at sensitive receivers.

Feasible and reasonable mitigation measures would be implemented to minimise the potential impacts predicted, as described in Section 11.5.

11.4.3 Construction vibration

Safe working buffer distances

Typical vibration levels generated by various construction plant are listed in Table 11.8.

Table 11.8 Predicted vibration levels from construction equipment

Vibration Source	Approximate vibration levels (mm/s) based on distances (m) to source			
	10	20	50	100
Roller	6.0	3.4	1.7	1.0
15 tonne vibratory roller	8.0	4.6	2.2	1.3
7 tonne compactor	6.0	3.4	1.7	1.0
Dozer	4.0	2.3	1.1	0.6
Backhoe	1.0	0.6	0.3	0.2
Excavator	2.1	1.2	0.6	0.3
Piling (impact)	30	17.2	8.3	4.8
Piling (vibratory)[1]	16.8	7.3	2.4	1.1
Piling (bored)[1]	7.4	4.3	2.1	1.2

Note 1: Based on levels derived from BS 5228:2009. Bored piling through stones or other obstruction. Vibratory piling based on relationship provided in Table E.1 of this standard.

Based on these typical vibration levels, safe working buffer distances to comply with the human comfort vibration criteria are listed in Table 11.9. In multi-level buildings, vibration may be amplified through the structure to the upper floors. A doubling of the buffer distances provided in Table 11.9 would provide a conservative allowance for this possible effect.

Table 11.9 Vibration safe working buffer distances

Activity	Human comfort buffer distance (m) (1.0 mm/s)[1]
General construction activities	
Roller	90
15 tonne vibratory roller	140
7 tonne compactor	90
Dozer	60
Backhoe	10
Excavator	25
Piling	
Piling (impact)	700
Piling (vibratory)[1]	110
Piling (bored)[1]	120

Note 1: Based on levels derived from BS 5228:2009. Bored piling through stones or other obstruction. Vibratory piling based on relationship provided in Table E.1 of this standard.

General construction activities

The number of potentially impacted receivers are provided in Table 11.10 for the anticipated vibration generating equipment. During general construction activities, vibration is predicted to be perceptible at up to 219 sensitive receivers (208 residential and 11 non-residential) that are within 140 metres of the proposal. These sensitive receivers are generally spread along the length of the proposal, but are also in greater density within Moree, Bellata, Edgeroi, Gurley, Croppa Creek and North Star.

Piling

Vibration impacts due to impact piling have the potential to impact on the comfort of receivers located up to 700 metres from the works, while impacts due to vibratory piling or bored piling can impact receivers located up to 110 metres and 120 metres, respectively. About 820 receivers may receive perceptible vibration where impact piling is used, while up to 50 receivers may be impacted by vibratory piling and up to 56 receivers impacted if bored piling is used, as listed in Table 11.10. These receivers are mostly within Moree and are near to either the Mehi River bridge or the Jones Avenue overbridge.

Table 11.10 Construction vibration activities - number of potentially impacted sensitive receivers

Activity	Number of sensitive receivers potentially impacted by vibration
General construction activities	
Roller	144
15 tonne vibratory roller	219
7 tonne compactor	144
Dozer	79
Backhoe	7
Excavator	28
Piling (Bridges)	
Piling (impact)	820
Piling (vibratory)[1]	50
Piling (bored)[1]	56

Note 1: Based on levels derived from BS 5228:2009. Bored piling through stones or other obstruction. Vibratory piling based on relationship provided in Table E.1 of this standard.

Human comfort impacts

Construction vibration from general construction work and at crossing loops may be perceptible at distances of up to 140 metres from the works. There are 219 residential receivers identified within this buffer distance that may be impacted from the works.

Piling works are required for bridge construction. Vibration impacts due to boring of the cast in-situ piles has the potential to impact receivers up to 120 metres from the work area, which may impact up to 56 residential receptors. If impact driven piles are to be used, the affected area increases to about 700 metres from the works.

Impacts during different working hours

Impacts of works during the primary proposal construction hours

For works during the primary proposal construction hours, the assessment concluded that vibration may be perceptible at up to 820 sensitive receiver locations, if impact piling is carried out. Where vibration generating activities are proposed within 140 metres of an occupied residence, mitigation would be implemented where feasible and reasonable.

Impact of works outside proposed construction hours

Receivers are likely to have higher sensitivity to vibration experienced outside the primary proposal construction hours compared to that experienced during proposed hours. For works outside the primary proposal construction hours, mitigation would be considered and implemented where vibration generating activities are proposed within 140 metres of an occupied residence, where feasible and reasonable.

11.4.4 Operation noise

Noise generated by operation of the rail vehicles

As noted in Section 11.2.3, the predicted rail noise levels need to exceed the RING trigger values listed in Table 11.3 and Table 11.4 to initiate an assessment of noise impacts and mitigation measures. Modelling was undertaken to compare the existing no build (2020) noise levels with the predicted noise levels for the future build scenarios (2025 and 2040).

Most of the RING exceedances were around the Moree, North Star and Bellata, with the remainder scattered throughout the study area. This is because there is a higher concentration of receivers located close to the proposal site near the towns.

Modelling indicated that the RING trigger values for night noise criteria would be exceeded at:

- 110 residential receivers and 9 non-residential receivers for the 2025 scenario
- 152 residential receivers and 9 non-residential receivers for the 2040 scenario.

It is noted that the 2020 no build scenario represents the 2025 and 2040 no build scenarios, since there are no predicted changes in operational conditions/ parameters without the proposal proceeding.

Sensitive receiver exceedances for the 2025 and 2040 scenarios are presented on Figure 11.3. Further information in relation to exceedances at individual locations is provided in Technical Report 5.

Feasible and reasonable mitigation measures would be implemented to minimise the potential impacts predicted, as described in Section 11.5.

Horn noise

Horns are an important safety device and are a normal part of train operations. Trains are required to sound their horns as they pass through level crossings and at certain other times. ARTC's *Locomotive Specific Interface Requirements* (WOS 01.300) (ARTC, 2005) provides minimum and maximum levels for horn noise. It is acknowledged that noise emitted by train horns can be a source of annoyance for the general public. The minimum distance from the horn required to achieve the RING trigger value is listed in Table 11.11.

Figure 11.3a Sensitive receiver locations and operational exceedances for 2025 and 2040

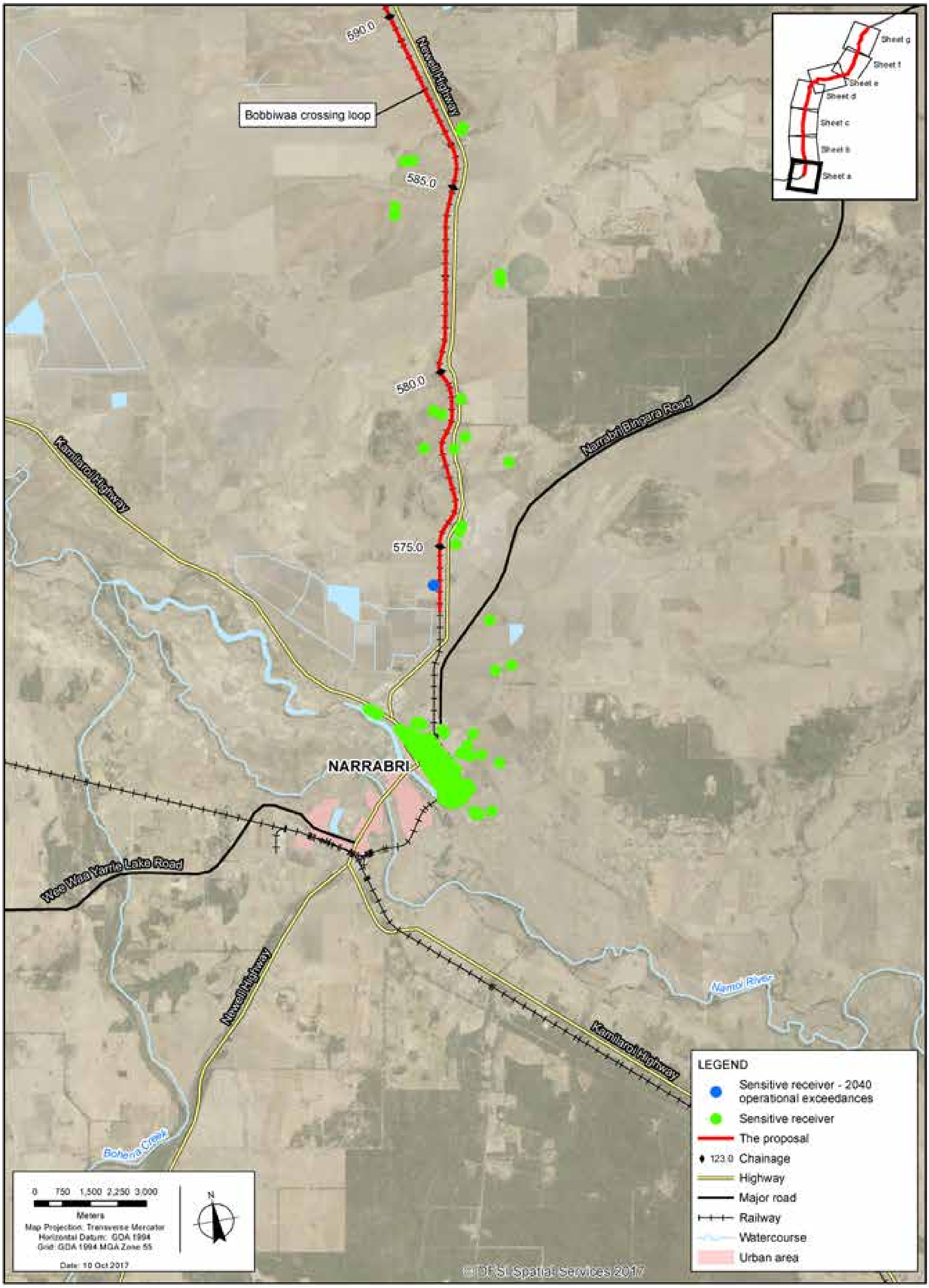


Figure 11.3b Sensitive receiver locations and operational exceedances for 2025 and 2040

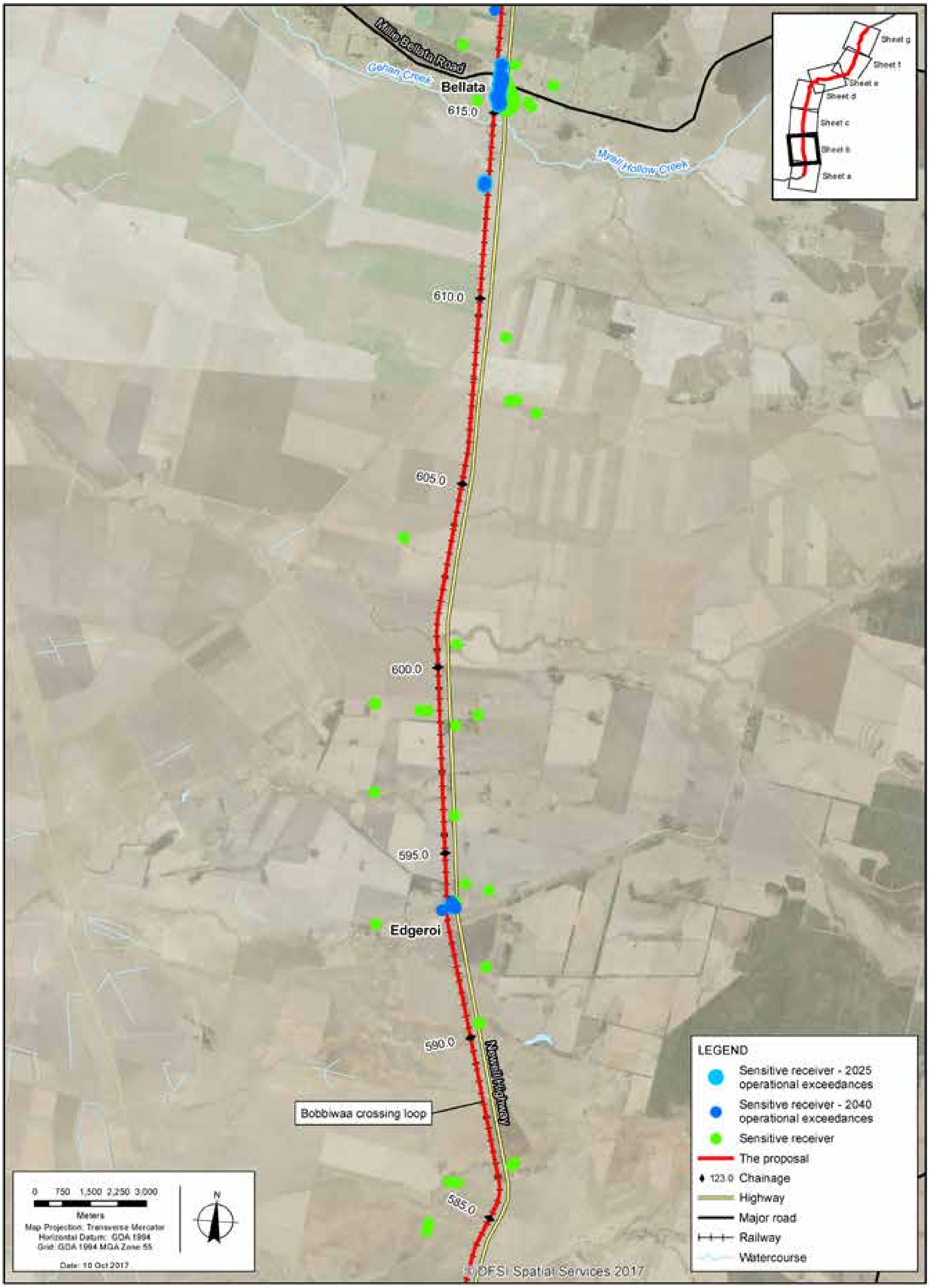


Figure 11.3c Sensitive receiver locations and operational exceedances for 2025 and 2040

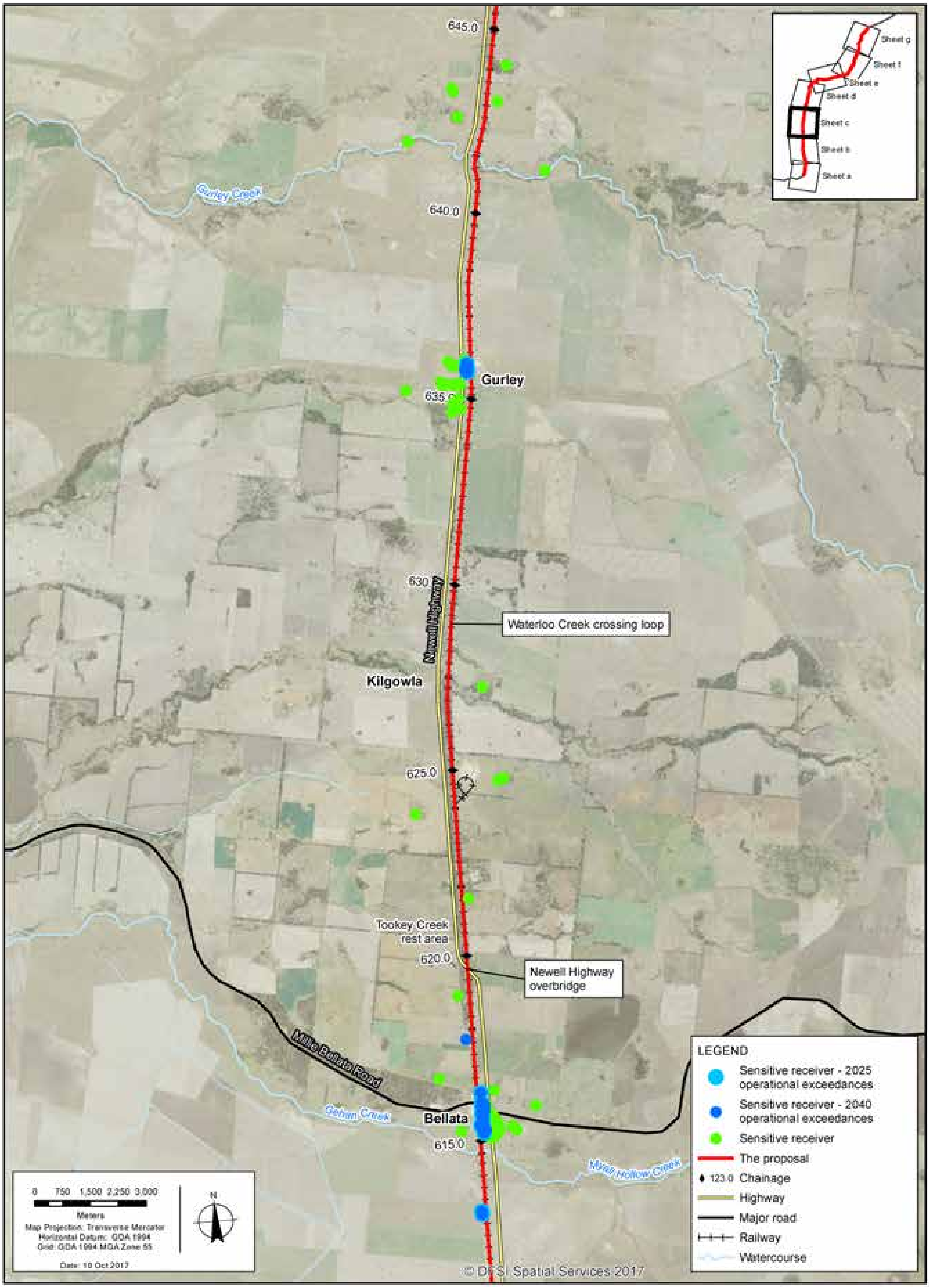


Figure 11.3d Sensitive receiver locations and operational exceedances for 2025 and 2040

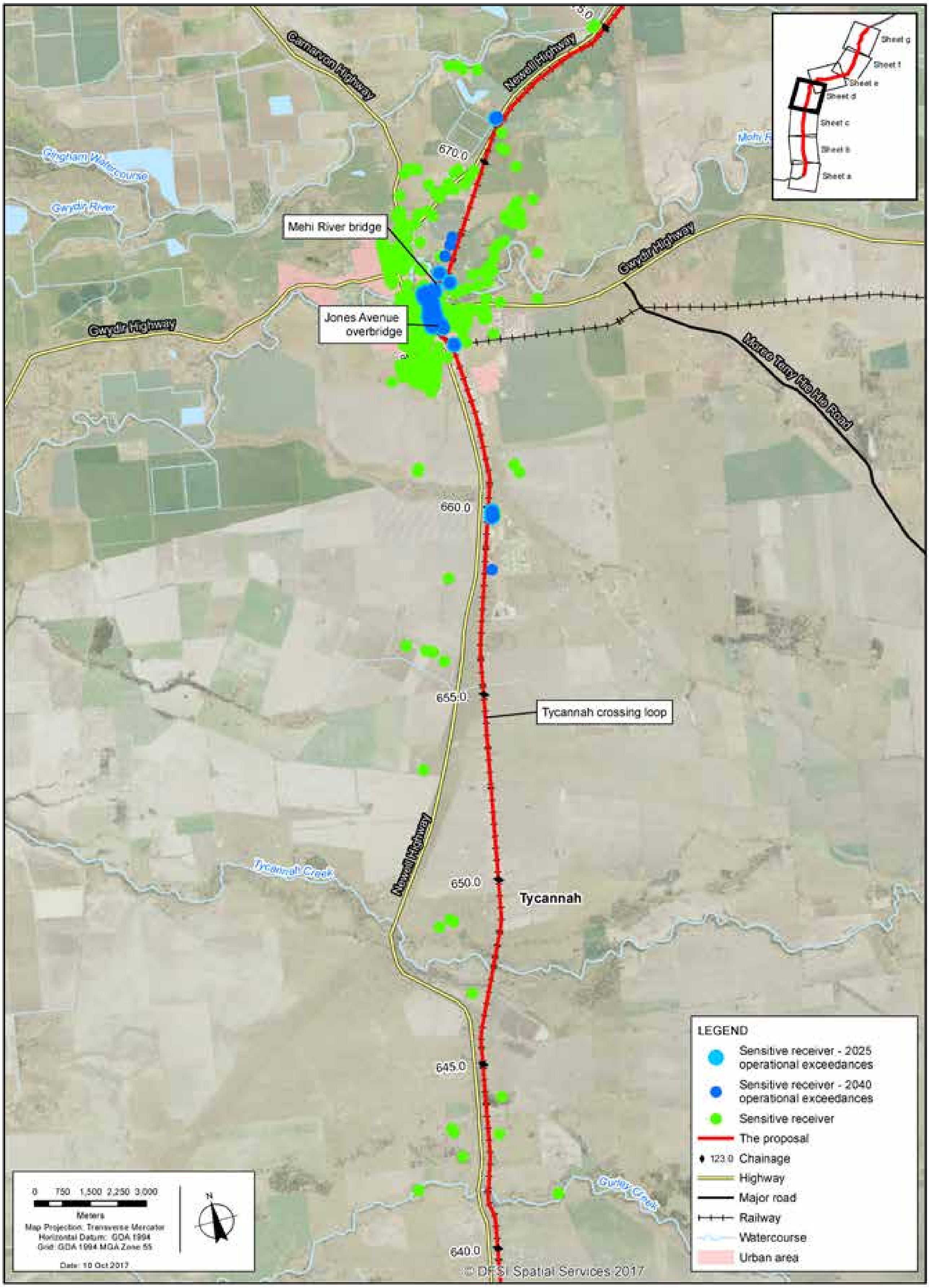


Figure 11.3e Sensitive receiver locations and operational exceedances for 2025 and 2040

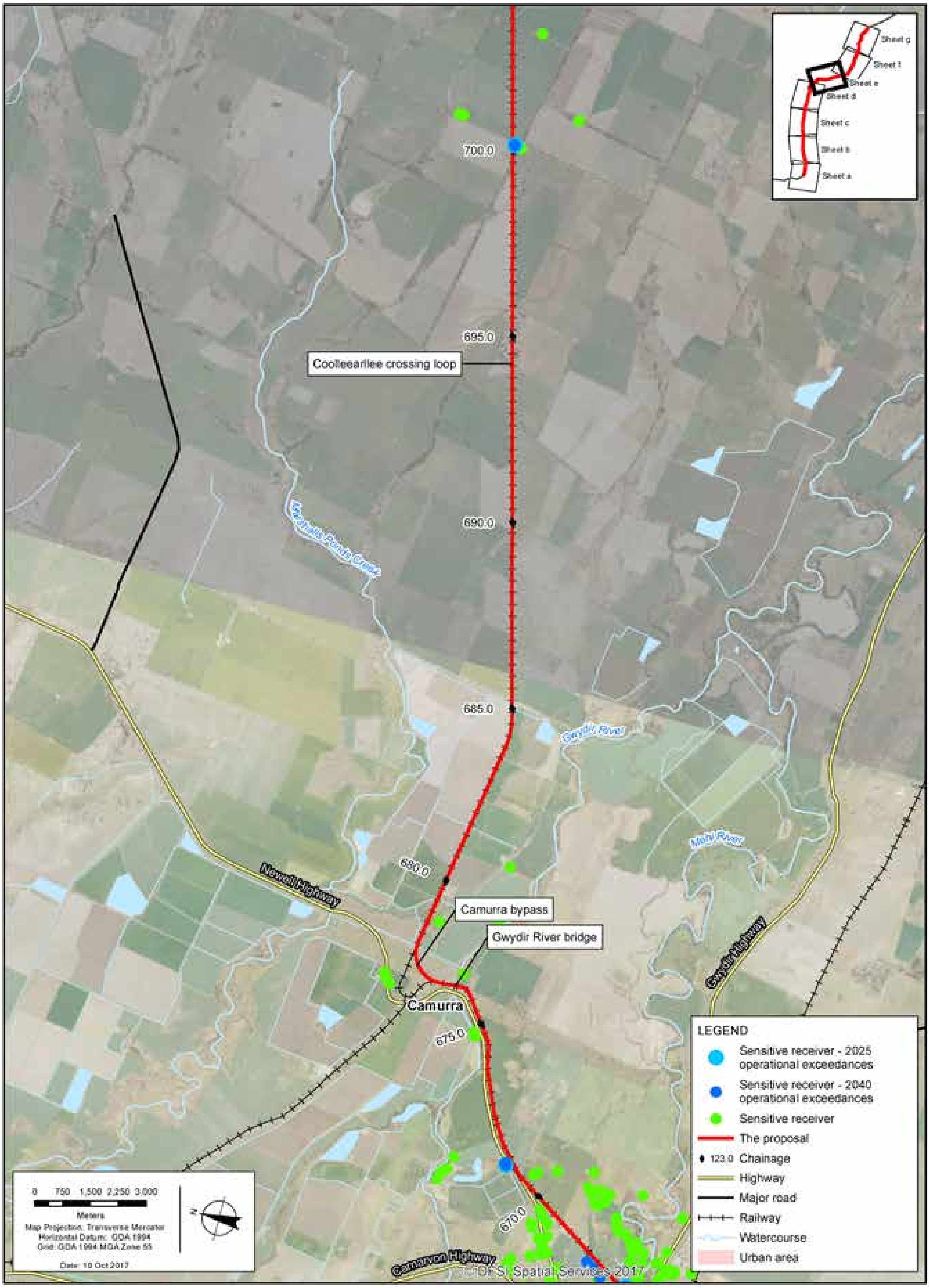


Figure 11.3f Sensitive receiver locations and operational exceedances for 2025 and 2040

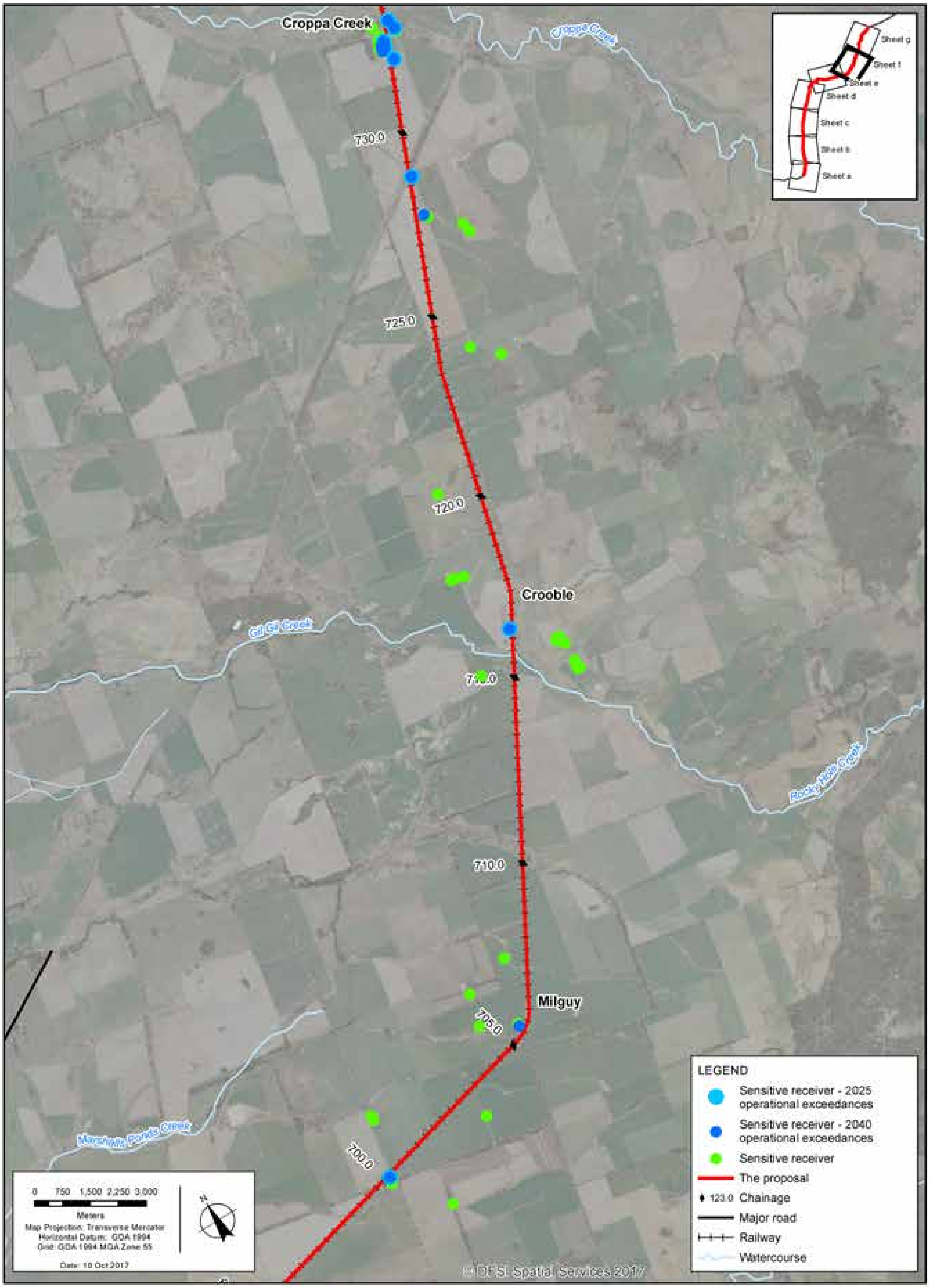


Figure 11.3g Sensitive receiver locations and operational exceedances for 2025 and 2040

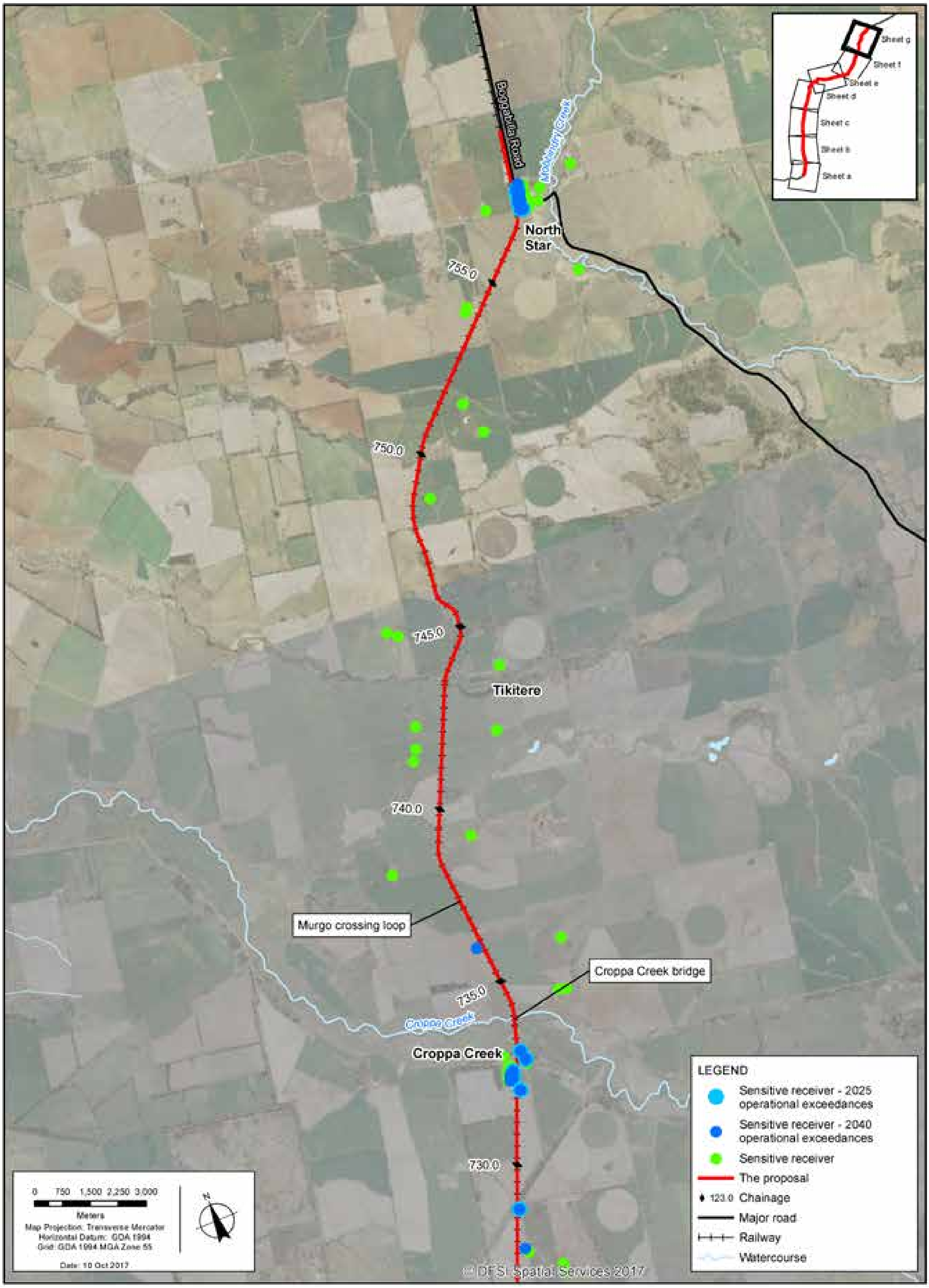


Table 11.11 Estimated distance from train horn to achieve the RING LAmax trigger value

Item	High noise level horn	Low noise level horn	
Speed	Stationary	Stationary	Stationary
External noise limit	88 dB(A) minimum, measured 200 m in front	85 dB(A) minimum, measured 100 m in front	90 dB(A) maximum, measured 100 m in front
Minimum distance to achieve L_{Amax} 85 dB(A)	282 m	100 m	180 m

Source: ARTC's *Locomotive Specific Interface Requirements* (WOS 01.300).

During operation, an increase in the number of horn events is expected due to the projected increase in train numbers.

Operational road noise

Assessment of the expected noise impacts in accordance with the *Road Noise Policy* are as follows:

- The controlling criteria is not expected to be exceeded during the day-time period as a result of the proposal.
- The controlling criteria is not expected to be exceeded during the night-time period.
- Noise levels are not predicted to exceed the day-time acute criteria of 65 dB(A) $L_{Aeq(15\ hour)}$ or night-time acute criteria of 60 dB(A) $L_{Aeq(9\ hour)}$.
- The increase in noise levels between the no-build and build scenarios are less than 2 dB for the receivers that exceed the controlling criterion during the day-time period, therefore mitigation measures are not warranted.
- The Relative Increase Criterion is not applicable to any receiver due to realignment of the Newell Highway overbridge or construction of the Jones Avenue overbridge.

The proposed Newell Highway overbridge and the Jones Avenue overbridge are not expected to adversely impact any sensitive receiver from a noise perspective within the study area.

The *Road Noise Policy* provides guidance for the assessment of sleep arousal due to traffic noise however does not set a sleep disturbance assessment criterion. Sleep disturbance impacts are likely to be dependent on the following:

- maximum noise level of an event
- number of occurrences
- duration of the event
- level above background or ambient noise levels.

For continuous traffic flow, the *Environmental Noise Management Manual* (Roads and Traffic Authority of NSW, 2001) identifies that sleep disturbance may be caused if criteria are exceeded by more than 15 dB(A) when the noise levels is greater than 65 dB(A) external to the property.

Construction of the Jones Avenue overbridge is unlikely to increase the number of maximum noise levels events on the western side of the rail due to existing noise level contributions from the Moree Bypass and Newell Highway. The maximum noise level events causing sleep disturbance impacts on the eastern side of the rail have the potential to increase. However, construction of a new road will not increase the maximum noise levels due to an improved road surface, which is likely to reduce road irregularities, and associated maximum noise level events.

11.4.5 Operational vibration

Ground-borne rail vibration from heavy rail infrastructure can adversely affect sensitive receivers situated close to a rail line. Vibration can contribute to annoyance and human comfort impacts at levels, which are often only slightly higher than the limit of perception.

Operation of the proposal would involve increasing the operational load capacity from 23 to 30 tonnes. Typically, a doubling of axle load can be expected to double vibration, and a proportional increase in vibration due to increased axle loading is likely.

The vibration assessment predicted that daytime vibration levels for human comfort levels would be acceptable at distances of more than 14 metres from the alignment, while night-time levels are predicted to be acceptable at distances of more than 17 metres from the alignment.

Estimated vibration levels at three receivers located in Moree are predicted to trigger the night-time human comfort criteria. The closest receiver is about 15 metres from the existing alignment.

11.5 Mitigation and management

11.5.1 Approach to mitigation and management

ARTC has developed the Inland Rail Noise and Vibration Strategy (provided in Appendix M) to guide assessment and construction of new and upgraded infrastructure and the operation of Inland Rail. The strategy:

- considers relevant legislation, licences and guidelines for NSW, Victoria and Queensland
- aims for consistency in the management of noise and vibration between states
- integrates with existing ARTC policies and guidelines.

The strategy includes a Rail Noise Abatement Program Framework which aims to provide noise mitigation for residential dwellings that are exposed to "acute" levels of rail noise from existing rail lines that have experienced high growth in rail traffic. Management of noise and vibration during construction and operation of the proposal would consider the strategy to ensure consistency with Inland Rail.

Construction

The Inland Rail NSW Construction Noise and Vibration Management Framework (provided in Appendix H) has been developed in accordance with the Inland Rail Noise and Vibration Strategy, to show how construction noise and vibration will be managed for this proposal and Inland Rail NSW projects as a whole. It provides a framework for managing construction noise and vibration impacts in accordance with the *Interim Construction Noise Guideline,* to provide a consistent approach to management and mitigation across Inland Rail in NSW.

Specifically the framework identifies the requirements and methodology to develop Construction Noise and Vibration Impact Statements. These would be prepared prior to specific construction activities and based on a more detailed understanding of the construction methods, including the size and type of construction equipment, duration and timing of works, and detailed reviews of local receivers if required. A Construction Noise Impact Statement would include:

- a more detailed understanding of surrounding receivers, including particularly sensitive receivers such as education and child care, and vibration sensitive medical, imaging, and scientific equipment
- application of appropriate noise and vibration criteria for each receiver type
- an assessment of the potential noise and vibration impacts as a result of different construction activities
- minimum requirements in relation to standard noise and vibration mitigation measures
- noise and vibration auditing and monitoring requirements
- additional mitigation measures to be implemented when exceedances to the noise management levels are likely to occur - these measures are aimed at pro-active engagement with potentially affected receivers, provision of respite periods, and alternative accommodation for defined exceedance levels.

The proposal would be constructed in accordance with the Inland Rail NSW Construction Noise and Vibration Management Framework, the CEMP, site-specific Construction Noise and Vibration Impact Statements, the conditions of approval for the proposal, and the construction environment protection licence.

Operation

An operational noise and vibration review would be prepared to detail how the predicted operation impacts would be mitigated. The operational noise and vibration review would define the further design work and iterative noise modelling required during detailed design to identify feasible and reasonable mitigation measures for operational noise. This would involve consideration of the mitigation options described on the following page. The final form of the mitigation options would be determined during detailed design.

The operational noise and vibration review would:

- confirm predicted project noise and vibration levels at sensitive receivers, which may include the results of façade testing for non-residential receivers
- assess feasible and reasonable noise and vibration measures in a hierarchical manner, consistent with RING
- identify options for controlling noise and vibration at the source and/or receiver, including location, type, and timing of implementation (as described in following subsection)
- specify noise and vibration abatement measures for all relevant sensitive receivers
- include a consultation strategy to seek feedback from directly affected stakeholders on the proposed noise and vibration abatement measures
- include a timetable for delivery of abatement prior to operation
- outline post-operational monitoring to verify noise and vibration predictions.

The proposal would be operated in accordance with the operational noise and vibration review, the conditions of approval for the proposal, and the environment protection licence.

Where exceedances of criteria for non-residential sensitive receivers have been predicted, this would be verified during detailed design, and would involve further investigation of the façade performance at these receivers.

The predicted noise and vibration levels, and the noise and vibration mitigation measures, would be confirmed during detailed design.

To validate the predicted noise levels, monitoring would be undertaken after the commencement of operation of Inland Rail as a whole. Monitoring would confirm compliance with the predicted noise levels, as modified by the review of feasible and reasonable mitigation measures undertaken at the completion of detailed design.

If the results of modelling indicate that the predicted operational noise and vibration levels are being exceeded, then additional feasible and reasonable mitigation measures would be implemented in consultation with affected property owners.

Options for operational noise impact mitigation

The assessment predicts that mitigation measures would be required for operational rail noise at affected sensitive receivers. Three main strategies are used to reduce noise and vibration impacts:

- controlling noise and vibration at the source
- controlling noise and vibration on the source to receiver transmission path
- controlling noise and vibration at the receiver.

Strategies would be assessed against a range of issues to determine whether they are feasible and reasonable, including:

- cost of construction and ongoing maintenance
- potential environmental, visual and social impacts
- consideration of feedback from relevant stakeholders and landowners.

The RING recommends that control strategies should be considered in a hierarchical manner so that all measures that reduce noise at the source are exhausted before property-based measures are considered.

Preliminary information on a range of potential noise mitigation options is provided in Table 11.12. These mitigation options would be considered as part of detailed design. Further information on the approach to noise and vibration mitigation is provided in Technical Report 5.

Table 11.12 Summary of potential operational noise mitigation options

Mitigation option	Description
Rail dampers	Rail dampers are preformed elements made of an elastic material containing steel strips. Dampers are placed on the sides of the tracks, dampening the vibration of the rails as the train passes over them and reducing noise emissions. Noise reduction in the order of 2 to 5 dB(A) can be achieved, depending on the rail roughness (the smoother the rail, the less attenuation). However, this is only valid when the wheel-rail interface is the main noise source. In the context of freight train pass-bys, rail dampers would not attenuate L_{Amax} levels, which are normally dominated by locomotive noise, but would reduce wagon noise.
Track lubrication	Trackside lubrication strategies can be implemented to improve the performance of the track and reduce noise, particularly from rail squeal and flanging on tight curves. This can result in a substantial noise reduction in L_{Aeq}, and L_{Amax} noise levels. However, there are very few tight radius curves in the proposal, so track lubrication would have limited application.
Noise barriers/earth mounds	Noise barriers are typically constructed on the edge of the rail corridor to shield sensitive receivers from the noise generated by the operation of rail vehicles. Depending on the situation, noise barriers can achieve a 10 to 15 dB(A) attenuation. Noise barriers can result in cost and visual impacts. They are generally preferable where noise attenuation at a larger number of receivers is required, and are not typically cost-effective for a small number of receivers. Earth mounds can sometimes be used as noise barriers, and can provide effective mitigation of noise if sufficient spoil and space for the required height is available. However, earth mounds generally provide less attenuation of noise than noise barriers, and require a larger area to reach a sufficient height. During detailed design the potential to utilise the proposed spoil mounds (described in Section 7.4.2) as noise barriers would be investigated.
Road traffic noise mitigation	Predicted noise levels are not expected to exceed the controlling criterion during the day or night-time periods. Therefore, no residential properties qualify for noise mitigation. Where noise mitigation is required the Roads and Maritime Services (2015) *Noise Mitigation Guideline* provides recommendations that should be considered during the road design stage. The *Noise Mitigation Guideline* recommends the following noise mitigation options in order of preference: ▸ quieter pavement surfaces ▸ noise mounts ▸ noise walls.

11.5.2 Summary of mitigation measures

To mitigate the potential for noise and vibration impacts, the measures listed in Table 11.13 would be implemented.

Table 11.13 Noise and vibration - summary of mitigation measures

Stage	Impact	Mitigation measures
Detailed design/ pre-construction	Noise and vibration control	The proposal would be designed with the aim of achieving the operational noise and vibration criteria identified by the noise and vibration assessment. An operational noise and vibration review would be undertaken as described in Section 11.5.1 to guide the approach to identifying feasible and reasonable mitigation measures to incorporate in the detailed design.
Construction	Construction noise and vibration management	The Inland Rail NSW Construction Noise and Vibration Management Framework would be implemented, and the proposal would be constructed, with the aim of achieving the construction noise management levels and vibration criteria identified by the noise and vibration assessment. All feasible and reasonable noise and vibration mitigation measures would be implemented. Any activities that could exceed the construction noise management levels would be identified and managed in accordance with the Inland Rail NSW Construction Noise and Vibration Management Framework and the CEMP. Notification of impacts would be undertaken in accordance with the communication management sub-plan for the proposal.
Operation	Operational noise and vibration	The proposal would be operated with the aim of achieving the operational noise and vibration criteria identified by the noise and vibration assessment, the requirements of the conditions of approval, and the relevant environment protection licence.
	Monitoring	Once Inland Rail has commenced operation, operational noise and vibration compliance monitoring would be undertaken at representative locations to compare actual noise performance against that predicted by the noise and vibration assessment. Compliance monitoring requirements would be defined as part of the operational noise and vibration review. The results of monitoring would be included in an operational noise and vibration compliance report, prepared in accordance with the conditions of approval.

12. Vibration (structural) impacts

This chapter provides a summary of the vibration assessment undertaken for the proposal as it relates to the potential for structural impacts on buildings or objects. It describes the existing environment, assesses the impacts from construction and operation of the proposal, and provides recommended mitigation measures. The full Noise and Vibration Assessment report is provided as Technical Report 5.

This chapter focuses on the potential for structural impacts only, mainly as a result of vibration. The potential for amenity-related noise and vibration impacts is considered in Chapter 11.

12.1 Assessment approach

12.1.1 Methodology

Vibration impacts described in this chapter are those with the potential to result in structural damage to buildings or other structures. The structural vibration assessment:

- identifies vibration sensitive receivers
- identifies the main potential vibration sources during construction and operation
- establishes structural vibration criteria/ management levels to provide a basis for:
  - assessing the potential for impacts during construction
  - assessing the potential for impacts during operation
  - establishing the levels that would be used to refine the design of the proposal
  - monitoring during construction and operation
- assesses the potential for vibration to exceed the applicable criteria
- provides vibration (structural) mitigation measures.

As there is no blasting proposed during construction, there is no risk of damage due to blast-induced vibration or overpressure.

Vibration monitoring for the assessment is described in Section 11.1.1.

Identification of vibration sensitive receivers

Potentially sensitive receivers are those that may be affected by changes in vibration levels. Vibration sensitive receivers were identified based on the activities proposed to be undertaken and the nature of the building or structure. Sensitive receivers are summarised in Section 12.3.2.

Construction vibration

Vibration from construction was assessed at identified sensitive receivers (buildings and heritage items). The methodology for the construction vibration assessment included the following tasks:

- Typical vibration levels for different construction equipment were sourced from the *Environmental Noise Management Manual* (Roads and Traffic Authority, 2001), BS 5228.2 *Code of Practice for noise and vibration control on construction and open sites: Part 2 Vibration* and the *Construction Noise Strategy* (Transport for NSW, 2012a).
- Vibration from construction plant and equipment was predicted and assessed, and criteria established, based on *Assessing Vibration: a technical guideline* (Department of Environment and Conservation, 2006a) and the German standard DIN 4150-3:1999-02 *Structural Vibration – Part 3: Effects of vibration on structures.*
- A quantitative assessment was undertaken of potential vibration impacts from the proposed construction equipment. Predictions of vibration impacts were made using distance attenuation calculations.
- Where vibration levels were predicted to exceed threshold levels, appropriate construction vibration mitigation measures were provided.

Operational vibration

Operational vibration criteria were established based on *Assessing Vibration: a technical guideline* (Department of Environment and Conservation, 2006a). An assessment of operational vibration impacts was undertaken using the assessment methodology provided in the RING. The assessment was based on measured rail vibration levels and the proposed changes in operation, such as the increase in rail movements, track realignments, new track, and effect on train speeds due to the proposal.

12.1.2 Legislative and policy context to the assessment

Other guidelines and policies relevant to the assessment include:

- *Environmental Management System Guide: Noise and Vibration from Rail Facilities* (Sydney Trains, 2013)
- BS 5228-2:2009 *Code of practice for noise and vibration on construction and open sites – Part 2: Vibration*
- AS 2436-2010 *Guide to noise and vibration control on construction, demolition and maintenance sites*
- *Transit noise and vibration impact assessment* (USA Federal Transit Administration, 2006).

12.2 Vibration management levels/criteria

12.2.1 Structural damage criteria

Minimum safe levels of short- term vibration are listed in Table 12.1. In accordance with DIN 4150-3, a measured value exceeding the safe level does not necessarily lead to damage. However, further investigations are required if these values are likely to be significantly exceeded.

12.3 Existing environment

12.3.1 Existing vibration levels

As noted in Section 11.3.2, vibration levels of about 1.0 to 1.3 millimetres per second were recorded at the vibration logger during train pass-by events. Between pass-by events, background vibration levels were about 0.1 millimetres per second.

Table 12.1 Guideline values for short-term vibration on structures (DIN 4150-3)

Type of structure	Guideline values for velocity, vi(t) (mm/s)[1]		
	1 Hz to 10 Hz[2]	10 Hz to 50 Hz	50 Hz to 100 Hz[3]
Buildings used for commercial purposes, industrial buildings, and buildings of similar design.	20	20 to 40	40 to 50
Dwellings and buildings of similar design and/or occupancy.	5	5 to 15	15 to 20
Structures that, because of their particular sensitivity to vibration, cannot be classified under lines 1 and 2 and are of great intrinsic value (such as heritage listed buildings under preservation order).	3	3 to 8	8 to 10

Source: DIN 4150-3:1999-02 *Structural Vibration – Part 3: Effects of vibration on structures*
Notes 1: The term vi refers to vibration levels in any of the x, y or z axes.
2: In the absence of confirmation of the hertz level, the lowest guideline levels are considered (i.e. 1 to 10 Hz).
3: At frequencies above 100 Hz, the values given in this column may be used as minimum values.

12.3.2 Sensitive receivers

There is the potential that vibration levels could impact the physical structure of buildings and structures near to the proposal site. Sensitive receivers include:

- dwellings and buildings of similar design
- buildings used for commercial purposes, industrial buildings, and buildings of similar design
- structures that, because of their particular sensitivity to vibration, cannot be classified under the points above and are of great intrinsic value (for example listed buildings or heritage items).

In the area surrounding the proposal site the most common structural receiver would be residential dwellings,however in the towns there may be other receivers close to the proposal site, including heritage items. The type and location of heritage items in the study area are discussed in detail in Chapter 18.

Listed heritage items (non-Aboriginal) located within 180 metres of the proposal site, are identified in Table 12.2. The non-Aboriginal heritage assessment (Chapter 18) also identified items with potential heritage significance within and in the vicinity of the proposal site. As noted in Table 12.3 construction vibration impacts for heritage items may extend up to 180 metres from the proposal site.

Table 12.2 Listed heritage items

Item name	Location	Distance to corridor/track
Mehi River bridge	Moree – Mungindi Line 666.340 kilometres from Sydney	On alignment
Moree Railway Station	As listed in LEP: Gosport Street, Moree adjacent to Lot 158, DP 1157018 As listed on S170: Morton Street	On alignment / immediately adjacent
Gwydir River bridge	Camurra – Mungindi Line 676.220 kilometres from Sydney	On alignment
Victoria Hotel	339 Gosport Street, Moree	Approximately 100 metres to west
Moree Baths and swimming pool	Corner of Anne and Warialda streets, Moree	Approximately 100 metres to west
Gwydir River underbridge, Camurra	Camurra – Mungindi Line	Approximately 180 metres to west (different bridge to above)
Moree Showground	Warialda Street, Moree	Approximately 100 metres to north-west (Pavilion mentioned in listing, approximately 270 metres to the north-west)
A.B. Meppem and Co.	30 Railway Parade (Newell Highway), Bellata	Approximately 80 metres to east
Bellata Police Station and Official Residence	24 Railway Parade (Newell Highway), Bellata	Approximately 80 metres to east
Oldhams Smallgoods	26 Railway Parade (Newell Highway), Bellata	Approximately 80 metres to east
Post Office	28 Railway Parade (Newell Highway), Bellata	Approximately 80 metres to east
LS Rowe Stock and Station Agents	40 Railway Parade (Newell Highway), Bellata	Approximately 80 metres to east
Nandewar Hotel	Lot 1 Railway Parade (Newell Highway), Bellata	Approximately 80 metres to east

12.4 Impact assessment

12.4.1 Risk assessment

Potential impacts

The environmental risk assessment for the proposal (Appendix B) included an assessment of the potential structural risks from vibration. Potential risks were rated between low and medium, and included:

- damage to structures from vibration caused by construction activities
- damage to structures from vibration caused by the operation of trains.

How potential impacts would be avoided

Potential vibration impacts would be avoided by:

- designing, constructing and operating the proposal to minimise the potential for vibration (structural) impacts, including the implementation of mitigation measures in Section 11.5
- developing specific mitigation approaches in accordance with the Inland Rail NSW Construction Noise and Vibration Management Framework described in Section 11.5
- implementation of mitigation measures listed in Section 11.5.

12.4.2 Construction impacts

The operation of construction plant and equipment has the potential to generate vibration at a level that could result in structural damage to buildings located close to the proposal site.

Typical vibration levels generated by various construction plant are listed in Table 11.8.

Based on these typical vibration levels, safe working buffer distances to comply with the human comfort vibration criteria are listed in Table 12.3. The number of dwellings and heritage structures that may be impacted by the proposal are listed in Table 12.4.

Table 12.3 Vibration safe working distances

Activity	Safe working distance (metres) For heritage buildings (*criteria: 3 mm/s*)	For standard dwellings (*criteria: 5 mm/s*)
General construction activities		
Roller	24 m	13 m
15 tonne vibratory roller	35 m	18 m
7 tonne compactor	24 m	13 m
Dozer	15 m	8 m
Backhoe	3 m	2 m
Excavator	7 m	4 m
Piling		
Piling (impact)	180 m	100 m
Piling (vibratory)	50 m	30 m
Piling (bored)	35 m	17 m

Table 12.4 Construction vibration activities - number of potentially impacted sensitive receivers

Activity	Heritage building / structure (DIN 4150-3 criteria: 3 mm/s)[1]	Residential buildings (DIN 4150-3 criteria for standard dwellings: 5mm/s)[1]
General construction activities		
Roller	2	13
15 tonne vibratory roller	2	20
7 tonne compactor	2	13
Dozer	2	6
Backhoe	1	4
Excavator	1	5
Piling (bridges)		
Piling (impact)	0	45
Piling (vibratory)	0	5
Piling (bored)	0	1

Note: 1 Numbers in table are not cumulative.

General construction activities

The expected magnitude of ground vibration from general construction activities would not be sufficient to cause damage if works are undertaken at distances greater than 18 metres from standard residential buildings, and distances greater than 35 metres from heritage structures. Safe working distances are listed in Table 12.3.

Twenty structures (residential buildings) have been identified within 18 metres of potential general construction activities and may receive vibration levels exceeding the 5 mm/s structural damage criteria. These structures are mostly located within Bellata and Moree, with two situated adjacent to the proposal between Moree and North Star.

Vibration due to construction activities such as vibratory rolling and rock breaking, has the potential to exceed the structural damage criteria for heritage structures. Heritage listed items located within 100 metres of the proposal site are provided in Table 12.2. Three of these would potentially be impacted by general construction activities as listed in Table 12.4.

Many heritage structures nearby the proposal site consist of station buildings, sidings and silos which are directly adjacent to the track and bridges that are on the actual alignment. Moree Station and some potential heritage items are located within the buffer distance. The Mehi River and Gwydir River bridges are also located with this buffer distance, but would be removed as part of the proposal.

Piling

Vibration impacts due to piling activities have the potential to exceed structural vibration values for heritage structures at distances from the activity of 180 metres for impact piling, 50 metres for vibratory piling and 35 metres for bored piling. For standard residential buildings vibration impacts have the potential to exceed structural impact values at distances from the activity of 100 metres for impact piling, 30 metres for vibratory piling and 17 metres for bored piling.

The following locations may all require pilling activities during the construction works:

- Jones Avenue overbridge
- Newell Highway overbridge
- Mehi River bridge
- Gwydir River bridge
- Croppa Creek bridge.

The number of buildings potentially impacted by work activities are listed in Table 12.4. In the event that the buffer distances for piling are not practical, other methods may be investigated such as press-in hydraulic piling or jacked-in piling. These methods generally exhibit much lower vibration levels compared to impact, vibratory and bored piling.

Piling works are not proposed near any heritage structures being retained.

12.4.3 Operational impacts

Vibration from the operation of rail infrastructure can impact sensitive structures located close to the rail line. Vibration can cause buildings, windows, and other fixtures to shake, and can interfere with vibration-sensitive equipment. The level of vibration experienced at a sensitive receiver is a function of the energy of the vibration source, the propagation through the ground, and the coupling of the ground to the receiver structure or building.

The vibration level generated by trains during operation is predicted to be similar to that currently experienced at the nearest sensitive receivers. As noted in Section 11.3.2, vibration levels of about 1.0 to 1.3 millimetres per second were recorded during train pass-by events at the vibration logger located 15 metres from the proposal site. This level is significantly lower than the structural damage criteria of 5 millimetres per second for typical dwellings, and 3 millimetres per second for heritage structures. The closest residential receiver is located about 15 metres from the proposal site.

Operation of the proposal would involve increasing the operational load capacity from 23 to 30 tonnes. This increase is not predicted to result in any significant increases in vibration levels at the closest sensitive receivers.

The proposal is not expected to increase operational vibration levels noticeably, and is not expected to exceed structural damage criteria. While no specific mitigation measures are considered necessary, track features such as crossovers, turnouts, and rail joints have the potential to increase vibration levels, and should be avoided near vibration sensitive structures where practicable.

12.5 Mitigation and management

12.5.1 Approach to mitigation and management

As described in Section 11.5, the approach to vibration management during construction and operation would consider the overarching Inland Rail Noise and Vibration Management Strategy (provided in Appendix M). The approach to managing vibration during construction would be guided by the Inland Rail NSW Construction Noise and Vibration Management Framework (provided in Appendix H).

12.5.2 Summary of mitigation measures

To mitigate the potential for structural vibration impacts, the measures outlined in Table 12.5 would be implemented.

Table 12.5 Structural vibration - summary of mitigation measures

Stage	Impact	Mitigation measures
Detailed design/pre-construction	Vibration control	The proposal would be designed with the aim of achieving the vibration criteria identified by the noise and vibration assessment. Track features such as crossovers, turnouts, and rail joints would be avoided near vibration sensitive structures where practicable.
	Construction vibration	Where vibration levels are predicted to exceed the screening criteria, a more detailed assessment of the structure and vibration monitoring would be carried out in accordance with the Inland Rail NSW Construction Noise and Vibration Management Framework, to ensure vibration levels remain below appropriate limits for that structure.
	Operational noise and vibration review	An operational noise and vibration review would be undertaken as described in Section 11.5.1 to guide the approach to identifying feasible and reasonable mitigation measures to incorporate in the detailed design.
Construction	Construction vibration management	The Inland Rail NSW Construction Noise and Vibration Management Framework would be implemented, and the proposal would be constructed, with the aim of achieving the construction vibration criteria identified by the vibration assessment.
		All feasible and reasonable vibration mitigation measures would be implemented. Any activities that could exceed the vibration criteria would be identified and managed in accordance with the Inland Rail NSW Construction Noise and Vibration Management Framework and the CEMP. Notification of impacts would be undertaken in accordance with the communication management sub-plan for the proposal.
Operation	Operational vibration	The proposal would be operated with the aim of achieving the operational vibration criteria identified by the vibration assessment, the requirements of any conditions of approval, and the relevant environment protection licence.

13. Air quality

This chapter provides the air quality impact assessment undertaken for the proposal. It describes the existing environment, assesses the impacts from construction and operation of the proposal, and provides recommended mitigation and management measures.

13.1 Assessment approach

13.1.1 Relevant pollutants

Air quality may be impacted by a number of pollutants, each of which has different emission sources and effects on human health and the environment. The air quality assessment of the proposal focusses on the highest-risk impacts with the potential to occur during construction and operation. During construction, there is the potential for impacts as a result of airborne particulate matter and dust deposition.

Fine particles associated with exhaust emissions from vehicles and plant used during construction activities are accounted for in the emission factors for earthmoving and handling used in the air quality assessment. Exhaust emissions during construction are expected to be discontinuous, transient, and mobile.

Total suspended particles and dust deposition is usually assessed against annual criteria however, these criteria are less relevant to the proposal as construction works would be transient. As a result, for this proposal, air quality was assessed in terms of distances at which relevant criteria are achieved at any time.

During operation, the highest-risk impacts are likely to occur from rail exhaust emissions as a result of the increase in train movements, with the main emissions for consideration being oxides of nitrogen and particulate matter.

13.1.2 Methodology

The air quality assessment involved:

- reviewing existing regional ambient air quality and meteorology
- undertaking a screening level construction air quality impact assessment
- identifying sensitive receivers near the proposal site that may be exposed to levels of construction dust above the relevant criteria
- qualitatively assessing the potential for air quality impacts during operation
- recommending mitigation measures.

13.1.3 Legislative and policy context to the assessment

The *Protection of the Environment Operations Act 1974* (POEO Act) provides the statutory framework for managing pollution in NSW, including the procedures for issuing licences for environmental protection on aspects such as waste, air, water and noise pollution control. Companies and property owners are legally bound to control emissions (including particulates and deposited dust) from construction sites under the POEO Act. Activities undertaken on-site must not contribute to environmental degradation, and pollution and air emissions must not exceed the standards. Where an environment protection licence applies, air quality requirements (including criteria) will be specified by the licence. Further information on the POEO Act as it relates to the proposal is provided in Chapter 3.

The *Protection of the Environment Operations (Clean Air) Regulation 2010* (the Clean Air Regulation) provides regulatory measures to control emissions from motor vehicles, fuels, and industry. The proposal would be operated to ensure it complies with the Clean Air Regulation.

Air quality impact assessment criteria are prescribed by the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (Department of Environment and Conservation, 2005) (known as 'the Approved Methods'). These generally apply to stationary sources of air pollution. However, as the construction period for the proposal as a whole would be around 24 months, the particulates and deposited dust criteria in the Approved Methods were considered to be appropriate.

Odour from stationary sources is assessed using the *Technical framework: Assessment and management of odour from stationary sources in NSW* (Department of Environment and Conservation, 2006c). Odorous air emissions are not generally associated with locomotives and freight haulage, as the concentrations of odorous substances such as nitrogen dioxide (NO_2), sulphur dioxide (SO_2), and volatile organic compounds (VOCs) have relatively low odour thresholds, and are generally not detected at concentrations below their health-related air quality objectives.

The National Environment Protection Council (NEPC) set uniform national standards for ambient air quality. These are known as the National Environment Protection (Ambient Air Quality) Measure ('the Air NEPM'). The Air NEPM includes non-binding standards and ten-year goals (for 2026). The goal for the Air NEPM is a PM_{10} of 50 micrograms per cubic metre (µg/m^3) as a 24-hour average (no exceedances per year) and a $PM_{2.5}$ goal of 25 µg/m^3 as a 24-hour average.

The Air NEPM standards apply to regional air quality as it affects the general population. The standards do not apply in areas impacted by localised air emissions, such as industrial sources, construction activity, and heavily trafficked streets and roads.

Background concentrations of air pollutants are ideally obtained from ambient monitoring data collected at a proposal site in accordance with the Approved Methods. The Approved Methods recognises that this kind of data is rare, and that data is typically obtained from monitoring sites as close as possible to a proposal site, where sources of air pollution are representative of the proposal site.

13.2 Existing environment

13.2.1 Ambient (background) air quality

Regional air quality within the study area is mainly influenced by rural activities, vehicle emissions, and limited industrial/processing activities. The National Pollutant Inventory lists five sources of emissions between Narrabri and North Star. Two of these are feedlots from which the primary emissions are likely to be odour. Three industries are associated with mineral, metal and chemical wholesaling, where volatile organic compounds may be released.

There is no publicly available air quality monitoring data for the study area (the proposal site and immediate surrounds). The nearest air quality monitoring station that provides publicly available data is operated by OEH at Tamworth (located about 135 kilometres to the south-east of Narrabri). Background air quality was derived using particulate matter (PM_{10}) average and 70th percentile PM_{10} values for the last five years for Tamworth. These background air quality values are provided in Appendix F.

A conservative approach was adopted for the assessment, and the highest 70th percentile PM_{10} value was used to represent background air quality for the study area. The highest 70th percentile PM_{10} was 19.1 µg/m^3, which is below the NSW annual average criteria of 30 mg/m^3.

Due to the inland location of the proposal site, and the lack of any concentrated emission sources, the ambient background levels of gaseous pollutants such as SO_2, NO_2 and carbon monoxide (CO) was considered to be negligible, at a level of zero. Background levels of odours were also considered to be negligible.

13.2.2 Local meteorology

Climate data was obtained from the Bureau of Meteorology (BoM) Narrabri Airport site (site number 054038) and the Moree Aero site (site number 053115). The data indicates that the study area has a warm temperate climate, with significant temperature variations between summer and winter. January is the hottest month at both sites, with a mean maximum temperature of 33.7 degrees Celsius at Narrabri, and 34.3 degrees Celsius at Moree. The temperature drops to 17.8 and 18 degrees Celsius in July at Narrabri and Moree respectively. Most of the annual rainfall (561 millimetres at Narrabri and 589 millimetres at Moree) occurs in summer, with autumn and winter being usually drier. Wind speeds, which are of particular importance when determining the potential for dust impacts, are typically greater in spring and summer.

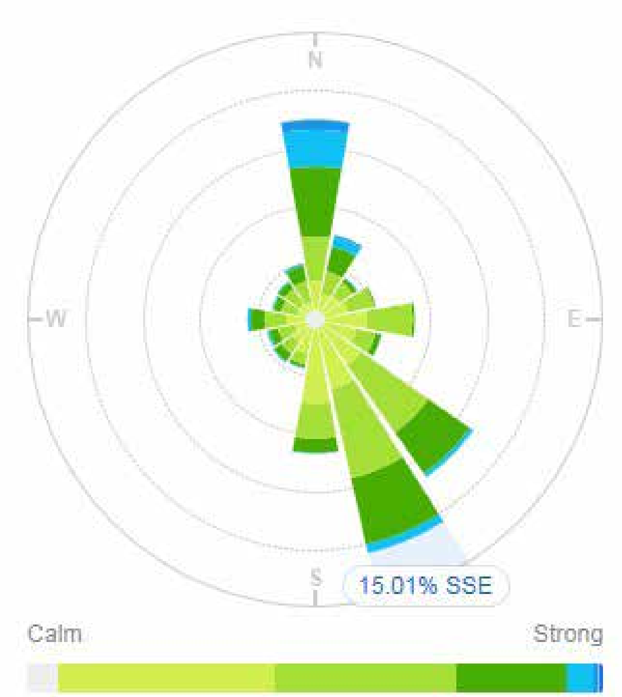
Local meteorology depends on local topography, land use, vegetation, and watercourses and would vary along the proposal site. To conduct a conservative assessment, worst-case meteorology was assumed for dust dispersion, based on all possible wind directions and speeds.

Five year wind roses were sourced for the study area for Narrabri and Moree airports. As shown in Figure 13.1, the five year wind rose for Narrabri Airport shows that calm, light, and gentle winds occur for nearly 75 per cent of the time, with 25 per cent of winds above 19.8 kilometres per hour. This is a level that could cause nuisance dust. Most high winds occur from the north and south quadrants, meaning that dust impacts would be more likely to occur opposite to these directions.

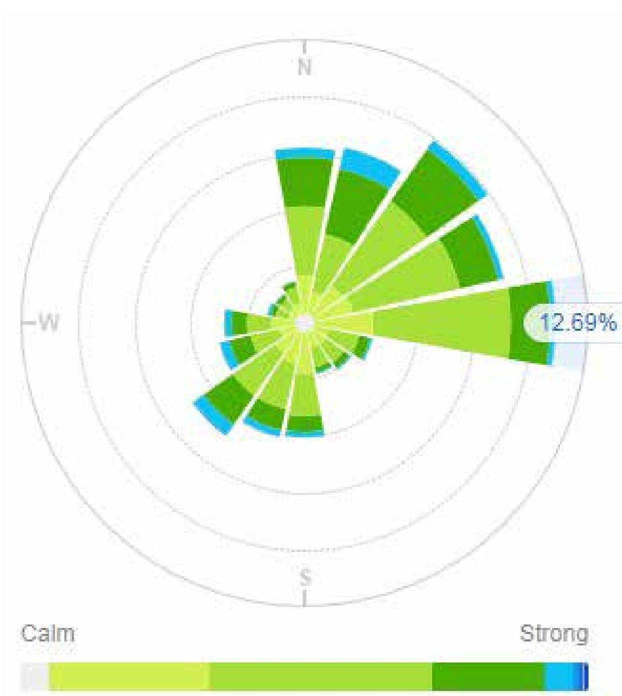
The five year wind rose for Moree Airport shows that calm, light, and gentle winds occur for nearly 75 per cent of the time, with 25 per cent of winds above 19.8 kilometres per hour. This is a level that could cause nuisance dust. Most high winds occur from the north-east quadrant, meaning that dust impacts would be more likely to occur opposite to these directions.

Figure 13.1 Five year wind roses for Narrabri and Moree airports

Wind rose for Narrabri Airport



Wind rose for Moree Airport



Source: www.willyweather.com.au

13.3 Assessment criteria

The air quality impact assessment criteria for the proposal are provided in Table 13.1.

The criteria for particulate matter (PM_{10}) and total suspended particles are prescribed by the Air NEPM and the Approved Methods, respectively. PM_{10}, which has a 24 hour assessment criteria, is most relevant for assessing construction impacts. Dust deposition criteria are mainly used to assess the potential for amenity impacts. These criteria should to be met at existing or future off-site sensitive receptors. Particulate and dust deposition levels are provided as cumulative impacts, where the predicted impact of the proposal is added to the adopted background levels.

Assessment criteria relating to operation of the proposal (SO_2, NO_2, PM_{10}, $PM_{2.5}$, CO, and benzene) are also provided in Table 13.1.

13.4 Impact assessment

13.4.1 Risk assessment

Potential impacts

The environmental risk assessment for the proposal (summarised in Appendix B) included an assessment of the potential air quality risks. The assessed risk level for the majority of potential risks to air quality was between low and medium. Risks with an assessed level of medium or above include:

- generation of dust during construction (from exposed soil/stockpiles, excavation, and vehicle movements)
- emissions from vehicles or plant during construction.

Table 13.1 Adopted air quality impact assessment criteria

Pollutant	Averaging period	Criteria[1]
PM_{10}	24 hours	50 µg/m^3
	Annual	25 µg/m^3
$PM_{2.5}$	24 hours	25 µg/m^3
	Annual	8 µg/m^3
Total suspended particles	Annual	90 µg/m^3
Dust deposition	Annual	2 g/m^2/month[2]
SO_2	10 minutes	712 µg/m^3
	1 hour	570 µg/m^3
	24 hours	228 µg/m^3
	Annual	60 µg/m^3
NO_2	1 hour	246 µg/m^3
	Annual	62 µg/m^3
CO	15 minutes	100 mg/m^3
	1 hour	30 mg/m^3
	8 hours	10 mg/m^3
Benzene	1 hour	29 µg/m^3

1 Based on the Air NEPM and the Approved Methods
2 Maximum increment. Maximum cumulative impact of 4 g/m^2/month

How potential impacts would be avoided

In general, potential air quality impacts would be avoided by:

- managing air quality in accordance with relevant legislative and policy requirements, as outlined in Section 13.1.3
- managing air quality in accordance with the environment protection licences for construction and operation
- implementing the air quality mitigation measures provided in Section 13.5.

13.4.2 Sensitive receivers

Sensitive receivers are locations where people live and work that would be sensitive to changes in air quality for reasons of human health or amenity. Some environmental features such as wetlands may also be considered sensitive to changes in air quality, particularly dust.

Residences, schools, sports grounds, medical clinics, hospitals, wetlands, and some flora are considered to be sensitive receivers in relation to the potential health and amenity impacts of dust. Most of the proposal site traverses sparsely settled rural land. In some areas the proposal site would be located within/close to towns and residences. The potential for indirect impacts to biodiversity as a result of dust generation are considered in chapter 10.

The proposal would generally be located more than 200 metres from most residences and non-residential sensitive receivers. Based on a review of aerial photography and GIS mapping, 243 sensitive receivers (residences), were identified within 200 metres of the proposal. The identified sensitive receivers are shown in Figure 13.2.

13.4.3 Construction impacts

The processes that have the potential to generate particulate matter during construction are:

- mechanical disturbance – dust emissions as a result of the operation/movement of construction vehicles and equipment
- wind erosion – dust emissions from exposed, disturbed soil surfaces under high wind speeds.

Fine particle emissions associated with exhausts from mobile plant and stationary engines used during construction activities were accounted for in the study's dust emission factors for earthmoving and handling.

Dust dispersion modelling

An emissions inventory for potential particulate sources was derived for the proposal and is provided in Appendix F. Table 13.2 summarises the estimated total dust emissions from the main identified sources. The site compound emissions were assumed to be from site establishment, not ongoing operation during construction. Dust impacts from spoil sites were not considered significant due to their small size and low level of potential emissions.

A concrete batching plant with a capacity of 5,000 cubic metres per annum is assumed as a worst-case scenario for construction, which makes up half of the total estimated concrete batching capacity for the proposal. The emissions were estimated assuming dust controls are in place, which may include water sprays, enclosures, hoods, curtains or other controls.

Table 13.2 Estimated emissions of PM_{10} during construction

Source of construction dust	Assumed dimensions for the purposes of the assessment	Total emissions of PM_{10} (grams per second)
Construction in the rail corridor	30 x 100 m	0.03
Construction outside the rail corridor	30 x 100 m	0.11
Site compound	250 x 250 m	0.59
Spoil site	50 x 50 m	0.02
Concrete batching	15 x 10 m	0.008

Figure 13.2a Air quality sensitive receiver locations

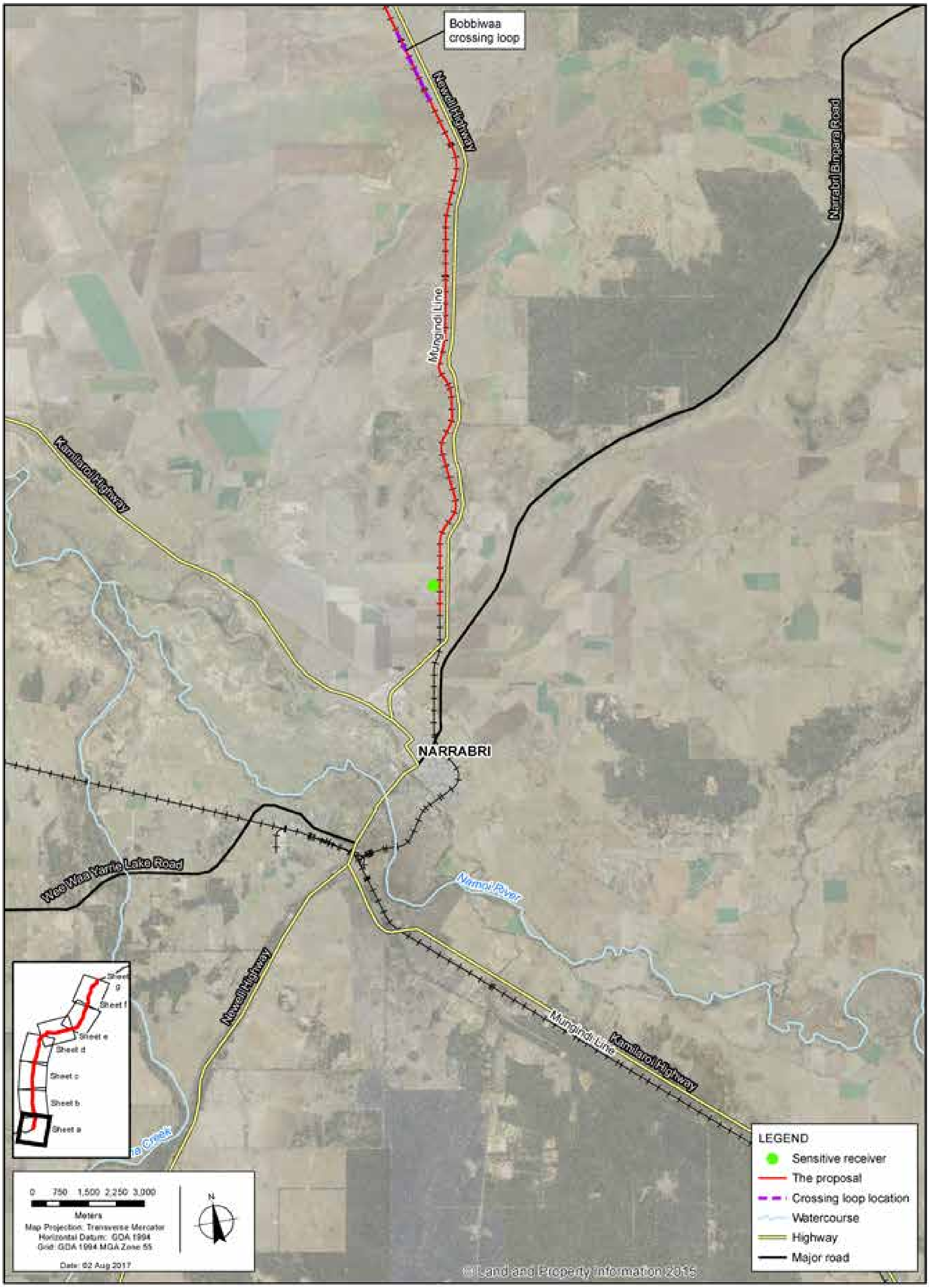


Figure 13.2b Air quality sensitive receiver locations

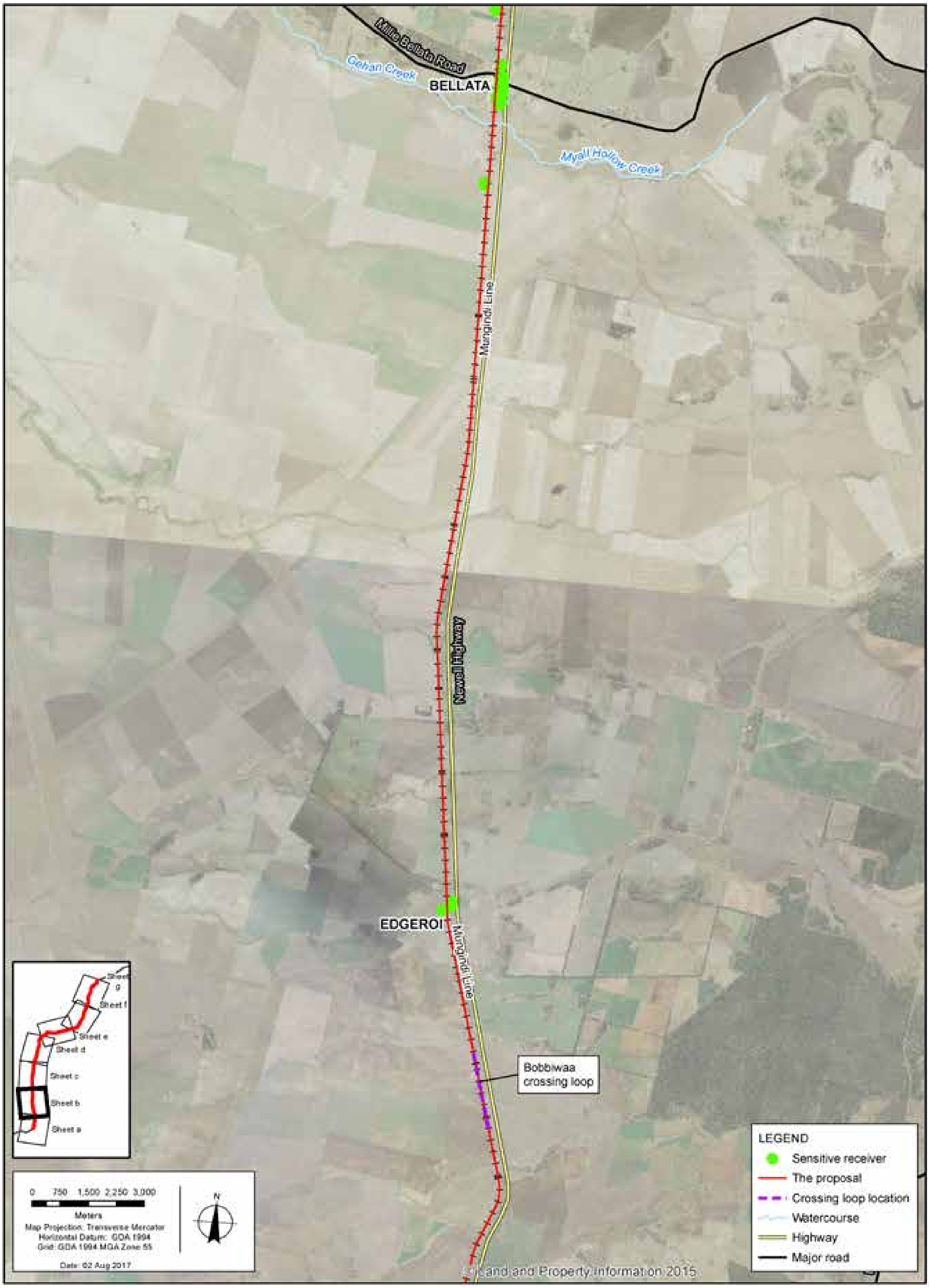


Figure 13.2c Air quality sensitive receiver locations

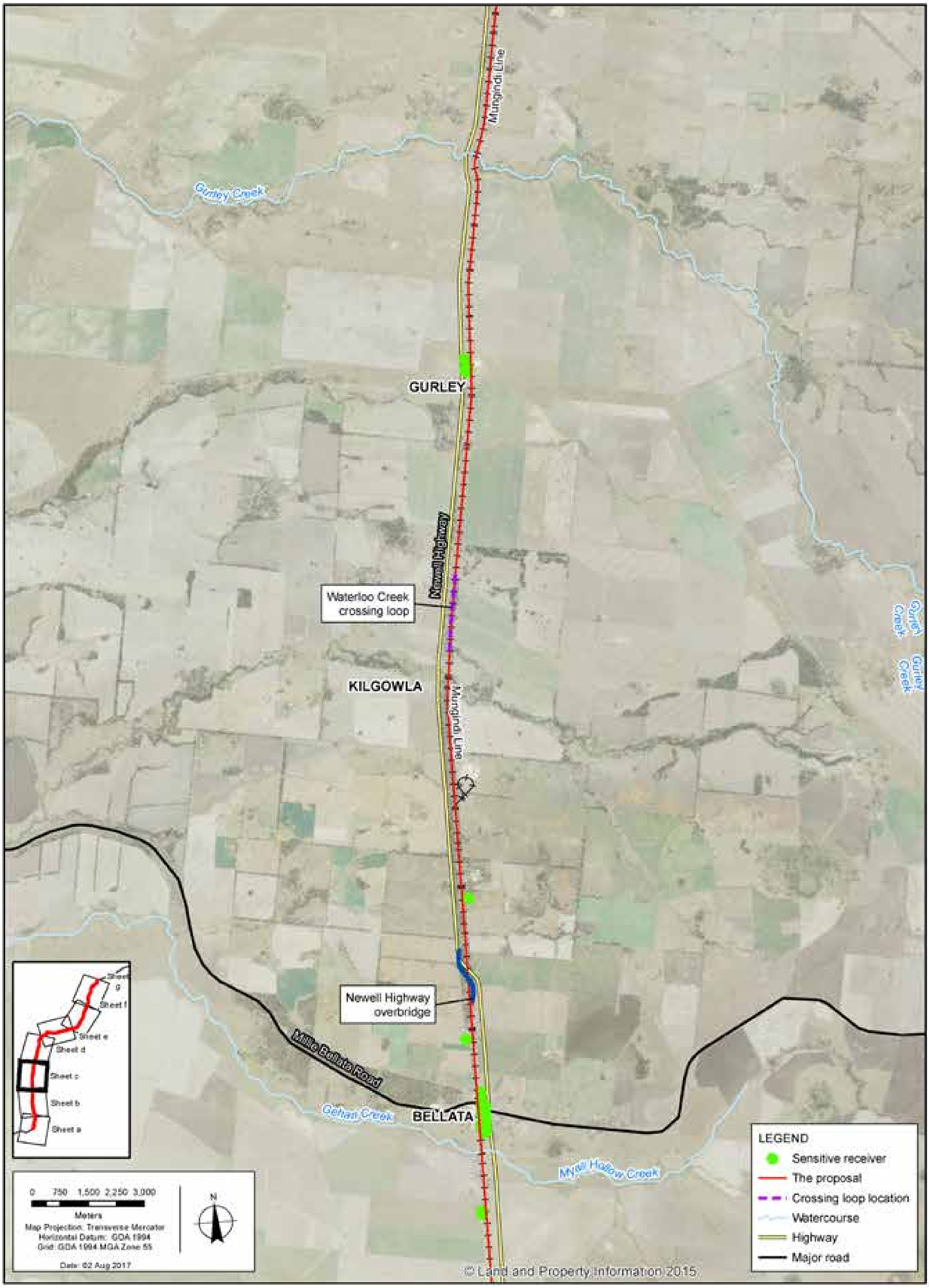


Figure 13.2d Air quality sensitive receiver locations

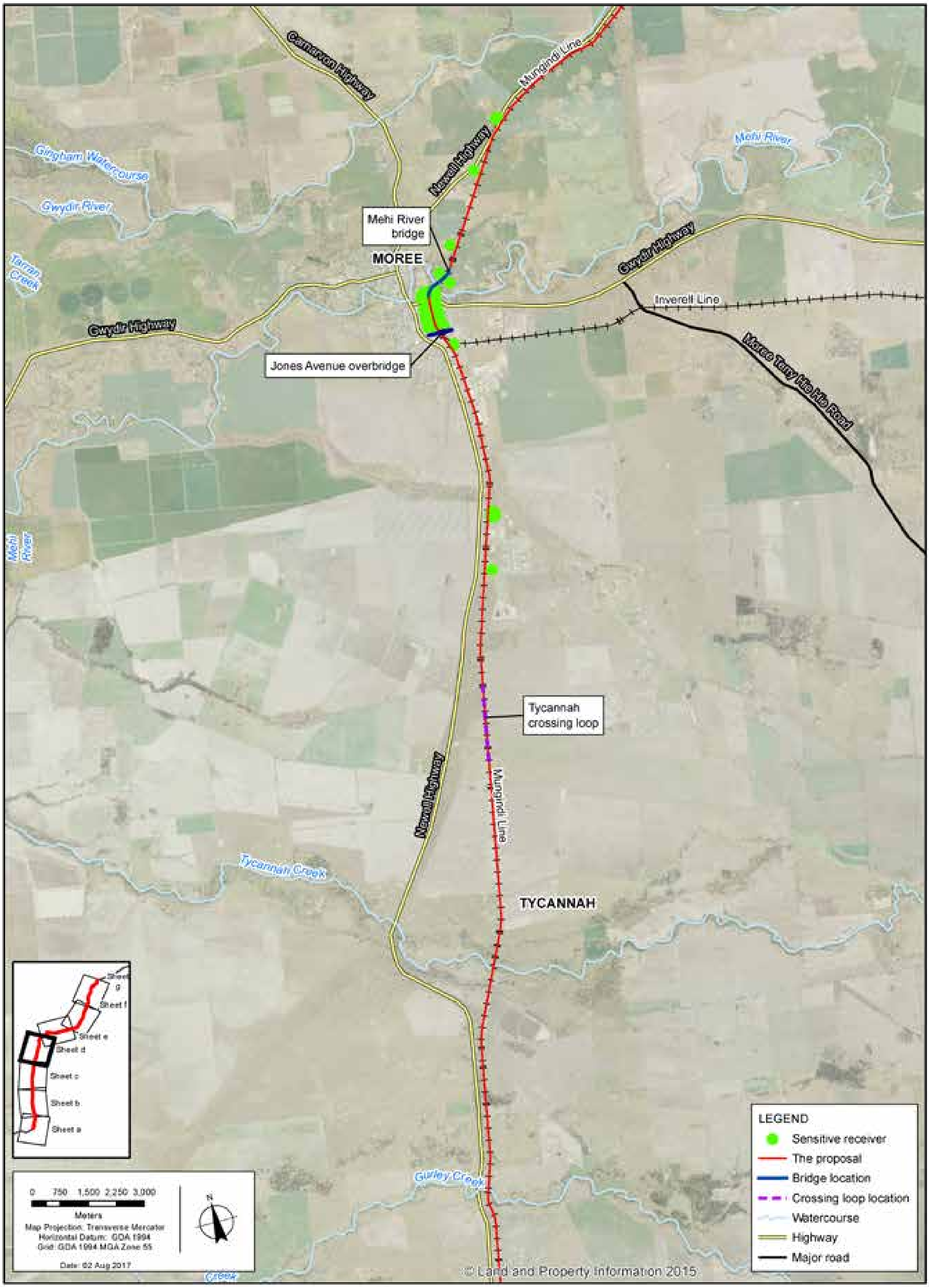


Figure 13.2e Air quality sensitive receiver locations

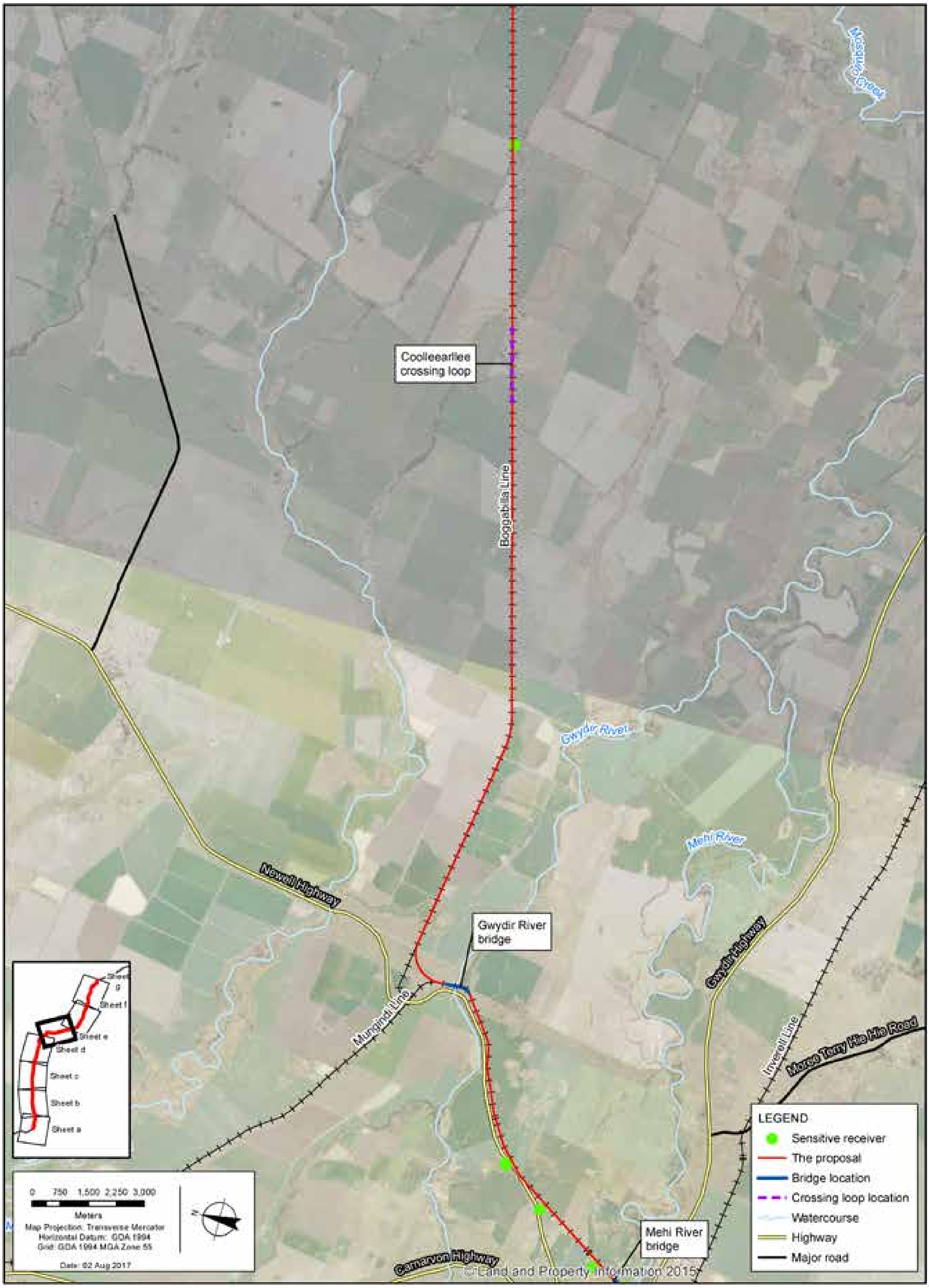


Figure 13.2f Air quality sensitive receiver locations

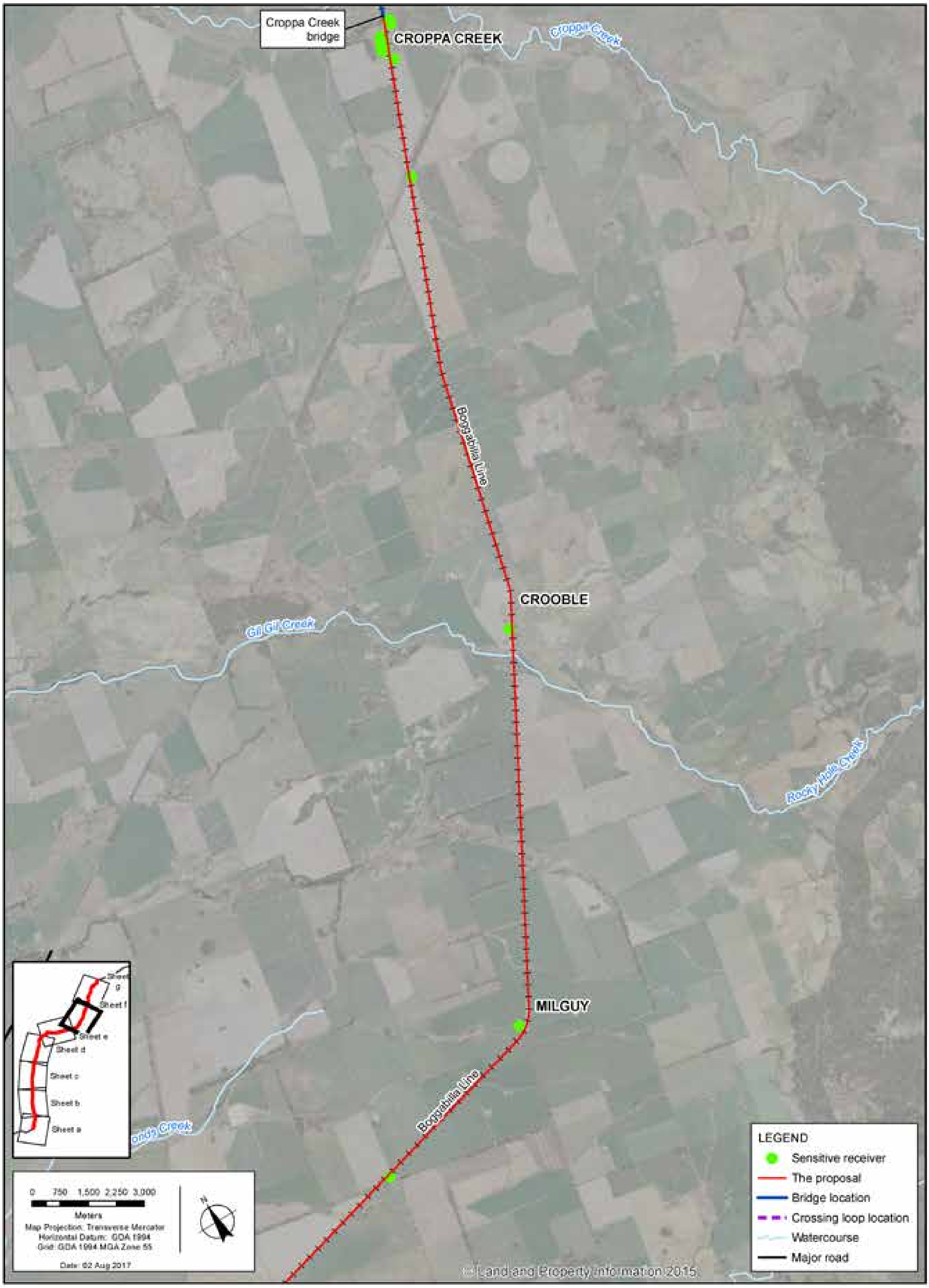
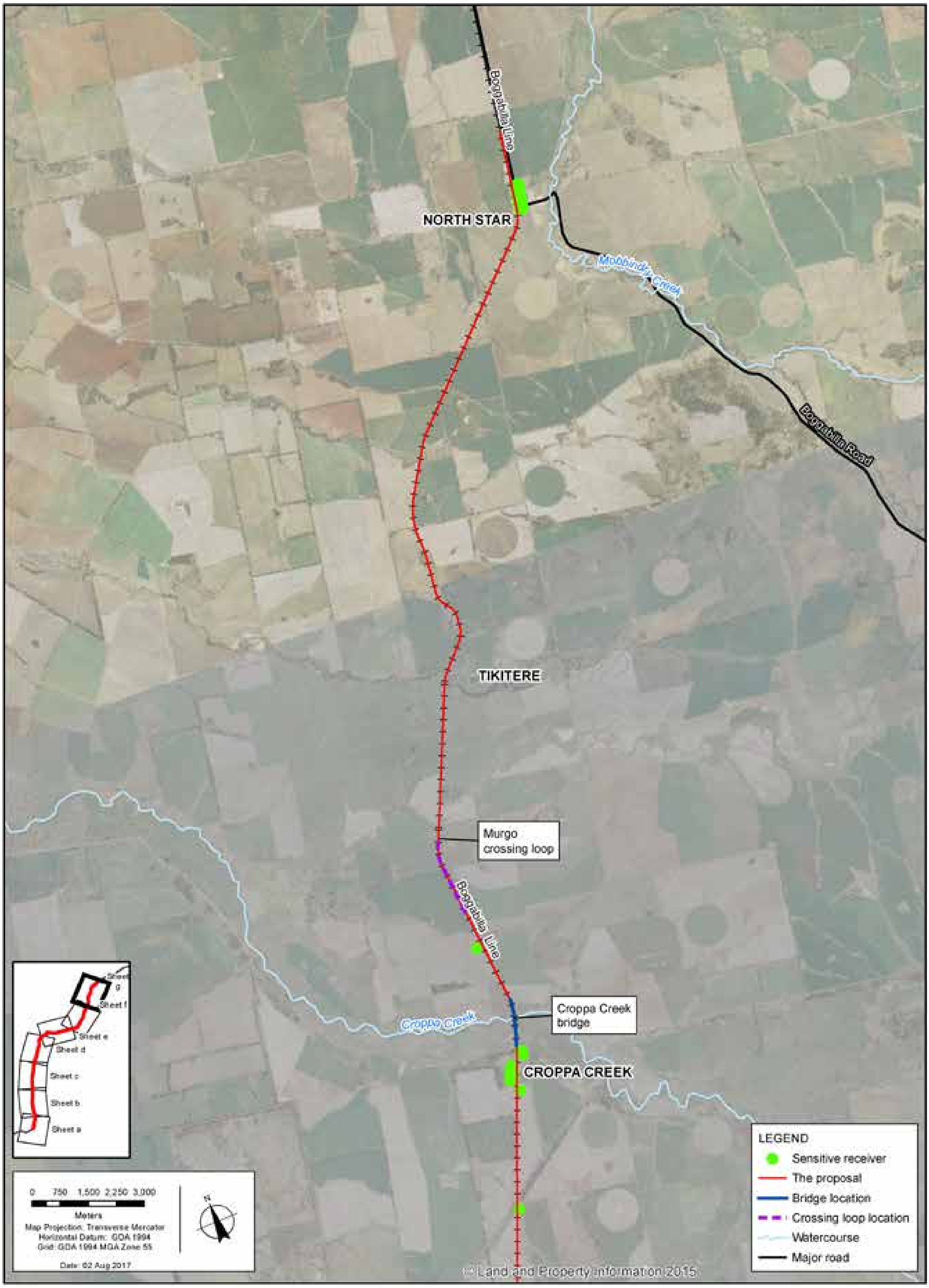


Figure 13.2g Air quality sensitive receiver locations



A screening level assessment was undertaken with consideration to the Approved Methods. The predicted worst-case 24 hour PM10 concentrations are presented in Appendix F as concentration versus distance graph for the following scenarios:

- **Scenario 1** - construction works outside the rail corridor, including the Jones Avenue overbridge, the Newell Highway overbridge, the Camurra bypass, and new bridges over Mehi River, Gwydir River and Croppa Creek. This work would include areas where upgrades to formation are required and widening of embankments.
- **Scenario 2** – construction within the proposal site where the track is being upgraded, significant earthworks are not expected, and the potential for dust impacts is lower than for scenario 1.
- **Scenario 3** – establishment of site compounds.
- **Scenario 4** – concrete batching plants.

The calculations used a background dust level of 19.1 µg/m^3 and are worst-case predictions, with the actual values dependent on background dust levels and local meteorology.

Modelling results

The results for scenario 1 show that the PM_{10} 24 hour criteria of 50 µg/m^3 may be exceeded at a distance of up to 100 metres from the proposal site under worst-case conditions. There are 10 sensitive receivers on the south side of Dingwall Place located within 100 metres of the proposed Jones Avenue overbridge. Most earthworks would be confined to the approach embankments.

The Newell Highway overbridge is located over 300 metres from the nearest sensitive receiver, and the Camurra bypass is over 250 metres from the nearest sensitive receiver.

There are no receivers within 100 metres of the other out of corridor works.

The results for scenario 2 show that the PM_{10} 24 hour criteria of 50 µg/m^3 may be exceeded at a distance of up to 20 metres from the proposal corridor under worst-case conditions.

There are three sensitive receivers in Moree within 20 metres of the proposal site. This is a worst-case predicted dust level and would only occur if construction was occurring directly adjacent to these receivers, with strong winds blowing directly towards them for an entire 24 hour period.

The impacts from construction along the proposal site would be short-term only as construction works would move along the proposal site, limiting the duration of potential impacts at any one location.

The results for scenario 3 show that the PM_{10} 24 hour criteria of 50 µg/m^3 could be exceeded at a distance of up to 150 metres from the compound site under worst-case conditions. This impact would be temporary and short-term, as once the site is established, the potential for dust impacts would be much lower and dust impacts would not be anticipated.

The results from scenario 4 show that the PM_{10} 24 hour criteria of 50 µg/m^3 could be exceeded at a distance of approximately 20 metres from a concrete batching site under worst-case conditions. This scenario assumes that the batching plant has dust emission controls in place as previously discussed.

13.4.4 Operation impacts

Operation of the proposal would result in an increase in the number of freight trains travelling along the rail corridor. It is estimated that the operation of Inland Rail would involve an annual average of about 10 trains per day travelling north of Moree (between North Star and Moree) and 12 trains per day travelling south of Moree (between Moree and Narrabri) in 2025. This would increase to about 19 trains per day north of Moree (between North Star and Moree) and 21 trains per day south of Moree (between Moree and Narrabri) in 2040. This rail traffic would be in addition to the existing rail traffic using the Narrabri to North Star line.

Diesel locomotives, like trucks and cars, emit nitrogen oxides and particulate matter to the air. Air quality impacts from busy rail corridors are generally only an issue in densely populated areas, with poor outdoor air circulation. *Development near rail corridors and busy roads – interim guideline* (Department of Planning, 2008), suggests that air quality should be a design consideration within 20 metres of a freeway or main road with moderate congestion levels. The guideline provides no specific reference to a distance from rail corridors.

The majority of the proposal site traverses a rural area with few sensitive receivers and low background emission levels compared to other transport corridors in NSW. The potential for air quality impacts would be greater in the town of Moree, which has the greatest density of housing close to the alignment.

The results of the *Northern Sydney Freight Corridor Strathfield Rail Underpass Air Quality Assessment* (Parsons Brinckerhoff, 2012) were reviewed with respect to the potential impacts of the operation of freight trains. The assessment included air quality modelling of 81 class diesel locomotives undertaking a minimum of 32 movements per day (16 in each direction) at 75 kilometres per hour. The results of modelling indicated that for all assessed pollutants (NO_2, SO_2, CO, PM_{10}, $PM_{2.5}$ and benzene) the predicted levels were significantly below the impact assessment criteria at a distance of 50 metres from the track. The predicted increment of PM_{10} as a 24-hour average was 0.06 μg/m^3, and the increment of $PM_{2.5}$ was 2 μg/m^3, which complied with the assessment criteria at all sensitive receivers. The frequency of train movements in the assessment was substantially greater than those involved in the proposal. As such, the findings apply to the proposal as a conservative over estimate.

As the levels of operational rail traffic along the proposal site would be much lower than for the Northern Sydney Freight Corridor, the operational emissions as a result of the proposal are expected to be much lower. The emissions from use of the existing rail corridor as a result of the proposal would increase as a result of the increase in the number of trains travelling along the corridor, however the emissions are still expected to be below the relevant impact assessment criteria.

Air pollution from transport corridors decreases significantly with distance, and is expected to be negligible for the proposal.

13.4.5 Cumulative impacts

The construction impact assessment in Section 13.4.3 includes existing dust levels in regional NSW. The results show cumulative dust levels, which include the background and predicted increment from construction in the study area. The assessment found that the predicted particulate levels from construction would be unlikely to extend farther than 150 metres from work areas, and would have insignificant cumulative impacts with other approved projects. Predicted particulate increment from construction would not impact on regional air quality, and would be localised to a few hundred metres of the construction works.

Operational air quality impacts are not expected at distances greater than 20 metres from the proposal site. There are no identified significant sources of air pollutants within 20 metres of the proposal site and cumulative impacts are not expected.

13.5 Mitigation and management

13.5.1 Approach to mitigation and management

An air quality and dust management sub-plan would be prepared as part of the CEMP and implemented during construction to ensure that air quality impacts do not exceed relevant air quality criteria. The air quality and dust management sub-plan would help ensure that dust and emissions are managed in an environmentally sound manner, and in accordance with statutory requirements.

During operation, air quality would be managed to achieve compliance with the operational environment protection licence.

13.5.2 Consideration of the interactions between mitigation measures

Mitigation measures to control air quality impacts may overlap with the measures proposed for the control of erosion and sedimentation (described in Chapters 14 and 16), as the major pollutant of concern is dust.

All mitigation measures for the proposal would be consolidated and described in the CEMP. The CEMP would identify measures that are common between different aspects. Common impacts and common mitigation measures would be consolidated to ensure consistency and implementation.

13.5.3 Managing residual impacts

The mitigation and management measures proposed are expected to reduce the potential for impacts to air quality resulting from construction and operation. With the implementation of these measures, residual impacts are expected to be minimal.

13.5.4 Summary of mitigation measures

The measures outlined in Table 13.3 would be implemented to mitigate the potential impacts to air quality.

Table 13.3 Air quality – summary of mitigation measures

Stage	Impact	Mitigation measures
Pre-construction/ construction	General air quality impacts	An air quality and dust management sub-plan would be prepared and implemented as part of the CEMP. It would include measures to minimise the potential for air quality impacts on the local community and environment, and would address all aspects of construction, including: ▸ spoil handing ▸ machinery operating procedures ▸ soil treatments ▸ stockpile management ▸ haulage ▸ dust suppression ▸ monitoring.
	Construction activities and activities with earthworks that may cause dust impacts	Where sensitive receivers are located within 150 metres of construction works, or visible dust is generated from vehicles using unsealed access roads, road watering would be implemented.
Operation	Rail vehicle emissions	The proposal would be managed in accordance with the air quality management requirements specified in the environment protection licence.
	Impacts during maintenance	Maintenance service vehicles and equipment would be maintained and operated in accordance with the manufacturer's specifications.

14. Contamination and soils

This chapter provides the results of the soils and contamination assessment undertaken for the proposal. It describes the existing soil environment including the identification of potential contamination, assesses the impacts from construction and operation, and provides recommended mitigation and management measures.

14.1 Assessment approach

14.1.1 Methodology

As an input to the concept design of the proposal, contamination and geotechnical assessments were undertaken to identify design constraints and the potential for human health impacts and/or environmental risks. These assessments were reviewed, and results relevant to the potential for soil and contamination impacts are provided in this chapter.

The contamination assessment undertaken as an input to the concept design included a desktop assessment to identify the potential for contamination along the proposal site, involving:

- a review of historical aerial photographs and a site visit to identify whether there are or have been any land uses that may have resulted in contamination issues
- searches of the NSW EPA Contaminated Sites Register and the list of sites which have been notified to the EPA
- a review of ARTC's contaminated site register.

The geotechnical assessment undertaken as an input to the concept design involved excavating 121 test pits along the proposal site. For the contamination assessment, contamination testing was undertaken at 111 of these test pit locations. Test pit locations are shown on Figure 14.1. Soil samples were submitted to a National Association of Testing Authorities (NATA) accredited laboratory for analysis of the following contaminants of potential concern:

- asbestos
- total recoverable hydrocarbons
- polycyclic aromatic hydrocarbons
- organochlorine pesticides
- heavy metals (arsenic, cadmium, chromium, copper, mercury, lead, nickel, and zinc)
- polychlorinated biphenyls.

A summary of the results relevant to the EIS is provided in this chapter.

14.1.2 Legislative and policy context to the assessment

Assessment framework

The contamination assessments were undertaken in accordance with guidelines made under section 105 of the *Contaminated Land Management Act 1997* (the CLM Act). Relevant guidelines include:

- *Contaminated Sites: Guidelines for Consultants Reporting on Contaminated Sites* (OEH, 2011a)
- *Contaminated Sites: Guidelines on the Duty to Report Contamination under the Contaminated Land Management Act 1997* (EPA, 2015a)
- *Contaminated Sites: Sampling Design Guidelines* (EPA, 1995)
- *National Environment Protection* (*Assessment of Site Contamination) Measure 1999*, 2013 amendment (the site contamination NEPM)
- *Acid Sulfate Soils Assessment Guidelines* (Acid Sulfate Soils Management Advisory Committee, 1998)
- *Managing Land Contamination Planning Guidelines SEPP 55 – Remediation of Land* (Department of Urban Affairs and Planning and EPA, 1998).

Assessment criteria

The assessment criteria (investigation levels) for the contamination assessment were taken from the following guideline levels provided by the site contamination NEPM (refer to Schedule B1 of the NEPM):

- Health investigation levels:
  - to assess human health risk via all relevant pathways of exposure
  - the level adopted for this assessment was D – commercial/industrial use.
- Health screening levels:
  - for hydrocarbon vapour intrusion under different land use scenarios
  - the level adopted for this assessment was D – commercial/industrial use.

The desktop assessment did not identify a potential risk to ecological receptors from contaminated soils during construction. Therefore, ecological screening/investigation levels were not adopted as assessment criteria.

Asbestos

The assessment criteria for asbestos was taken from the site contamination NEPM and *Managing asbestos in or on soil* (WorkCover NSW, 2014). These provide guidance on what constitutes an 'acceptable' level of asbestos in soil. The site contamination NEPM emphasises that the assessment and management of asbestos contamination should take into account the condition of the asbestos materials, the potential for damage, and resulting release of asbestos fibres. Bonded asbestos in sound condition represents a low human health risk. However, both friable and fibrous asbestos materials have a significantly higher potential to generate, or be associated with, free asbestos fibres, and may represent a significant human health risk if disturbed and fibres are made airborne.

Waste classification

A preliminary soil waste classification was completed to guide any off-site soil disposal that may be required. The analyte concentrations in the tested soil samples were compared to the criteria in Table 2 of the *Waste Classification Guidelines - Part 1: Classifying waste* (EPA, 2014) (Waste Classification Guidelines). Further information on the application of the waste classification guidelines is described in Chapter 25.

14.2 Existing environment

14.2.1 Geological and soil settings

The proposal site generally consists of gentle rises and falls with areas of near level to undulating terrain.

The proposal site is located within an alluvial floodplain in the Gunnedah Basin, crossing the Goondiwindi thrust fault east of Camurra, and passing into the New England Fold Belt. Near surface materials include Tertiary to Quaternary aged red silty alluvium over intermittently outcropping folded and faulted Silurian and Ordovician aged sedimentary and minor metamorphic sequences.

Between Narrabri to Moree South the rail corridor is located within an alluvial floodplain, associated with the Mehi River to the north and Namoi River to the south.

Published soil units for the proposal site include deep reactive clays, including black earths, occurring on flat alluvial and undulating plains west of the Goondiwindi Fault. East of the fault, are variable soil conditions including deep reactive clays, basaltic soils, red and brown sandy and silty clay soils. Soil types are shown on Figure 14.1.

Based on regional groundwater bore information, groundwater is anticipated to be located between 5 and 50 metres below the ground surface, and generally greater than at 10 metres depth. Subsurface conditions noted during the contamination and geotechnical assessment are summarised in Table 14.1.

Of the soils present in the proposal site, the main potential issue relates to dispersive alluvial and residual soils, which were found in a significant proportion of the tested soils. Dispersive soils break down in water, forming a cloudy colloidal suspension. The suspension contains clay particles that are much finer than silt, hence conventional silt fences would not combat the turbid runoff during rainfall. The erosion potential of the alluvial and residual soils was assessed to be moderate to high.

Figure 14.1a Soils and contamination

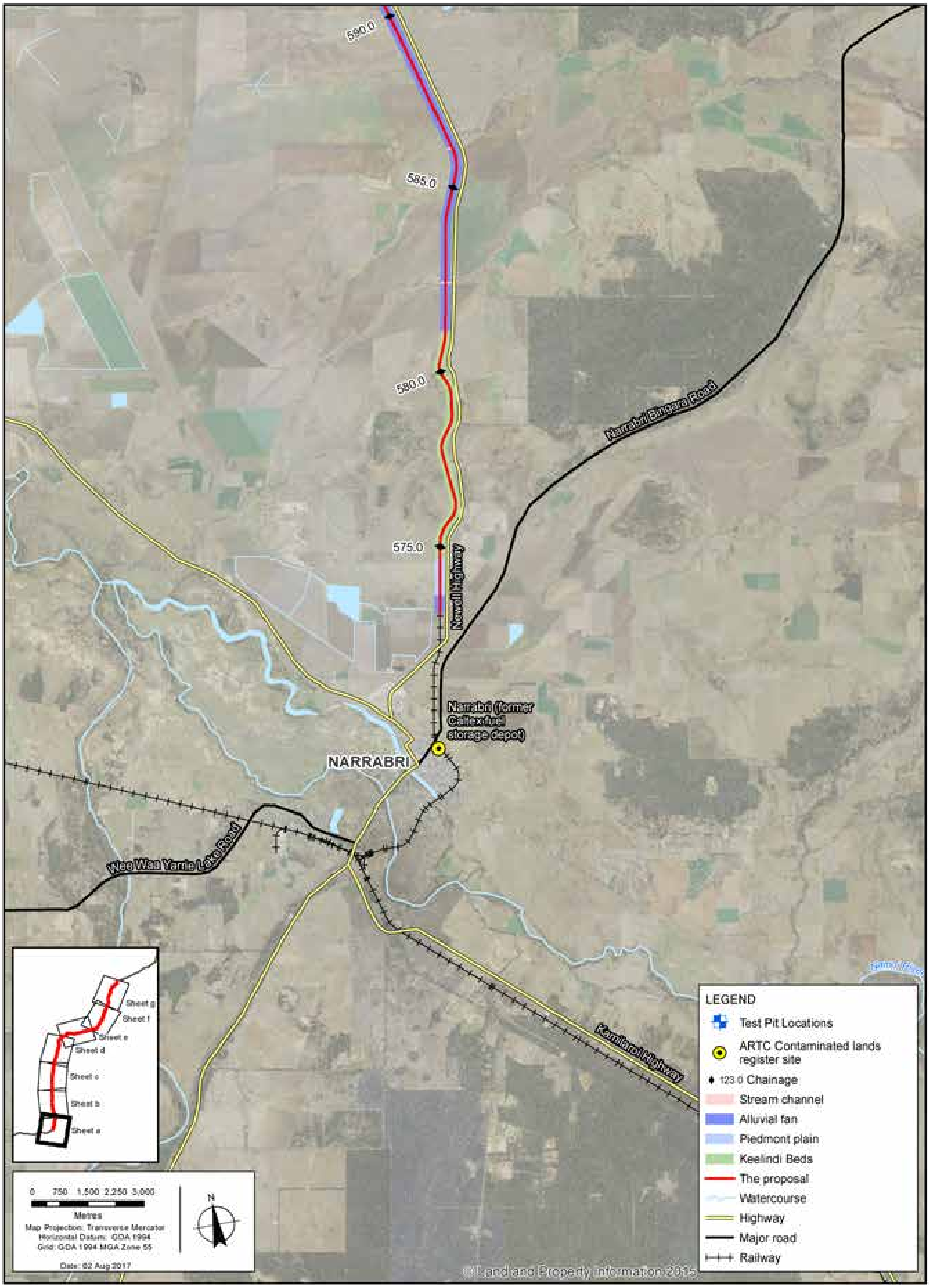


Figure 14.1b Soils and contamination

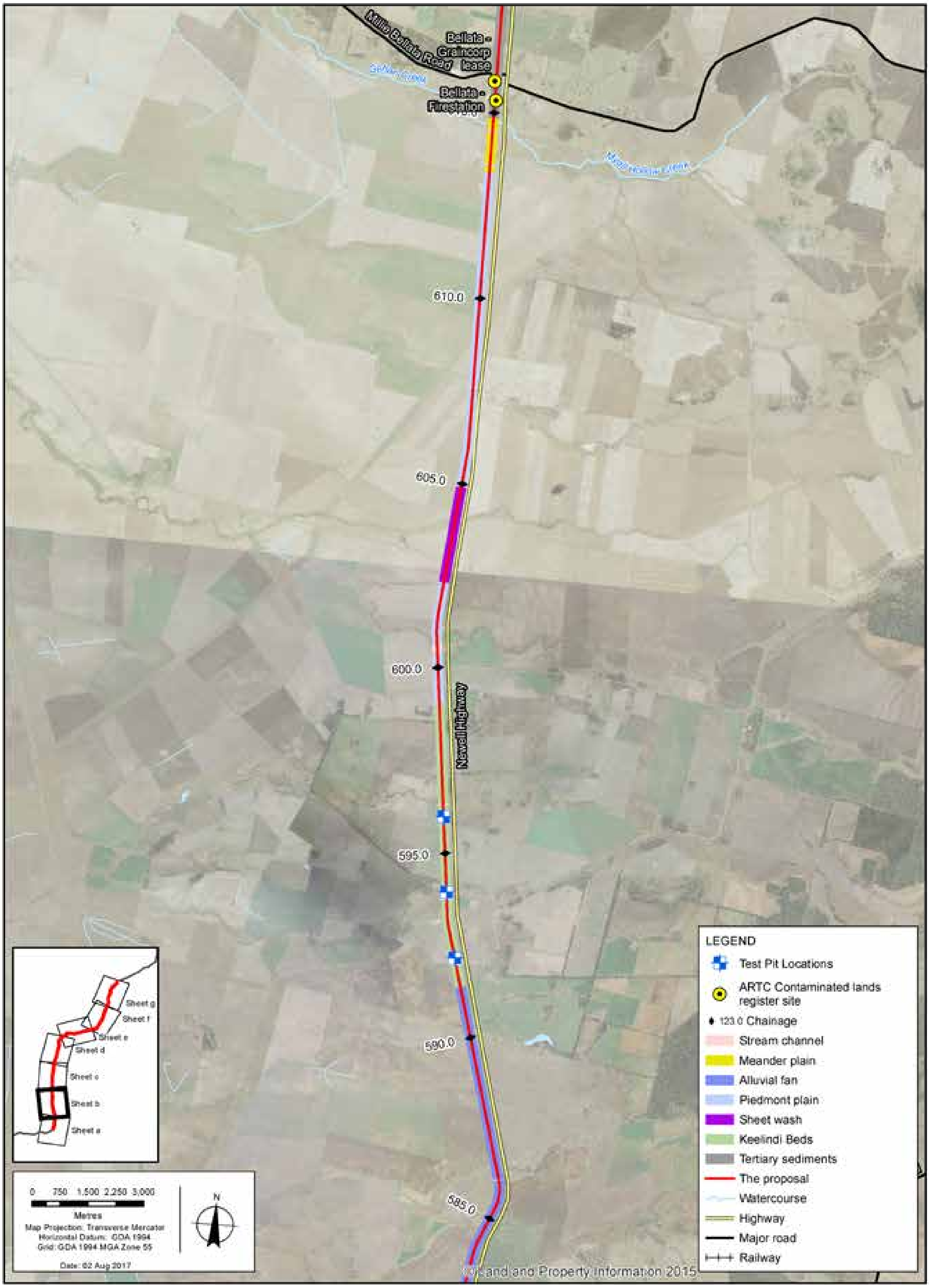


Figure 14.1c Soils and contamination

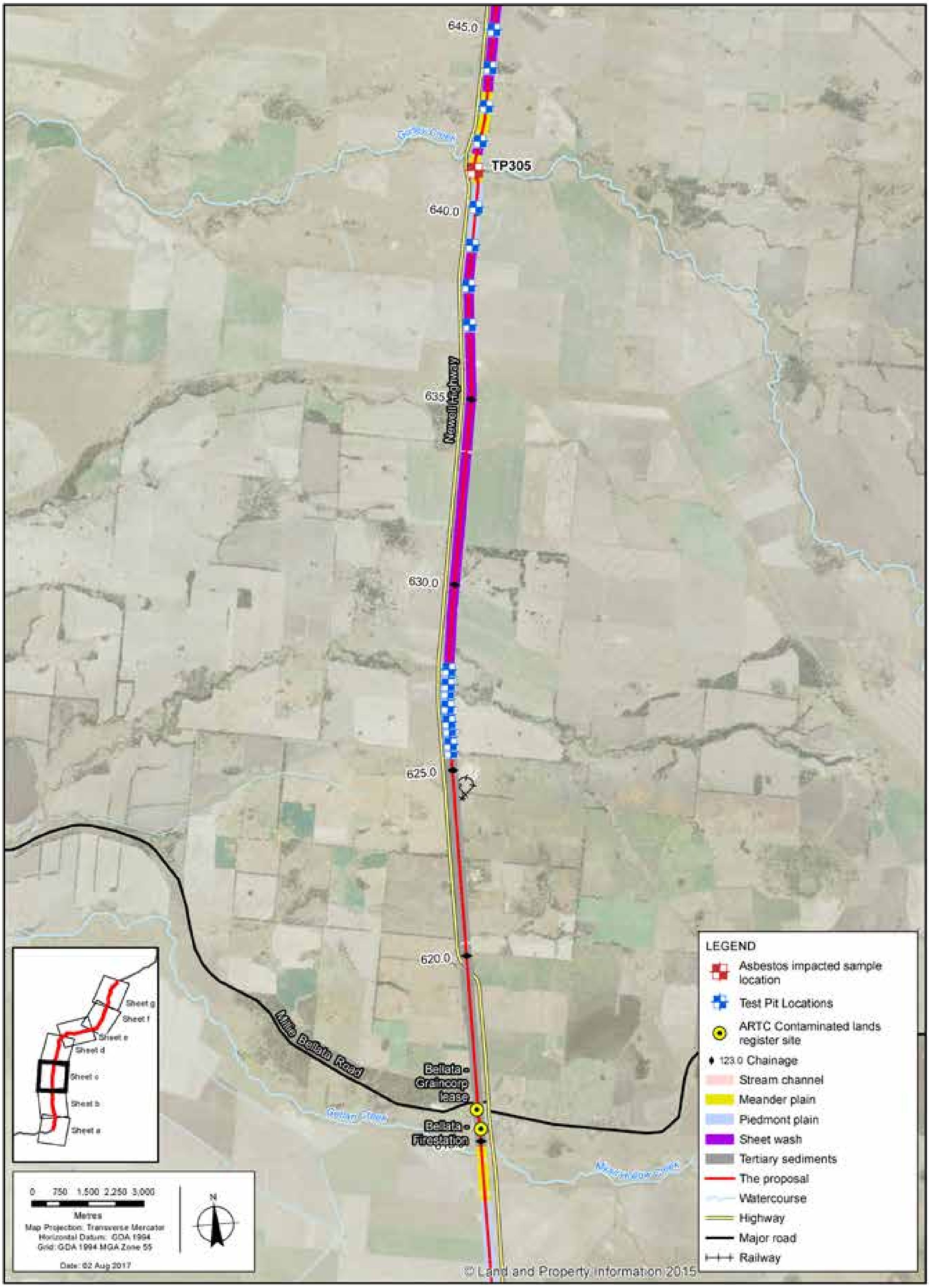


Figure 14.1d Soils and contamination

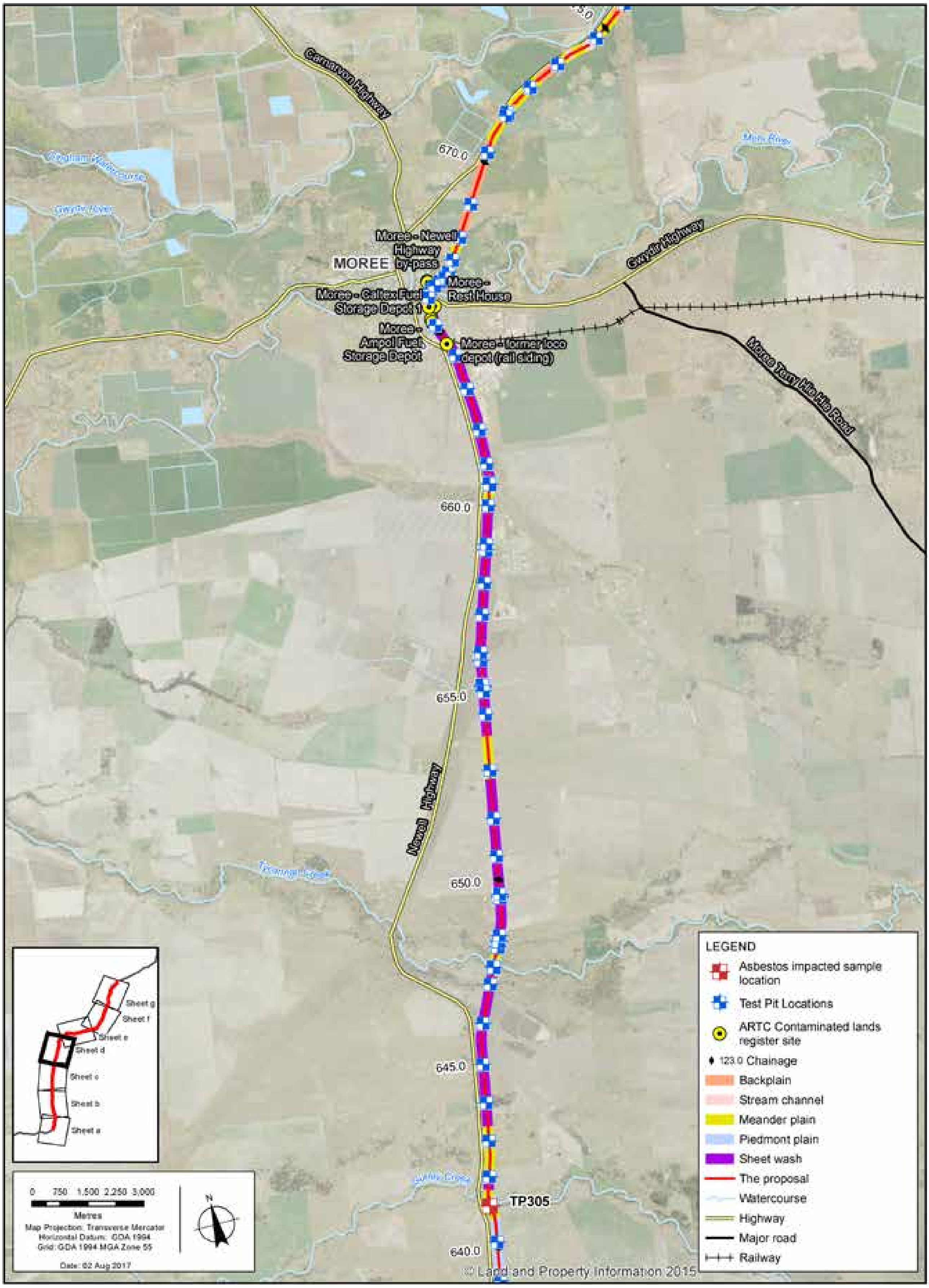


Figure 14.1e Soils and contamination

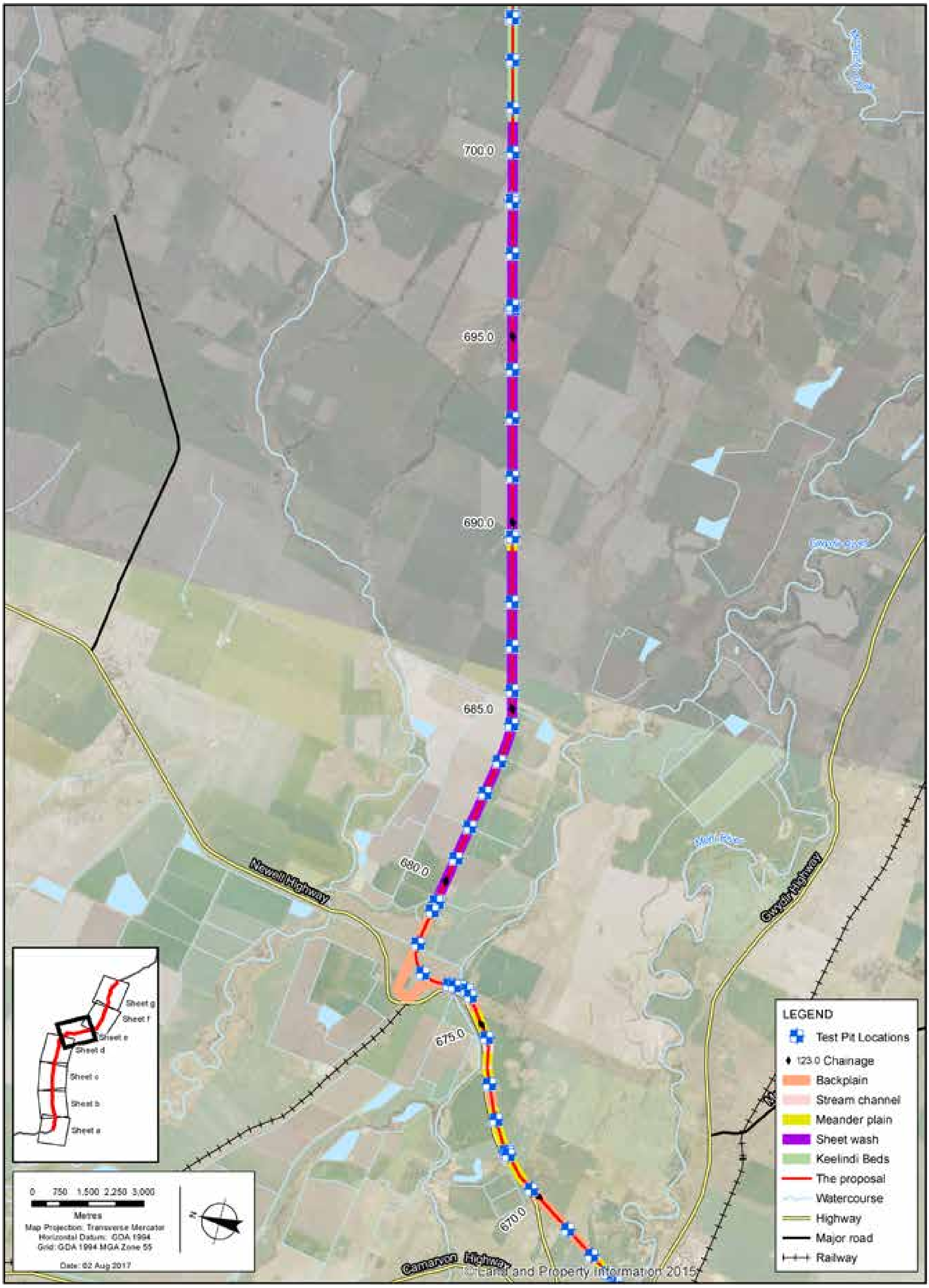


Figure 14.1f Soils and contamination

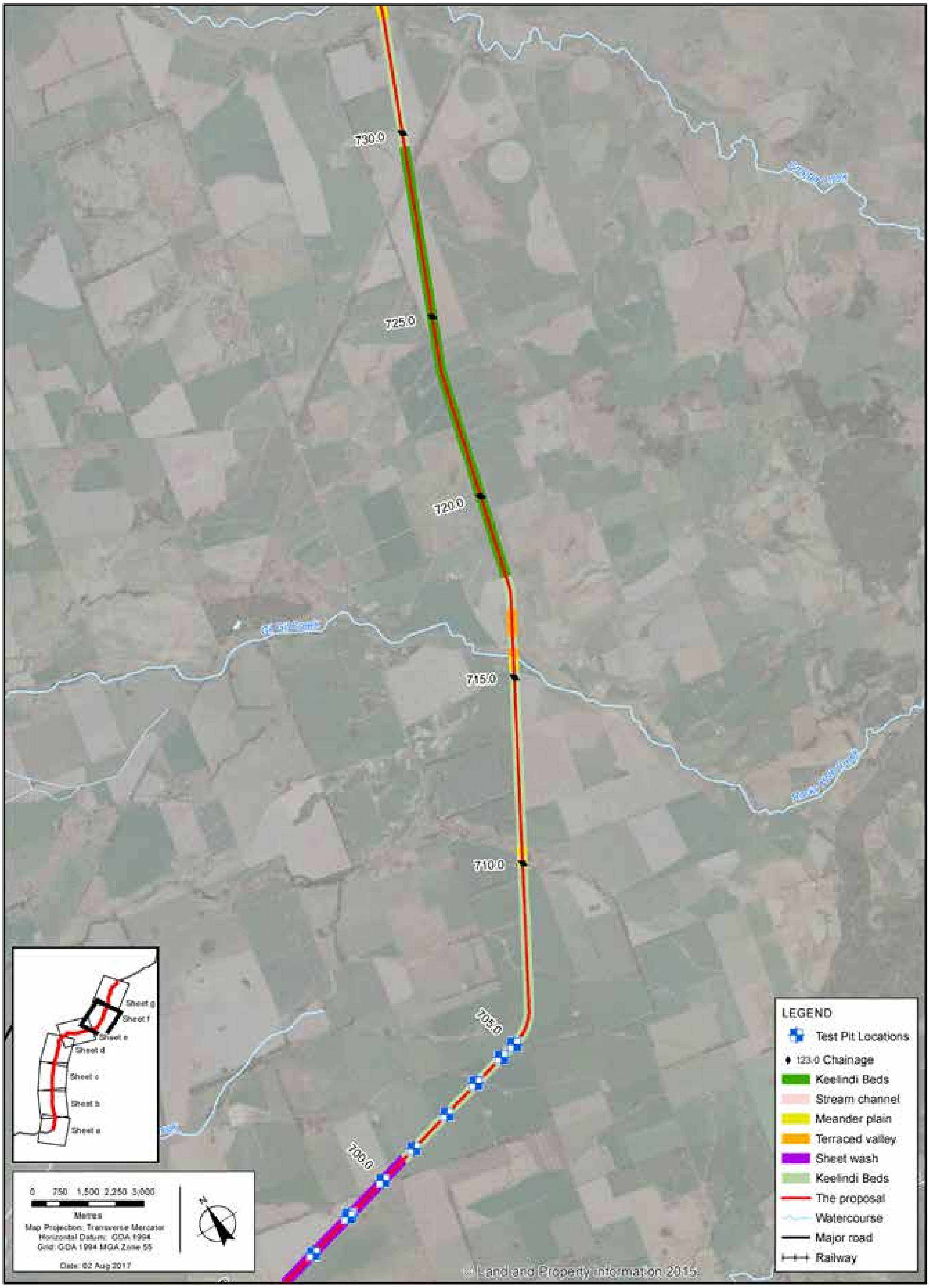


Figure 14.1g Soils and contamination

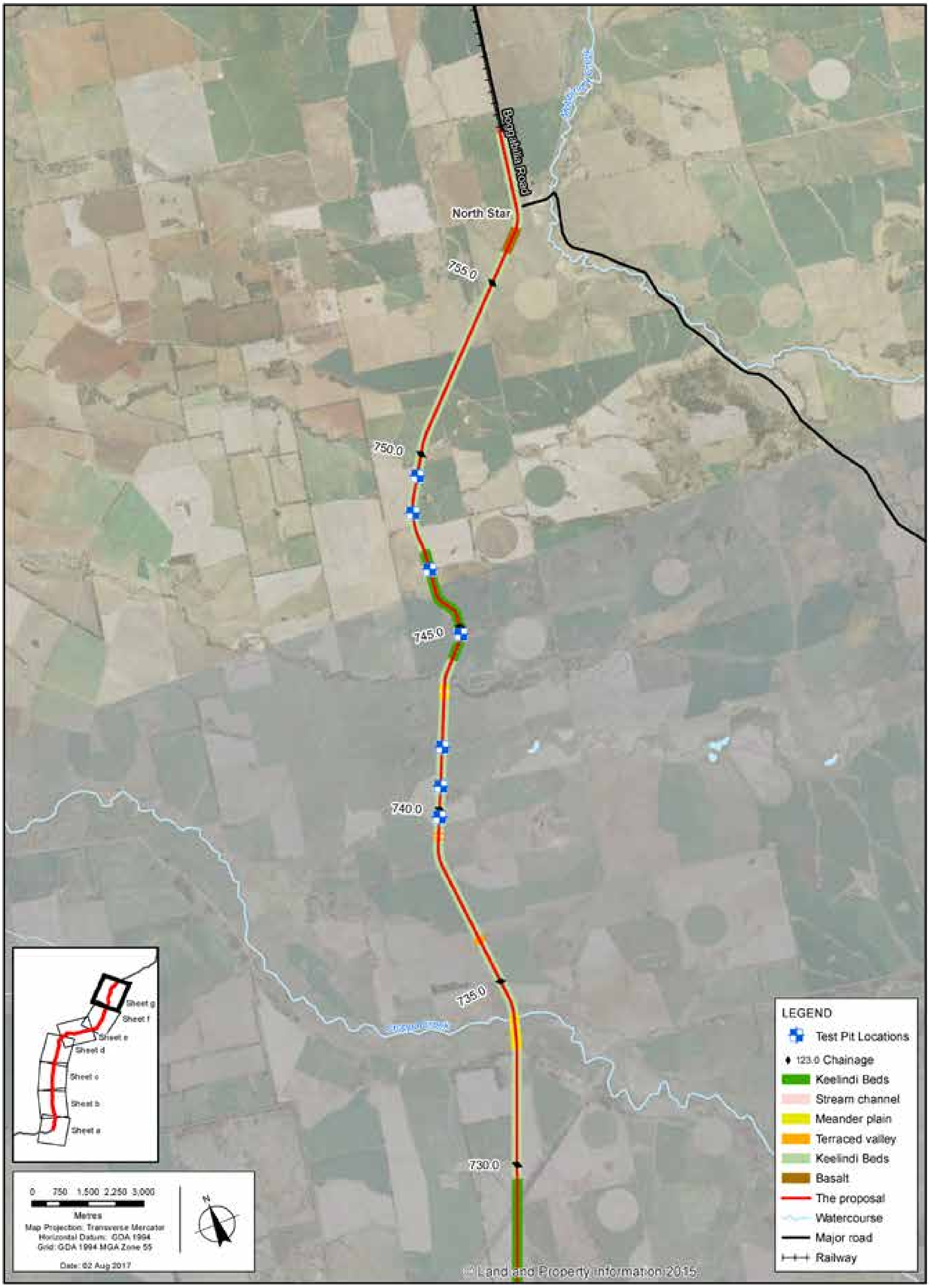


Table 14.1 Summary of subsurface conditions

Subsurface type	Depth encountered (metres)	Generalised description
Ballast – encountered in track formation only		
Top ballast	0.14	Gravel, coarse angular to sub-angular igneous gravel. Clean to moderately fouled.
Sub-ballast	Between 0.34 to 0.5	Gravel, fine to coarse grained, angular to sub angular basalt. Typically, with sand. Fouled to highly fouled.
Fill		
Gravelly ash fill (in track formation only)	Between 0.6 to 1.05	Typically gravelly sand or sandy gravel with low plasticity fines.
Clay fil (cohesive)	Between 1.05 to 1.75	Typically clay, sandy clay and gravelly clay, medium to high plasticity.
Sand fill (non-cohesive)	Between 0.6 to 1.40	Gravelly Sand, or clayey sand. Fine to medium grained or coarse grained. Moist to wet.
Natural soil		
Alluvium	Between 0.73 to 1.65	Typically clay and sandy clay, medium to high plasticity.
Residual	Between 0.85 to 1.77	Typically clay or sandy clay with medium to high plasticity. Can also include sandy gravel or clayey gravel, fine to coarse grained, dense to very dense.

Acid sulfate soils

Acid sulfate soils are the common name given to naturally occurring sediments that contain iron sufide minerals. If the soils are drained, excavated or exposed to air, the sulfides react with oxygen to form sulfuric acid. Acid sulfate soils are widespread around coastal regions and are also locally associated with saline sulfate-rich groundwater in some agricultural areas, or with freshwater wetlands. Given the distance of the proposal site from the coast and its elevation, no acid sulfate soils are expected or known to occur. A review of the *Australian Soil Resource Information System* undertaken on 17 June 2016 (Commonwealth Scientific and Industrial Research Organisation, 2016) found that the proposal site is located in an area of low probability to no known occurrence of acid sulfate soils. The potential to encounter acid sulfate soils during construction has therefore not been considered further.

Saline soils

Areas prone to salinity are usually at low positions in the landscape, such as in valley floors and along floodplains. The OEH NSW soil and land information system contains data points identifying evidence of soil salinity where soils have been sampled previously. A review of this database undertaken on the 17 June 2016 (eSPADE, 2016) indicated that generally no salting was evident at sample locations in the vicinity of the proposal site (within 1 kilometre). Salting was evident at isolated locations in the vicinity of the proposal site the closest being about 2.5 kilometres to the east of the proposal site near Narrabri, however these are likely associated with farming practices and are site-specific.

14.2.2 Potential for contamination

There are six sites listed on the EPA's Contaminated Sites Register and 11 sites on the list of contaminated sites notified to the EPA located within the LGAs of Narrabri, Moree Plains and Gwydir. The majority of these properties are service station sites located in Moree. Eleven sites located in the townships of Narrabri, Bellata, North Star and Moree, have been listed on ARTC's contaminated sites register. The majority of these sites have been leased from ARTC for use as either service stations, grain storage or fuel storage (as shown on Figure 14.1).

Based on the land uses immediately surrounding the proposal site (described in chapters 2 and 20) and the findings of the desktop assessment, potential sources of contamination in the vicinity of the proposal site are considered to include:

- Agricultural activities – which may be associated with hydrocarbons, pesticides and hazardous materials from demolition, deterioration of old buildings, and/or landfilling.
- Unknown fill and waste materials within the road corridor – which may be associated with various hazardous materials, including asbestos, heavy metals, pesticides and hydrocarbons.
- Imported fill and ballast within the rail corridor – which may be associated with asbestos, hydrocarbons, heavy metals, and polycyclic aromatic hydrocarbons.
- Industrial activities adjacent to the rail corridor – which may be associated with hydrocarbons, oils, chemical storage, heavy metals, and hazardous building materials.

The targeted site investigations found no visual or olfactory evidence of contamination in any of the test pits.

All samples, except one, had laboratory results either below the limit of reliability or below the relevant human health based screening criteria.

One site recorded the presence of chrysotile asbestos in gravel fill material consisting of ash and slag (site TP305 – located on the rail corridor directly south of the crossing with Gurley Creek). This location is shown on Figure 14.1. This ash fill layer was found beneath the ballast at the majority of locations, at depths between 0.4 and 1.6 metres below top of rail. Soils in the vicinity of location TP305 would be classified as Special Waste (Asbestos). Soils sampled at other test pit locations along the rail corridor are consistent with a General Solid Waste classification.

The contamination assessments confirmed that the soils are considered suitable to remain within the proposal site for the use proposed (that is, for railway purposes). Based on the findings of the contamination assessment, the proposal site does not contain gross contamination and does not meet the criteria requiring it to be notified to the EPA under section 60 of the CLM Act.

14.3 Impact assessment

The following assessment considers the potential for soil and contamination impacts as a result of the construction and operation of the proposal. The potential for impacts to water quality as a result of soil erosion, run-off, and potential contamination is considered in Chapter 16. The potential for impacts as a result of the transport of hazardous materials and dangerous goods is considered in Chapter 25.

14.3.1 Risk assessment

Potential impacts

The environmental risk assessment for the proposal (summarised in Appendix B) included an assessment of the potential for soils and contamination risks. The assessed risk level for the majority of potential risks to soils, and from contamination, was between low and medium. Risks with an assessed level of medium or above include:

- impacts associated with the disturbance of contaminated soils during construction
- increased erosion and sedimentation due to excavation activities and vehicle movement
- contamination of soils/groundwater due to spills and leaks during construction
- changes to the surface, including as a result of vegetation removal and the creation of embankments, increasing the potential for erosion and sedimentation down-gradient.

How potential impacts would be avoided

In general, potential soils and contamination impacts would be avoided by:

- managing contamination in accordance with relevant legislative and policy requirements, as described in Section 14.1.2
- designing, constructing and operating the proposal to minimise impacts from soil issues
- implementing the soil and contamination management and impact mitigation measures described in Section 14.4.

14.3.2 Construction impacts

Soils

Excavation and ground disturbance activities, if not adequately managed, could have the following impacts:

- erosion of exposed soil and stockpiled materials
- mobilisation of saline soils or acid sulfides, where present
- dust generation from excavation, backfilling and vehicle movements over exposed soil
- an increase in sediment loads entering the stormwater system and/or local runoff, and therefore nearby receiving waterways.

These impacts are considered to be minimal, as exposure of soils would be temporary and short-term in duration. It is expected that the majority of excavated spoil, consisting of either ballast, fill, or natural soils, would be either reused during track formation works, or used to construct permanent spoil mounds within the rail corridor (as described in Chapter 8). Excess spoil not able to be used for either backfill or mounding due to the presence of contamination would be stockpiled in a suitable location within the nearest site compound, for transportation and disposal off-site at an appropriately licensed waste facility.

The following construction activities have the potential to directly impact on the soil environment.

Earthworks and vegetation removal

Construction would temporarily expose the ground surface through vegetation removal, and excavation of construction footprints for structures, including culverts and underbridges. The temporary exposure of these areas to water runoff and wind could increase soil erosion potential, particularly where construction is undertaken in areas which are characterised by dispersive soils. In addition, the removal of vegetation and topsoil could increase the amount of water infiltration, particularly in areas of perched groundwater (refer Chapter 15), causing the water table to rise and bringing salt to the root zone and soil surface. Increased salinity in soils can affect plant health, leading to a loss of productive species and a dominance of salt-tolerant species.

Periods of heavy and frequent rainfall could lead to increased runoff and flooding. Loose material may be eroded during rainfall events by runoff, increasing the potential for movement of soils and sedimentation of local drainage lines. This may in turn influence the vegetation and habitat of adjacent areas by smothering groundcover vegetation or by changing soil surface characteristics.

Runoff from disturbed or stockpiled acid sulfate soils or saline soils could result in the release of acid sulfates or an increase in saline runoff to receiving environments, which could either increase surface salinity levels or impact aquatic environments (including groundwater dependant ecosystems) and/or drainage lines. However, given the likelihood of encountering saline or acid sulfate soils is very low, the risk of impacts associated with potential acid sulfate soils and saline soils are considered negligible.

The potential for soil erosion and runoff impacts would be minimised by the implementation of the mitigation measures described in Section 14.4.

Reinstatement

Reinstatement activities would require minor earthworks that could lead to the erosion of disturbed soils where they are not stabilised.

Vehicle movements, including machinery and support vehicles

Vehicles and machinery used during construction could result in compaction or erosion of surface soils, and/or transport excess material onto sealed roads. These impacts would be minimised by the implementation of the mitigation measures described in Section 14.4.

Contamination

As described in Section 14.2.2, potentially contaminating land uses are present along and in the vicinity of the proposal site. If land associated with these land uses is disturbed, there is the potential for off-site contamination. Exposure or disturbance of contaminants may have the following potential impacts:

- direct contact and/or inhalation by site workers, users and visitors
- impacts to surrounding environmental receivers (including surrounding ecosystems and flora and fauna, where present)
- mobilisation and migration of surface and subsurface contaminants via leaching, runoff and/or subsurface flow, impacting nearby soils, surface water, and groundwater.

Based on the results of the targeted site investigations, there is minimal potential for contamination to be encountered during construction. Based on the potential presence of asbestos in the ash fill layer beneath the ballast there is the risk of exposure for site workers and the nearby community during track formation works. Given that asbestos was found in only one location the risks are likely to be low.

Unexpected soil contamination could also be encountered, the evidence of which could include:

- unexpected staining or odours
- potential asbestos containing materials
- unexpected underground storage tanks, buried drums or machinery, etc.

There is also potential for chemical and fuel spills during construction as a result of the operation and movement of construction plant and vehicles, which may result in localised contamination of soils and/or groundwater.

These impacts would be managed by implementing the mitigation measures described in Section 14.4.

14.3.3 Operation impacts

Soil

During operation, erosion of dispersive soils could result in silting up of drainage infrastructure, including culverts. To manage this potential operational impact, dispersive soils would be treated where exposed during construction, in cut batters, culvert crossings, and drainage lines. Additional operational impacts from unsuitable soils would be minimised by taking soil types into consideration during detailed design and construction.

Maintenance and repair activities may require excavation and ground disturbance, which could result in short-term impacts similar to those described in Section 14.3.2. These impacts would be managed by implementing the mitigation measures described in Section 14.4.

Contamination

During operation, there is a risk of accidental spillage of petroleum, chemicals or other hazardous materials as a result of leakage or rail accidents. Spills could pollute downstream waterways and groundwater if unmitigated. The potential for contamination is considered to be low, based on the amount of vehicles and equipment which would likely be used during maintenance. This impact would be minimised by implementing existing ARTC procedures to manage spills.

14.4 Mitigation and management

14.4.1 Approach to mitigation and management

Soil

Site-specific analysis would be undertaken during detailed design as an input to the design of the proposal and appropriate treatment measures identified (as required). Design documents would specify construction procedures to identify and address 'unsuitable' subgrade soils.

Prior to construction, a soil and water management sub-plan would be prepared as part of the CEMP in accordance with relevant guidelines, including *Managing Urban Stormwater: Soils and Construction* Volume 1 (Landcom, 2004) and Volume 2C: Unsealed roads (DECC, 2008).

Auditing and monitoring would be undertaken during construction to ensure that the CEMP and relevant sub-plans are being implemented.

Contamination

A contamination and hazardous materials sub-plan would be developed as part of the CEMP to detail how potential and actual contaminated soils and materials would be managed to minimise the potential for on and off-site impacts. An unexpected finds protocol would be developed as part of the sub-plan to ensure that any unexpected contamination encountered during construction does not expose workers, site users, and/or the environment to contamination in excess of regulatory guideline levels.

The unexpected finds protocol would outline the activities to be undertaken in the event that previously undetected contamination is identified, which would include making the site safe, carrying out an assessment of the finds, and managing the finds based on the results of the assessment.

A spoil and waste management sub-plan would also be developed as part of the CEMP, as described in Chapter 24. The waste management plan would include an asbestos management component to ensure waste materials which contain asbestos are appropriately managed.

The health and safety plan (described in Section 25.4) would also include measures to help minimise the exposure of workers to potentially contaminated soil, including material containing asbestos.

Further information on the approach to environmental management during construction is provided in Chapter 27.

14.4.2 Consideration of the interactions between mitigation measures

Mitigation measures to control impacts associated with soil and contamination may overlap with measures proposed for the control of air quality, health and safety, and waste management impacts. All mitigation measures for the proposal would be consolidated and described in the CEMP. The plan would identify measures that are common between different aspects. Common impacts and common mitigation measures would be consolidated to ensure consistency and implementation.

14.4.3 Summary of mitigation measures

To mitigate the potential for soil and contamination impacts, the measures outlined in Table 14.2 would be implemented.

Table 14.2 Summary of soil and contamination mitigation measures

Stage	Impact	Mitigation measures
Detailed design	Structural integrity	Foundation and batter design would include engineering measures to minimise operational risks from shrink swell, dispersive, and/or low strength soils.
Pre-construction/ construction	General soil and erosion management	A soil and water management sub-plan would be prepared as part of the CEMP. It would include a detailed list of measures that would be implemented during construction to minimise the potential for soil and contamination impacts, including: ▸ allocation of general site practices and responsibilities ▸ material management practices ▸ stockpiling and topsoil management, including prompt stabilisation of spoil mounds and treatment of dispersive soils in mounds (for example, through mixing of gypsum) ▸ surface water and erosion control practices that take into account site-specific soil types (for example, dispersive soils).
	Contamination	A contamination and hazardous materials sub-plan would be prepared and implemented as part of the CEMP. It would include: ▸ measures to minimise the potential for contamination impacts on the local community, workers, and environment ▸ procedures for incident management and managing unexpected contamination finds (an unexpected finds protocol).
Operation	Soil erosion and sedimentation	During any maintenance work where soils are exposed, sediment and erosion control devices would be installed in accordance with *Managing Urban Stormwater: Soils and Construction*.
	Contamination	ARTC's existing spill response procedures would be reviewed to determine applicability and suitability during operation. The adopted procedure would include measures to minimise the potential for impacts on the local community and the environment as a result of any leaks and spills.

15. Hydrology and flooding

This chapter provides a summary of the hydrology and flooding impact assessment undertaken for the proposal. It describes the existing environment, assesses the impacts from construction and operation of the proposal, and provides recommended mitigation and management measures. The full Hydrology and Flooding Assessment report is provided as Technical Report 6.

15.1 Assessment approach

15.1.1 Methodology

Surface water and drainage infrastructure assessment

The surface water and drainage infrastructure assessment involved:

- a review of background information relevant to the study area, including previous studies, mapping, survey data, topography, and climate data
- modelling of local catchment surface flow rates for the rail corridor
- identifying and assessing construction and operational activities that may impact on the surface water hydrology of watercourses within the proposal site
- identifying management and mitigation measures to manage potential impacts.

Flooding assessment

The hydrologic analysis involved identifying the existing structures to establish the base (existing) flooding conditions. For the existing base case condition, the geometry and form of each structure was analysed based on existing data. The local catchment area draining to each of the structure locations was determined.

Design rainfalls were applied to each local catchment to determine the peak rate of runoff from the catchments for a broad range of design rainfall durations. The predicted flood extent was mapped for a range of rainfall conditions. Hydrologic and hydraulic modelling was undertaken to examine the effect of the existing railway corridor on flooding, and enable the potential impact of the proposal to be assessed. Modelling considered the location and level of existing and proposed structures (mainly culverts) that enable water to flow through the rail formation and drain to downstream watercourses.

This information was used to:

- estimate the minimum rail level required to keep the track and ballast above the one per cent annual exceedance probability (AEP) flood event level for local catchment flooding
- model flood event impacts for regional catchments
- identify the culvert upgrades required to minimise potential changes to flood levels and patterns.

Flood modelling was then undertaken based on the concept design of the proposal, including the proposed change in vertical alignment associated with raising the rail track and formation. The flood management objectives for this assessment were also considered.

Potential flood impacts were assessed by modelling the flooding behaviour of the existing rail corridor compared to the proposal. Flood modelling was undertaken for a range of design flood events, including the 50, 20, 10, 5, 2, and 1 per cent AEP events, and the probable maximum flood (PMF). The PMF is defined as an extreme flood deemed to be the maximum flood likely to occur in a particular catchment.

Flooding conditions for the 0.5 per cent and 0.2 per cent AEP events were also considered to represent climate change scenarios.

Flood modelling results were overlaid on aerial photography to identify potential impacts to land use, including built up areas, farm infrastructure, cropping areas, grazing, and forested areas, likely evacuation routes, and flood refuges. This allowed the magnitude of the predicted impacts to be identified for a range of flooding parameters.

The proposal includes upgrading an existing rail corridor across floodplains. The proposal would be designed to convey flood flows in the same location as the existing rail corridor, to minimise changes to flow patterns. While culverts in the proposal site would be replaced, the locations of culverts would not change from the existing scenario, and flow patterns would be generally maintained. Therefore, changes to flow patterns have not been assessed.

Seven new culverts would also be built along the new alignment for the Camurra bypass. The location of these new culverts were selected to maintain existing flow paths and minimise the potential impacts to flood depths upstream and downstream of the culverts. Where culverts under the existing Camurra hairpin bend are retained (four in total), it is likely that these culverts would experience a slight reduction in flow compared with the existing situation. As a result, it is anticipated that these culverts would generally continue to function in a similar way to the existing situation.

Modelling of the existing rail corridor indicated that ponding currently occurs upstream of these existing culverts on the Cammura hairpin bend, due to their poor condition. Following construction of the Camurra bypass, water would pass through the new culverts and then through the existing culverts. As the existing culverts are not being removed, ponding would still occur between the existing and proposed Inland Rail alignment. The inundation is expected to be very similar to the existing situation. Further assessment would be undertaken during detailed design to validate this.

The hydrologic analysis considered flood events resulting from rainfall on individual and small groups of catchments immediately upstream of the existing rail corridor. The modelling of local (upstream) catchment flooding was considered to represent the conditions under which the new formation and track would have the greatest influence on flood levels. Downstream conditions were not assessed for the following reasons:

- The proposal site is already used for rail infrastructure, and culverts and bridge would be generally upgraded in their existing location. As a result, the pattern of flooding and drainage downstream of the rail corridor is expected to be largely unaffected.
- If more extensive flood modelling was undertaken, broader flood processes (for example major river flooding, tailwater affects, etc) would dominate the results, rather than the impacts of the proposal.
- Increasing the extent of inundation upstream would result in a corresponding reduction in extent downstream.
- By assuming that water would flow unimpeded through the culverts, the maximum potential flow velocities (that is, the worst-case scenario) were estimated. This assisted in the identification of scour protection requirements without requiring downstream modelling.

Therefore, while downstream conditions were not explicitly modelled, the design would include downstream erosion and scour protection measures, and culverts would be widened, which would assist in reducing discharge velocities and encourage the spread of flows.

While the flood assessment focussed on local catchment rainfall and runoff events, a regional flood impact assessment was undertaken for the Gwydir and Mehi rivers and associated floodplains (the Gwydir and Mehi river systems). This was undertaken to determine the works required to lift the existing rail alignment above the one per cent AEP event, whilst ensuring that there is no significant increase in flooding levels within Moree and Narrabri.

Further information on the methodology is provided in Technical Report 6.

15.1.2 Legislative and policy context to the assessment

The following legislation, policies, and guidelines were considered for the hydrology and flooding assessment:

- *Floodplain Development Manual: the management of flood liable land* (Department of Infrastructure Planning and Natural Resources, 2005)
- *Floodplain Risk Management Guideline: Practical Consideration of Climate Change* (Department of Environment and Climate Change, 2007)
- *Planning circular: New guideline and changes to section 117 direction and EP&A Regulation on flood prone land* (Department of Planning, 2007)
- *Moree Plains Shire Flood Emergency Sub Plan* (State Emergency Services, 2012)
- *Gwydir Shire Flood Emergency Sub Plan* (State Emergency Services, 2013)
- *Narrabri Shire Flood Emergency Sub Plan* (State Emergency Services, 2015)

The area in which the proposal site is located is subject to the following water sharing plans relevant to groundwater that cover all or part of the study area:

- Upper and Lower Namoi Groundwater Sources
- NSW Great Artesian Basin Groundwater Sources
- NSW Murray Darling Basin Porous Rock Groundwater Sources
- Water Sharing Plan for the NSW Murray Darling Basin Fractured Rock Groundwater Sources
- NSW Great Artesian Basin Shallow Groundwater Sources
- Namoi Unregulated and Alluvial Water Sources
- Lower Gwydir Groundwater Source
- Gwydir Unregulated and Alluvial Water Sources.

15.2 Existing environment

15.2.1 Regional context – river and basin systems

The proposal site is located within the major water catchments of the Namoi River, the Gwydir River, and the Macintyre River basins.

The Namoi River starts in the western slopes of the Great Dividing Range and flows westwards through Lake Keepit towards Boggabri, Narrabri, crossing the proposal site, and then to Wee Waa, before meeting the Barwon River at Walgett. The Barwon River is a tributary of the Murray – Darling Basin, meeting the Darling River near Bourke.

The Gwydir River starts west of Armidale, fed by the Rock River and Booroolong Creek. The Gwydir River flows north-west to Lake Copeton, before turning west to Bingara and Moree, crossing the proposal site, before continuing westwards, meeting the Barwon River north of Collarenebri.

The Macintyre River starts west of Glencoe, flowing in a north-west direction towards the NSW – Queensland border near Boggabilla. The Macintyre River catchment includes the Croppa Creek and Gil Creek, both of which pass under the proposal site south of North Star. The Macintyre Rivers catchment is part of the larger Border Rivers catchment, which drains from the western side of the Great Dividing Range in the far north of NSW and southern Queensland.

15.2.2 Watercourses

Figure 15.1 shows the watercourses along the proposal site within the broad regional context of the larger watercourses in the study area. A total of 18 watercourses of stream order three or above (based on the Strahler stream classification system) cross the proposal site. These are listed in Table 15.1. Further information on these watercourses is provided in Technical Report 6. The proposal site also includes culvert crossings over a large number of minor local drainage lines.

The major river systems in the study area are the Namoi River and Gwydir River (which includes the Mehi River), which are perennial systems. With the exception of Namoi River and Gwydir River, surface water within the proposal site is generally characterised by ephemeral waterways. This is a result of the size of the contributing catchment area, rainfall pattern, and lack of base flow resulting from groundwater expression.

Many watercourses are considered to be in good geomorphic condition and are typically stable and well vegetated. Over half the assessed watercourses are in moderate geomorphic condition because of historical disturbances associated with agricultural practices.

The rail corridor and associated infrastructure has had only minor localised impacts on watercourse form. This consists mainly of an increased propensity for scour and erosion immediately downstream of a few watercourse crossing structures.

Table 15.1 Watercourses crossed by the proposal site

Catchment	Watercourse	Flow regime	Stream Order	River Style	Condition
Namoi	Unnamed	Ephemeral	3	Valley fill	Moderate
Namoi	Spring Creek	Ephemeral	4	Low sinuosity fine grained	Poor
Namoi	Bobbiwa Creek	Ephemeral	4	Low sinuosity fine grained	Good
Thalba Creek	Tarlee Creek	Ephemeral	1	Valley fill	Moderate
Thalba Creek	Galathera Creek	Ephemeral	2	Valley fill	Moderate
Thalba Creek	Ten Mile Creek	Ephemeral	5	Low sinuosity fine grained	Good
Thalba Creek	Pan Creek	Ephemeral	2	Valley fill	Poor
Thalba Creek	Bulldog Creek	Ephemeral	4	Low sinuosity fine grained	Moderate
Thalba Creek	Boggy Creek	Ephemeral	3	Low sinuosity fine grained	Moderate
Thalba Creek	Gehan Creek	Ephemeral	4	Valley fill	Moderate
Thalba Creek	Tookey Creek	Ephemeral	3	Valley fill	Good
Thalba Creek	Waterloo Creek	Ephemeral	4	Low sinuosity fine grained	Good
Thalba Creek	Little Bumble Creek	Ephemeral	2	Valley fill	Good
Mehi River	Gurley Creek	Ephemeral	5	Low sinuosity fine grained	Good
Mehi River	Tycannah Creek	Ephemeral	6	Low sinuosity fine grained	Good
Mehi River	Clarks Creek	Ephemeral	1	Valley fill	Moderate
Mehi River	Halls Creek	Ephemeral	2	Valley fill	Moderate
Mehi River	Mehi River	Permanent	5	Low sinuosity fine grained	Good
Mehi River	Duffys Creek	Ephemeral	NA	Valley fill	Good
Gwydir River	Skinners Creek	Ephemeral	NA	Valley fill	Moderate
Gwydir River	Gwydir River	Permanent	8	Low sinuosity fine grained	Moderate
Gil Gil Creek	Coolleearlee Watercourse	Ephemeral	2	Channelised fill	Moderate
Gil Gil Creek	The Ponds	Ephemeral	2	Valley fill	Moderate
Gil Gil Creek	Marshalls Ponds Creek	Ephemeral	2	Valley fill	Moderate
Gil Gil Creek	Bunna Bunna Creek	Ephemeral	3	Low sinuosity fine grained	Moderate
Gil Gil Creek	Gil Gil Creek	Ephemeral	5	Low sinuosity fine grained	Moderate
Whalan Creek	Croppa Creek	Ephemeral	6	Low sinuosity fine grained	Good
Whalan Creek	Yallaroi Creek	Ephemeral	4	Low sinuosity fine grained	Moderate
Whalan Creek	Tackinbri Creek	Ephemeral	2	Low sinuosity fine grained	Good
Whalan Creek	Mungle Creek	Ephemeral	3	Low sinuosity fine grained	Good
Whalan Creek	Dry Creek	Ephemeral	1	Valley fill	Poor

Figure 15.1a River basins and watercourses

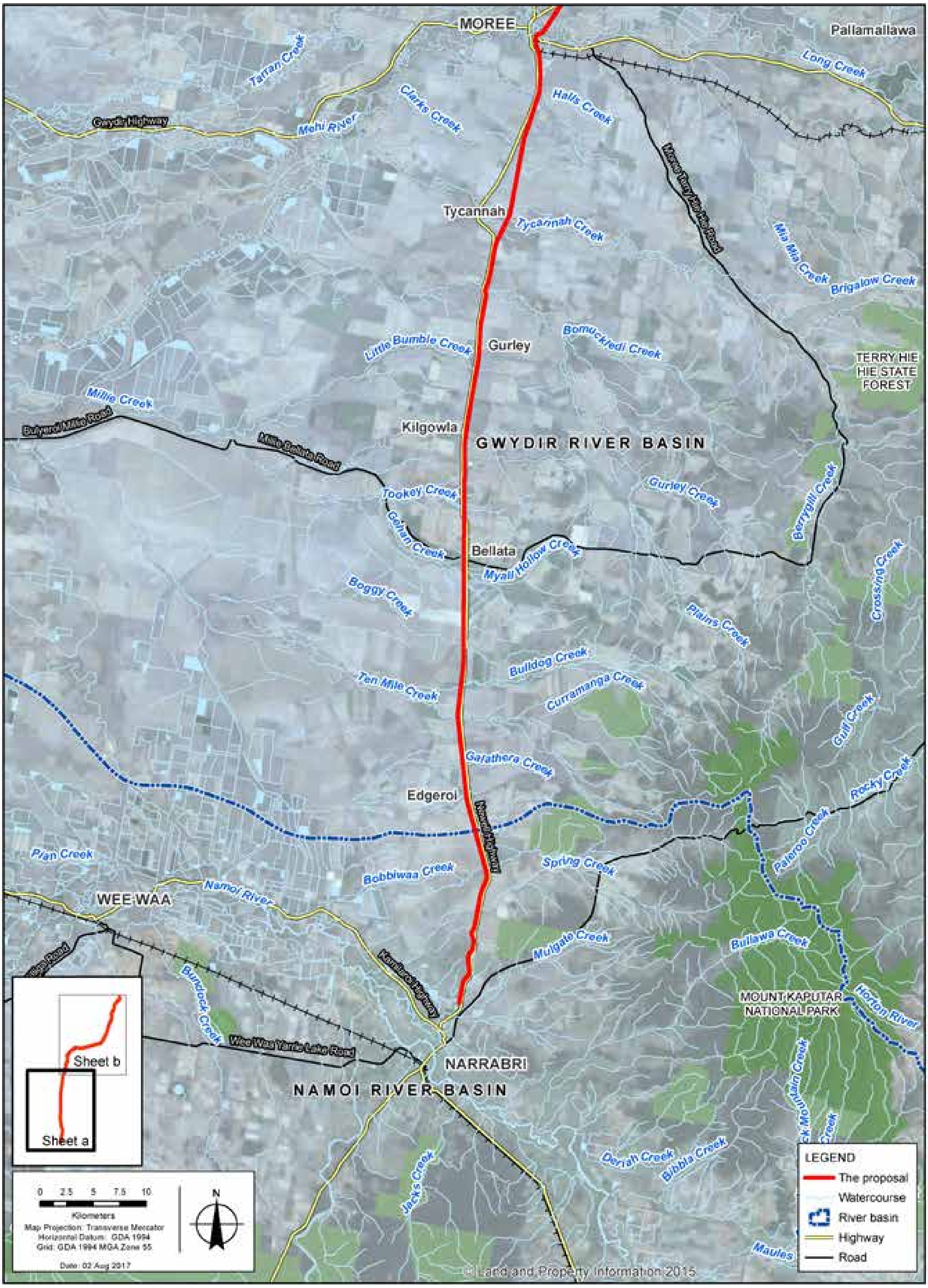
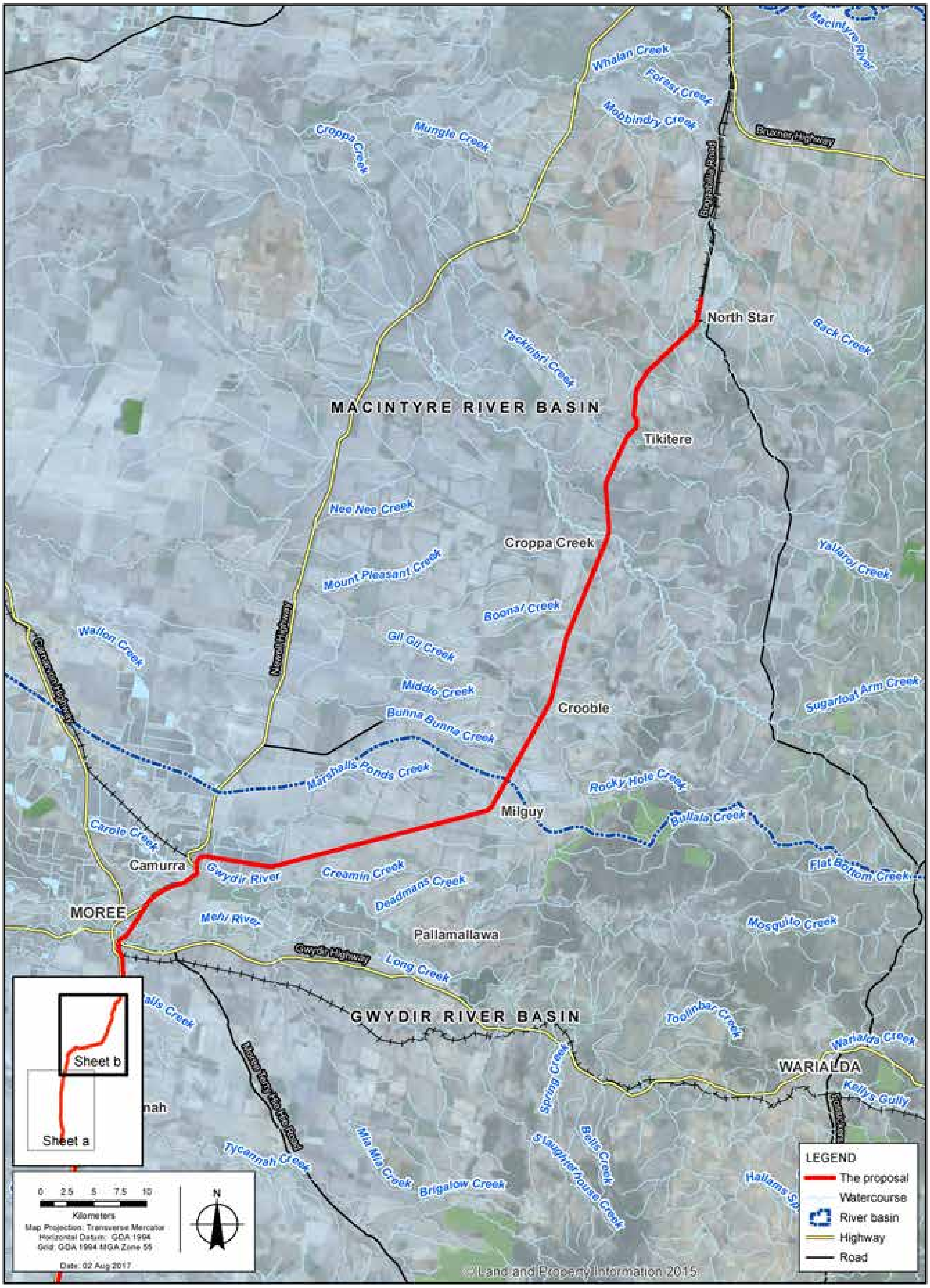


Figure 15.1b River basins and watercourses



15.2.3 Groundwater

A total of 104 registered bores are located within 250 metres of the proposal site. The nearest bore is located about 17 metres east of the proposal site, near the village of Croppa Creek. A number of the bores have cancelled licences. Of the identified bores, 47 are registered for stock, domestic, recreation, or irrigation purposes. Based on the dominant land use in the study area, it is considered likely that the main use would be for stock or irrigation purposes. The remaining bores were registered as monitoring bores or test bores (30), town water supply or public/municipal water (9), industrial or commercial use (6), groundwater remediation (3), farming (1), and 8 were unknown.

Groundwater bores in the vicinity of Moree and Narrabri intercept alluvial sediments associated with the Namoi and Gwydir rivers to a depth of over 40 metres below ground level. Groundwater levels would be expected to rise and fall depending on rainfall.

The alluvial aquifer is underlined by fractured rock. This fractured rock overlies the Great Artesian Basin aquifer. There is potential for perched groundwater in the fractured rock above the Great Artesian Basin. This perched groundwater system, if present, is likely to be low yielding. The bore search did not identify any registered bores likely to be extracting from this geological formation.

Outside the extent of the alluvial aquifers, the results of the bore search indicated that the majority of registered bores extend to depths greater than 100 metres below ground level. These bores are likely to be extracting from the Great Artesian Basin aquifer.

Shallow alluvial sediments of less than 10 to 20 metres below ground level may be intercepted along watercourses crossing the proposal site. These perched shallow groundwater sources would be recharged by rainfall infiltration, with groundwater levels expected to rise following rainfall events.

15.2.4 Flooding

In general, the study area is characterised by relatively flat land that gradually falls from about 260 metres Australian height datum (AHD) near Narrabri, to a low point near Moree that is at about 230 metres AHD, before rising to an elevation of about 330 metres AHD near Crooble.

The existing rail corridor is subject to flooding, which overtops the rail line and in some locations does not comply with ARTC's design requirements for flood immunity. Existing level crossings are also inundated during some flood events.

Flooding in the study area may be influenced by floods from two sources (or a combination of these sources):

- Regional flood event: Flooding caused by high flows in the Namoi or Gwydir rivers (which includes the Mehi River). These events are known as regional floods, resulting from rainfall over a significant portion of the river catchment. With the exception of flooding from the Gwydir and Mehi rivers, regional flooding was not considered for this assessment, as it is impractical to design the proposal to be flood free against this source of flooding.
- Local flood event: Flooding as a result of rainfall over the local catchment draining to an individual underbridge or group of culverts in isolation of the regional flooding behaviour.

A summary of the results of the hydrologic and hydraulic modelling undertaken for the assessment is provided in the following sections.

Locations and extents of overtopping

Rail

During the maximum modelled local flood event (one per cent AEP event), it is predicted that about 11 kilometres of the existing rail corridor would be overtopped, and the maximum water depth over the rail level would be 0.75 metres (refer to Table 15.2).

Table 15.2 Summary of rail overtopping in local flood events under existing conditions

Design event (% AEP)	Overtopping length (m)	Maximum overtopping depth (m)
50	122	-
20	872	0.63
10	1,240	0.64
5	2,457	0.66
2	6,722	0.74
1	11,124	0.75

With regards to regional flood events, anecdotal information from the Moree area has indicated that flooding from the Gwydir and Mehi river systems overtops the existing rail line. Detailed flood modelling of these systems indicates that the rail would overtop during events in excess of the 20 per cent AEP event, as shown in Table 15.3.

The predicated overtopping locations along the existing rail corridor for a one per cent AEP local and regional event are shown in red on Figure 15.2.

Table 15.3 Summary of rail overtopping in regional flood events under existing conditions

Design event (% AEP)	Overtopping length (m)
10	2,975
1	6,310

ARTC's technical requirements require that for locations where the ballast for the upgraded track is not above the modelled one per cent AEP, local flood level need to be identified and recorded. Table 15.4 lists the extent of non-conformance of the existing rail corridor with ARTC's technical requirements, assuming a depth of ballast from the top of the rail level to the top of the formation of 582 millimetres.

Table 15.4 Formation non-conformance – existing rail corridor

Design event (% AEP)	Extent of formation non-conformance (m)
50	1,630
20	3,140
10	4,780
5	10,770
2	20,160
1	27,810

For the maximum local flood event (one per cent AEP), the predicted length of non-conformance with ARTC's technical requirements is estimated to be about 28 kilometres. Smaller local flood events result in overtopping of the rail line, at fewer locations.

With regards to regional flood modelling, Table 15.5 lists the extent of non-conformance of the existing rail corridor with ARTC's technical requirements during the 1 and 10 per cent AEP regional events. The regional flood modelling results also indicate that smaller flood events result in overtopping of the rail line, at fewer locations.

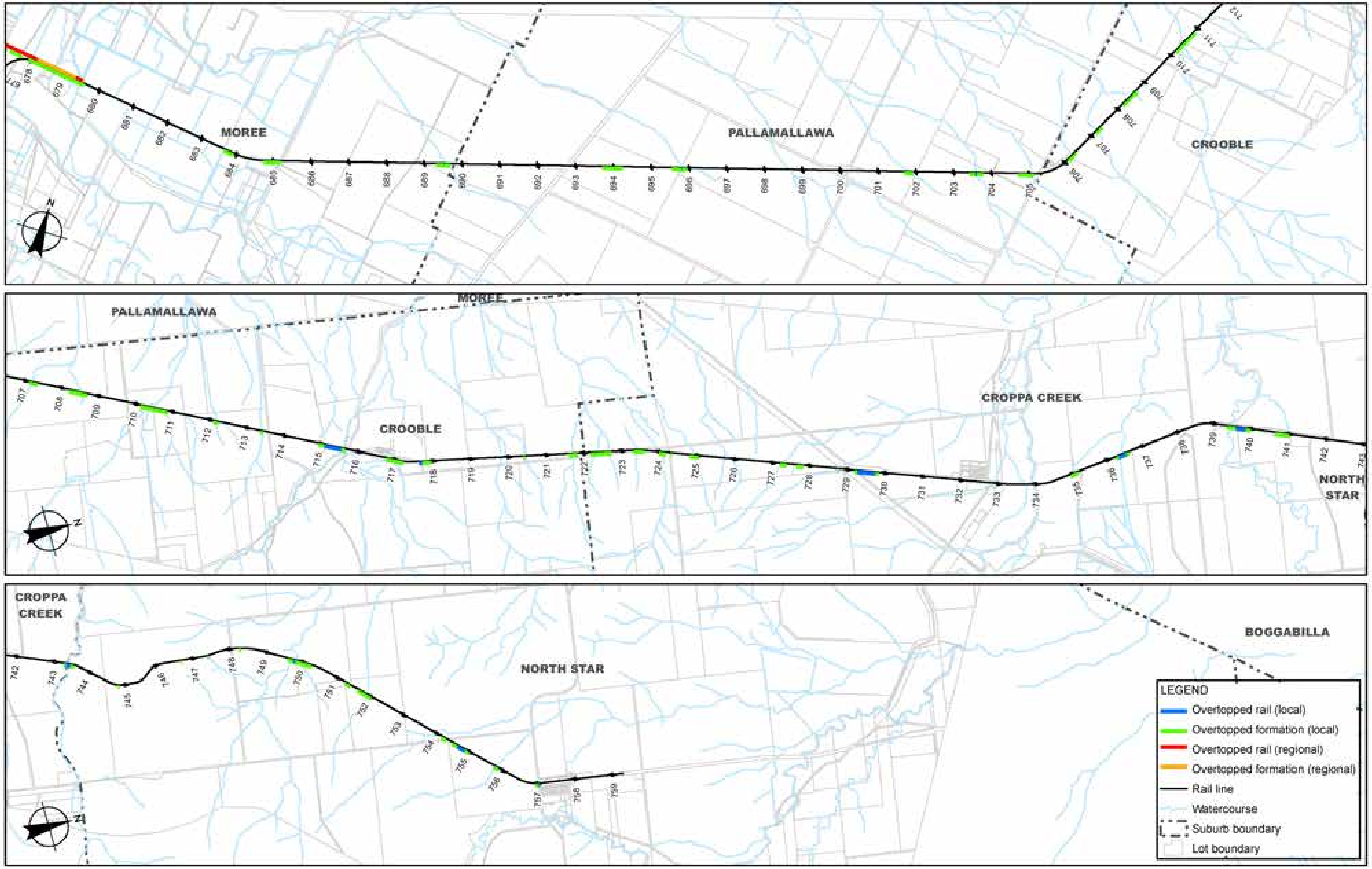
Taking into consideration the estimated formation non-conformance for both the local and regional one per AEP event, about 40 kilometres of the existing formation is currently does not conform with ARTC's technical requirements (refer to Table 15.5).

Table 15.5 Formation non-conformance under existing conditions – regional and combined regional and local flooding

	Extent of formation non-conformance (m)	
Design event (% AEP)	Regional catchments (Gwydir and Mehi river systems) only (m)	Combined regional and local catchments (m)
10	5,660	11,900
1	12,380	39,930

Figure 15.2a Existing rail overtopping locations for 1% AEP event – local and regional catchment flooding

Figure 15.2b Existing rail overtopping locations for 1% AEP event – local and regional catchment flooding



Level crossings

The flood modelling indicates that for the existing rail corridor five public level crossings would be overtopped during flood events up to and including the one per cent AEP (listed in Table 15.6).

Table 15.6 Level crossing overtopping – existing rail corridor

Public level crossing	Level crossing overtopping depth (m)					
	50% AEP	20% AEP	10% AEP	5% AEP	2% AEP	1% AEP
Unnamed road	-	-	-	-	-	0.12
Unnamed road	-	-	-	-	-	0.02
Gil Gil Creek Road	-	-	-	-	0.02	0.16
Crooble Road	-	-	0.07	0.08	0.10	0.11
IB Bore Road	-	0.03	0.20	0.25	0.49	0.61

Roads

Modelling was used to identify locations where main roads in the study area are predicted to be impacted by local and regional flooding (existing situation). The results for local flooding events are summarised in Table 15.7 and show the maximum water depth is predicted to be about 2.03 metres at Oregon Road. These predicted closure locations are in close agreement with information from the State Emergency Services (State Emergency Services, 2011, 2012 and 2013), which indicate road closure at or near those indicated in Table 15.7.

Table 15.7 Main road overtopping – exiting situation

Road	Maximum depth of overtopping (m)					
	50% AEP	20 % AEP	10% AEP	5% AEP	2% AEP	1% AEP
Gil Gil Creek Road	-	-	-	-	0.17	0.30
Gurley Creek Road	-	-	-	-	0.41	0.96
Mosquito Creek Road	-	-	-	-	0.00	0.00
Newell Highway (multiple locations)	-	0.14	0.27	0.33	0.57	0.73
Oregon Road	0.09	0.90	1.40	1.65	1.89	2.03
Railway Parade	-	0.24	0.25	0.27	0.30	0.31

The regional flood modelling indicates that the main road through Moree (that is the Newell Highway) is inundated to a depth of up to 2 metres during the one per cent AEP regional flood event. Consequently, the Newell Highway is not considered to be a suitable emergency access route during major flood events.

Flooding upstream of the existing rail corridor

Flood extents

As described in Section 15.1.1 predicted flood levels for the existing rail corridor were examined for a range of design events, from the 50 per cent AEP to the PMF.

Figure 15.3 shows the predicted local and regional flood extents upstream of the existing rail corridor for a range of flood events. Table 15.8 summarises the local catchment flood affectation areas for events up to the PMF. This indicates that 9,592 hectares is predicted to be inundated by the PMF local flood event.

The regional modelling indicates that an area of about 27,000 hectares upstream of the existing rail corridor is predicted to be inundated during a one per cent AEP flood event.

Table 15.8 Local catchment flood affectation areas – existing rail corridor

Design event (% AEP)	Area of inundation (ha)
50	401.8
20	554.1
10	852.8
5	1,373.0
2	2,093.5
1	2,668.9
0.5	3,031.8
0.2	3,414.9
PMF	9,591.7

Flood velocities

Flow velocities on the floodplain would generally be low during flood events that do not overtop the existing rail line. There would be localised areas of greater velocities immediately upstream of culverts as the water approaches and enters the structure. The approach velocities are not expected to exceed about 1.5 metres per second. The velocity in watercourses would be greater than that on broad floodplain areas, and is predicted to be less than 2 metres per second, except in very localised areas. These predicted velocities are not anticipated to result in watercourse instability.

During flood events that overtop the rail line, there would be a progressively larger proportion of the flow that would pass overland than through the culverts. As a result, there would not be a significant increase in the flow velocity over the floodplain areas.

Periods of flooding

The periods/duration of flooding are related to the area of the catchment. It generally takes about nine hours for flood levels to fall to less than 0.1 metres deep at culverts for smaller catchments, and up to 36 hours for larger catchments. Regional flood events, which are typically a result of flooding from major rivers and watercourses after rainfall over a significant portion of catchment, can extend for several days or more.

Flooding downstream of the existing rail corridor

Flood events

In most areas downstream of the existing rail corridor there is expected to be a reduction in flood levels up to the one per cent AEP flood event. There may be localised changes in flood levels immediately downstream of structures, but these are expected to be confined to the existing rail corridor.

Flood velocities

During flood events that do not overtop the level of rail corridor, flow downstream of the culverts would generally be confined within the individual waterways.

When floods overtop the rail level (assuming the ballast does not erode), there would be a localised relatively high velocity of flow down the downstream face of the rail track and formation. As the rail level is generally not very high, it is anticipated that the velocity on the face of the track and formation is unlikely to exceed about 2.5 metres per second. This could erode the downstream face of the track and formation.

Historical records show that the rail ballast generally fails and washes out, at least for part of the overtopping length, prior to or about the same time as the rail is overtopped. This could result in a flow on the downstream formation of the rail line of up to about 2 metres per second, which is a reduction in velocity when compared to no ballast failure or washout.

Periods of flooding

Watercourses downstream of the existing rail corridor are likely to be inundated for similar periods to those upstream.

Building impacts

The review of aerial imagery overlaid with existing flooding conditions showed that 16 buildings are likely to be potentially impacted for the predicted one per cent AEP local catchment flood events, consisting of:

- one house
- five businesses
- nine garages or sheds
- one park structure/public amenity area.

The modelling of existing regional conditions indicates that significantly more properties are considered to be flood prone as a result of regional flooding than local flooding, with an estimated 976 properties affected by the regional one per cent AEP flood event.

Figure 15.3a Existing local and regional catchment flooding extents

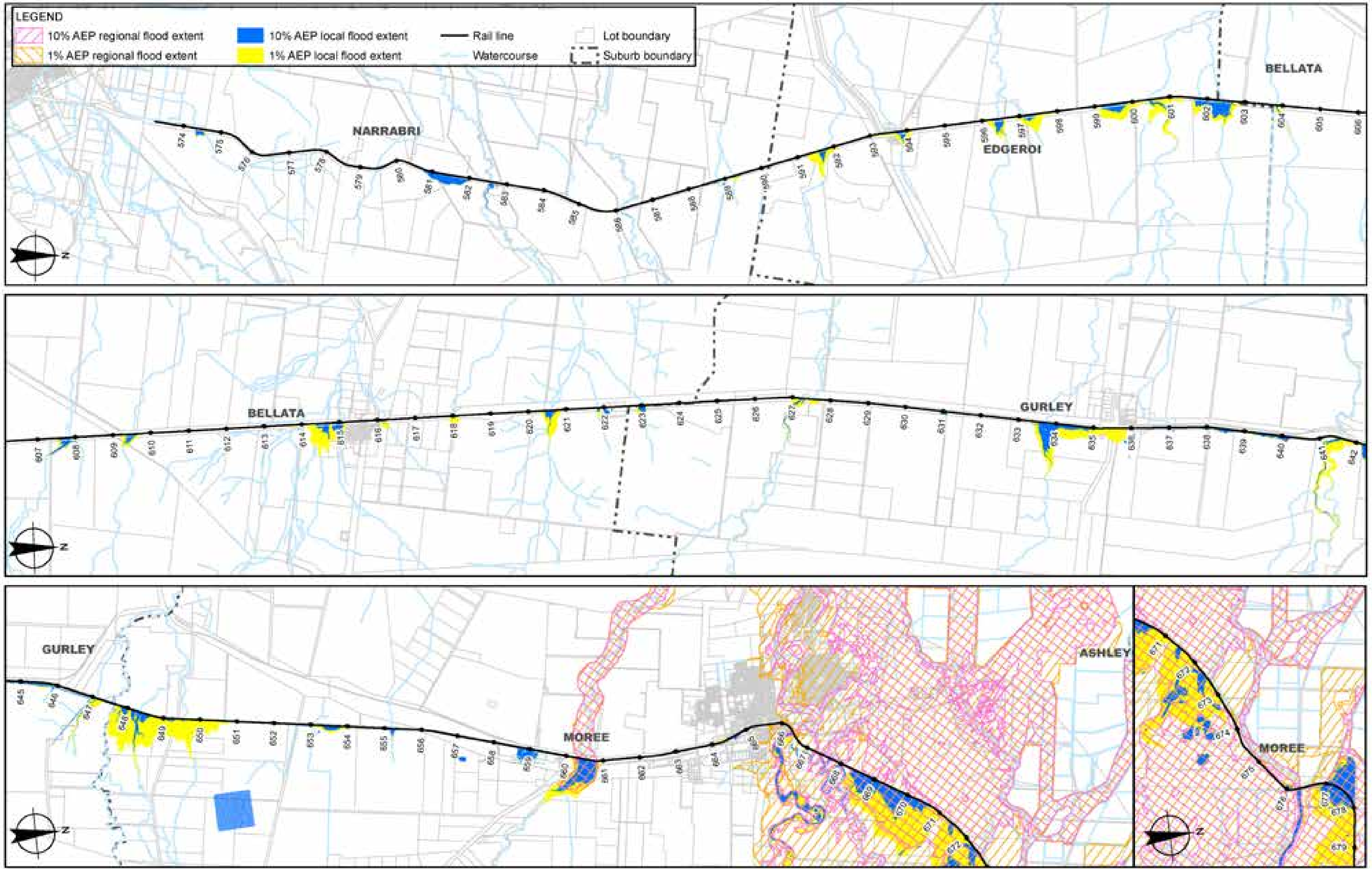
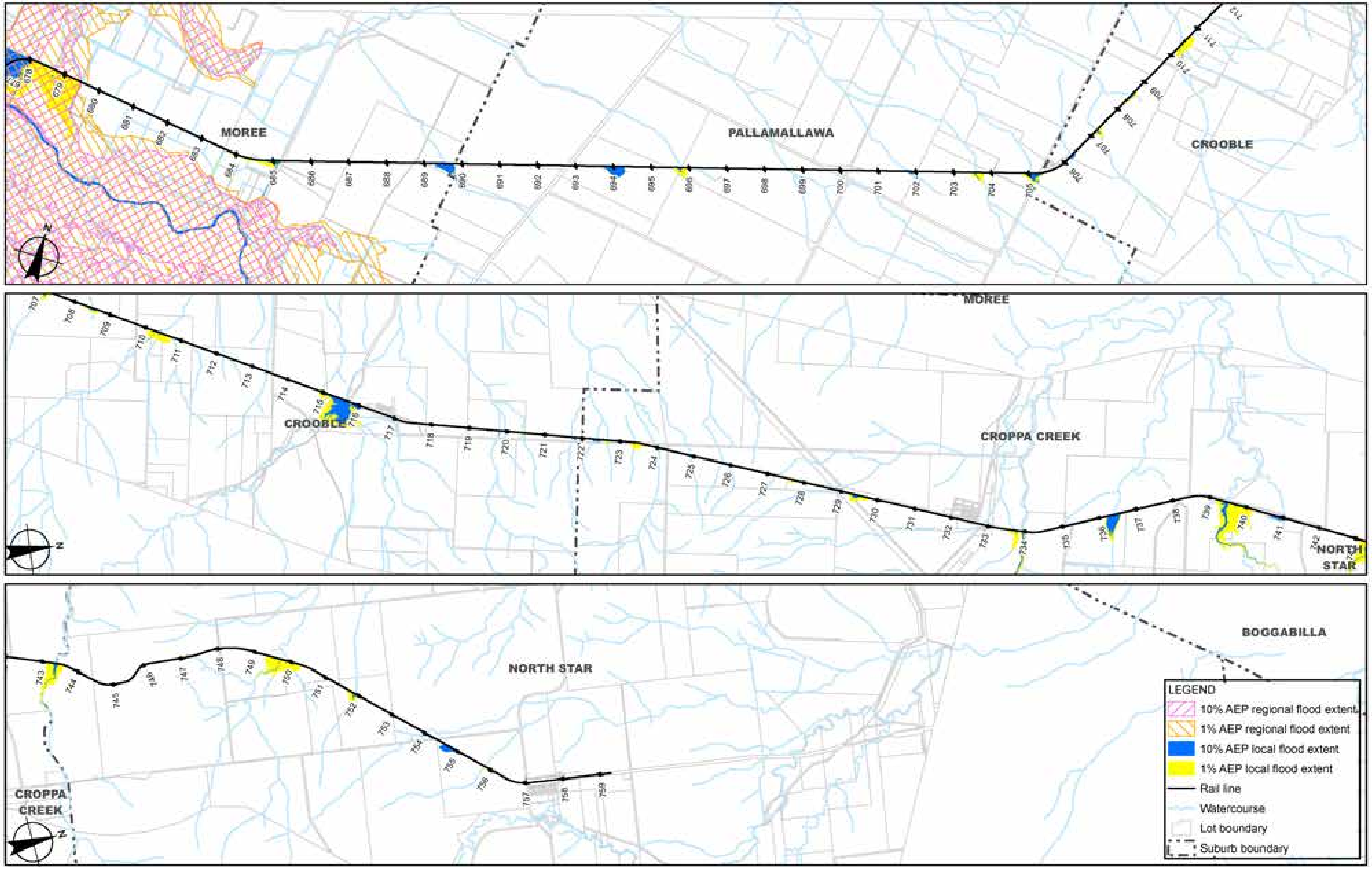


Figure 15.3b Existing local and regional catchment flooding extents



15.3 Impact assessment

15.3.1 Risk assessment

Potential impacts

The environmental risk assessment for the proposal (summarised in Appendix B) included an assessment of the potential risks associated with hydrology and flooding. The assessed level for the majority of potential risks was medium to high. Risks with an assessed level of medium or above included:

- impact of flooding on unprotected areas during construction resulting in wash-outs or erosion
- temporary impact to the behaviour of local surface water systems during construction
- presence of, or change to structures associated with the proposal could impact upstream and downstream local flood behaviour
- change to structures associated with the proposal and track height could impact upstream and downstream regional flood behaviour
- changes to flow patterns and altered hydrology due to construction in watercourses
- blockages of flow paths affecting low flows through construction within watercourses and through erosion and sedimentation control structures
- sedimentation and changes to geomorphology (aggradation in bed channels) in watercourses
- impacts on upstream and downstream drainage due to the introduction of built structures such as embankments, culverts and bridges
- direct and indirect impacts on waterfront land as defined in the *Water Management Act 2000*.

The proposal would impact on flooding in the study area, because it generally involves raising the height of tracks to provide flood immunity. For the proposal, flood immunity is defined as the one per cent AEP flood event. The proposal would form a raised rail level across the floodplain.

How potential impacts would be avoided/minimised

The proposal has been designed to avoid and minimise potential flooding impacts and modifications to surface and groundwater flows. The strategies that have been, and would continue to be, implemented include the following:

- Key infrastructure would not be located within the one per cent AEP flood prone areas or where it is not practical to design for a flood immunity greater than one per cent AEP.
- Culverts would be upgraded to permit an appropriate flow and minimise the potential for adverse flooding impacts, as described in Section 7.2.3.
- Where practical, culverts would replace existing structures in order to maintain existing flow patterns. Where new culverts are required (for example at the Cumarra bypass), culverts would be placed within existing drainage lines.
- Culverts would include suitable scour protection to reduce discharge velocities and promote the spreading of flows downstream.
- Swales would be constructed along the outside edges of the track and formation to minimise the potential for water infiltration into the formation.
- Culverts would be installed prior to, or concurrent with track works.
- Standardised culvert shapes have been adopted to facilitate the use of pre-cast structures. This would minimise the amount of works required on-site, and therefore the potential impact on watercourses. This would also reduce water usage at the proposal site.
- Spoil mounds would be designed and located to minimise impacts on flows as they are directed toward culverts or where they discharge from culverts.

15.3.2 Construction impacts - hydrology

Impacts on natural processes within rivers and floodplains

The proposal would involve works within and around ephemeral watercourses and perennial waterways (Gwydir River and Mehi River), including:

- installing erosion protection measures in accordance with the CEMP
- construction of culverts or underbridges as described in Chapter 8
- rehabilitating the disturbed area once works are complete.

If inadequately managed, work in watercourses has the potential to change the flow regime, impact riparian vegetation and aquatic ecology (considered in Chapter 10), and contribute to erosion, sedimentation, and water quality impacts (considered in Chapter 16).

The potential for impacts would be minimised by implementing the mitigation measures provided in Sections 15.4 and 16.4.

Direct or indirect increases in erosion, siltation, destruction of riparian vegetation or a reduction in the stability of riverbanks or watercourses

Construction would result in a small increase in impervious areas (such as construction compounds), which would have the potential to increase the volume of water flowing to watercourses. However, the change in impervious area would be negligible compared to the overall catchment area.

Construction would involve temporary diversions to transfer runoff around worksites. This may involve excavations and embankments that would alter localised flow patterns and impact the stability of surrounding surface water receivers. These changes would be temporary and limited to the construction phase. Following construction, the landform would be restored as close as practicable to the pre-works condition, with the exception of spoil mounds along the length of the proposal (described in Section 7.4.2), which would be located so that they do not impact on flow paths and patterns.

Increases in overland flow, and/or changes to surface water flow patterns, could result in increased erosion and siltation of watercourses in the proposal site, considered in Chapter 16.

The majority of watercourses that cross the proposal site are ephemeral and in moderate condition. Where watercourses are perennial, erosion and sedimentation impacts would be mitigated through the implementation of standard erosion and sediment control measures therefore any impacts to surface water hydrology and flow regimes as a result of construction would be limited in extent.

Minimising the effects of proposed stormwater and wastewater management on natural hydrological attributes and conveyance capacity

Surface water at construction sites would be managed by implementing standard erosion and sediment control measures in accordance with *Managing Urban Stormwater: Soils and Construction*.

Wastewater could result from the following activities/sources:

- use of site amenities at construction compounds
- dewatering of groundwater from excavations
- use of mobile concrete batching plants
- use of vehicle wash down areas.

Wastewater from site amenities would be removed via vacuum trucks on a regular basis, and would be disposed of in accordance with relevant regulatory requirements.

Wastewater from other construction activities would be initially contained on-site to confirm it meets relevant water quality requirements (considered in Chapter 16). Discharge of wastewater to surface water would consider the hydrological attributes of the receiving waterbody, including whether the receiving waterway has sufficient flow volume and velocity to incorporate and disperse the potential discharge.

The potential to encounter groundwater during construction is considered below.

Water take from all surface and groundwater sources

As described in Chapter 8, water would be required to control dust, compact soil, undertake site concrete works, and establish vegetation. Estimated water demand would be in the order of 150 megalitres (up to about 75 megalitres per year). The actual amount of water required at the time of construction would depend on final design details, weather, and the adopted construction methodology.

Potential water sources identified include:

- Narrabri Shire Council (wastewater) – 5 megalitres
- private bores within 5 kilometres of the proposal site – about 5 to 10 megalitres per bore
- private dams within 10 kilometres of the proposal site – about 20 megalitres
- Namoi River – 10 to 15 megalitres
- Gwydir River – 10 to 15 megalitres
- Mehi River – 10 to 15 megalitres
- Moree Shire Council (wastewater) – 5 megalitres.

Use of water from these sources would be subject to relevant approvals, access agreements, and the amount of water available at the time of construction.

Water use for the proposal could reduce the availability of water for irrigation, and impact surface water and groundwater flow regimes. This impact is expected to be short-term, as different water sources would be used along the length of the proposal site, and water sources would recharge following rainfall.

Groundwater extracted from bores during construction may have a short-term impact on flows within the alluvial layer as a result of water used during construction. The lateral extent of impacts would be localised around individual extraction locations, and is unlikely to extend more than about 50 metres from the extraction point. Existing private bores would be used for the extraction of groundwater.

Consultation would be undertaken with relevant stakeholders (including landowners/occupants) prior to construction, and appropriate approvals and agreements would be sought for the extraction of surface water and groundwater. Monitoring would be undertaken during extraction to ensure volumes stipulated by license requirements and/or private landholder agreements are not exceeded. The CEMP would include measures to minimise water usage during construction. The location of surface water and groundwater extraction points would take into consideration the presence of surrounding water users, and the requirements of relevant water sharing plans.

Water usage during construction could also increase infiltration rates and surface water runoff within the proposal site. The impact of this additional discharge is expected to be minimal, as the additional flow and infiltration would be negligible compared to regional rainfall levels. Any impacts would be short-term.

Excavation will generally not exceed 1.0 metre below ground surface therefore, groundwater is unlikely to be encountered during the majority of works. However, there is the potential for shallow groundwater to be encountered during construction of bridges. As the groundwater is likely to be perched (limited in extent) and recharged via rainfall, any impacts would be short-term.

There is likely to be a residual redirection of alluvial flows around the piers, and this is unlikely to extend more than five metres from individual piers. This would be a minor, localised impact.

15.3.3 Construction impacts - flooding

Any detrimental increases in the potential flood affectation of properties, assets, and infrastructure

The presence of construction work sites and compounds in floodplains has the potential to impact on surrounding properties. The layout of construction work sites and compounds would be prepared with consideration of overland flow paths, avoiding flood liable land where possible to avoid detrimental impacts.

During construction, there is also the potential for works to be impacted by flooding. As described in section 15.3.1, the proposal has been designed to minimise the duration of on-site work in watercourses, which would enable increased flexibility when scheduling works around forecast rain periods.

Soil and water management measures would be implemented in accordance with *Managing Urban Stormwater: Soils and Construction* to minimise any potential impacts resulting from flooding during construction. Where possible, construction would be staged to minimise the duration of the works and exposure to wet weather periods.

Beyond the potential impacts described above, the impact of construction on flood behaviour is expected to be negligible compared to regional flood levels and behaviour.

15.3.4 Operational impacts - hydrology

The proposal would impact on the hydrology and hydraulics of the study area during operation. This is because the existing rail corridor would generally be raised across the floodplain, and upgraded structures would be required to enable surface water to flow under the rail formation.

Impacts on natural processes within rivers and floodplains

The proposal would raise the height of the rail formation in the majority of the proposal site (with the exception of level crossings and in Moree), which would impact the surface water flows across the floodplain. This would change the upstream flooding regime and result in more concentrated flows through culverts that discharge to downstream watercourses. Raising the formation also has the potential to change the frequency of flow interaction between adjacent catchments upstream of the proposal site.

The proposal could also modify flow paths across floodplains as a result of the installation of replacement or additional culverts and bridges. Changes to such structures could change the pattern of cross drainage from upslope to downslopes areas, which may change the patterns of erosion and scouring within existing watercourses and drainage lines, and within the broader floodplain area. These impacts are likely to be minimal, because the culverts and bridges have been designed to convey flows at rates similar to those for the existing rail corridor. This would minimise surface water redirections or restrictions.

The proposal would have minimal impact on groundwater during operation. Replacing the drainage structures in the proposal site would generally have a beneficial effect on water flow, including groundwater recharge potential. The change in ponding duration upstream of the proposal is not sufficiently long such that it would impact on the infiltration volume of water into groundwater.

Direct or indirect increases in erosion, siltation, destruction of riparian vegetation or a reduction in the stability of riverbanks or watercourses

The proposal could result in increases in erosion and siltation and an associated reduction in stability of riverbanks and watercourses, due to increased flood levels and velocities upstream and downstream of culverts and underbridges. The potential for these changes are considered below.

It is predicted that there would be a negligible change in upstream flood velocities with the proposal in place, because the same floodplain processes would apply. Velocities on the floodplain would continue to be low, and would be higher immediately upstream of a culvert. The approach velocities are not expected to exceed 1.5 metres per second.

The upstream velocity in watercourses would be larger than that on broad floodplain areas. For these locations, the velocity is predicted to be less than 2.0 metres per second, except in very localised areas.

The predicted low velocities are not anticipated to create watercourse instability. It is estimated that the average velocities of flows to the new structures would increase by less than 0.1 metres per second. As a result, the proposal is unlikely to impact on the geomorphology of watercourses upstream of the proposal site.

While upstream velocities are not expected to change appreciably, downstream of the culverts there is the potential for peak flow velocities to increase by between 0.5 and 1.0 metre per second, as a result of increased flood levels upstream at some structures.

The increase in water flowing through culverts has the potential to result in erosion and impacts to downstream stream stability. The results of the assessment predict that, without mitigation, these impacts could result in increased erosion and scour at a number of locations downstream of culverts. A rock energy dissipation layer (a rock blanket) is proposed across the full width of culverts to reduce the flow velocity of water exiting the culverts prior to discharging onto the ground. Further assessment would be undertaken during detailed design to confirm the locations and required erosion protection.

Minimising the effects of proposed stormwater and wastewater management during operation on natural hydrological attributes and conveyance capacity

Surface water during maintenance activities would be managed by implementing standard erosion and sediment control measures in accordance with *Managing Urban Stormwater: Soils and Construction*.

There are not expected to be any activities undertaken during operation that would generate wastewater requiring discharge.

Water take from all surface and groundwater sources

No water would be required from surface and groundwater sources during operation of the proposal. Any water required during maintenance activities would be trucked to site in accordance with ARTC's existing maintenance procedures.

Maintenance activities are not expected to require excavation to depths at which groundwater may be encountered.

15.3.5 Operational impacts – flooding

Any detrimental increases in the potential flood affectation of other properties, assets and infrastructure

Rail overtopping

Modelling of the potential impacts of the proposal indicates that the length of the rail corridor that would be overtopped in the one per cent AEP local flood event would substantially reduce compared to the existing situation. The predicted length of overtopping would reduce by 88 per cent, from 11,124 metres to 1,338 metres.

Regional modelling of the potential impacts of the proposal near Moree indicates that the length of the rail corridor that would be overtopped in the one per cent AEP regional flood event would marginally increase, compared to the existing situation. The predicted length of overtopping would increase by about six per cent, from 6,310 metres to 6,720 metres. This is the result of the proposed "like for like" replacement of structures.

Overtopping locations for both the local and regional one per cent AEP event are shown in Figure 15.4. These locations coincide with the location of level crossings. With regards to formation non-conformance, modelling indicated that about 26 kilometres would not conform with ARTC technical requirements during a one per cent AEP local and regional flooding event. This equates to a reduction of about 13 per cent in formation non-conformance compared to the existing situation.

Public road overtopping

Table 15.9 lists the predicted locations where main roads would be overtopped during local flooding events with the proposal in place. The results indicate that:

- one road which is not inundated under existing conditions would be inundated with the proposal in place, IB Bore Road, however Oregon Road would no longer be inundated.
- for the one per cent AEP event:
  - the depth of overtopping would decrease for Gurley Creek Road, Railway Parade, and some sections of Newell Highway
  - Mosquito Creek Road would remain flood free
  - overtopping of Gil Gil Creek Road is predicted to increase in depth by about 1.4 metres.

The modelling indicates that flood depths would increase along some localised sections of public roads, and decrease along other sections. However, the modelling generally indicates that the potential for public roads to be flooded would be relatively unchanged.

Table 15.9 Road overtopping – local flooding

Road	Maximum depth of overtopping (m)					
	50% AEP	20 % AEP	10% AEP	5% AEP	2% AEP	1% AEP
Gil Gil Creek Road	-	-	-	0.27	1.11	1.73
Gurley Creek Road	-	-	-	-	-	0.24
Mosquito Creek Road	-	-	-	-	-	0.00
Newell Highway (various locations)	-	-	-	0.28	0.39	0.43
IB Bore Road	-	-	0.08	0.21	0.64	0.83
Railway Parade	-	-	-	-	-	0.15

Figure 15.5 shows the predicted locations and extent of impacts of local flooding on public roads for the proposal compared with the existing situation. During larger flood events (regional flooding) the depth of flooding at some locations along the Newell Highway in Moree would increase by up to about 0.07 metres when compared to existing conditions. However, as the road is currently non-trafficable during major flood events and would remain so with the proposal there would be no additional impacts to the community or emergency services.

Adjacent land impacts - flood extents

Figure 15.6 shows the predicted upstream flood extents for modelled events. Table 15.10 lists the land area that would be impacted by a range of flooding, for events compared to the existing situation. With the proposal in place, it is predicted that the area of upstream flooding would reduce for all events, excluding the 0.2 per cent AEP event.

Table 15.10 Local catchment flood affectation areas

Design event (% AEP)	Area of inundation (ha) for the existing rail corridor	Area of inundation (ha) for the proposal	Change in area of inundation due to the proposal (%)
50	401.8	383.8	- 4.5
20	554.1	496.6	- 10.4
10	852.8	627.1	- 26.5
5	1,373.0	1,009.1	- 26.5
2	2,093.5	1,777.3	- 15.1
1	2,668.9	2,515.3	- 5.8
0.5	3,031.8	2,893.7	- 4.6
0.2	3,414.9	3,465.5	+ 1.5
PMF	9,591.7	9,159.6	- 4.5

Impacts on land use due to changes in the inundation pattern are considered in Chapter 20.

The proposal is predicted to reduce flood levels in most areas downstream of the proposal site, for events up to the one per cent AEP local flood event. There may be very localised changes in levels immediately downstream of structures, but these are expected to be confined to the existing rail corridor.

Near Moree, the regional scale modelling undertaken for the Gwydir and Mehi river systems indicates that the maximum modelled flood depths and extents are expected to remain generally consistent with the existing conditions, with only localised areas of flood depth increases up to about 200 millimetres expected outside (to the north) of the residential areas of Moree during the one per cent AEP regional flood event.

Figure 15.4a Rail overtopping during operation for 1% AEP – local and regional catchment flooding

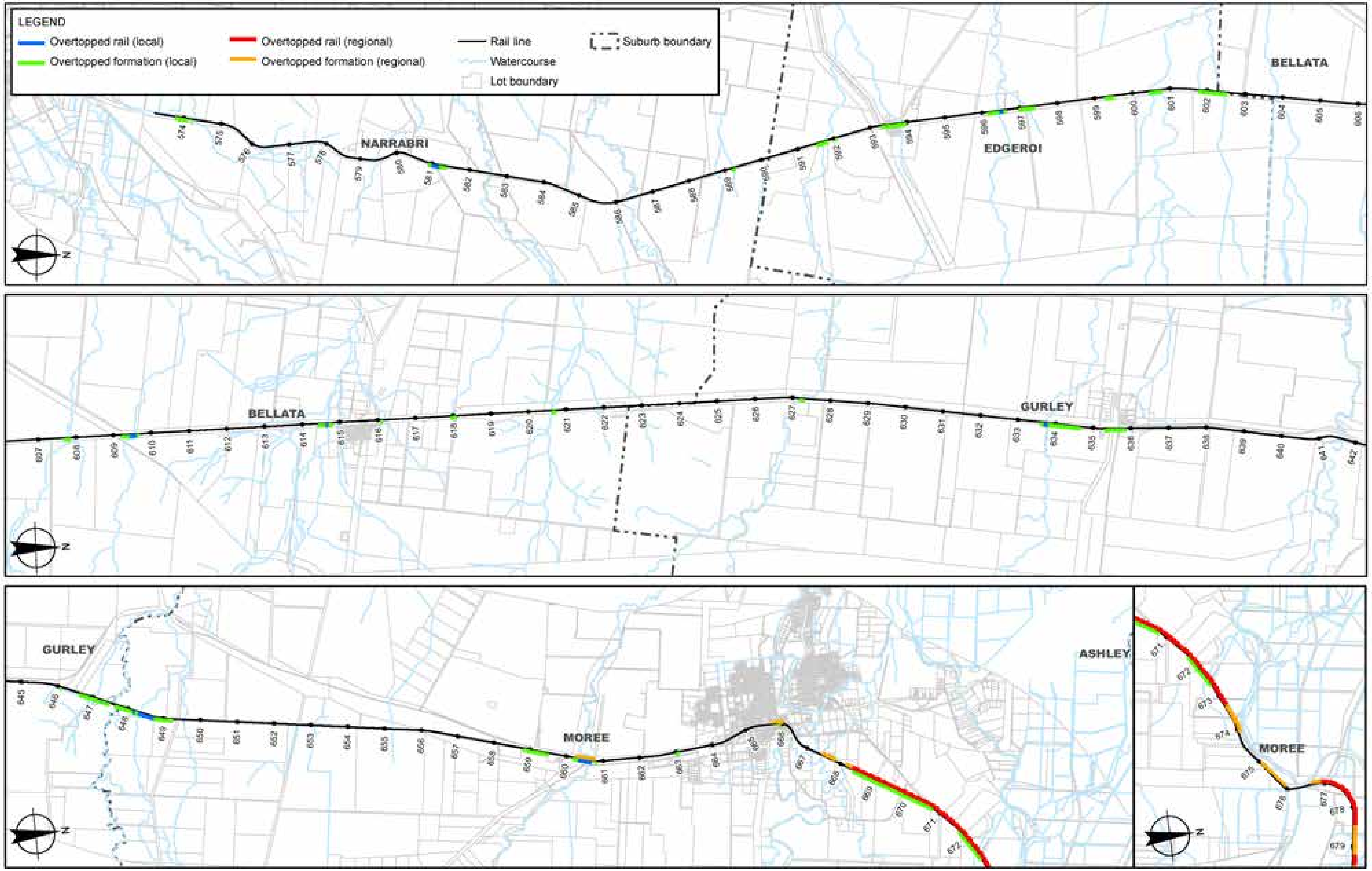


Figure 15.4b Rail overtopping during operation for 1% AEP – local and regional catchment flooding

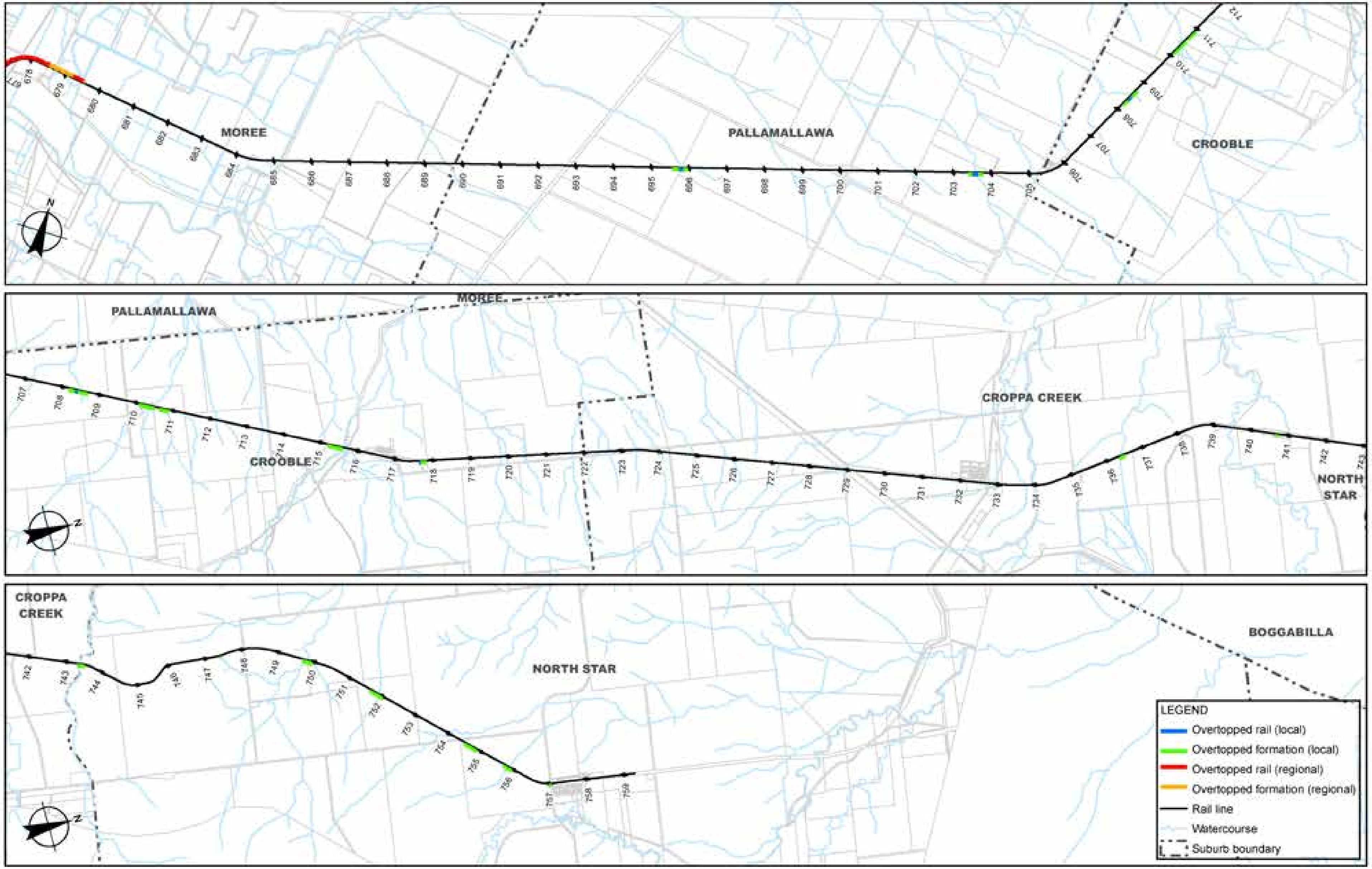
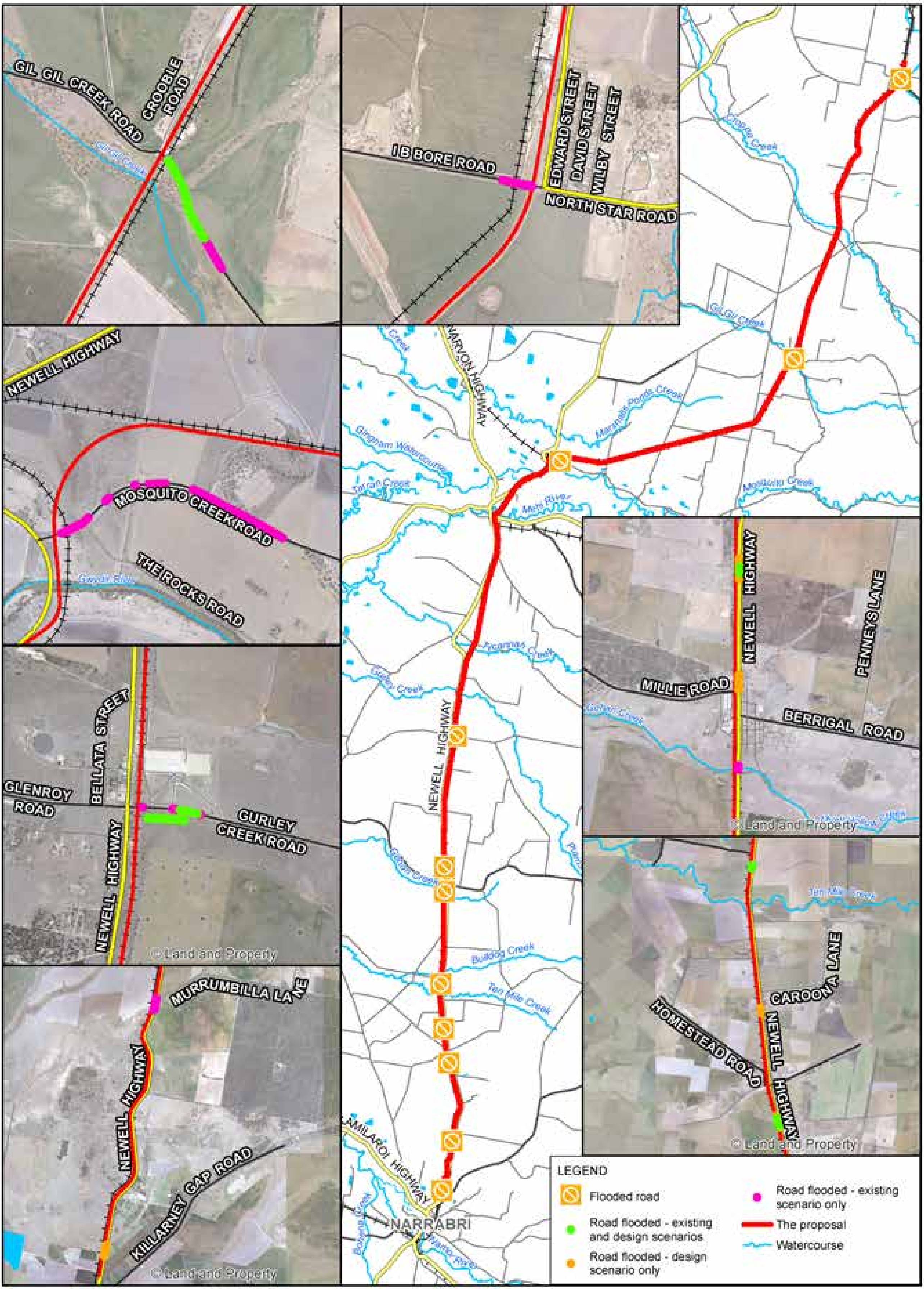


Figure 15.5 Roads impacted by local catchment flooding



Adjacent land impacts - period of flooding

Periods of upstream flooding for local catchment flood events are predicted to be slightly longer than the existing situation. This is because all water runoff for events up to the one per cent AEP event would flow through culverts. However, the increase in size of the culverts relative to the existing structures would mitigate this potential impact. Typically, the increased duration of ponding is likely to be up to about three hours.

Watercourses downstream of the proposal site would be inundated for periods similar to the upstream areas.

No appreciable change to flood duration is expected during the modelled regional flood events.

Building and property impacts

A review of aerial photography indicates that, for the current design, 20 buildings/structures (outside of the regional flood model for the Moree area) would potentially be inundated during the predicted one per cent AEP flood levels, consisting of:

- three houses, which is two more than the existing situation
- six businesses, which is one more than the existing situation
- ten garages or sheds, which is one more than the existing situation
- one park structure/public amenity, which is no change from the existing situation.

Seven additional structures are expected to be adversely affected, whilst three structures are expected to experience reduced flood impacts during the one per cent AEP local flood event due to the proposal, when compared to the existing situation.

Three of the potentially affected buildings/structures (one house, one shed associated with a petrol station and one agricultural shed/outbuilding) are located about 15 kilometres north of Narrabri (around Edgeroi), while two houses (one with two nearby sheds) are located on the northern edge of Bellata. The property details of these buildings/structures that would be inundated due to the proposal are provided in Table 15.11, as is a summary of the change in the estimated one per cent AEP flood levels (at the nearest rail corridor culvert).

The regional modelling indicated that an additional 23 properties (of 999 affected properties) could be impacted during the one per cent AEP flood event. These properties are located at the outer edges of the modelled flood extents where the changes in the maximum modelled flood levels are relatively small. In addition, assumption that the floor levels of these dwellings is equal to the adjacent ground level is likely to be an overestimate, with actual floor levels above the modelled flood levels. Additional assessment would be undertaken during detailed design to confirm these impacts (including a survey of floor levels of the affected properties).

Changes in local and regional flood extents for the one per cent AEP flood event are shown in Figure 15.6 and more detailed figures, which show the location of those additional structures inundated during a local flooding event, are provided in Appendix L of Technical Report 6.

Table 15.11 Design flood levels at affected properties – local catchments

Location	Lot and DP	1% AEP flood level[1] Existing (mAHD)	Design (mAHD)	Change (metres)
Edgeroi	Lot X DP394753 (dwelling)	241.91	242.20	+ 0.29
	Lot 61 DP753952 (shed)			
	Lot 73 DP753952 (shed)			
Bellata	Lot 1 DP758081 (dwelling)	229.90	230.82	+ 0.92
	Lot 2 DP708391 (dwelling and two sheds)			

Note 1: estimated flood level at the adjacent rail corridor culvert

Figure 15.6a Changes in local and regional catchment flood extents for the proposal

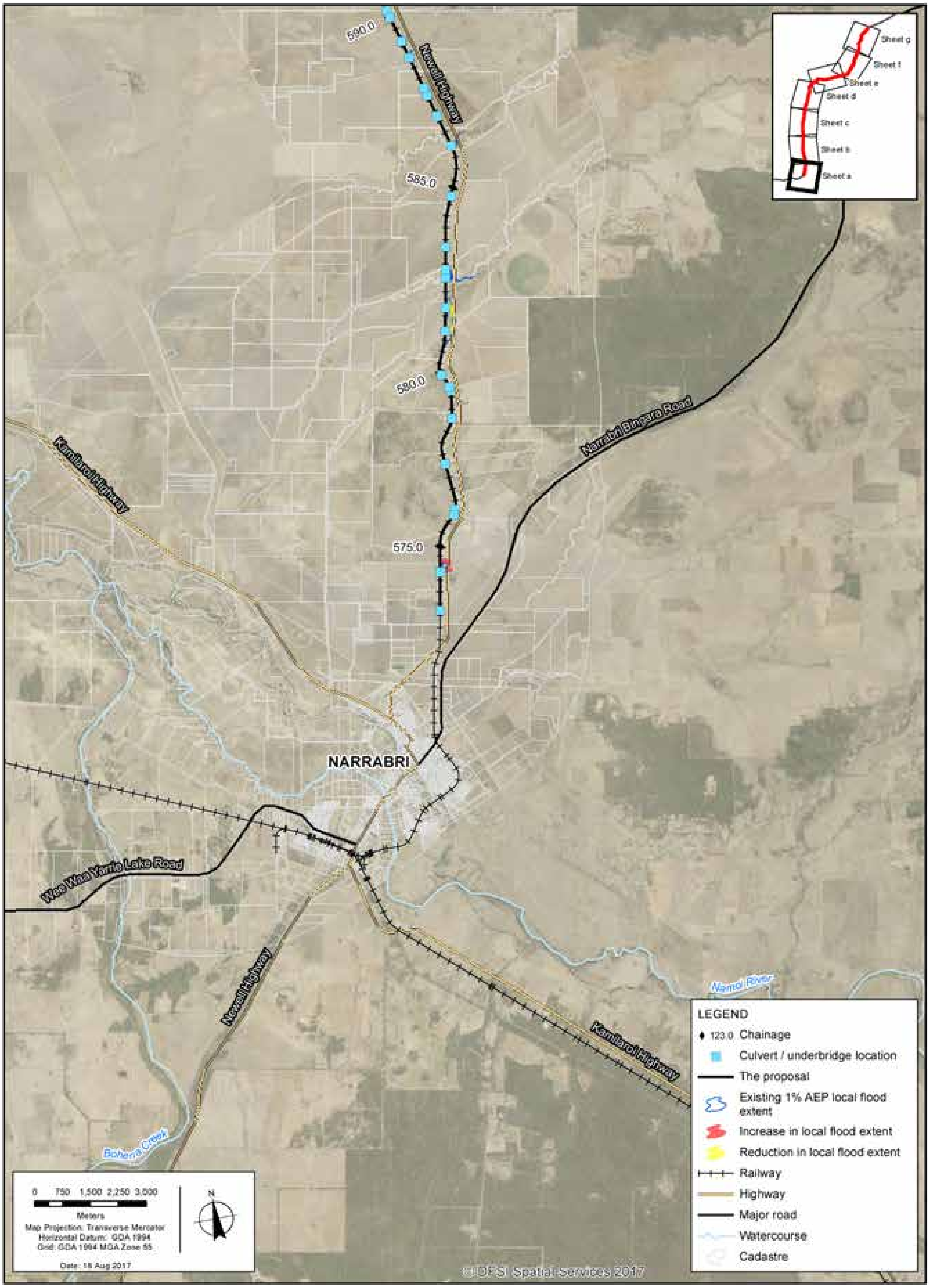


Figure 15.6b Changes in local and regional catchment flood extents for the proposal

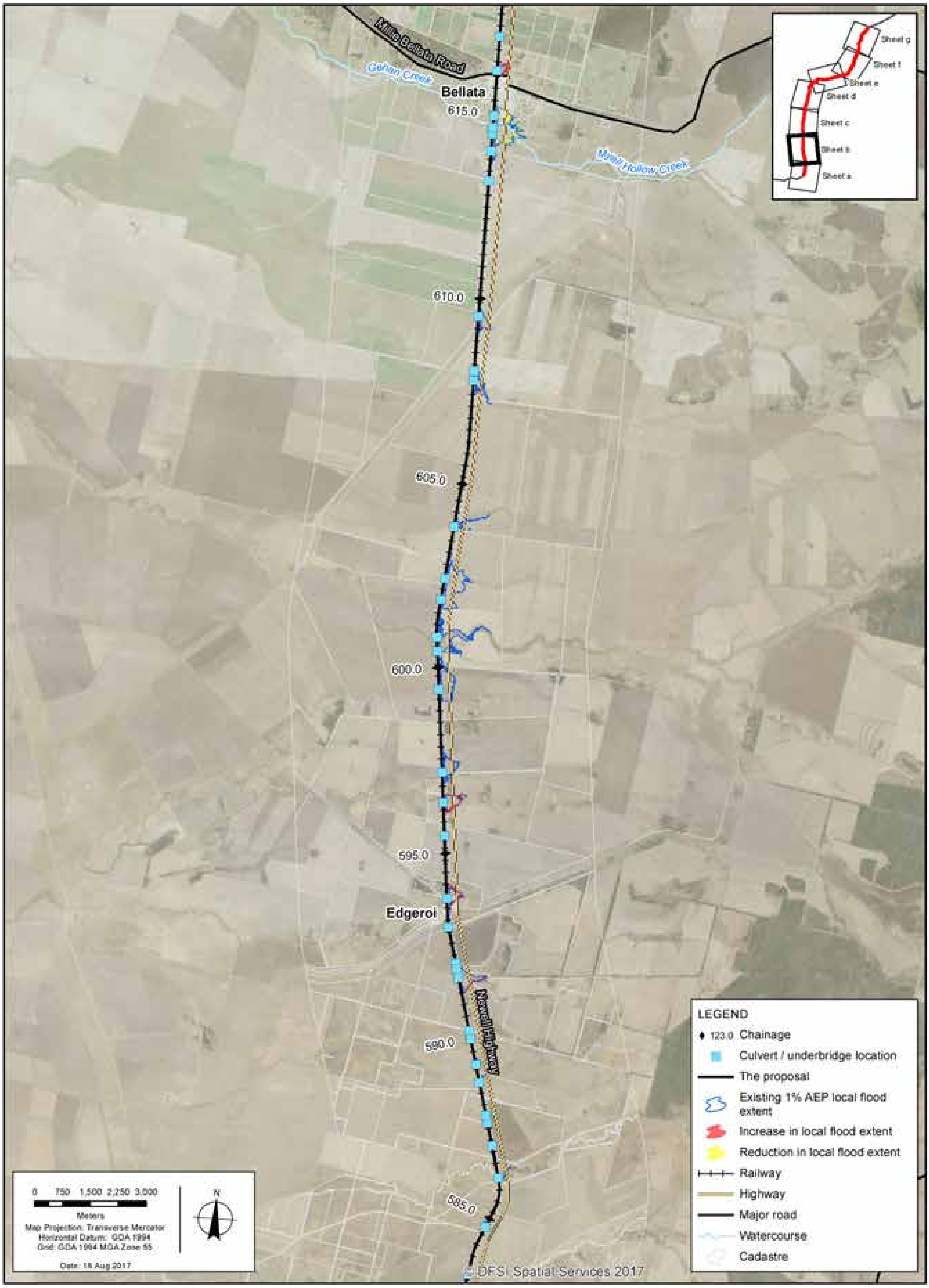


Figure 15.6c Changes in local and regional catchment flood extents for the proposal

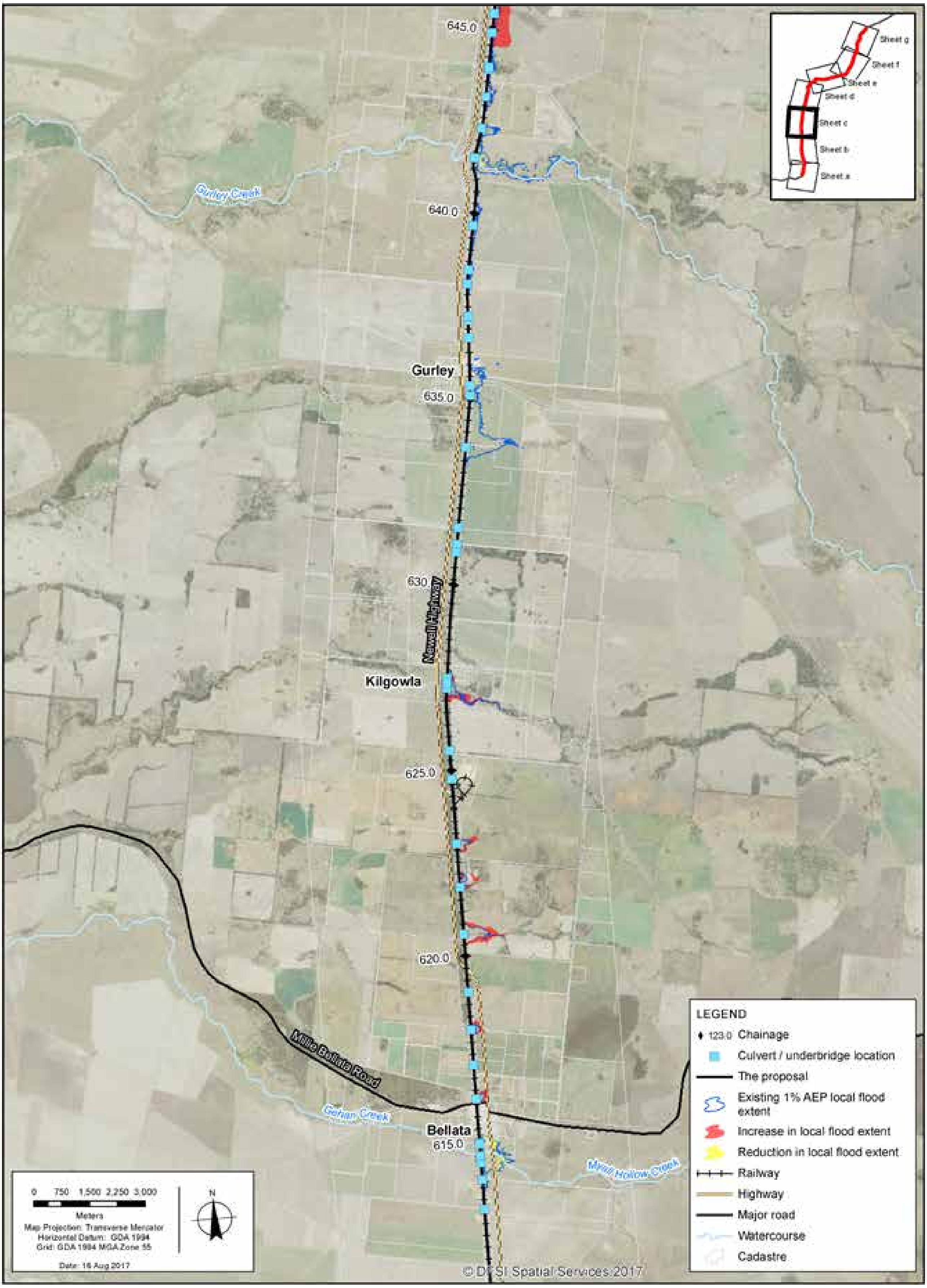


Figure 15.6d Changes in local and regional catchment flood extents for the proposal

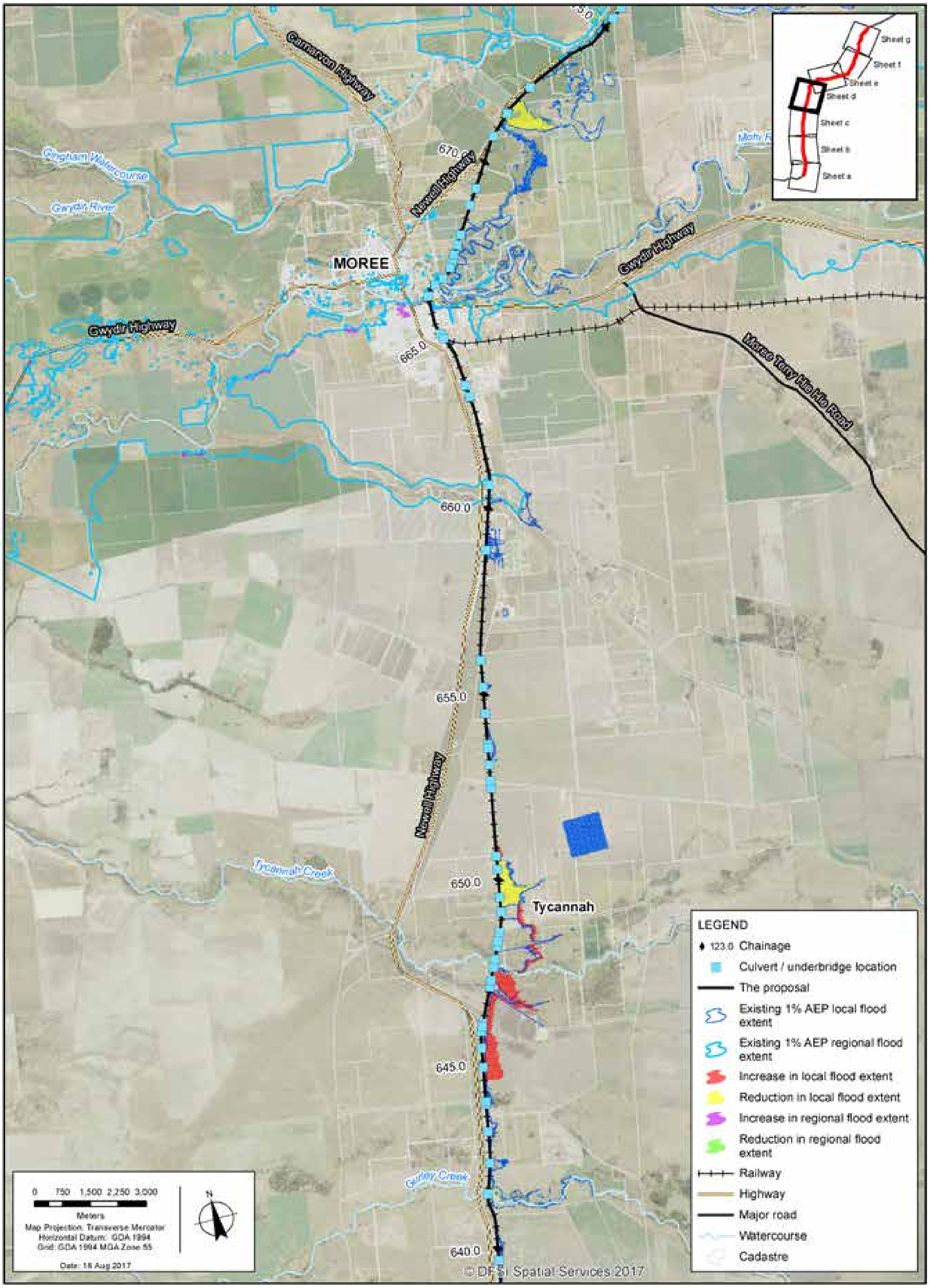


Figure 15.6e Changes in local and regional catchment flood extents for the proposal

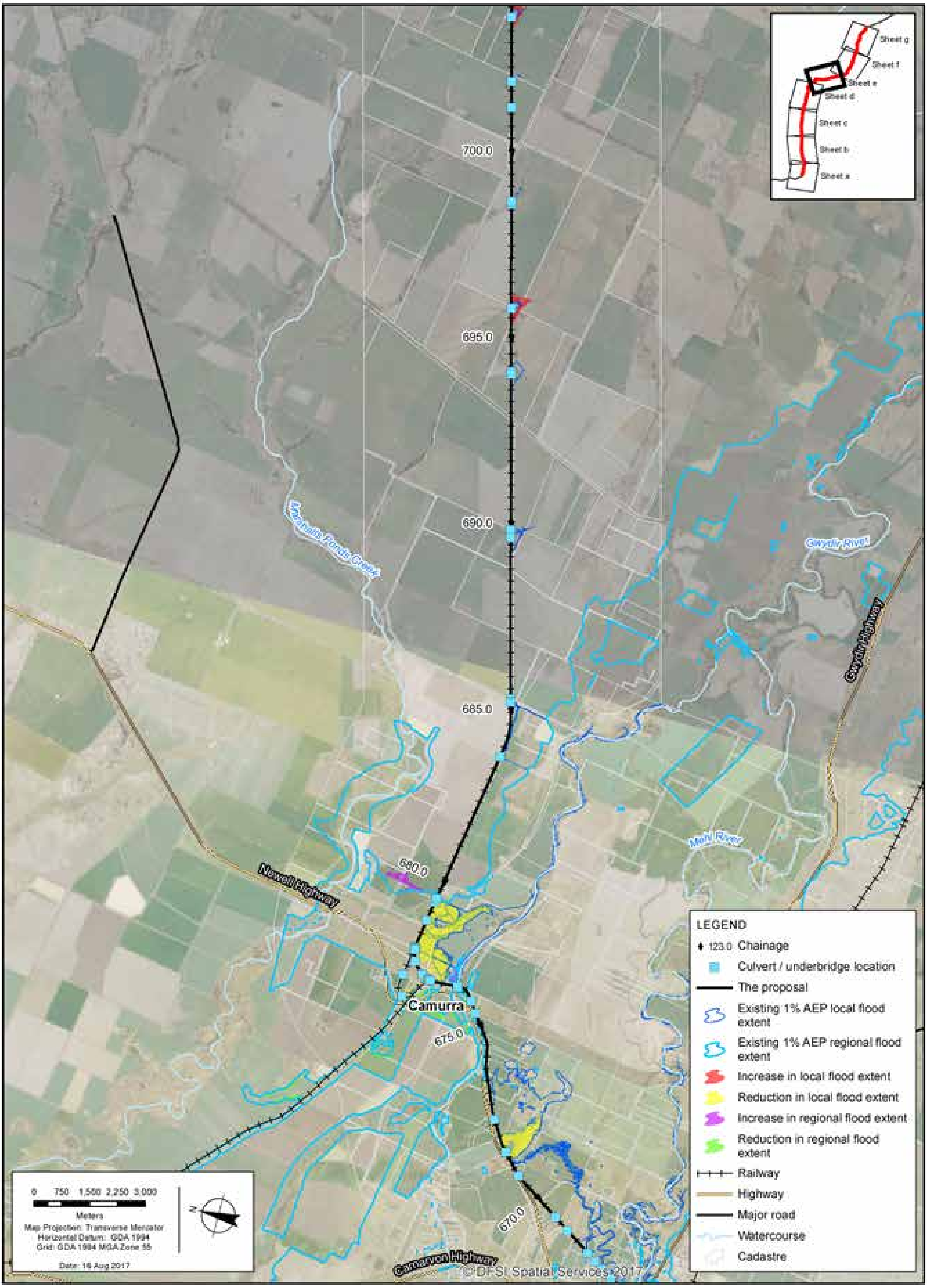


Figure 15.6f Changes in local and regional catchment flood extents for the proposal

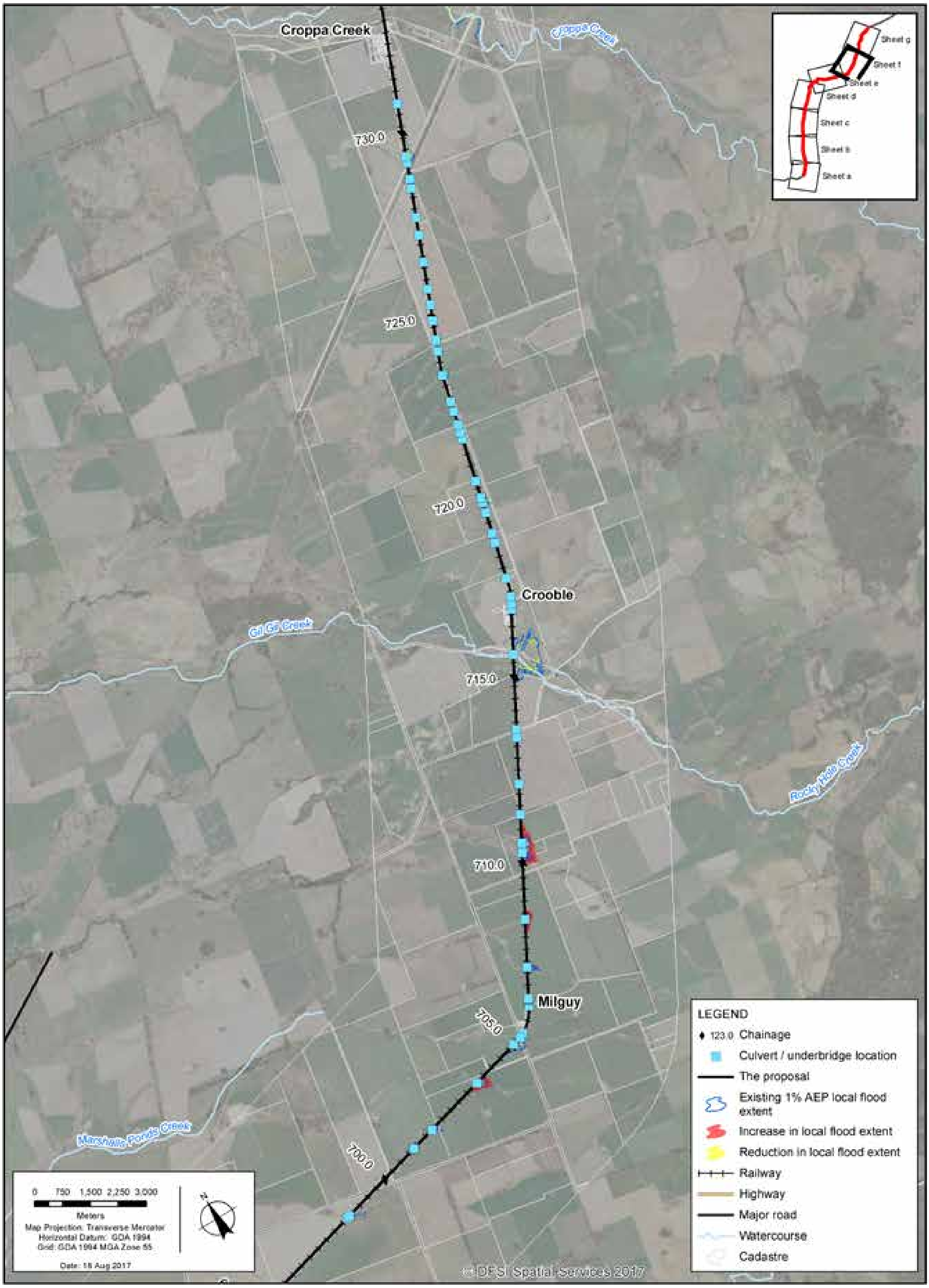
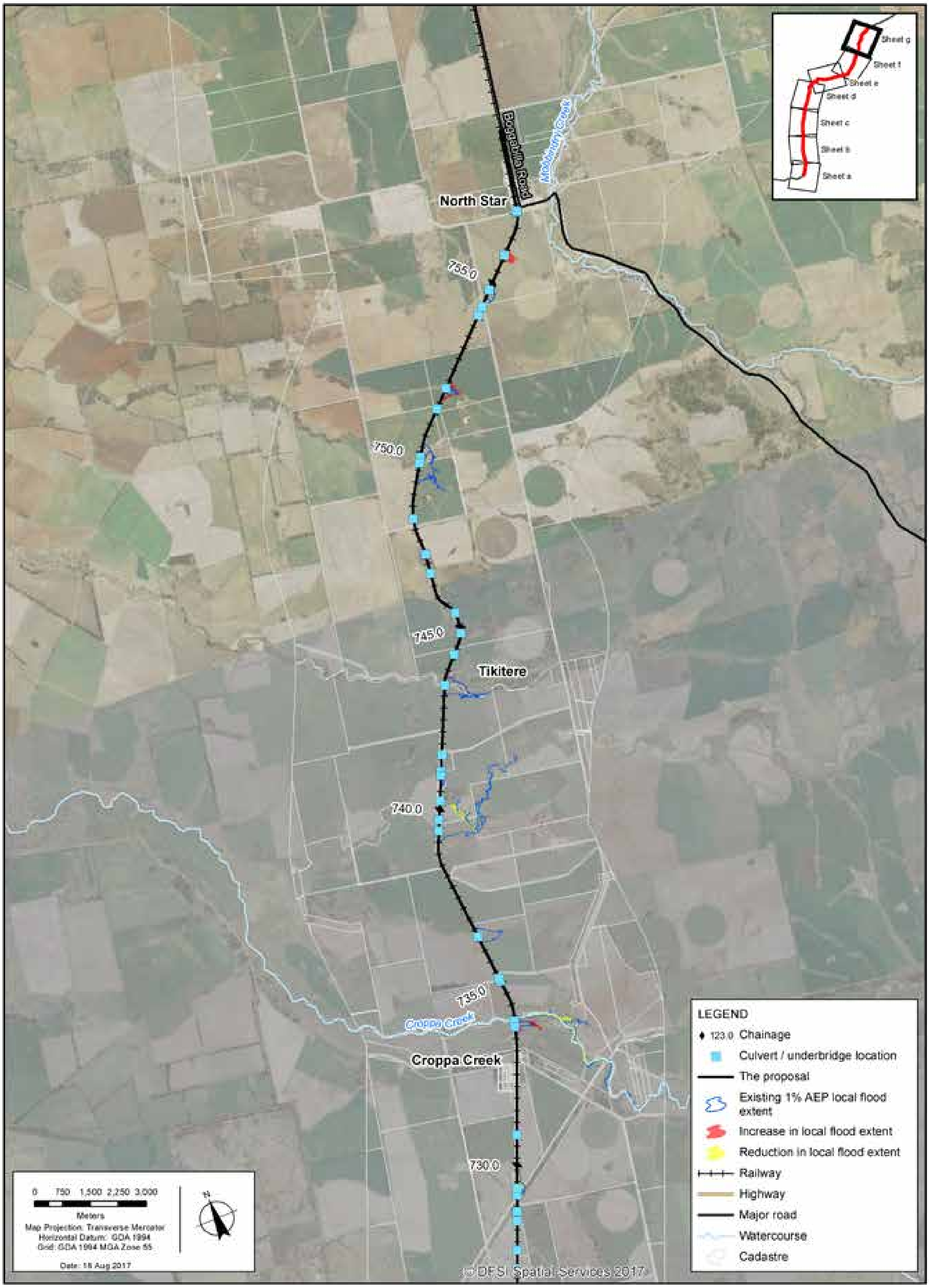


Figure 15.6g Changes in local and regional catchment flood extents for the proposal



Further modelling would be undertaken during detailed design to determine how the proposal can be modified so that the flooding characteristics with regards to property and buildings inundation are not worsened. Design modifications would likely consist of culvert resizing and potentially changes to the proposed formation height in the vicinity of the properties identified above.

Consistency with applicable Council floodplain risk management plans

The existing floodplain risk management plan for Moree and the surrounding area (Parsons Brinkerhoff, 2008) needs to be updated following the recent completion of a flood study review (WRM, 2016).

Detailed flood modelling has been undertaken to assess the potential impacts of the proposal on residential, commercial, and industrial areas in Moree. The results of this assessment found that raising the level of the rail alignment above the one per cent flood level without changing the culverts would substantially increase upstream flood levels. Increased upstream flood levels would result in increases to maximum flow velocities through the existing culverts. As a result, the proposal retains the existing track and formation heights so as not to change the floodplain hydraulics in Moree. Therefore, the proposal is not expected to result in significant changes to floodplain risk management in Moree.

A flood study has been undertaken for the Narrabri LGA (URS, 2014) but the results have not yet been incorporated into a floodplain risk management plan. The southern end of the proposal site is located within an area that is generally used for farming. As a result, it is not considered as sensitive to flood hazards as the residential, commercial, and industrial areas of Narrabri located further south of the proposal site.

No floodplain risk management plan was identified for the Gwydir LGA, however modelling indicates that flood levels and extents are not expected to significantly increase around that portion of the proposal site located within the Gwydir LGA (from about Croppa Creek to North Star). As a result, flood hazards are expected to remain generally consistent with the existing conditions.

Compatibility with the flood hazard of the land

Floods can create hazardous conditions, including fast flowing, shallow water or slow-flowing deep water, in which humans are vulnerable. It is the human interaction with the floodplain and the associated exposure to flood hazards that creates flood risk. Without the human element there would be no risk to the community. Flood hazards can include direct impacts to people (fast currents sweeping them away) or impacts to the built environment including infrastructure required for the functioning of the community such as roads and rail.

With the exception of Moree, the proposal site generally passes through rural land, with land uses that are less sensitive to flood hazards as there are less people and infrastructure likely to be impacted. Additionally, the modelling indicates that flood depths and velocities due to the proposal are not expected to appreciably change the existing flood hazard in rural areas and changes in flood levels are not generally expected to adversely affect flooding of roads.

The highest risk area (in respect to flooding and community risk) is Moree, however the proposal will maintain existing flood levels and track and formation heights at Moree. Therefore, there will be no substantive change to the existing flood hazard of the land in Moree.

Compatibility with the hydraulic functions of flow conveyance in flood ways and storage areas of the land

The proposal would generally maintain the location of bridges and culverts, with the capacity of new structures generally exceeding that of the existing structures. Therefore, it is considered that the function of flow conveyance in flood ways would be preserved or improved.

The proposal would generally maintain the existing alignment of the rail line, with the exception of the Camurra bypass, and works outside of the rail corridor would be limited. As a result, the existing areas of flood storage would generally be maintained, albeit with some changes to flood levels and extents (both increases and decreases) at some locations. Overall, the function of flood storage areas is expected to be maintained as a result of the proposal.

Downstream velocity and scour potential

There is predicted to be an increase in the extent of erosion downstream of culverts at around 15 locations, with erosion likely to extend up to 100 metres downstream of a structure at these locations. Increased erosion could affect flow regimes and water quality. Watercourses located downstream of many culverts already exhibit signs of erosion. Rock protection is proposed immediately downstream of structures to reduce the flow velocity and distribute flow laterally. During detailed design, each location would be reviewed in detail to provide site specific erosion protection to mitigate this potential impact. Visual monitoring would also be undertaken during construction to assess the effectiveness of erosion protection devices, particularly following rainfall, and further measures would be installed if required.

Impacts of flooding on existing emergency management arrangements

Vehicles can become unstable when flood depths on roads exceed 0.3 metres (NSW Government, 2005) leading to road closure. Therefore, emergency management/evacuation arrangements may be impacted where flood depths on roads increase, or where the location of road flooding changes, coinciding with potential community evacuation and emergency management routes.

Comparing the results in Table 15.9 to those for the existing conditions in Table 15.7, it is evident that the proposal would have minimal impact on the closure of potential evacuation and management routes.

Modelling indicates that, during the one per cent AEP event, flood depths could exceed 0.3 metres at three locations: Gil Gil Creek Road, Newell Highway (various locations), and IB Bore Road. Mosquito Creek Road and Oregon Road are predicted to be flood free, whilst Railway Parade and Gurley Creek Road are expected to be passable with care, or cut off for only a short period. Whilst modelling indicates that the flood depth at Gil Gil Creek Road could increase by 1.43 metres during the one per cent AEP, the road is closed during existing conditions, so there would be no change in the road closure status.

Gurley Creek Road and Railway Parade are currently closed during existing conditions, so the proposal would improve conditions along these roads by making them passable with care during the one per cent AEP event. The proposal would have the potential to cause road closure during the one per cent AEP at IB Bore Road, which is not closed during existing conditions. However, Oregon Road would no longer be closed.

Newell Highway through Moree would remain closed during regional flooding events.

It is considered that the overall impact of the proposal on road closures would not impact existing emergency management arrangements.

Ongoing liaison with local councils, Roads and Maritime Services and emergency services would continue to be undertaken throughout detailed design to identify potential opportunities to improve the impacts of the proposal on road flooding.

Impacts the development may have on the social and economic costs to the community as a consequence of flooding

Given that the increase in flood levels would only occur at areas already subject to flooding (with the exception of IB Bore Road), the proposal would not require changes to existing community emergency management arrangements for flooding, and there would not be increased social and/or economic costs to the community as consequence of flooding.

15.4 Mitigation and management

15.4.1 Approach to mitigation and management

As described in Section 15.3.1, the proposal would incorporate a number of design features to avoid and/or minimise the potential impacts on flooding and watercourses.

Flood modelling has indicated that despite the implementation of the design features described in Section 15.3.1 there may still be some impacts to buildings and structures and watercourses downstream of culverts. Further modelling would be undertaken during detailed design and the design refined such that the proposal does not worsen existing flooding characteristics, where feasible.

Additional mitigation measures are provided below to mitigate the impacts that are not avoided by the proposal design. This would include implementation of measures specified in the soil and water management sub-plan prepared as part of the CEMP, to minimise the potential impacts on watercourses during construction.

15.4.2 Summary of mitigation measures

To mitigate the potential hydrology and flooding impacts of the proposal, the measures outlined in Table 15.12 would be implemented.

Table 15.12 Summary of hydrology and flooding mitigation measures

Stage	Impact/issue	Mitigation measures
Detailed design/ pre-construction	Flooding	The design features listed in Section 15.3.1 would continue to be refined to not worsen existing flooding characteristics, where feasible and reasonable, up to and including the one per cent AEP event. Detailed flood modelling would consider potential changes to: ▸ building and property inundation ▸ level crossing and road flood levels and extent ▸ overland flow paths and storage effects due to spoil mounds and other proposal infrastructure ▸ flood evacuation routes. Flood modelling to support detailed design would be carried out in accordance with the guidelines listed in Section 15.1.2. Flood modelling and mitigation would consider future floodplain risk management plans, and would be undertaken in consultation with the relevant local council, the OEH, and State Emergency Services.
	Emergency responses	Where feasible, facilities and routes identified as being critical to emergency response operations would be protected from the PMF level.
	Downstream watercourse stability	Further modelling would be undertaken during detailed design to confirm the locations downstream of culverts that require erosion protection, and the extent and type of protection required.
Construction	Flooding	Construction planning and the layout of construction work sites and compounds would be carried out with consideration of overland flow paths and flood risk, avoiding flood liable land and flood events where possible.
	Water usage (private bores and surface water)	Consultation would be undertaken with relevant stakeholders (including landowners/occupants) prior to construction and appropriate approvals and agreements would be sought for the extraction of water. Monitoring would be undertaken during extraction to ensure volumes stipulated by license requirements and/or private landholder agreements are not exceeded.

16. Water quality

This chapter provides a summary of the potential water quality impacts of the proposal. It describes the existing environment, assesses the impacts from construction and operation of the proposal, and provides recommended mitigation and management measures. The full Water Quality Assessment report is provided as Technical Report 7.

16.1 Assessment approach

16.1.1 Methodology

A qualitative water quality assessment was undertaken, which involved:

- reviewing design information
- reviewing existing conditions using GIS mapping to identify locations of sensitive receiving environments, such as channels, watercourses, wetlands, national parks, conservation areas, and nature reserves
- identifying water quality objectives for the catchments in which the proposal site is located, based on the *NSW Water Quality and River Flow Objectives*
- reviewing the existing and the proposed hydrological conditions (described in Chapter 15) to identify risks to water quality that are related to hydrology
- assessing the potential impacts of the proposal on water quality
- identifying measures that could be used to mitigate the impact of construction and operation.

No baseline water quality sampling was undertaken for this assessment as the majority of watercourses are ephemeral and the majority of impacts to watercourses within the proposal site would be mitigated through the implementation of standard construction measures. For perennial watercourses in the study area, publicly available information was used to give an understanding of the likely water quality in the proposal site, which was considered sufficient for the purposes of this assessment. This available data would need to be supplemented by pre-construction monitoring to create a reliable understanding of baseline water quality.

16.1.2 Legislative and policy context to the assessment

The main NSW legislation relevant to water quality are the *Protection of the Environment Operations Act 1974* (POEO Act), the *Water Management Act 2000* (Water Management Act) and the *Water Act 1912* (Water Act).

Section 120 of the POEO Act prohibits the pollution of waters by any person. Under section 122, the holding of an environment protection licence is a defence against accidental pollution of watercourses. The Act permits (but does not require) an environmental protection licence to be obtained for a non-scheduled activity for the purpose of regulating water pollution resulting from that activity. As noted in Section 3.4.3, ARTC holds an environment protection licence to carry out railway systems activities on certain parts of the NSW rail network. With respect to water quality, the licence requires ARTC to comply with section 120 of the POEO Act.

The Water Management Act and the Water Act control the extraction of water, the use of water, the construction of works such as dams and weirs, and the carrying out of activities in or near water sources in NSW. The provisions of the Water Management Act are being progressively implemented to replace the Water Act.

The area in which the proposal site is located is subject to the following water sharing plans that cover part or all of the study area:

- Gwydir Regulated River Water Sources
- Gwydir Unregulated and Alluvial Water Sources
- Lower Gwydir Groundwater Source
- Namoi Unregulated and Alluvial Water Sources
- Upper and Lower Namoi Groundwater Sources
- NSW Border Rivers Regulated River
- NSW Murray-Darling Basin Porous Rock Groundwater
- NSW Great Artesian Basin Groundwater Sources
- NSW Great Artesian Basin Shallow Groundwater Sources.

These are statutory instruments made under section 50 of the Water Management Act, which include rules for protecting the environment, water extractions, managing licence holders' water accounts, and water trading in the plan area.

As the proposal is State significant infrastructure, an activity approval is not required to undertake works in or near waterfront land (described in Section 3.4). However, the design and construction of the proposal would take into account the Office of Water's *Guidelines for Controlled Activities on Waterfront Land*.

The *NSW Aquifer Interference Policy* (Department of Primary Industries, 2012) explains the water licensing and impact assessment processes for aquifer interference activities under the Water Management Act and other relevant legislation. Further information is provided in Section 3.4.

The *National Water Quality Management Strategy* is a nationally agreed set of policies, processes, and 21 guidelines documents developed jointly by the Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) and the Australian and New Zealand Environment and Conservation Council (ANZECC). The strategy establishes objectives to achieve sustainable use of the nation's water resources by protecting and enhancing their quality. The strategy contains healthy river guidelines for the protection of lowland river aquatic ecosystems.

The *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (known as the ANZECC 2000 guidelines) (ANZECC/ARMCANZ, 2000a) forms part of the strategy. This document sets water quality guidelines (numerical concentration limits or descriptive statements) for a range of ecosystem types, water uses (environmental values), and water quality indicators for Australian waters.

In 2006, water quality and river flow objectives were developed for 31 river catchments in NSW based on the ANZECC 2000 guidelines. The objectives (the *NSW Water Quality and River Flow Objectives*) are the agreed environmental values and long-term goals for NSW's surface water receptors. Guidance to using the ANZECC 2000 guidelines and the NSW Water Quality Objectives is provided by *Using the ANZECC Guidelines and Water Quality Objectives in NSW* (Department of Environment and Conservation, 2006d).

16.2 Existing environment

16.2.1 Catchments and watercourses

The proposal site is located within the Namoi, Gwydir and McIntyre river basins. All three river basins eventually drain to the Murray River.

A total of 16 ephemeral watercourses and two permanent watercourses (Gwydir River and Mehi River) with a stream order of three or above cross the proposal site. Flow occurs in the ephemeral watercourses during and after rainfall events, and the watercourses dry out between rainfall events.

Further information on the existing hydrological environment is provided in Section 15.2.

16.2.2 Existing water quality

There is no existing water quality data for the watercourses crossing the proposal site. No data has been collected as part of this assessment, as described in Section 16.1.1.

The *National Water Quality Assessment* (SKM, 2011) classified the water quality in the Gwydir River and Namoi River catchments as being relatively poor (listed in Table 16.1), exceeding the ANZECC 2000 guidelines for a number of criteria.

A more recent State of the Environment report (Molino Stewart, 2015) indicates that there has been a progressive reduction in recorded electrical conductivity values during the period 2011-12 to 2014-15 for the Central West region of NSW. The same report also indicates a reduction in recorded Escherichia coli (E. coli) counts in watercourses over the period 2012-13 to 2014-15.

Table 16.1 Water quality – Gwydir River and Namoi River catchments

Parameter	Namoi River catchment	Gwydir River lower catchment
Turbidity	Fair 31% of samples exceeded guideline values	Fair Median values ranged from 4 to 190 NTU. 52% of samples complied with ANZECC/ ARMCANZ guideline value of 50 NTUs
Salinity	Fair 50% of samples exceeded guideline values	Poor 53% of samples exceeded the ANZECC/ ARMCANZ guideline value. Median values were generally higher in the tributaries and several were close to, or exceeded 1,000 mS/cm
pH	Poor	Poor
Total nitrogen	Very poor 91% of samples did not meet guideline values	Very poor 90% of samples exceeded guideline values
Total phosphorus	Poor 95% of samples did not meet guideline values	Very poor 95% of samples exceeded guideline values

16.2.3 Water quality objectives and criteria

The NSW Water Quality and River Flow Objectives provides water quality objectives for the Gwydir River, Namoi River and Macintyre River (Border Rivers) catchments, for the protection of:

- aquatic ecosystems
- visual amenity
- primary contact recreation
- secondary contact recreation
- livestock water supply
- irrigation water supply
- homestead water supply.

The water quality objective for aquatic ecosystems is to '*maintain or improve the ecological condition of waterbodies and their riparian zones over the long-term*'. The indicators and criteria (trigger values) for this objective are listed in Table 16.2. These are based on the ANZECC 2000 guideline default trigger values for the protection of aquatic ecosystems in slightly disturbed river ecosystems in south-eastern Australia.

Table 16.2 Trigger values for water quality parameters

Indicator	Criteria (lowland rivers)
Total phosphorus	50 ug/L
Total nitrogen	500 ug/L
Chlorophyll-a	5 g/L
Turbidity	6-50 NTU
Salinity (electrical conductivity)	125-2,200 uS/cm
Dissolved oxygen (per cent saturation)	85-110 %
pH	6.5-8.5
Oils and petroleum hydrocarbons	Insufficient data to give trigger value although the environmental protection licence is likely to require no visible oils or sheen in discharge water

A detailed list of the indicators and criteria for the other water quality objectives for the Gwydir River, Namoi River and Border Rivers (which includes the Macintyre River catchment) catchments is provided in Technical Report 7. The drinking water objectives were not considered due to the predominantly rural land use in the study area, and the potential for water to be extracted for multiple uses. Drinking water objectives apply to all current and future licensed offtake points for town water supply, and to specific sections of rivers that contribute to drinking water storages or immediately upstream of town water supply offtake points. The objectives also apply to sub-catchments or groundwater used for town water supplies. No drinking water supply points were identified within the proposal site.

The Gwydir River, Namoi River and Border Rivers catchments contain the following environmental values (Department of Primary Industries (Water), 2017):

- The Lower Gwydir wetlands, which are located downstream from Moree, and are listed as a site of international significance under the Ramsar Convention (Gwydir River catchment).
- Morella Lagoon, Pungbopugal Lagoon and Boobera Lagoon, (Border Rivers catchment) which are part of a wetland complex that is listed as a site of national importance in the Directory of Important Wetlands in Australia. This wetland complex is located a minimum of 30 kilometres north-west of the proposal site.
- The Pilliga Scrub (Namoi River catchment) is the largest remaining dry sclerophyll forest west of the Great Dividing Range and is located in the Pilliga Nature Reserve and Pilliga State Conservation Area, about 25 kilometres south-west of the proposal site.
- Downstream of Narrabri there are many wetlands, small lagoons and anabranches associated with the Namoi River (Namoi River catchment).
- Lake Goran (Namoi River catchment) which is listed as a wetland of national significance and is located about 110 kilometres south-east of the proposal site.

16.3 Impact assessment

16.3.1 Risk assessment

Sensitive receiving environments

A sensitive receiving environment is one that has a high conservation value, or supports human uses of water that are particularly sensitive to degraded water quality (Department of Environment and Climate Change, 2008). In the context of this proposal, sensitive receiving environments are considered to be:

- nationally important wetlands
- National parks, nature reserves and state conservations areas
- threatened ecological communities associated with aquatic ecosystems
- known and potential habitats for threatened fish
- key fish habitats
- recreational swimming areas
- areas that contribute to drinking water catchments.

The majority of the watercourses in the proposal site are ephemeral and do not contain sensitive environments. However, as described in Chapter 10, the Mehi and Gwydir rivers are key fish habitats, and a number of threatened species have been identified. Additionally, the watercourses in the proposal site are within the catchments of the Gwydir, Namoi and Macintyre (Border Rivers) rivers. These catchments are sensitive receiving environments that contain the environmental values described in Section 16.2.3.

The design control measures considered in this section, and the mitigation measures provided in Section 16.4, have been developed to protect the identified sensitive receiving environments and their associated environmental values, where relevant to the proposal.

Potential impacts

The environmental risk assessment for the proposal (summarised in Appendix B) included an assessment of the potential risks to water quality and the environmental values of the identified sensitive receiving environments, associated with the construction and operation of the proposal. The assessed level for the majority of potential water quality risks was medium to high. Risks with an assessed level of medium or above include:

- reduced water quality (including increased total suspended solids and turbidity) as a result of erosion and sedimentation near watercourses
- contamination due to spills and leaks
- impacts on groundwater quality and quantity during drawdown/extraction
- modification to existing drainage infrastructure resulting in water quality impacts
- impact to surface water quality and receiving environments due to increased runoff from impervious areas.

How potential impacts would be avoided and minimised

Due to the nature of the proposal, the main potential impacts would occur during and following rainfall events. Potential impacts on water quality would be minimised by managing water quality in accordance with the requirements of the POEO Act and the environment protection licence for the proposal.

Potential impacts that are unable to be avoided would be minimised by designing, constructing, and operating the proposal so that potential impacts on hydrology are minimised, which in turn mitigates the potential for water quality to be impacted by increases in sediment loads in runoff.

This would include the following:

- designing flow discharge points (structures) to include erosion controls, such as rock protection, to slow flow velocities and minimise the risk of erosion as surface water enter and exits the structure
- designing culverts to have a minimal impact on existing surface flow paths across the proposal site
- locating structures in positions that are natural low points along the proposal site to avoid creating new water storage areas and facilitate fish passage
- incorporating protection measures, such as sedimentation basins, water quality ponds, and spill basins as required
- designing batters and retaining structures using appropriate slope gradients to minimise erosion, or using terracing
- design of ballast drainage to discharge to suitable outlets and control points
- selection of fill material for embankments to minimise the risk of erosion.

The design of the proposal has taken into account the requirements of relevant water sharing plans, by:

- using prefabricated culverts that would minimise the need for excavation and potential shallow aquifer interaction
- restricting the potential amount of water extraction for construction purposes (described in Section 15.3.2).

Implementing the water quality mitigation measures provided in Section 16.4.3 would also minimise the potential for water quality impacts. These measures would minimise the potential impacts on relevant water sharing plans (listed in Section 16.1.2).

Implementation of the design control measures identified above and the water quality measures provided in Section 16.4.3 would enable the proposal to be designed, constructed and operated to avoid or minimise water pollution, and protect human health and the environment.

16.3.2 Construction impacts

Potential water quality impacts

Construction presents a risk to downstream water quality if management measures are not implemented, monitored, and maintained throughout the construction period. If inadequately managed, construction activities can impact water quality if they disturb soil or watercourses, result in the uncontrolled discharges of substances to watercourses, or generate contamination.

Potential sources of water quality impacts include:

- increased sediment loads from exposed soil transported off-site to downstream watercourses during rainfall events
- increased sediment loads from discharge of sediment laden water from dewatering of excavations
- increased levels of nutrients, metals and other pollutants, transported in sediments to downstream watercourses or via discharge of wastewater to watercourses
- chemicals, oils, grease, and petroleum hydrocarbon spills from construction machinery directly polluting downstream watercourses
- litter from construction activities polluting downstream watercourses
- contamination of watercourses due to runoff from contaminated land.

The downstream effects of water quality impacts can include:

- smothering aquatic life and/or inhibiting photosynthesis conditions for aquatic and riparian flora
- impacts to breeding and spawning conditions of aquatic fauna
- changes to water temperature due to reduced light penetration
- impacts to the ecosystems of downstream sensitive watercourses, wetlands and floodplains
- increased turbidity levels above the design levels of water treatment infrastructure
- reduced visibility in recreation areas.

The potential for soil and contamination impacts during construction are considered in Chapter 14. Waste management impacts and mitigation measures are considered in Chapter 24. The main potential sources of water quality impacts for the proposal are considered in the following sections.

Changes to surface water flows

Changes to surface water flows can impact water quality – an increase in flow rate and volume can lead to increased erosion and turbidity. The potential impacts of changes to surface water flows are considered in Chapter 15.

Works in watercourses

The proposal involves works in watercourses to upgrade culverts and undertake track works. These works would disturb bed and bank substrates, and potentially lead to localised erosion and sediment transport downstream. As described in Section 16.3.1, the proposal includes a number of design features, particularly in relation to culvert upgrades, to minimise the potential for impacts to watercourses and therefore water quality. This includes the use of pre-fabricated concrete culverts to minimise the extent of disturbance to watercourses.

Earthworks, stockpiling, and general runoff from construction sites

Excavations and the construction of embankments can impact water quality in downstream watercourses as a result of erosion. Runoff from stockpiles has the potential to impact downstream water quality during rainfall if the stockpiles are not managed appropriately. Sediments from the stockpiles could wash into watercourses, increasing levels of turbidity. This in turn could have the following impacts on human health and the environment:

- reduce the aesthetic quality of receiving watercourses
- harm fish and other aquatic life by reducing food supplies, affecting gill function and degrading spawning beds
- reduce light penetration and visibility
- increase surface water temperature.

Stockpiling cleared vegetation creates a risk of tannins leaching into watercourses, resulting in an increased organic load. Discharge of water high in tannins can increase the biological oxygen demand of the receiving environment, which may in turn result in a decrease in available dissolved oxygen. Once discharged to the environment, tannins may also reduce visibility, light penetration, and change the pH of receiving waters. These impacts may affect aquatic ecosystems in receiving environments.

Sediment loads in watercourses can increase in the vicinity of hard surfaces (such as roads) and compacted areas (such as construction laydown sites) due to increased surface runoff.

The mitigation measures provided in Sections 14.4 and 16.4 would be implemented to minimise the potential for water quality impacts as a result of earthworks, stockpiling, and general runoff from construction sites. In general, with implementation of the mitigation measures provided, water quality impacts due to construction runoff would be negligible when compared to runoff from surrounding agricultural properties following a regional rainfall event.

Pollutant laden runoff or discharge to surface water

Identify and estimate the quality and quantity of all pollutants

In addition to the above, the proposal has the potential to introduce the following pollutants to surrounding watercourses:

- nitrogen and phosphorous – due to use of pesticides and herbicides for weed control
- chemicals, oils, grease and petroleum hydrocarbons – due to leaks and spills during construction or the discharge of water from vehicle wash down areas
- alkaline wastewater due to the operation of mobile concrete batching plants.

By implementing management measures provided in the CEMP, pollutant runoff due to leaks and spills and weed control would be minimal, and would be unlikely to cause long-term harm to human health or the environment.

The exact volume of discharge water and discharge points would be identified prior to construction. Discharge points would take into consideration the hydrological attributes of the receiving watercourse, including whether there is sufficient flow volume and velocity to incorporate the discharge volume.

Maintaining or achieving the water quality objectives

The NSW Water Quality Objectives and their relevance to the proposal are defined in Technical Report 7 for the Namoi, Gwydir and Border rivers catchments, and are summarised in Table 16.2 for those pollutants that the proposal may introduce into the water cycle.

As described in Section 16.2.2 the existing water quality is poor and generally does not meet the water quality objectives provided in Table 16.2. The poor quality is likely to reflect existing soil conditions and agricultural land use practices within the identified catchments.

The proposal constitutes only a small component of the Gwydir, Namoi and Border rivers catchments, and progress towards meeting the water quality objectives depends on activities in the catchment as a whole. Water quality impacts would generally be limited to the construction phase and would be short-term only.

Construction and operation would be undertaken in accordance with the management measures provided in Section 15.4, which would minimise the potential for the proposal to reduce the quality of water in the surrounding watercourses. Discharge would be undertaken in accordance with the relevant environmental protection licences meaning also that any discharge water would meet the water quality objectives provided in Table 16.2 and would be of better quality than that within the surrounding watercourses.

Additionally, the proposal (particularly the proposed replacement of culverts and raising of track formation to greater than the level of the one per cent AEP flood event) would mean that flow in watercourses is generally maintained and, with suitable erosion and scour protection measures, erosion potential downstream from culverts is generally reduced. This would have a beneficial impact on water quality in the study area, with the quality of water more likely to meet the relevant objectives. Implementation of the design control measures identified in Section 16.3.1 would not prevent or hinder the development or implementation of any future strategies that may assist in meeting overall water quality objectives for the catchments over the long-term.

Groundwater quality

As existing groundwater is predominately perched and recharged by rainfall infiltration (described in Section 15.2.3), the volumes of dewatering are likely to be minimal, resulting in minimal long-term impacts. Potential risks to groundwater quality from changes to surface water include:

- contamination by hydrocarbons from accidental fuel and chemical spills
- contaminants contained in turbid runoff from unpaved surfaces.

Surface water from site runoff may infiltrate and impact groundwater sources. As the infiltration process is generally effective in filtering polluting particles and sediment, the risk of contamination of groundwater from any pollutants bound in particulate form in surface water, such as heavy metals, is generally low.

Soluble pollutants, such as pH altering solutes, salts and nitrates, as well as soluble hydrocarbons, can infiltrate soils and contaminate the groundwater system. Under certain pH conditions, metals may also become soluble and could infiltrate groundwater.

The mitigation measures provided in Section 16.4 would be implemented to minimise the potential for groundwater quality impacts.

16.3.3 Operation impacts

Potential water quality impacts during operation could occur as a result of changes to hydrology or contamination of runoff. The release of toxicants and litter into watercourses during operation (including during maintenance activities) has the potential to impact on surface water quality and consequently on aquatic ecosystems. This also has the potential to impact on other water quality objectives by reducing visual and recreational amenity. During operation, the main risk to surface water from the release of pollutants is from spills or the release of litter and toxicants such as heavy metals, petroleum hydrocarbons and polycyclic aromatic hydrocarbons from vehicles, surface runoff from tracks, and maintenance of rail vehicles. The potential for contamination impacts as a result of accidental spills during operation is considered in Section 14.3.3.

The majority of the watercourses crossed by the proposal are moderately disturbed as a result of existing land use practices, and any contribution of contaminants due to surface runoff from the proposal is anticipated to be minimal.

During operation, surface water runoff would be controlled through a drainage system that connects to cross drainage infrastructure at existing drainage lines and watercourses. The drainage system would include scour protection at culvert outlets to minimise the potential for scouring and erosion. Where appropriate, culvert outlets would be lined to minimise scouring.

As described in Section 15.3.4, without mitigation, the increase in water flowing through culverts has the potential to result in erosion in some locations. Further modelling would be undertaken during detailed design to confirm the locations and required erosion protection.

16.4 Mitigation and management

16.4.1 Approach to mitigation and management

The main risks to water quality are associated with erosion and sedimentation, and works within watercourses. The soil and water management sub-plan prepared as part of the CEMP would include management measures that are commonly implemented during construction of linear infrastructure projects to manage issues associated with erosion and sedimentation that have the potential to impact on water quality. The soil and water management sub-plan would be prepared and implemented in accordance with *Managing Urban Stormwater: Soils and Construction*. In accordance with these publications management measures would be designed to cope with a 10 per cent AEP rainfall event.

Where discharge to surface watercourses is required, a monitoring program would be developed and implemented to assess water quality prior to discharge. Due to the ephemeral nature of the majority of the watercourses discharge to, and monitoring of, surface water would consider the hydrological attributes of the receiving waterbody.

During operation, water quality would be managed to comply with the operational environmental protection licence for the proposal.

16.4.2 Consideration of the interactions between mitigation measures

Mitigation measures to control impacts on water quality may overlap with mitigation measures proposed for the control of soil and contamination, hydrology and flooding, health and safety, and waste management impacts.

All mitigation measures for the proposal would be consolidated and described in the CEMP. The plan would identify measures that are common between different aspects. Common impacts and common mitigation measures would be consolidated to ensure consistency and implementation.

16.4.3 Summary of mitigation measures

In addition to the measures provided to manage the potential for soil and contamination impacts (in Section 14.4), the measures outlined in Table 16.3 would be implemented to manage water quality impacts.

Table 16.3 Summary of water quality mitigation measures

Stage	Impact/issue	Mitigation measures
Detailed design/ pre-construction	Water quality	The design features listed in Section 16.3.1 would continue to be refined and implemented to minimise the potential impacts of the proposal on water quality.
Construction	Soil erosion and sedimentation	A soil and water management sub-plan would be prepared as part of the CEMP. It would include a detailed list of measures that would be implemented during construction to minimise the potential for soil, water quality and contamination impacts, including: ▸ allocation of general site practices and responsibilities ▸ material management practices ▸ stockpiling and topsoil management ▸ surface water and erosion control practices.
	Discharge to surface water	Discharge to surface water would be undertaken in accordance with the environmental protection licence for Inland Rail, and would consider the hydrological attributes of the receiving waterbody.
	Surface water monitoring framework	A surface water monitoring framework would be developed and implemented, to monitor water quality at discharge points and selected watercourses where works are being undertaken. The framework would include the relevant water quality objectives, parameters, and criteria from Technical Report 7, and specific monitoring locations which have been identified based on the hydrological attributes of the receiving watercourse, in consultation with Department of Primary Industries (Water) and the EPA.
Operation	Water quality	The proposal would be managed in accordance with the water quality management requirements specified in the environment protection licence.

17. Aboriginal heritage

This chapter provides a summary of the Aboriginal Cultural Heritage and Archaeological Assessment of the proposal undertaken by Umwelt. It describes the existing Aboriginal heritage environment, assesses the potential impacts of the proposal on Aboriginal heritage within the proposal site, and provides recommended mitigation measures. The full Aboriginal Cultural Heritage and Archaeological Assessment report is provided as Technical Report 8.

17.1 Assessment approach

17.1.1 Methodology

The Aboriginal cultural heritage and archaeological assessment was undertaken in accordance with the guidelines and requirements described in Section 17.1.2 and involved:

- a desktop review of archaeological literature and data to determine if Aboriginal sites have been previously identified within the study area, including a search/review of:
  - Aboriginal Heritage Information Management System (AHIMS) in July and October 2016 for a 500 metre buffer around the proposal site
  - EPBC Act Protected Matters Search Tool to identify any federally listed Aboriginal heritage sites or places near the proposal site
  - the Narrabri, Moree Plains, and Gwydir LEPs
  - previous archaeological investigations
- consultation with registered Aboriginal parties (described below)
- a field survey to identify any visible surface evidence of cultural heritage sites and landforms (described below)
- assessing the significance of sites/areas of potential archaeological sensitivity within the proposal site and evaluating the potential impacts of the proposal
- providing management and mitigation measures for the proposal.

The Aboriginal heritage assessment considered the potential for impacts to Aboriginal heritage within the proposal site (described in Chapter 2) and, to provide flexibility for the design of culvert and level crossing upgrades, it also considered additional assessment areas outside the proposal site (including but not limited to):

- an approximate 60 metre buffer around culverts
- an approximate 120 metre buffer around the locations of level crossings.

As described in Chapter 2, the need for works in these areas would be determined during detailed design. These areas do not currently form part of the proposal site for the purposes of the EIS.

Aboriginal consultation

Aboriginal consultation has been undertaken in accordance with the requirements of *Aboriginal cultural heritage consultation requirements for proponents 2010* (Department of Environment and Climate Change, 2010a). This included:

- notification of the proposal, assessment, and registration of interest, involving:
  - placing advertisements in relevant newspapers (including local newspapers and the Koori Mail) in December 2015 and January 2016
  - sending letters to agencies on 9 December 2015 requesting the identification of Aboriginal parties with cultural interest/ knowledge in the study area
  - sending letters to Aboriginal parties identified by agencies on 18 February and 9 December 2016 providing notification of the assessment and an opportunity to register their interest for consultation - 47 Aboriginal parties registered an interest and are the Aboriginal stakeholders for the proposal.
- presentation of information about the proposal:
  - a draft copy of the assessment methodology (with a request for comments) and a meeting invite was sent to registered Aboriginal parties (as registered by 2 April 2016)
  - meetings were held with registered Aboriginal parties in May 2016

- registered Aboriginal parties were invited to participate in the field survey, and 30 Aboriginal party representatives participated
- review of the draft Aboriginal Cultural Heritage and Archaeological Assessment report - a copy of the draft report was sent to registered Aboriginal parties for comment.

Further details, including advertisement and meeting dates, and copies of letters and responses, are provided in Technical Report 8.

Site survey

A targeted site survey was conducted between 10 and 27 October 2016. The survey was undertaken in accordance with the requirements for archaeological survey as established in *Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales* (Department of Environment and Climate Change, 2010b). The survey was designed to ensure assessment of an adequate sample of landforms within the proposal site.

The survey consisted of vehicle and pedestrian surveys. The vehicle survey was used to obtain a broader understanding of the general environment of the proposal site and was considered appropriate given the highly disturbed nature of the majority of the existing rail corridor. The pedestrian survey focussed on areas of greatest archaeological sensitivity, including previously recorded AHIMS sites, and landforms associated with watercourses crossing the proposal site.

The survey also considered the additional assessment areas described above.

17.1.2 Legislative and policy context to the assessment

The main piece of legislation relevant to Aboriginal heritage in NSW is the *National Parks and Wildlife Act 1974* (the NPW Act) and the supporting regulation. The NPW Act defines an Aboriginal object as 'any deposit, object or material evidence (not being a handicraft made for sale) relating to the Aboriginal habitation of the area that comprises New South Wales.'

Under section 84 of the NPW Act, an Aboriginal place must be declared by the Minister as a place that, in the opinion of the Minister, is or was of special significance with respect to Aboriginal culture. Section 86(4) of the NPW Act states that a person must not harm or desecrate an Aboriginal place.

Under the NPW Act, it is an offence to harm or desecrate an Aboriginal object or Aboriginal place. Under section 87(1) of the Act, it is a defence to a prosecution offence if the harm or desecration of an Aboriginal object was authorised by an Aboriginal Heritage Impact Permit (AHIP) and the activities were carried out in accordance with that AHIP. As described in Chapter 3, the provisions of the *Environmental Planning and Assessment Act 1979* (EP&A Act) provide an exemption from the requirement for an AHIP for activities approved as State significant infrastructure, however, the other provisions of the NPW Act still apply.

Aboriginal sites recorded by the AHIMS include:

- Aboriginal objects (as defined under the NPW Act) or groups of objects
- an area of land containing Aboriginal objects
- a 'potential archaeological deposit' (or PAD) which is an area where, based on previous investigation, Aboriginal objects are likely to be present
- a declared Aboriginal Place as defined under the NPW Act, which may or may not contain Aboriginal objects
- an Aboriginal site that has been partially or completely destroyed under the conditions of a past consent.

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) also provides provisions to list and protect Aboriginal sites or places considered to be of national significance. No Aboriginal sites or places listed under the EPBC Act were identified in the study area, and therefore there are no requirements under the EPBC Act relevant to the assessment.

The assessment was undertaken in accordance with:

- the requirements of the NPW Act
- *Code of practice for archaeological Investigation of Aboriginal Objects in New South Wales* (Department of Environment and Climate Change, 2010b)
- *Aboriginal cultural heritage consultation requirements for proponents 2010* (Department of Environment and Climate Change, 2010a)
- *Guide to investigating assessing and reporting on Aboriginal cultural heritage in NSW* (OEH, 2011c).

17.2 Existing environment

A summary of the historical context and existing environment with respect to Aboriginal heritage is provided in this section. Further information is provided in Technical Report 8.

17.2.1 Aboriginal historical context

The majority of historical sources indicate that the proposal site generally extends over the country of the Gomeroi people. The Gomeroi Nation composed numerous tribes, with distinct portions per tribe.

One of the first historical accounts of the region comes from the diaries of Thomas Mitchell and records observations made during his 1832 expedition to record and map a reported large inland river (the Kindur). Mitchell made a range of observations of Aboriginal people living in the region.

Aboriginal people established informal settlements on the outskirts of Moree, including a camp site at the crossing of the Mehi River known as the Steel Bridge Camp.

17.2.2 Aboriginal sites identified

Listed sites

The results of the AHIMS search identified four listed sites within 50 metres of the proposal site. Of these, the following two sites are mapped as occurring within the proposal site:

- Steel Bridge Camp site (10-3-0032) – an area of potential archaeological deposit[1] at the former Aboriginal fringe camp site, located on the bank of the Mehi River near the existing rail bridge.
- Duffys Creek site (10-3-0035) – artefact scatter and area of potential archaeological deposit. The site was described as contained over 100 artefacts and burnt clay nodules on a floodplain and terrace associated with Duffys Creek.

Both sites are listed as being associated with the Mehi River and its overflow channels. No visible Aboriginal objects were identified at these sites during the site survey.

The third registered site (10-6-0048), a scarred tree, was identified about 20 metres north-west of the proposal site. The fourth site (2-4-0073) is registered as being located within 15 metres of the proposal site but the single artefact recorded at this site was not visible during the site survey.

Aboriginal places

No Aboriginal places declared under section 84 of the NPW Act, or Aboriginal places of heritage significance defined by the *Standard Instrument - Principal Local Environmental Plan*, are located within or near the proposal site. The nearest place declared under the NPW Act is located at Terry Hie Hie about 30 kilometres north-east of Bellata.

New sites identified during the survey

Nineteen new sites were identified during the site survey, comprising 12 isolated artefacts and 7 artefact scatters (listed in Table 17.1). Of these sites, 12 (shown in bold) are located within the proposal site.

1 OzArk (2004) suggested that the area remains a site due to its association with the Steel Bridge Camp but has 'no prehistoric archaeological manifestation'.

Table 17.1 New Aboriginal sites

Site name[1]	Site type	Location	Archaeological potential of area
NNS IA2	Isolated artefact	20 metres west of proposal site, within additional assessment area	Low
NNS IA3	Isolated artefact	45 metres west of proposal site, within additional assessment area	Low
NNS IA4	Isolated artefact	10 metres west of proposal site, within additional assessment area	Low
NNS IA5	Isolated artefact	15 metres west of proposal site, within additional assessment area	Low
NNS IA6	Isolated artefact	Within proposal site	Low
NNS IA7	Isolated artefact	Within proposal site	Low
NNS IA8	Isolated artefact	Within proposal site	Low
NNS IA9	Isolated artefact	Within proposal site	Low
NNS IA10	Isolated artefact	Within proposal site	Low
NNS IA11	Isolated artefact	Within proposal site	Low
NNS IA12	Isolated artefact	Within proposal site	Low
NNS IA13	Isolated artefact	Within proposal site	Low
NNS AS1	Artefact scatter	One artefact within proposal site, remainder within additional assessment area	Low to moderate
NNS AS2	Artefact scatter	10 metres east of proposal site	Low
NNS AS3	Artefact scatter	40 metres west of additional assessment area. Adjacent to public access road.	Low
NNS AS4	Artefact scatter	Within 5 metres east of proposal site	Low
NNS AS5	Artefact scatter	Within proposal site	Low
NNS AS6	Artefact scatter	Three artefacts within proposal site, one artefact within 5 metres of proposal site	Low
NNS AS7	Artefact scatter considered unlikely to be in-situ and likely to have been imported to the site with gravel materials	Within proposal site	Low

Note 1: sites shown in bold are located within the proposal site

17.2.3 Native title

A review of the Native Title Tribunal records identified one registered Native Title claim (NC2011/006) that includes the entirety of the proposal site. The claim is in the name of the Gomeroi People and includes 19 listed applicants, many of whom registered an interest in the proposal as individuals or as part of other organisations.

17.2.4 Archaeological potential of the proposal site

The proposal site has been subject to significant disturbance. Within the existing rail corridor, the construction and maintenance of the existing rail line is likely to have resulted in the removal/relocation of archaeological evidence that may have been present. Similarly, there is limited archaeological potential in agricultural land surrounding the existing rail corridor, as this area has been impacted by historical and current agricultural practices.

On the basis that the majority of the proposal site is located within the existing rail corridor, it has been assessed as having low archaeological potential, with the exception of the terrace landforms bordering the Mehi River, Gwydir River, and Croppa Creek, and at the location of the proposed Newell Highway overbridge. At these locations, deposits may be present below the depth of current disturbance and modern flood deposits.

The following surveyed areas within the proposal site were identified as having moderate or higher archaeological potential:

- **Area 15** – the area associated with NNS AS1 outside the rail corridor at the proposed location of the Newell Highway overbridge
- **Area 42** – Gwydir River terraces – below depth of current disturbance
- **Area 55** – Croppa Creek and adjoining slopes and terraces – below depth of current disturbance
- **Area 56** – Mehi River and terraces – below depth of current disturbance
- **Area 57** – Camurra bypass on Gwydir River terraces – below depth of about 50 centimetres.

These archaeological survey areas are shown on Figure 17.1 and listed in Table 17.2.

17.2.5 Significance assessment

The Burra Charter of Australia (Australia ICOMOS, 1987) defines cultural significance in terms of aesthetic, scientific, historic, and social values. Aboriginal cultural heritage is typically assessed according to its social and scientific significance; however, other values may also be of importance. The assessment of significance provides a guideline for determining appropriate mitigation and management strategies. The relationship between levels of significance and management strategies can be summarised as follows:

- high significance – the site should be conserved and protected from the impacts of development, where possible
- moderate significance – the site should be protected if possible, however, if impacts to the site are unavoidable, appropriate mitigation strategies should be implemented prior to impact
- low significance – the site should be protected if possible, however, if impacts to the site are unavoidable, the presence of the site should not impede the proposed development.

As Aboriginal cultural significance relates to the values of a site, place or landscape to Aboriginal people, only the Aboriginal community can determine Aboriginal cultural significance. Consultation is ongoing with registered Aboriginal parties regarding the Aboriginal cultural significance of the proposal site (including the archaeological sites and areas of archaeological potential).

Archaeological significance

The archaeological significance of the Aboriginal sites identified was assessed using the following criteria:

- rarity
- representativeness
- research potential
- education potential
- integrity.

There are 18 sites located within or immediately bordering the proposal site that are not associated with areas of moderate or higher archaeological potential. These sites consist of isolated artefacts/ artefact scatters containing relatively low numbers of artefacts in a heavily disturbed context. When considered with reference to the criteria listed above, they rate as low for all criteria, resulting in an overall assessment of low archaeological significance.

Figure 17.1a Archaeological survey areas with moderate or higher archaeological potential

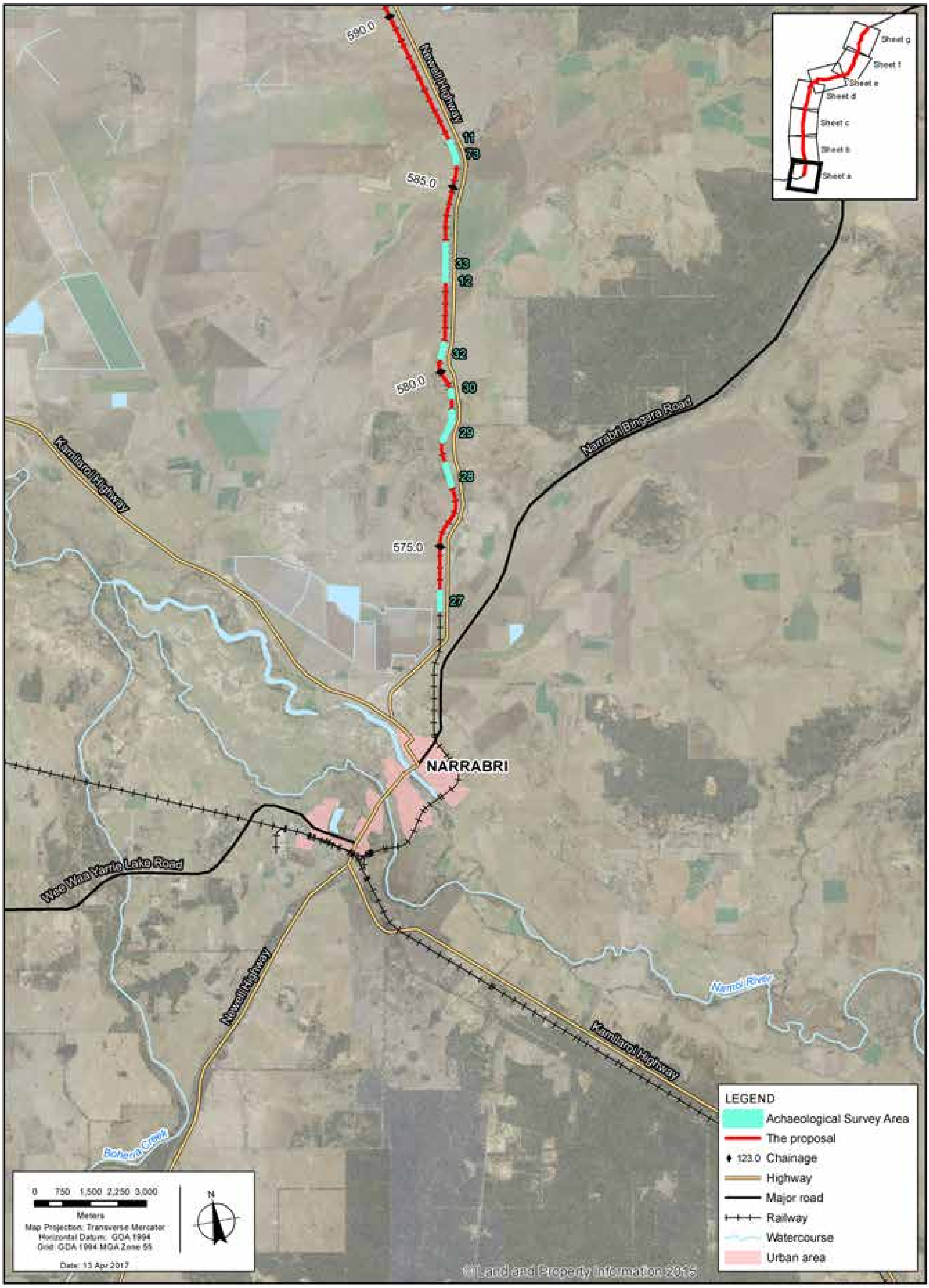


Figure 17.1b Archaeological survey areas with moderate or higher archaeological potential

Figure 17.1c Archaeological survey areas with moderate or higher archaeological potential

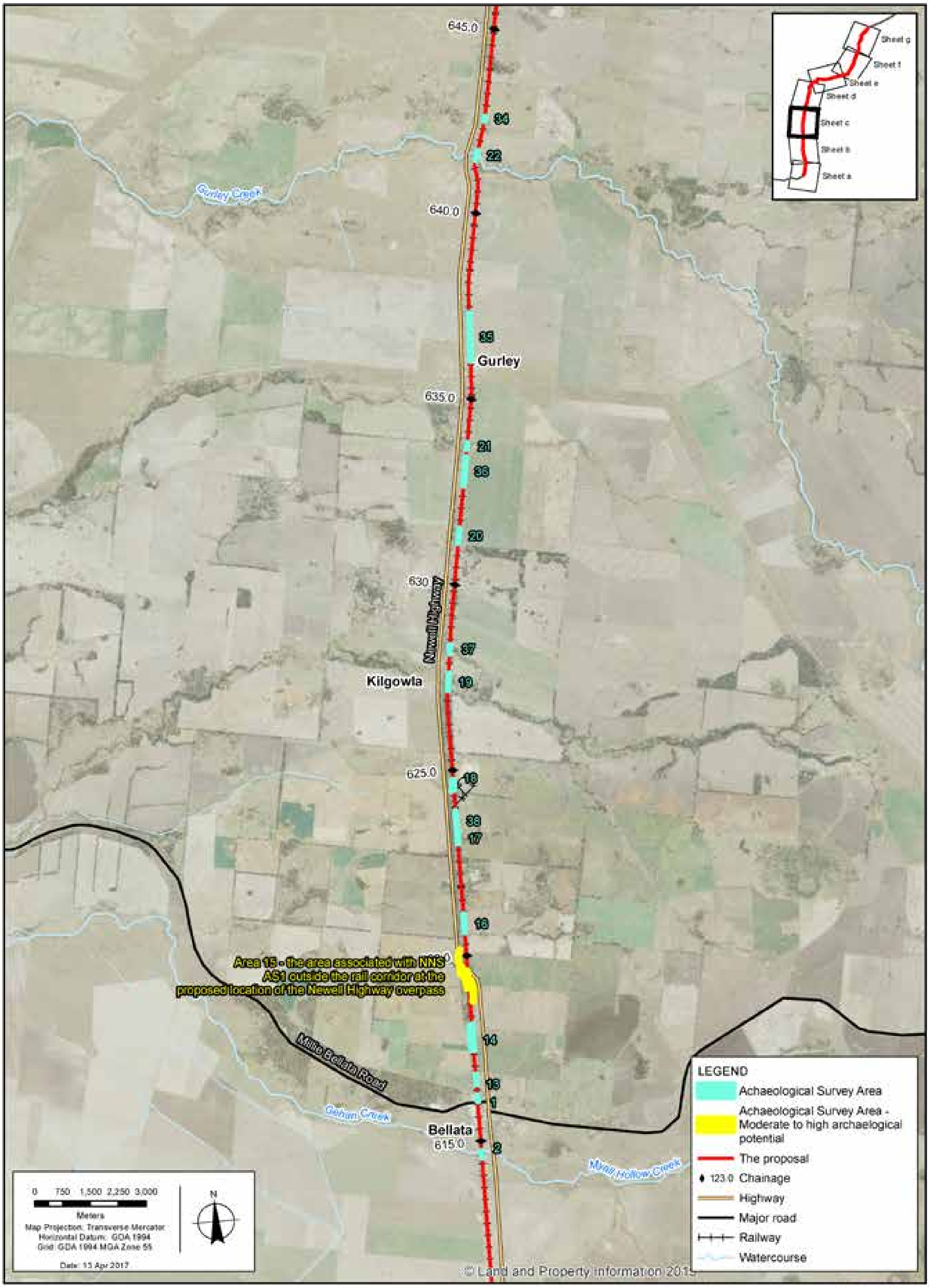


Figure 17.1d Archaeological survey areas with moderate or higher archaeological potential

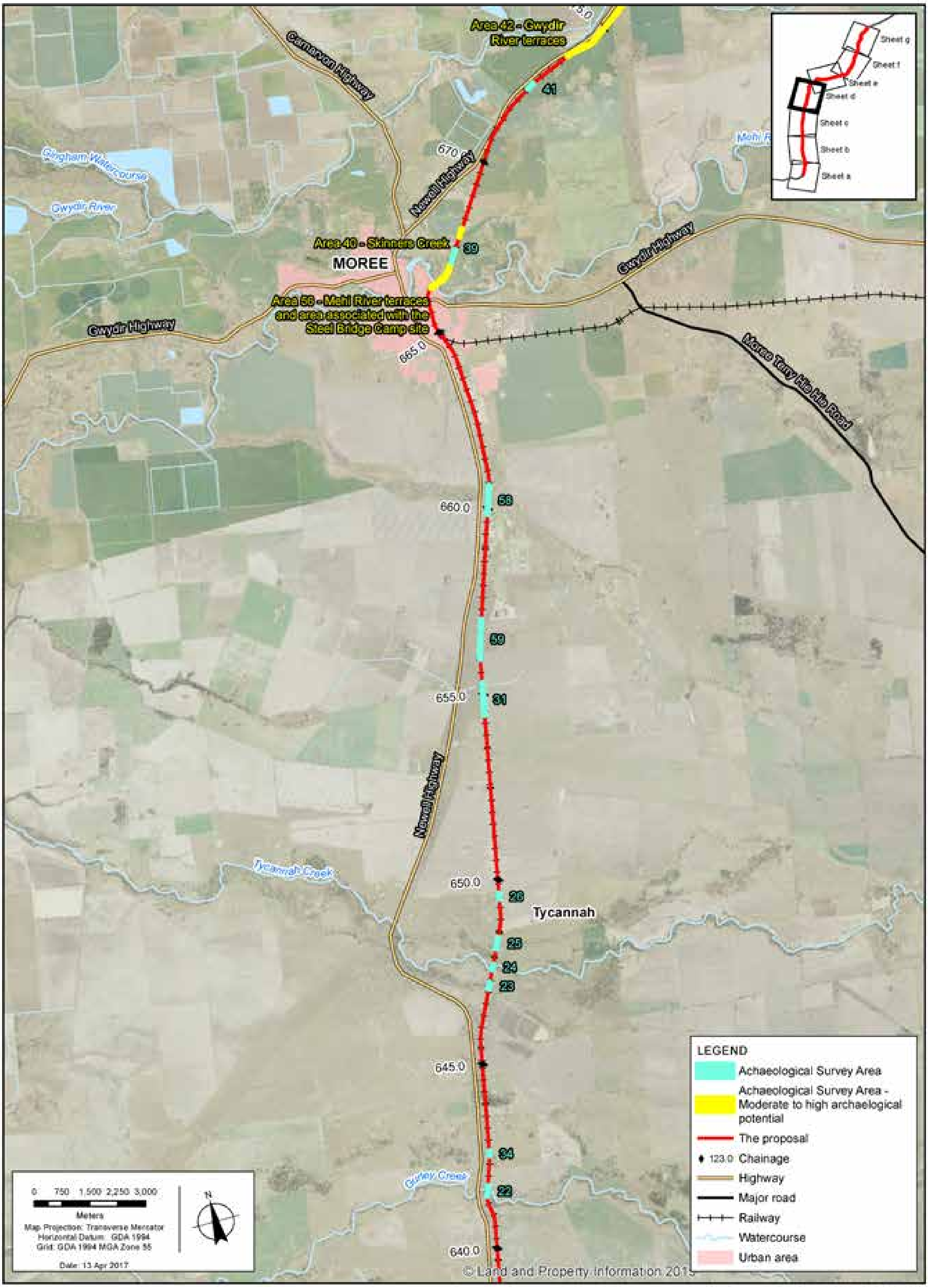


Figure 17.1e Archaeological survey areas with moderate or higher archaeological potential

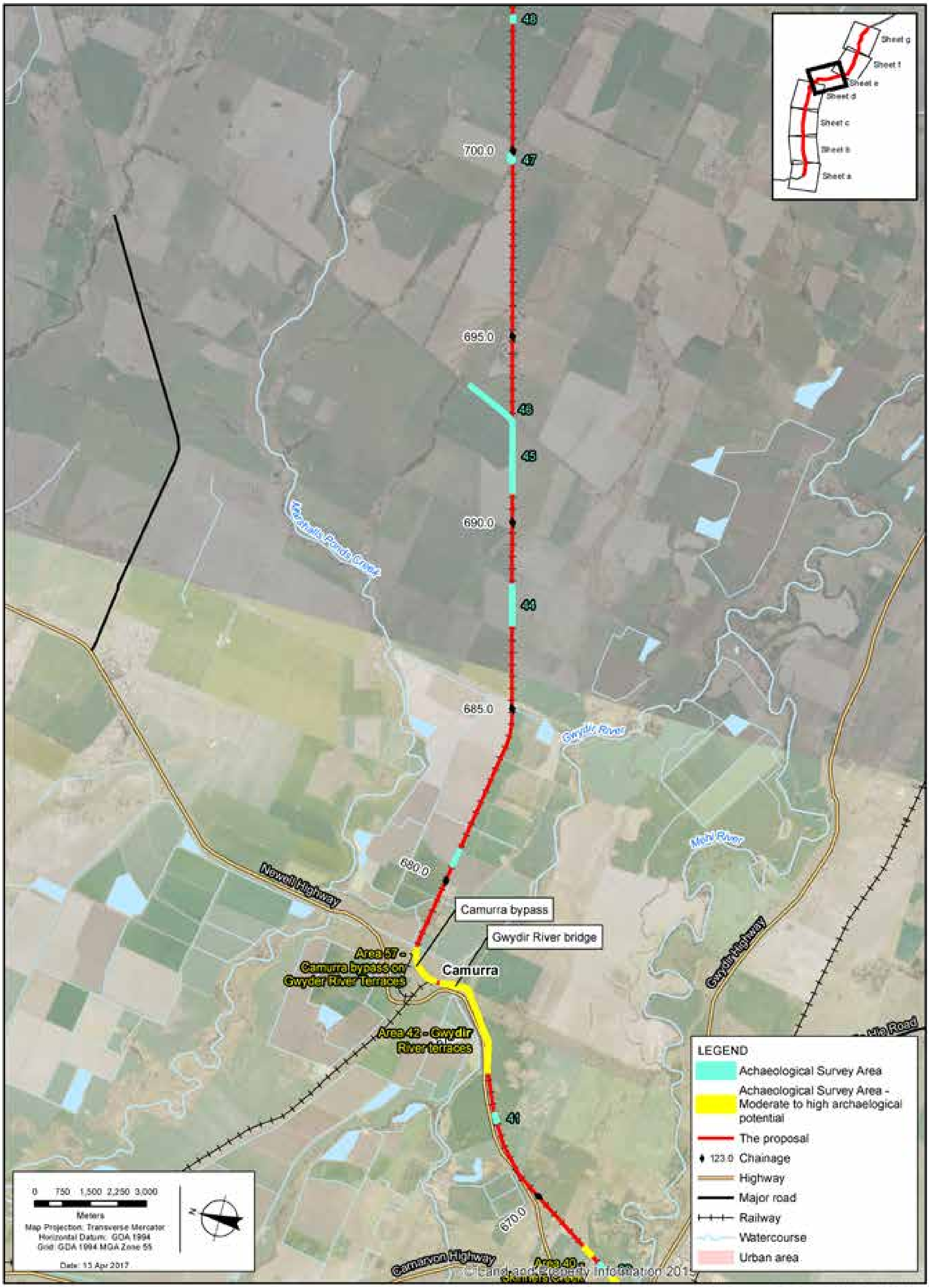


Figure 17.1f   Archaeological survey areas with moderate or higher archaeological potential

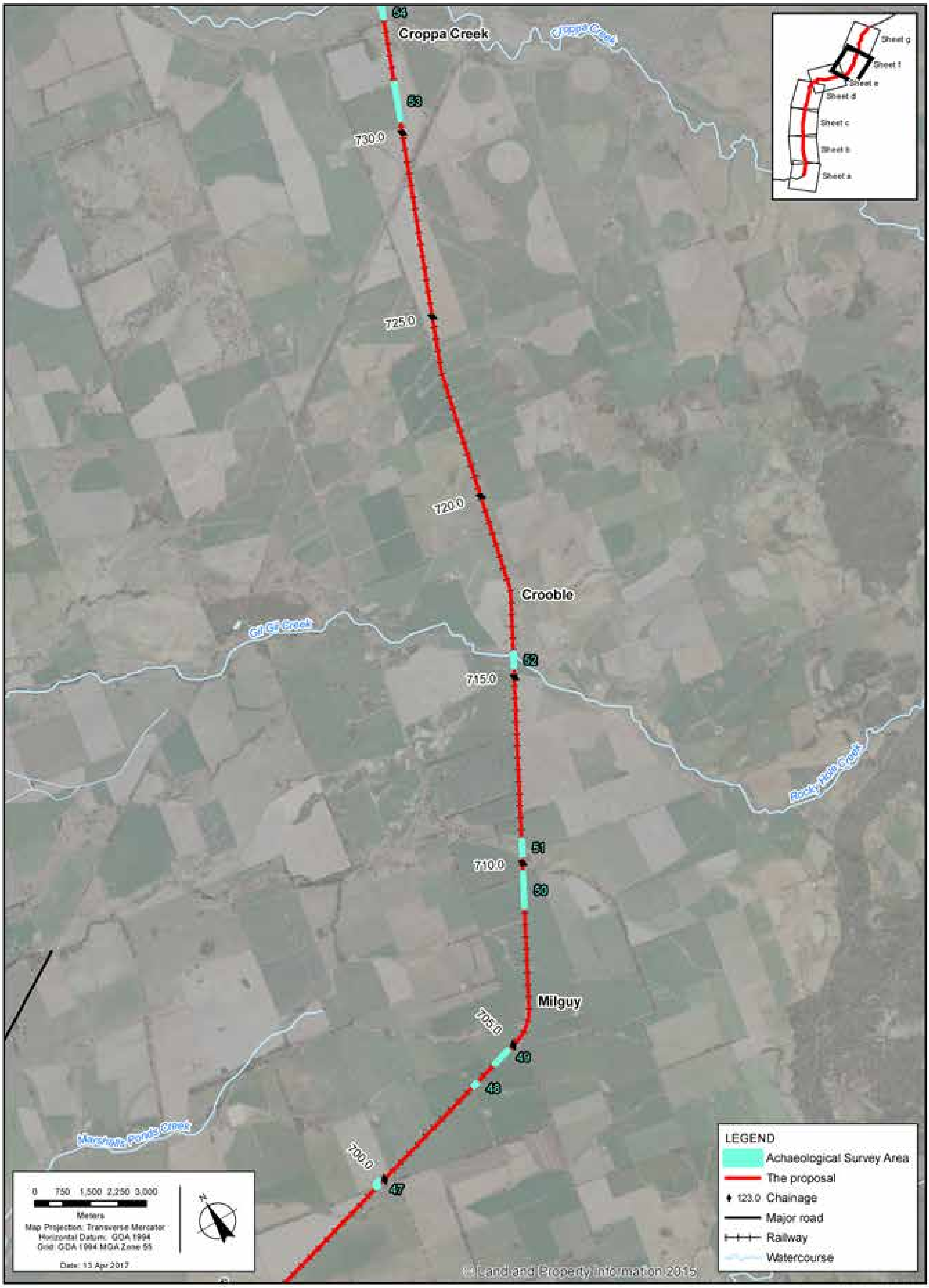
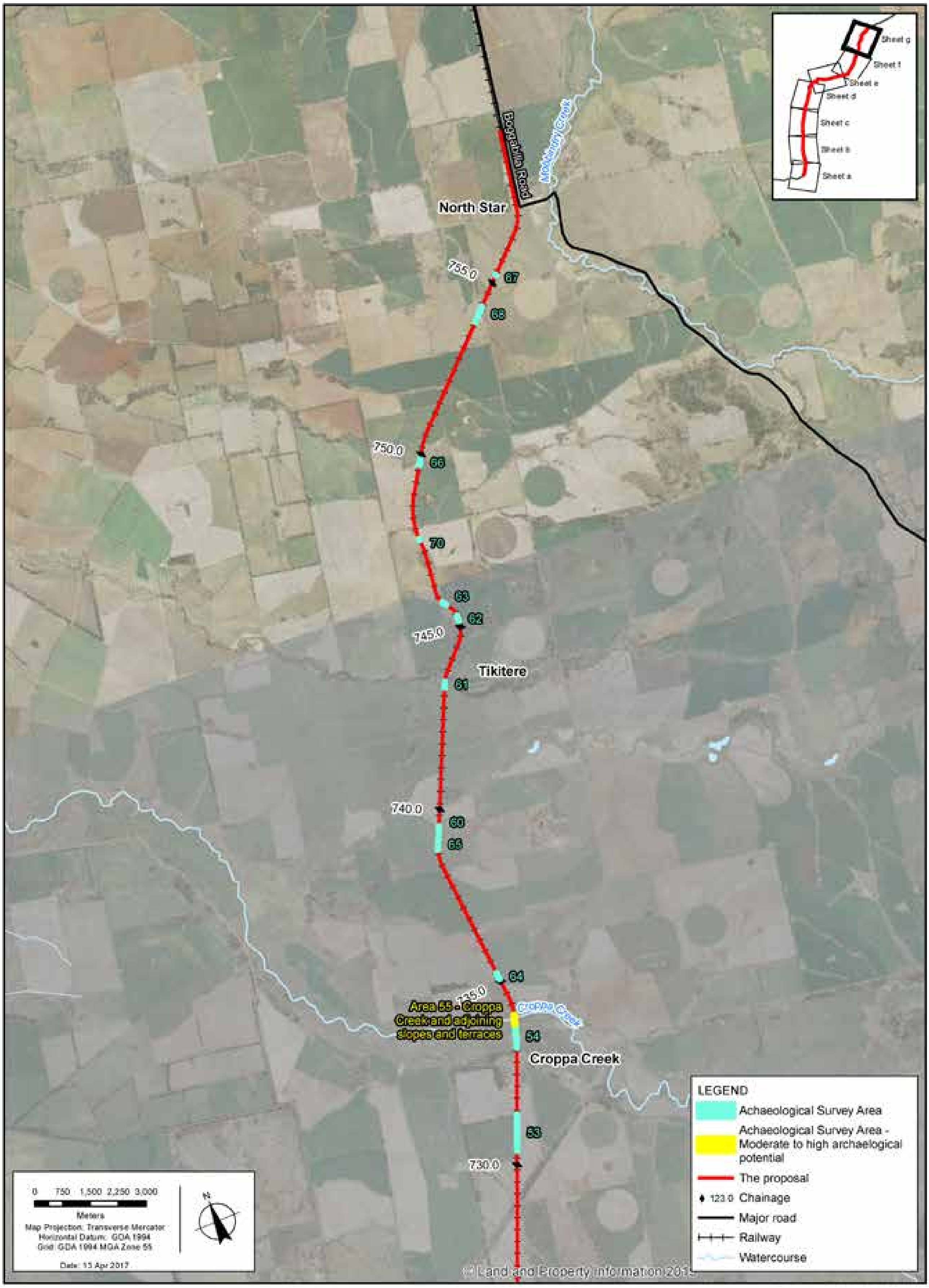


Figure 17.1g Archaeological survey areas with moderate or higher archaeological potential



The archaeological significance of the two previously recorded sites within the proposal site that did not contain visible evidence at the time of survey (10-3-0035 and 10-3-0032) was also considered. These sites were assessed as having low to moderate archaeological significance at the surface, and moderate to high archaeological significance below the current depth of disturbance.

The archaeological significance identified for areas of moderate or higher archaeological potential is provided in Table 17.2. The nature of archaeological deposits in these areas (should any exist) can only be confirmed following further investigation.

17.3 Impact assessment

17.3.1 Risk assessment

The environmental risk assessment for the proposal (summarised in Appendix B) included an assessment of the potential risks of the proposal on Aboriginal heritage. The assessed risk level for Aboriginal heritage was given a high rating due to the potential disturbance of known or unidentified items or places of Aboriginal heritage significance.

17.3.2 How potential impacts have been avoided

The route for Inland Rail has been designed to minimise the amount of ground disturbance required, with the majority of the rail line using existing infrastructure. However, some disturbance would still be required. The potential significance of this risk needs to be assessed in the context of the amount of ground disturbance required and areas of moderate to high archaeological significance. Potential impacts on heritage would continue to be avoided by:

- designing, constructing and operating the proposal to minimise the potential for impacts on Aboriginal heritage
- locating ancillary infrastructure including temporary construction compounds to avoid listed AHIMS sites and areas identified as having moderate to high archaeological potential
- managing the potential impacts on Aboriginal heritage in accordance with relevant legislative requirements, as outlined in Section 17.1.2, and the findings of the Aboriginal cultural heritage and archaeological assessment
- implementing the mitigation measures provided in Section 17.4.2.

Table 17.2 Assessment of archaeological significance – areas of moderate or higher potential

Survey area	Landform	Sites	Archaeological potential rating	Archaeological significance (based on potential only)
15	Lower slopes (gently inclined)	NNS AS1	Low within existing rail corridor Moderate within portion outside rail corridor (proposed Newell Highway overbridge)	Low within existing rail corridor Moderate within portion outside rail corridor (proposed Newell Highway overbridge)
42	Gwydir River terraces	None	Moderate to high below depth of current disturbance	Moderate to high below depth of current disturbance
55	Croppa Creek and adjoining slopes and terraces	None	Moderate below depth of current disturbance	Moderate below depth of current disturbance
56	Mehi River and terraces	10-3-0032	Moderate to high below depth of current disturbance	Moderate to high below depth of current disturbance
57	Floodplain (Camurra bypass)	None	Moderate below depth of about 50 cm (based on flood level and current disturbances)	Moderate below depth of about 50 cm (based on flood level and current disturbances)

17.3.3 Construction impacts

The main risks relating to Aboriginal heritage would occur during construction of the proposal. Works within the proposal site have the potential to directly or indirectly disturb identified Aboriginal sites and areas of archaeological potential. The impact assessment summarised in this section focuses on the potential impacts of the proposal on Aboriginal heritage in the proposal site (as defined in Chapter 2).

Proposal site impacts

Aboriginal sites

The proposal has the potential to impact the identified Aboriginal sites located within the proposal site, consisting of:

- two listed sites – the Steel Bridge Camp site (10-3-0032) and the Duffys Creek site (10-3-0035)
- the 12 newly identified sites located within the proposal site (NNS IA6 to NNS IA13, NNS AS1, and NNS AS5 to NNS AS7) (listed in Table 17.1).

Areas of archaeological potential

The proposal has the potential to impact the areas identified as having moderate or higher archaeological potential listed in Table 17.2.

Measures to mitigate the potential impacts identified are provided in Section 17.4.

17.3.4 Operation impacts

Access to the rail corridor would be required during routine maintenance and repairs. As these areas would have been previously assessed and disturbed during construction, further impacts on Aboriginal heritage are considered unlikely.

17.4 Mitigation and management

17.4.1 Approach to mitigation and management

ARTC is committed to minimising the environmental impact of the proposal and is investigating opportunities to reduce actual impact areas where practicable. The area of Aboriginal heritage significance that would be directly impacted by construction activities would depend on factors such as presence of significant vegetation, constructability, construction management and safety considerations, land form, slopes, and anticipated sub-soil structures. Direct impacts would be reduced as far as practicable.

There are two options to mitigate the potential impacts on artefact scatters in the proposal site. The first option is to avoid the site. Where this is not practicable, the second option is to salvage artefacts from the site prior to construction. In this instance, the collected items would be stored at an appropriate keeping place identified in consultation with Aboriginal parties and/or OEH.

For significant archaeological sites located outside the proposal site, the extent of the site would be identified with high visibility fencing, and construction impacts avoided. The sites should also be clearly marked on all mapping and plans used by contractors working on the project.

If impacts to Aboriginal objects are unavoidable, additional assessment may be required to clarify the nature, extent and significance of the sites in consultation with relevant Aboriginal stakeholder representatives.

17.4.2 Summary of mitigation measures

To mitigate the potential for Aboriginal heritage impacts, the mitigation measures listed in Table 17.3 would be implemented.

Table 17.3 Summary of Aboriginal heritage mitigation measures

Stage	Impact	Mitigation measures
Detailed design/ pre-construction	Avoiding and minimising impacts to Aboriginal heritage	Detailed design and construction planning would avoid direct impacts to the identified items/sites of Aboriginal heritage significance where practicable.
		An Aboriginal cultural heritage management plan would be prepared and would include measures to minimise the potential for impacts, manage Aboriginal heritage, and procedures for any unexpected finds. The plan would be prepared in consultation with registered Aboriginal parties, incorporate the recommendations of the Aboriginal Cultural Heritage and Archaeological Assessment report (Technical Report 8), and take into account the outcomes of further investigations following detailed design.
		The location of all construction compounds would be reviewed to ensure they are not located in areas of more than low archaeological potential.
	Impact to the following sites within the proposal site: ▸ Steel Bridge Camp site (10-3-0032) ▸ Duffys Creek site (10-3-0035) ▸ NNS IA6 to IA13 ▸ NNS AS1 and NNS AS5 to NNS AS7	Impacts to these sites would be avoided where possible. The sites would be fenced prior to construction and their locations marked on all plans. A buffer of 10 metres around the sites would be applied for fencing. If these sites cannot be avoided, salvage of artefacts would be undertaken prior to construction in accordance with the procedures detailed in the Aboriginal Cultural Heritage and Archaeological Assessment report (Technical Report 8).
	Impacts to site 10-6-0048 (scarred tree)	Impacts to the scarred tree (site 10-6-0048) and the dripline of the tree would be avoided. The site would be fenced prior to construction and marked on all plans.
	Impacts to areas of moderate to high archaeological potential within the proposal site: ▸ Gwydir River terraces (survey area 42) ▸ Croppa Creek and adjoining slopes and terraces (survey area 55) ▸ Mehi River and terraces (survey area 56)	If the detailed design identifies the potential for disturbance below the depth of existing disturbance, further consideration would be given to the potential for archaeological impacts. If required, a detailed methodology for any subsequent archaeological excavation would be developed in consultation with Aboriginal parties for inclusion within the Aboriginal cultural heritage management plan.
	Impacts to survey area 15 (Lower slopes - Newell Highway overbridge)	Consideration will be given to undertaking a program of archaeological subsurface testing within this area. Salvage excavations may be required depending on the results of any testing undertaking.

Stage	Impact	Mitigation measures
Detailed design/ pre-construction	Unexpected finds	An unexpected finds procedure would be developed and included in the CEMP to provide a consistent method for managing any unexpected Aboriginal heritage items discovered during construction, including potential heritage items or objects, and human skeletal remains.
Construction	Unexpected finds and human skeletal material	If potential Aboriginal items, objects, or human remains are uncovered, works within the immediate area of the item would cease, and the unexpected finds procedure would be implemented. During pre-work briefings, employees would be made aware of the unexpected finds procedures and obligations under the NPW Act.

18. Non-Aboriginal heritage

This chapter provides a summary of the non-Aboriginal heritage assessment of the proposal undertaken by Umwelt. It describes the existing environment in terms of non-Aboriginal/historic heritage, assesses the potential impacts of the proposal on listed and potential heritage items, and provides recommended mitigation and management measures. The full Non-Aboriginal Heritage Impact Statement is provided as Technical Report 9.

18.1 Assessment approach

18.1.1 Methodology

The non-Aboriginal heritage assessment involved:

- reviewing the following heritage databases to identify whether any listed heritage items are located in the vicinity of the proposal site:
  - ARTC's section 170 heritage register
  - State Heritage Inventory (including the State Heritage register)
  - Australian Heritage Database
  - Australian Heritage Places Inventory
- relevant LEPs including *Narrabri Local Environmental Plan 2012, Moree Plains Local Environmental Plan 2011* and the *Gwydir Local Environmental Plan 2013.*
- historical research including a literature review
- reviewing the proposal description and plans
- a site survey (see below) and photographic inventory
- assessing the potential impacts of the proposal, and preparing the Non-Aboriginal Heritage Impact Statement (Technical Report 9), in accordance with the guidelines listed in Section 18.1.2.

Site survey

A targeted site survey was conducted from 10 to 14 September 2014. The aim of survey was to inspect and record the location, nature, and current condition of listed heritage items/sites identified during the database and literature review, and any additional items identified during the survey. An additional targeted field inspection was undertaken between 23 and 27 May 2016, focusing on the sites of the former stations and items with a statutory heritage listing.

18.1.2 Legislative and policy context to the assessment

The main legislation relevant to non-Aboriginal heritage in NSW is the *Heritage Act 1977* (Heritage Act). The Heritage Act includes provisions to conserve the State's environmental heritage. It provides for the identification, registration, and protection of items of State heritage significance, constitutes the Heritage Council of NSW, and confers on it functions relating to the State's heritage.

As described in Section 3.4, some approvals under the Heritage Act (that is, approvals under Part 4 and Division 8 of Part 6, and excavation permits under section 139) are not required for approved State significant infrastructure.

The *Environmental Planning and Assessment Act 1979* (EP&A Act) establishes the framework for heritage values to be formally assessed in land use planning and local development consent processes. Under the EP&A Act, the definition of 'environment' includes cultural heritage. The Heritage Act defines 'environmental heritage' as places, buildings, works, relics, movable objects or precincts considered significant based on historical, scientific, cultural, social, archaeological, architectural, natural or aesthetic values.

Items and places of national heritage significance, as well as heritage places owned by the Australian Government, are managed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The EPBC Act provides for the identification, registration, and protection of items of national heritage significance. National heritage is one of the nine matters of national environmental significance protected by the EPBC Act.

The assessment of non-Aboriginal heritage has been undertaken in accordance with the *NSW Heritage Manual 1996* (the NSW Heritage Manual) (Heritage Office and Department of Urban Affairs and Planning, 1996) and relevant guidelines, including *Assessing Heritage Significance* (Heritage Office, 2001), and *Statements of Heritage Impact* (Heritage Office and Department of Urban Affairs and Planning, 2002).

The assessment has also taken into consideration the principles contained in The Burra Charter: The Australia ICOMOS Charter for Places of Cultural Significance (Australia ICOMOS, 2013) ('the Burra Charter') and the *Historical Archaeology Code of Practice* (Heritage Office, Department of Planning 2006).

18.2 Existing environment

18.2.1 Heritage context

A summary of the historic and heritage context for the assessment is provided below. Further information is provided in Technical Paper 9.

Grazing/agriculture

The region within which Narrabri, Moree, and North Star are located was first explored by John Oxley (Surveyor General of NSW from 1812), who discovered the Castlereagh and Peel rivers. In 1828, Thomas Mitchell (Surveyor General from 1828) further explored the region, including the Namoi, Gwydir and Macintyre rivers. Mitchell's expedition route became the basic supply route for squatting activity in the region.

Pastoralists began bringing their cattle to western NSW following John Oxley's explorations. The expanding market for meat due to population growth in NSW, and the demand for grazing land to meet the needs of the developing sheep industry, provided impetus for increased squatting activity during the 1830s. The first squatter in the Narrabri area established a station in 1834. Following initial squatting activity, large pastoral runs were opened from 1835. The runs in this region were predominantly cattle.

The land between the Liverpool Range and Pilliga Scrub, running west to Dubbo, consisted of fertile, well-watered land. As such, selection of land in this area became popular after 1861. Wheat growing began around Narrabri in 1873.

The 1884 Land Act encouraged smaller leases of mixed farming, and the 1895 Homestead Selection Act encouraged wheat cultivation. This caused a shift in production from cattle to wheat, wool, and lambs, which was also later boosted by the construction of inland railway lines. Soldier settlement after the First World War, and private subdivision of land, allowed wheat to become a key crop.

Wheat was introduced in the Gurley area in 1937, and by 1938 commercial crops were being grown around and sold at Bellata. Wheat growing entered the region comparatively slowly from the eastern boundary with the New England region. It eventually spread across the region, especially with the break-up of the large pastoral stations. The discovery of breeds that could withstand the northern summers, resulted in Moree becoming the centre of a large wheat growing region around the middle of the twentieth century. A flour mill was built at Moree in 1951.

Bulk handling of wheat grain was first phased in during the 1920s. This meant that grain did not need to be bagged before being stored and shipped, leading to substantial savings of time and money, as well as protection from pests. The first grain silo along the rail lines in the study area was constructed at Narrabri in 1934.

Mining

Gold was found to the south-east of the study area at Nundle, and on the Peel River, which is part of the Namoi catchment.

Urban areas

Settlement and growth came to the region in the second half of the nineteenth century. Moree was gazetted as a town in 1862 and the town became a municipality in 1890. Narrabri was gazetted as a town in 1860. Settlement at Narrabri increased with the arrival of the inland railway to Narrabri West in 1882, and the rail line from Moree to Narrabri, which opened in 1897. Gurley was proclaimed a village in 1913.

The prosperity and growth of villages and towns in the study area depended on whether a rail line linked the settlement with wider NSW. While larger towns were established independent of the railway (such as Dubbo), other towns were established as the railway extended through the region, and some smaller towns/villages were created specifically by the arrival of the railway. The development of the railway through the region enabled the bulk transportation of wheat, and was a major factor in encouraging agricultural expansion.

Railway

As noted in Chapter 2, Narrabri and Moree are located on the Mungindi railway line. The Mungindi line was extended from Boggabri to Narrabri and Moree in 1897. Moree Station was opened in 1897 and was initially used as the major rail head for the large sheep stations in the vicinity. Stations at Edgeroi, Bellata, Gurley, and Tycannah were also opened in 1897. The line was extended to Camurra in 1913, and to Mungindi in 1914. Only Narrabri, Bellata, and Moree stations remain in use.

North Star is located on the disused Boggabilla line, which branches from the Mungindi line at Camurra. North Star Station was opened in 1932 with the opening of the Boggabilla line. Construction of the Boggabilla line was undertaken during the depression, with large construction worker camps located at Camurra, Crooble, Croppa Creek, North Star, and Boggabilla. Stations on the Boggabilla line in the study area opened between 1932 and 1934. All stations are now closed.

In NSW, rail lines were historically built to two main standards: main lines, and branch/pioneer lines. The economic depression of 1889 to 1894 dramatically slowed railway construction in NSW. When expansion of the rail system resumed, it was under a new era of austerity. The change involved the introduction of 'pioneer lines' on routes serving agricultural areas. To minimise the need to construct expensive bridges, routes were selected where possible to be located beside or between the major inland rivers. Pioneer rail lines were constructed using light rails and low-quality sleepers with no ballast. Rail traffic was kept at a minimum, except for the heavy seasonal demand dictated by agricultural and pastoral industries.

In the period 1910 to 1930, a large number of branch/pioneer railway lines were constructed through western and north-western NSW, with the aim of establishing access to wheat growing areas and reaching the edge of the productive wool growing areas. In the study area, the Moree to Mungindi section of the Mungindi line, and the Boggabilla line, were established as pioneer lines. Of these lines, the proposal site travels along the Moree to Camurra section of the Mungindi line, and the Camurra to North Star section of the Boggabilla line.

Further information on rail lines and rail services in the study area is provided in Chapter 2.

18.2.2 Heritage listed items

Three locally listed heritage items are located within the proposal site:

- Mehi River bridge
- Moree Station
- Gwydir River bridge.

Although locally listed (on both the Moree Plains LEP and Railcorp's section 170 heritage register), Moree Station is considered (by the LEP) to have State significance. The Mehi River and Gwydir River bridges, listed on ARTC's section 170 heritage register, are considered to have local significance.

These items, and other listed heritage items within 100 metres of the proposal site, are summarised in Table 18.1. The locations of these items are shown in Figure 18.1. A detailed description is provided in Technical Report 9. Photographs of items within the proposal site are provided as Plate 18.1 to Plate 18.3.

Table 18.1 Heritage listed items within and close to the proposal site

Item name	Location	Listing	Significance	Distance from the proposal site
Mehi River bridge	Mehi River, Moree	ARTC's section 170 heritage register	Local	In the proposal site
Moree Railway Station	Gosport Street, Moree	Moree Plains LEP 2011 Railcorp's section 170 heritage register	State (under the LEP)	In the proposal site
Gwydir River bridge	Gwydir River, Camurra	ARTC's section 170 heritage register	Local	In the proposal site
Victoria Hotel	339 Gosport Street, Moree	Moree Plains LEP 2011	Local	100 m to the west
Moree Baths and Swimming Pool	Corner of Anne and Warialda Street, Moree	National Heritage List	National	100 m to the west
Moree Showground	Warialda Street, Moree	Moree Plains LEP 1995	Local, recommended for listing on the State Heritage Register	100 m to the north-west
A.B. Meppem and Co.	30 Railway Parade (Newell Highway), Bellata	Narrabri LEP	Local	80 m to the east
Bellata Police Station and Official Residence	24 Railway Parade (Newell Highway), Bellata	NSW Policy Force's section 170 register	Local	80 m to the east
Oldhams Smallgoods	26 Railway Parade (Newell Highway), Bellata	Narrabri LEP	Local	80 m to the east
Post Office	28 Railway Parade (Newell Highway), Bellata	Narrabri LEP	Local	80 m to the east
LS Rowe Stock and Station Agents	40 Railway Parade (Newell Highway), Bellata	Narrabri LEP	Local	80 m to the east
Nandewar Hotel	Lot 1 Railway Parade (Newell Highway), Bellata	Narrabri LEP	Local	80 m to the east

Plate 18.1 Mehi River bridge (view to the south-west)

Plate 18.2 Moree Station (view to the south)

Plate 18.3 Gwydir River bridge (view to the south-east)

18.2.3 Potential heritage items and archaeological potential

The potential historical heritage resource of the study area generally reflects the documented history of the region (summarised in Section 18.2.1) and the remaining rail alignment and infrastructure associated with the original Mungindi and Boggabilla lines. The majority of potential heritage items along the proposal site are rail related. The potential historical heritage resource in the proposal site includes the rail formation itself, with underbridges (that is, bridges spanning an opening under the rail line), and culverts of varying construction materials and age, evidence of the former stations, and other rail related structures and infrastructure.

A summary of potential heritage items along the proposal site is provided below. Further detail is available in Technical Report 9.

Rail related items with potential heritage significance

Rail line, underbridges and culverts

The rail line (including underbridges and associated rail infrastructure) has historical association with the expansion of the NSW rail network through the region, and its role in encouraging agricultural and pastoral development.

Underbridges and culverts can provide examples of the different techniques used to raise a rail line over watercourses. There are a number of underbridges along the proposal site that have timber components in addition to early concrete modifications, or are entirely constructed of timber. Examples of these are shown in Plate 18.4 and Plate 18.5, with others provided in Technical Report 9. These are likely to be representative of the earlier types of underbridges constructed along the rail line.

The bridge over Croppa Creek (Plate 18.6) comprises a steel span constructed half-through bridge on concrete piers, with concrete abutments. It is located on the north side of Croppa Creek Station. Although the policy for pioneer lines was to avoid expensive infrastructure such as bridges, the timber girder bridge design generally used for pioneer lines could not be used across larger rivers and creeks. The Croppa Creek bridge is an example of the need to construct a larger more expensive steel bridge along a pioneer line.

Figure 18.1 Heritage items – listed and potential

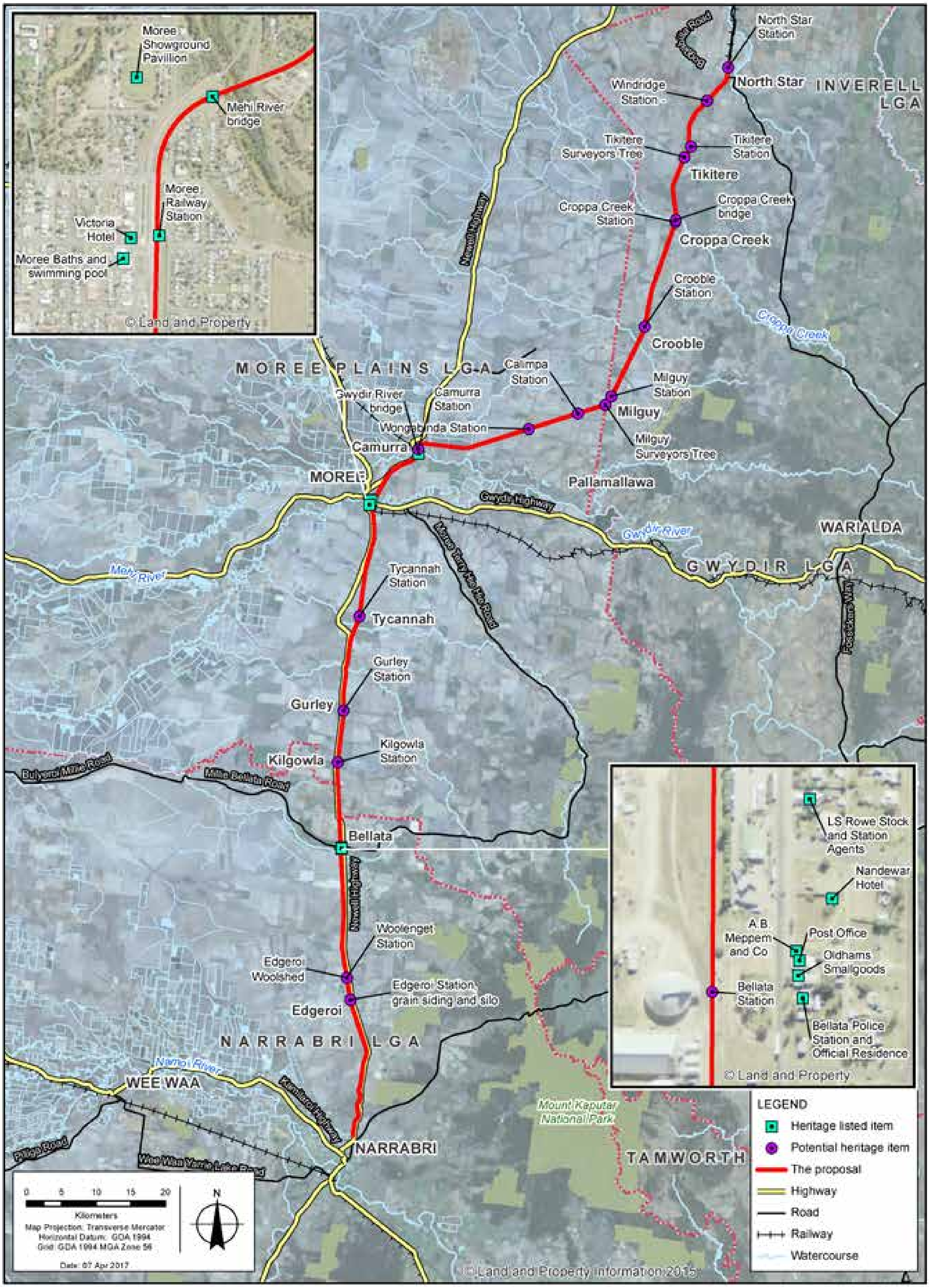
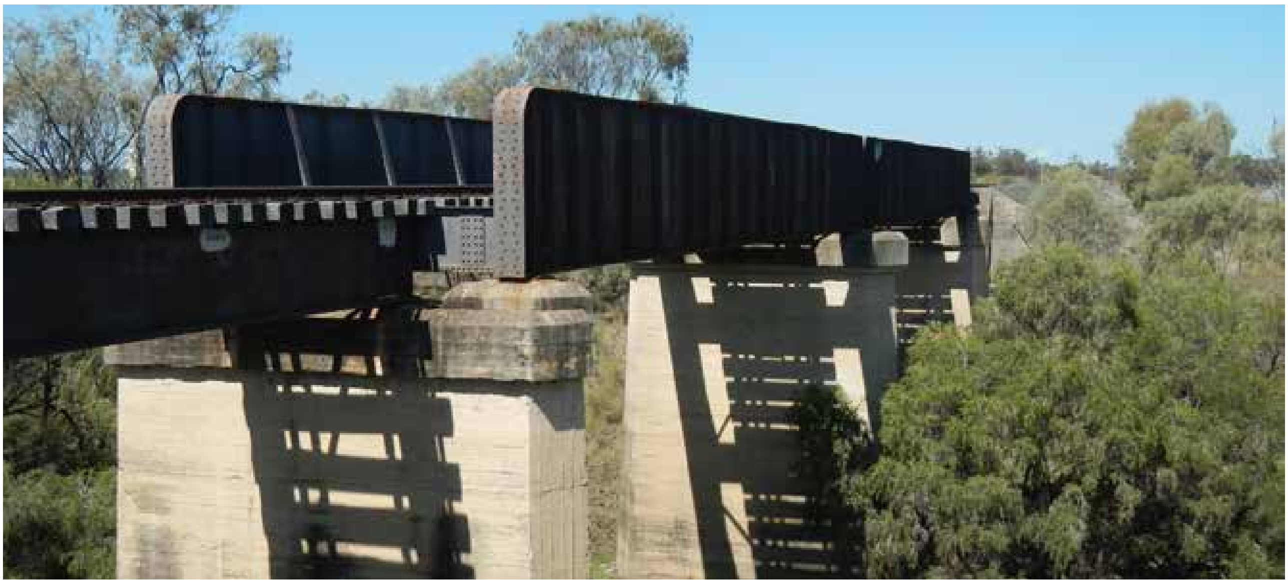


Plate 18.4 Example of a historic underbridge near Moree

Plate 18.5 Example of a historic underbridge near Moree

Plate 18.6 Croppa Creek bridge



Former stations

There are 13 former railway station sites and one existing station (Bellata) located within the proposal site (Moree Station is also located within the proposal site, and is a listed heritage item), and one former and one existing station (Camurra and Narrabri respectively) located close to the proposal site.

As most closed stations were demolished in the 1970s and 1980s, there is limited remaining evidence of the stations, with the exception of raised earthen embankments indicating former station platforms or rail siding loading banks.

Non-rail related items with potential heritage significance

Edgeroi Woolshed

The Edgeroi Woolshed, which is located close to the proposal site near the site of the former Woolenget Station, stands out as a feature of the landscape from the Newell Highway. As it currently exists, the woolshed is the remains of a much larger structure (the Edgeroi Pastoral Company woolshed).

Woolenget Station was opened in 1901 to service the woolshed, which is reported to have been the largest woolshed in the southern hemisphere. Much of the woolshed structure was removed after 1951 when Woolenget Station closed. The existing building, located just to the west of the rail corridor (about 10 metres from the fence marking the edge of the rail corridor), is what remains of the original woolshed. The building comprises a timber framed corrugated iron clad structure (shown in Plate 18.7).

Anzac Day Crossing

The Anzac Day Crossing of the rail corridor for the Boggabilla line is reported to have been located just south of Crooble Station. The crossing is reported to have been a regional meeting point for troops prior to departure for the Second World War, and it still used today on Anzac Day.

Surveyor's trees

Two trees with surveyor's blazes were identified during the field survey in the vicinity of Milguy and Tikitere stations. These trees are located outside the proposal site.

Archaeological potential

There is potential for archaeological evidence associated with the former Aboriginal fringe camp located near the Mehi River bridge (the Steel Bridge Camp). It is unlikely that any archaeological evidence of structures associated with the fringe camp remain. However, dispersed artefacts associated with Aboriginal life at the former camp may remain. If present, such remains may have high research potential and significance. With the exception of the Steel Bridge Camp, no other potential historical archaeological resources were identified within or close to the proposal site.

Plate 18.7 Edgeroi Woolshed – view to the north-west

Summary statement of significance for potential heritage items

An assessment of significance was undertaken of the potential heritage items along the proposal site. The assessment concluded that, for items not currently subject to a heritage listing:

- The existing rail line between Narrabri and North Star is considered to be generally of local significance as a result of its:
  - relationship with the construction of pioneer rail lines in rural NSW at the end of the nineteenth and beginning of the twentieth century
  - role in encouraging settlement, and agricultural and pastoral development in the study area, and in capitalising on trade between NSW and Queensland
  - surviving elements, such as steel truss underbridges, timber constructed underbridges, and evidence of former stations.
- Croppa Creek bridge is considered to be of local significance as a good example of steel bridges, constructed on a pioneer line (the Boggabilla line) using American bridge technology.
- The Edgeroi Woolshed is considered to be of local significance as evidence of a substantial woolshed associated with a large early land grant, and as an important landmark in the area.
- The two surveyors trees are considered to be of local significance as evidence of the activities of surveyors and the different methods and procedures they used.
- The Anzac Day Crossing of the Boggabilla line at Crooble is considered to have significant associations for the families of local servicemen and women.

18.3 Impact assessment

18.3.1 Risk assessment

Potential impacts

The environmental risk assessment for the proposal (provided in Appendix B) included an assessment of the potential risks of the proposal on non-Aboriginal heritage. The assessed risk level for the majority of potential heritage risks was medium. Risks with an assessed level of medium or above included:

- impacts on listed heritage items or items with potential heritage significance as a result of demolition, altered heritage arrangements and access; impacts to visual amenity, landscape and vistas, and curtilage, and any impacts as a result of noise mitigation measures
- damage to heritage items from vibration during construction or operation
- disturbance of known or unidentified items or places of non-Aboriginal heritage significance.

How potential impacts have been avoided

The option development and assessment process for Inland Rail as a whole is summarised in Chapter 6. As noted in Chapter 6, the shortlist of route options was subject to a detailed assessment, and the proposed alignment was refined based on evaluation of key considerations, including environmental impacts. The majority of Inland Rail would be located on upgraded track in existing rail corridors, minimising as far as practicable the potential for impacts to heritage located outside the rail corridor. However, the proposal would impact on existing rail infrastructure within the rail corridor.

Potential impacts on heritage outside the rail corridor would continue to be avoided by:

- designing, constructing and operating the proposal to minimise the potential for impacts outside the rail corridor
- managing the potential impacts on non-Aboriginal heritage in accordance with relevant legislative, as outlined in Section 18.1.2, and the findings of the historic heritage assessment
- implementing the heritage management and mitigation measures provided in Section 18.4.

18.3.2 Construction impacts

Impacts on listed heritage items

Direct impacts can occur during construction as a result of the physical loss of part or all of a heritage item or place, and/or changes to its setting.

Potential indirect impacts include:

- potential for vibration impacts to buildings/items located close the proposal site as a result of construction works and the movement of plant, vehicles and machinery
- inadvertent damage as a result of the movement of machinery and equipment
- altered historical arrangements and access
- impacts to visual amenity, landscape and vistas associated with the item
- impacts to the curtilage of an item.

Potential for direct impacts – Mehi River bridge and Gwydir River bridge

The Mehi River and Gwydir River bridges are listed on ARTC's section 170 heritage register and are considered to have local significance.

New bridges are proposed to replace the existing bridges as they do not meet Inland Rail requirements. The existing bridges would be removed prior to construction to allow construction of the new bridges on the same alignment.

The heritage assessment concluded that, although the bridges are considered to be good examples of steel bridges constructed on a pioneer line using American bridge technology, there are other similar examples, both regionally and throughout NSW. Measures are provided in Section 18.4.3 to mitigate this impact as far as possible.

Potential for direct impacts – Moree Station

As described in Section 7.2.2, the proposal involves realigning the rail line at Moree Station to move the existing track 125 millimetres away from the platform, and upgrading the existing pedestrian level crossing at the northern end of Moree Station to include gates with lights and bells. In addition, the eastern side of the platform may need to be upgraded to allow passengers to join or alight from the Xplorer passenger service.

Although the proposal site passes through the heritage listed boundary of Moree Station, the remaining features of the station, including the island platform layout and refreshment room, would not be directly impacted by the proposal. The station would remain a functioning railway station; easily recognisable and understandable as such.

As the station and line would remain operational, the upgrade of the existing rail line would not change the setting or character of this item. Potential visual impacts are considered in Chapter 19.

Potential for indirect impacts

The potential for structural vibration impacts was considered by the noise and vibration assessment (described in Chapter 12). The assessment concludes that existing heritage listed items, with the exception of Moree Station, are located a sufficient distance from the proposal site such that no impacts are predicted.

As construction works would be undertaken close to Moree Station, there may be the potential for impacts caused by vibration. The vibration assessment concluded that although vibration limits are not expected to exceed the project specific structural damage criteria, mitigation measures are recommended to minimise the potential for any impacts. The management of vibration in the vicinity of the station would be undertaken in accordance with the approach defined by the Inland Rail NSW Construction Noise and Vibration Management Framework (refer Appendix H). Further information on the framework with respect to the management of vibration is provided in Section 12.5.

Depending on the final design of the proposed fence and noise barriers along the rail corridor in Moree, these have the potential to create an additional physical and visual barrier between the station and the town of Moree. However, the station already has a degree of separation as a result of existing rail corridor fencing, the Moree Bypass (Newell Highway) on the western side of the corridor, and the existing earthen embankment/noise bund on the eastern side of Moree Station parallel to Morton Street.

If inadequately controlled, due to the proximity of construction works, the movement of construction machinery and equipment could result in inadvertent damage to the Moree Station buildings.

Potential impacts on the station would be minimised by implementing the measures listed in Section 18.4.3.

Impacts on items/places with potential significance

Potential for direct impacts

The proposal involves removing the existing rail line and associated infrastructure, and providing a new rail line within the same corridor. Although the majority of the former stations have been removed, any remaining evidence within the proposal site could be impacted. Retaining all evidence of the existing rail line is not feasible, as significant upgrades to the formation are required for it to comply with the Inland Rail performance specifications. The corridor would be retained for rail usage. The intact railway stations of Edgeroi, Bellata and Gurley would not be directly impacted.

The proposal involves constructing a new bridge over Croppa Creek to meet Inland Rail performance specifications. The existing bridge would be removed to allow for the construction of the new bridge on the same alignment. The bridge is considered to have potential local heritage significance, as a good example of a steel bridge, constructed on a pioneer line using American bridge technology. However, there are other similar examples, both regionally and throughout NSW.

The proposal also has the potential to impact the Steel Bridge Camp near the Mehi River bridge. As noted in Section 18.2.3, artefacts with potential significance may remain at this location and, as such, require consideration under the definition of archaeological 'relics' provided by the Heritage Act. If inadequately managed, any artefacts present could be impacted during construction.

The two surveyors trees would not be impacted by the proposal.

The proposal would impact the Anzac Day Crossing as it involves upgrading rail infrastructure across the crossing.

The measures listed in Section 18.4.3 would be implemented to minimise the potential significance of impacts.

Potential for indirect impacts

As noted above, the main potential for indirect impact relates to vibration generated by construction. Given the proximity of the former woolshed, and remaining structures associated with stations located in the proposal site (Edgeroi, Bellata and Gurley stations), there may be the potential for indirect impacts caused by vibration. As noted above, the noise and vibration assessment concluded that with appropriate selection of construction methods and equipment, vibration impacts are unlikely. The management of vibration in the vicinity of potential heritage items would be undertaken in accordance with the Inland Rail NSW Construction Noise and Vibration Management Framework.

The measures listed in Section 18.4.3 would be implemented to minimise the potential significance of indirect impacts.

18.3.3 Operation impacts

Operation of the proposal would not directly impact on any listed or potential heritage items. The main potential for indirect impacts relates to vibration generated by the movement of trains, and a change in the visual setting and/or character associated with the presence of new infrastructure.

The potential for structural vibration impacts was considered by the noise and vibration assessment (described in Chapter 12). No operational impacts on listed or potential heritage items were predicted.

The potential for visual impacts was considered by the landscape and visual impact assessment (described in Chapter 19). The assessment concluded that the overall visual impact of the proposal would be low, as the majority of the proposal involves minor works to existing infrastructure. Measures are provided in Section 19.4 to mitigate the potential for visual impacts.

18.4 Mitigation and management

18.4.1 Approach to mitigation and management

A photographic/archival recording of certain elements of the proposal site and items with potential heritage significance is proposed (including for the Mehi River bridge, the Gwydir River bridge, the Croppa Creek bridge, and culverts/underbridges with timber components). This is to ensure that a full understanding and accurate record of these items would be available for future generations.

In addition to recording, an interpretation strategy would be developed, in consultation with relevant stakeholders, to provide a concept and framework for interpretation of the original rail lines and rail infrastructure to be removed. This would ensure information regarding this infrastructure is accessible and available for the community to understand.

An archaeological management sub-plan would be prepared as part of the CEMP to define the measures proposed during construction at the former Aboriginal fringe camp site near the Mehi River bridge.

Potential vibration impacts on listed and potential heritage items would be managed in accordance with the Inland Rail NSW Construction Noise and Vibration Management Framework, described in Section 12.5.

18.4.2 Consideration of the interactions between mitigation measures

Measures to minimise the potential for vibration impacts (provided in Chapter 12) and visual impacts (Chapter 19) would minimise the potential for indirect impacts as a result of the proposal.

18.4.3 Summary of mitigation measures

To manage and mitigate the potential for non-Aboriginal heritage impacts, the mitigation measures listed in Table 18.2 would be implemented.

Table 18.2 Summary of Non-Aboriginal heritage mitigation measures

Stage	Impact	Mitigation measures
Detailed design/ pre-construction	Impacts to Moree Station	Detailed design would minimise the potential for impacts to Moree Station, and would have regard to, and be sympathetic with, its heritage significance.
	Impacts to the bridges over the Mehi and Gwydir rivers and Croppa Creek, underbridges, former stations, Edgeroi Woolshed	A photographic/archival recording would be undertaken of culverts/underbridges with timber components, bridges being replaced, former rail station sites, and Edgeroi Woolshed in accordance with ARTC's Archival Recording Standard. The photographic recording would include contextual photographs showing the relationship between the rail line and these items.
	Impacts to the Anzac Day Crossing	Where practicable, detailed design would provide for a level crossing at the same or a similar location as the Anzac Day Crossing south of Crooble.
	Impacts to the former Aboriginal fringe camp near the Mehi River bridge	An archaeological management sub-plan would be prepared as part of the CEMP to define the measures to be implemented during construction at the former Aboriginal fringe camp site near the Mehi River bridge. The plan would provide requirements for archaeological management, including a research design methodology.

Stage	Impact	Mitigation measures
Detailed design/ pre-construction	Potential vibration impacts to heritage structures	For listed and potential heritage items where screening vibration levels are predicted to be exceeded, a more detailed assessment of the structure and vibration monitoring would be carried out in accordance with the Inland Rail NSW Construction Noise and Vibration Management Framework, to ensure vibration levels remain below appropriate limits for that structure. The more detailed assessment would consider the heritage values of the structure in consultation with a heritage specialist, to ensure sensitive heritage fabric is adequately monitored and managed.
	Unexpected finds	An unexpected finds procedure would be developed and included in the CEMP to provide a consistent method for managing any unexpected heritage items or human skeletal remains discovered during construction.
Construction	Accidental impacts to heritage items and potential items within/close to the proposal site.	To minimise the potential for accidental impacts, the boundary of Moree, Edgeroi, Bellata, and Gurley stations, Edgeroi Woolshed, and the surveyor's trees, would be marked on plans and clearly defined during construction.
	Unexpected finds and human skeletal material.	In the event that unexpected archaeological remains, relics, potential heritage items, or human remains are discovered during construction, all works in the immediate area would cease, and the unexpected finds procedure would be implemented.

19. Landscape and visual

This chapter provides a summary of the landscape and visual impact assessment undertaken for the proposal. It describes the existing landscape and visual environment, assesses the impacts from construction and operation of the proposal, and provides recommended mitigation and management measures. The full Landscape and Visual Assessment report is provided as Technical Report 10.

19.1 Assessment approach

19.1.1 Methodology

A qualitative assessment of the landscape and visual impacts of the proposal was undertaken. The assessment involved:

- desktop analysis
- site visit and analysis
- landscape character assessment
- determining the ability of the landscape to absorb the proposal (the absorptive capacity)
- identifying potentially sensitive visual receivers
- assessing the potential for landscape and visual impacts (see below)
- developing mitigation measures to minimise the potential for negative impacts and enhance the potential for positive impacts.

Sensitive visual receivers typically include:

- occupiers of residences with views of a proposal site
- communities with a landscape setting or views valued by the community and/or visitors
- users of outdoor recreation areas whose attention or interest may be focused on the landscape
- motorists/pedestrians travelling along scenic roads/routes.

The potential sensitivity of receivers to change was determined and rated (from very low to high). Sensitivity depends on the location of receivers, the importance of their view, land uses, and the extent of existing screening.

Landscape character impacts refer to the relative capacity of the landscape to accommodate changes to the physical landscape through the introduction of new features or loss/modification of existing features. Impacts were assessed from representative viewpoints and rated (from very low to high).

The significance of potential visual impacts was determined by assessing the magnitude of impacts in combination with the sensitivity of the receiver. Potential impacts were rated according to their significance (severity), as shown in Figure 19.1.

Technical Report 10 provides further information on how the impact, sensitivity, and level of significance were assigned.

Figure 19.1 Impact significance rating matrix

Sensitivity of feature	Magnitude of impacts: High	Moderate	Low	Negligible
High	High	Moderate to high	Moderate	Negligible
Moderate	Moderate to high	Moderate	Moderate to low	Negligible
Low	Moderate	Moderate to low	Low	Negligible
Negligible	Negligible	Negligible	Negligible	Negligible

19.1.2 Policy context to the assessment

The landscape and visual impact assessment was undertaken with reference to the following guidelines, policies and standards:

- *Environmental Impact Assessment Guidance Note – Guidelines for landscape character and visual impact assessment 3rd edition* (Roads and Maritime Services, 2013a)
- Australian Standard - AS4282.1997 *Control of the obtrusive effects of outdoor lighting*
- *Beyond the Pavement: urban design policy, procedures and design principles* (Roads and Maritime Services, 2014)
- *Bridge Aesthetics: Design guidelines to improve the appearance of bridges in NSW* (Roads and Maritime Services, 2012)
- *NSW Sustainable Design Guidelines* Version 3.0 (Transport for NSW, 2013)
- *Urban Green Cover in NSW* (*Technical guidelines)* (OEH, 2015)
- *Dark Sky Planning Guideline* (Department of Planning and Environment, 2016).

Further information is provided in Technical Report 10.

19.2 Existing environment

The landscape and visual environment of the proposal site is characterised by its generally rural/agricultural nature, with areas of more concentrated urban development located in towns and settlements.

For much of the proposal site, the existing rail track, and associated rail infrastructure forms the main visual feature in the landscape (shown in Plate 19.1).

Features contributing to the visual appearance of the rural/agricultural areas include open rural land interspersed with scattered development, dwellings, buildings and sheds; small stands of existing native vegetation and scattered trees; watercourses and rivers (including the Mehi and Gwydir rivers which are crossed by the proposal site); road and rail infrastructure; and agricultural infrastructure such as grain silos. Features contributing to the visual environment of the urban areas include a mix of older commercial and residential buildings among new developments, heritage listed buildings, and general urban infrastructure.

Further information on the proposal site and surrounding land uses is provided in Chapters 2 and 20.

Plate 19.1 Existing rail track

19.2.1 Landscape character zones

For the purposes of the assessment, four landscape character zones were identified. These are areas with similar landscape and physical qualities. The character zones consist of two main landscape character types (settlement and agricultural landscape), with two sub-types in each. The absorptive capability relates to the ability of the landscape character zone to absorb the proposal within the existing landscape setting.

Where a zone has a high capability, this indicates the landscape or features within the landscape would not be markedly changed by the proposal. A low capability indicates the landscape is less able to absorb the impacts of the proposal and therefore would result in change.

The landscape character zones are described in Table 19.1 and are shown in Figure 19.2.

Table 19.1 Landscape character zones

Character zone	Description	Absorptive capability
Settlement – township	The proposal site starts on the northern edge of Narrabri and traverses Moree. In Narrabri, the landscape is typically flat in topography, with built form, public open space, and prominent street trees. Existing rail infrastructure skirts the town creating an edge between the buildings and the agricultural land. The buildings then continue towards the south-west, divided by Narrabri Creek which is a significant landscape feature within the town. In Moree, the proposal site is surrounded by/located close to light industrial and residential land uses; large public recreational spaces; larger lot residential; and road infrastructure (including the Moree Bypass). The street layout creates a north-south grid across the urban landscape and is divided by the Mehi River, which is a significant landscape feature within the town. The rail bridge crossing the Mehi River has historical significance. It runs parallel to the Newell Highway and although surrounded by dense tree planting is still visually significant in the landscape. Canopy trees lining some main roads buffer the character of townships by providing a natural visual screening to the rail corridor.	**High** The flat topography, built form, and street trees associated with the urban fabric and residential canopy coverage provide opportunities for changes to be absorbed in the existing landscape setting.
Settlement – village	There are a number of small villages/settlements located along the proposal site, the largest of which is Bellata. The proposal site extends through the outskirts of these settlement areas.	**High** The flat topography, built form, street trees associated with the urban fabric, and residential canopy coverage provide opportunities for changes to be absorbed in the existing landscape setting.

Character zone	Description	Absorptive capability
Agriculture – Gwydir undulating plains	This character zone is located between Narrabri and Moree. This zone consists of undulating plains, low ridges and creek channels. Farming residences and agricultural structures are dispersed across the landscape. From Narrabri to Moree, the majority of the land between outside of settlements is agricultural. North from Narrabri, open grasslands extend across the shallow slopes with the occasional tree, typically of a eucalyptus species. Between Narrabri and Bellata, the vegetation becomes denser. Extending beyond this area are open plains of grassland.	Moderate to high This landscape is low-lying with open grassland plains and minimal canopy coverage. This means there are limited opportunities for changes in the existing landscape setting to be absorbed.
Agriculture – northern marshland plains	This character zone is located between Moree and North Star. The terrain of this zone is typically near level to gently undulating. The landscape from Moree towards North Star comprises dense areas of woodlands that line the Mehi River. Dense woodland surrounds the west, north, and east boundaries of Croppa Creek village which creates a distinctive feature in the landscape.	Moderate to high Although this landscape is low-lying open grassland plains there is minimal canopy coverage, which provides limited opportunities for changes in the existing landscape setting to be absorbed.

19.2.2 Visual sensitivity

The extent from which the proposal would be visible from adjoining areas varies along the length of the proposal site. It is influenced by topography, vegetation, land uses (rural, residential, commercial), and associated buildings. The most sensitive visual receivers typically include:

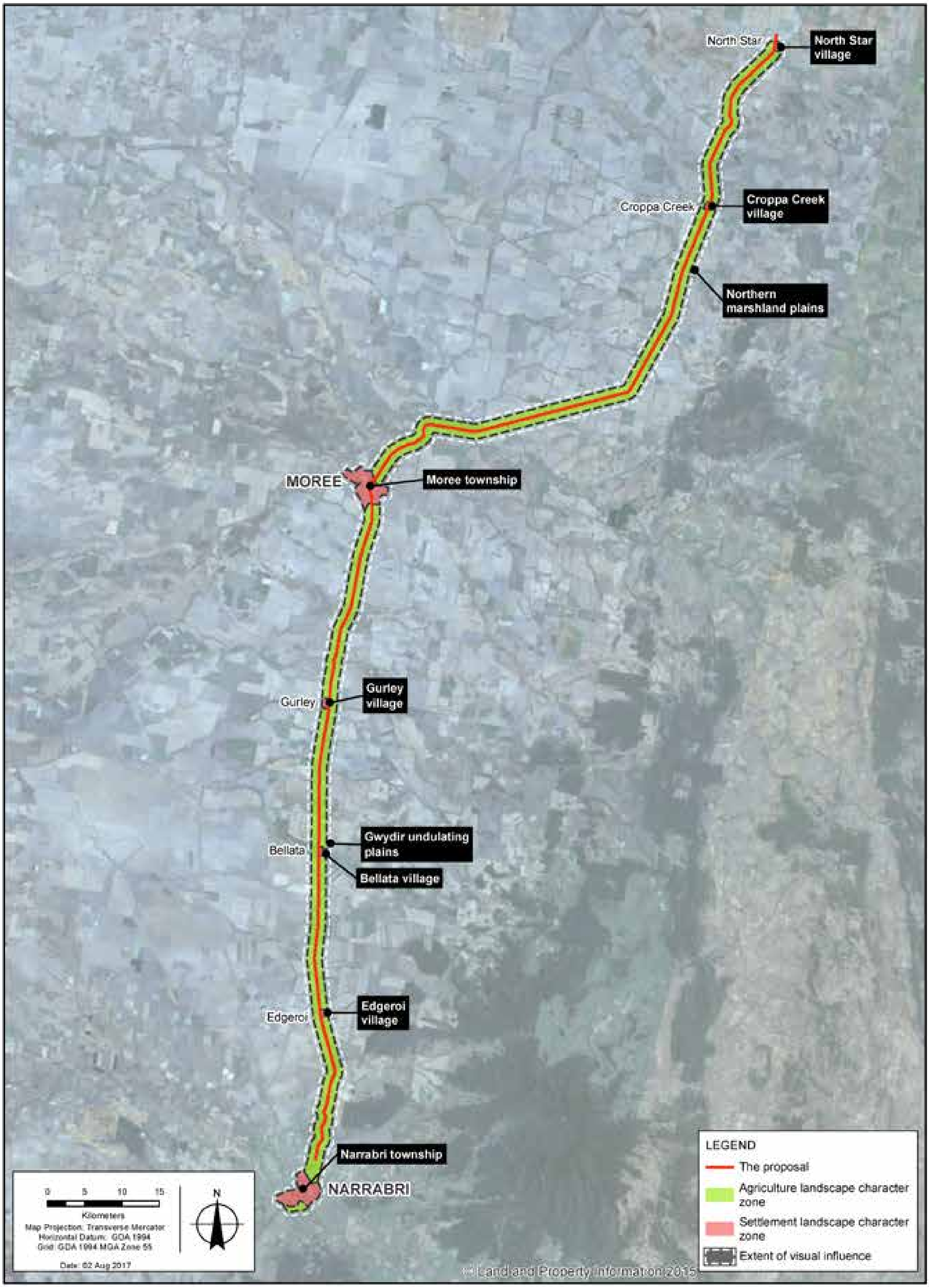
- occupiers of residences with views of the proposal
- communities where the proposal results in changes in the landscape setting or value of views enjoyed by the community
- users of outdoor recreational areas, including shared paths, whose attention or interest may be focused on the landscape
- views from tourist roads.

Most commonly, either moderate or high levels of visual sensitivity are recorded. Despite the proposal site traversing mainly agricultural landscapes, levels are often recorded as moderate where the Newell Highway is located parallel to the rail corridor in the local setting.

As the rail corridor passes through towns and settlements such as Belatta, Moree, Croppa Creek and Gurley, areas are recorded as highly visually sensitive due to the residences located in the proposal site's local setting. Generally, as the proposal site approaches towns and settlements , it passes through low density scatterings of residences, causing elongated segments of high visual sensitivity from the small urban settings.

Between Moree and North Star, there are fewer residences and main roads, resulting in long sections of very low visually sensitive areas, with large portions of land dedicated to agricultural uses. In the vicinity of Camurra, there is a high visual sensitivity due to there being a new piece of infrastructure with residences present in the sub-regional setting.

Figure 19.2 Landscape character zones



19.3 Impact assessment

19.3.1 Risk assessment

Potential impacts

The environmental risk assessment for the proposal (provided in Appendix B) included an assessment of the potential risks associated with changes to the landscape and visual environment. The assessed risk level for the majority of potential risks was between low and medium. Risks with an assessed level of medium or above are as follows:

- light impacts from out-of-hours work during construction
- adverse impacts on landscape character during construction, particularly in greenfield areas
- impacts on visual amenity due to the introduction of new built elements, including noise walls and embankments, and the removal of vegetation in a rural environment.

How potential impacts have been and would be avoided

The option development and assessment process for the Inland Rail location/route options is summarised in Chapter 6. As noted in Chapter 6, the shortlist of route options was subject to a detailed assessment, and the proposed alignment was refined based on evaluation of key considerations, including environmental impacts. The majority of Inland Rail would be located on upgraded track in existing rail corridors, minimising as far as practicable the potential for impacts outside the rail corridor. However, the proposal would impact on the existing rail infrastructure within the rail corridor.

For works outside the corridor, impacts to communities and landscape were included in the list of selection criteria used for the analysis of options. Potential impacts on landscape character and visual environment would continue to be avoided by:

- designing, constructing and operating the proposal to minimise the potential for impacts outside the rail corridor
- managing the potential impacts on the visual setting of non-Aboriginal heritage as described in Chapter 18
- designing, constructing and operating the proposal to minimise the potential for amenity impacts arising from visual amenity, including the implementation of mitigation measures in Section 19.4.

19.3.2 Construction impacts

During construction, positioning of plant and equipment within the view of neighbouring properties and existing road users would result in temporary visual impacts. Earthworks would also expose subsoil. The exposed soil, in the form of spoil mounds (described in Chapter 7), would form a visible element in the landscape for a limited period until the mounds are stabilised. Then the mounds are likely to contribute to visual screening of the proposal.

The proposal would require removal of some vegetation within the boundaries of the proposal site. This would include trimming and/or clearing of vegetation. Some of this vegetation contributes to the amenity and character of the local area and the setting of heritage listed bridges, and/or screens views from properties adjoining the rail corridor. The removal of this vegetation would have the potential to reduce some screening between residential dwellings and the rail corridor. This would lead to temporary visual impacts during construction until the works are complete and disturbed areas rehabilitated.

The construction work and cleared areas would also be visible to motorists, where roads are close to the proposal site. Visual impacts would be temporary and fleeting in nature. The flat topography and the rail line already forming an existing visual feature means visual modification would generally be low level and would be difficult to perceive from the wider road network.

The use of lighting for works outside standard working hours may result in light spill impacting neighbouring properties and residents. Light generated during construction of the proposal would be designed so it complies with *AS 4282-1997 Control of the obtrusive effects of outdoor lighting*, and designed considering the good lighting design principles documented in *Dark Sky Planning Guideline: Protecting the observing conditions at Siding Spring* (NSW Department of Planning and Environment, 2016). Generally, lighting would be designed to minimise off-site light spill.

Potential visual impacts during construction would be minimised through implementation of the safeguards and management measures outlined in Section 19.4.

19.3.3 Operational impacts

The proposal would result in the introduction of infrastructure in what is currently mainly a rural area. This would result in a change in the character of those properties that are directly impacted by the proposal, and a change in views from those viewpoints and properties with views to the proposal. Potential landscape character and visual impacts are considered below.

Main visual features of the proposal

The main features of the proposal with the potential for landscape and visual impacts are:

- replacing the existing track and formation with new materials, including height increases of 0.3 metres to 1.0 metre
- new sections of track at crossing loops and Camurra bypass
- new fencing and rail infrastructure in certain areas, including signage and signals
- spoil mounds (up to 2 metres high) within the rail corridor along the proposal site
- larger trains operating through the proposal site – trains would be double stacked, with a height of 6.5 metres (an example of a double stacked train is shown in Plate 19.2) and up to 1,800 metres in length
- Newell Highway overbridge
- Jones Avenue overbridge
- three new bridges at Mehi River, Gwydir River and Croppa Creek.

Landscape character impact

The potential impacts on each landscape character zone are summarised in Table 19.2.

The greatest impacts on landscape character generally occur where the ability to absorb the change is lowest. For the proposal, this occurs in the areas where the upgrade works are located near or at river crossings over the Mehi River, Gwydir River, and Croppa Creek. For other areas, the magnitude of impact is lower, as the visibility of the proposal is reduced by the typical flat topography.

Plate 19.2 Example of a double stacked train

Table 19.2 Summary of landscape character impact ratings

Zone (described in Table 19.1)	Main works in zone	Impact summary	Magnitude of impacts	Impact rating
Settlement – township	Upgrading the existing track including height increases of 0.3 metres to 1.0 metre. Jones Avenue overbridge in Moree. Mehi River bridge. Camurra bypass.	As most of the proposal occurs in the existing rail corridor it would have a relatively low impact on the surrounding landscape. The exception is Moree, where the proposal would introduce new structures in the landscape (the Jones Avenue overbridge and, to a lesser extent, the new bridge over the Mehi River) which would be visible to surrounding receivers.	Moderate	Moderate
Settlement – village	Upgrading the existing track including height increases of 0.3 metres to 1.0 metre.	The landscape character of the village zone would not experience significant impacts. In this zone, the proposal involves works to an existing rail line, with the rail line already forming a visual feature in the zone. The proposal would involve generally low levels of visual modification. The proposed height increases would be difficult to perceive in the wider landscape, or would be perceived as a small component within the wider landscape.	Low	Low

Zone (described in Table 19.1)	Main works in zone	Impact summary	Magnitude of impacts	Impact rating
Agriculture – Gwydir undulating plains	Upgrading the existing track including height increases of 0.3 metres to 1.0 metre. New crossing loops within the rail corridor at Bobbiwaa, Waterloo Creek and Tycannah Creek. Newell Highway overbridge and tie-ins near Bellata. Replacing bridges/culverts where the rail corridor crosses watercourses. Ancillary work comprising upgrades, closing or consolidating level crossings, work to communications, fencing and utilities.	Despite being highly cleared and cultivated resulting in large expanses of flat, open plains, the proposal would generally have a low impact on the agricultural landscape character zones due to a limited number of trees requiring clearing. In these zones, the proposal involves works to an existing rail line, with the rail line already forming a visual feature in the zone. The proposal would involve generally low levels of visual modification. The proposed height increases would be difficult to perceive in the wider landscape. The addition of the crossing loops would also be difficult to perceive within the wider landscape. The proposed overbridge at the Newell Highway would also require clearing in its moderately dense woodland setting, undergoing a high level of modification. The new overbridge would be absorbed within the remaining dense woodland. There are also limited receivers in the vicinity of this proposed structure	Low to moderate	Low to moderate
Agriculture – northern marshland plains	New crossing loops within the rail corridor at Coolleearllee and Murgo New rail bridges over the Gwydir River, and Croppa Creek Replacing bridges/culverts where the rail corridor crosses watercourses. Ancillary work comprising upgrades, closing or consolidating level crossings, work to communications, fencing and utilities.	Similar to the above agricultural zone, there would be limited visual impacts. The main potential impacts would be associated with the new bridges as a result of tree clearing.	Moderate	Low to moderate

Visual impact

Given the low profile and horizontal form of most of the proposal, the level of visual modification would be confined to a distance relatively close to the area subject to change. The effect of distance on modification levels was incorporated into this assessment by applying different modifications ratings to foreground (0.0 to 0.35 kilometres from the viewpoint), middle ground (0.35 to 0.7 kilometres) and background (0.7 to 1 kilometre) views. The visual modification rating would be highest in the foreground, except where foreground vegetation screens the proposal.

Typically, long sections of the proposal result in a low level of visual modification and low visual impact due to the proposal mainly consisting of the reinstatement and replacement of existing track and culverts. However, there are isolated cases of high visual modification and impact, particularly where road overbridges or new river crossings would result in distinct visual modifications.

The Newell Highway overbridge results in a high level of visual modification and impact, with the immediate proximity of the proposed structure compounded by the clearing of trees required in the moderately dense woodland setting. There are however few receivers close to this location to be impacted.

The three new river crossings replacing the existing heritage bridges within the same location results in a moderate to high level of visual sensitivity, but a low level of visual modification due to the replacement essentially being “like for like” resulting in an overall low to moderate visual impact. Visualisations of the proposed replacement bridge over the Mehi River are provided in Figure 19.3.

The Jones Avenue overbridge and associated road upgrades would also result in a high visual modification and impact as it occurs in the township of Moree, in close proximity to residential receivers. Despite the overbridge being immediately surrounded by industrial uses, the structure would create a high level of visual modification because of extended views available. Visualisations of the proposed overbridge at Jones Avenue are provided in Figure 19.4.

Crossing loops generally result in a moderate to high level of visual modification where located parallel to the Newell Highway, or a moderate level when intersecting rural roads. Generally, the crossing loops require no or minimal vegetation clearing.

Figure 19.3 Visualisations of the proposed Mehi River bridge

Figure 19.4 Visualisations of the proposed Jones Avenue overbridge

19.4 Mitigation and management

19.4.1 Approach to mitigation and management

The approach to mitigation includes preparing a landscaping plan during detailed design, to guide the management of construction activities.

19.4.2 Consideration of the interactions between mitigation measures

Measures to mitigate and manage the potential for biodiversity and heritage impacts (described in Chapters 10 and 18) would also assist in mitigating the potential for visual impacts.

19.4.3 Summary of mitigation measures

To manage and mitigate the potential impacts to the landscape and visual environment, the mitigation measures listed in Table 19.3 would be implemented.

Table 19.3 Summary of landscape and visual mitigation measures

Stage	Impact	Mitigation measures
Detailed design/pre-construction	Landscape character and visual impacts	Detailed design would be undertaken according to the design vision, objectives and principles, which underpin the concept design, and would take into account the guidelines listed in Section 19.1.2.
		Following completion of detailed design of the Mehi River bridge, and the Jones Avenue overbridge, artist impressions and perspective drawings would be developed for consultation purposes.
Pre-construction/ construction	Light spill	Temporary and any permanent lighting would designed and sited to comply with: - AS 4282-1997 *Control of the obtrusive effects of outdoor lighting* - *Dark Sky Planning Guideline: Protecting the observing conditions at Siding Spring* (Department of Planning and Environment, 2016).
	Spoil mounds	Spoil mounds would be shaped to reduce their angular profile and ensure that they are integrated within the landscape. Sharp transition angles in the surface profile would be avoided, and rounded profiles would be used to provide a more natural form. Grass cover would be established over the surface area in accordance with the rehabilitation strategy.

20. Land use and property

This chapter provides the land use and property impact assessment undertaken for the proposal. It describes the existing environment, assesses the impacts from construction and operation of the proposal on land use, including property, agriculture uses, biosecurity, and land use in general, and provides recommended mitigation and management measures.

20.1 Assessment approach

20.1.1 Methodology

The land use and property impact assessment involved:

- reviewing the regulatory framework for land use and management, including relevant State, regional and local planning legislation, environmental planning instruments, policies, strategies and guidelines
- reviewing, identifying and mapping existing land uses within the proposal site and immediate surrounds (study area), based on a desktop review of GIS (geographical information system) spatial data and aerial photography, including:
  - land uses based on land use zoning provided by the zoning maps that form part of the relevant LEPs including *Narrabri Local Environmental Plan 2012, Moree Plains Local Environmental Plan 2011* and the *Gwydir Local Environmental Plan 2013*
  - significant properties and/or landholdings
  - agricultural uses, including any areas of regionally significant farmland; areas used for cropping, grazing and horticulture; travelling stock reserves; and agricultural infrastructure
  - Crown land
  - conservation and forest reserves, including national parks, conservation areas, and State forests
  - exploration and mining leases and licenses
- assessing the potential for impacts on agricultural land uses during construction and operation, including undertaking a land use conflict risk assessment in accordance with the *Land Use Conflict Risk Assessment Guide* (Department of Primary Industries, 2011)
- consideration of the potential for impacts on other land uses during construction and operation
- providing measures to mitigate and manage the impacts identified.

20.1.2 Legislative and policy context to the assessment

Relevant legislation and planning instruments are summarised in Chapter 3. Land use planning strategies relevant to the study area and proposal are summarised in Chapter 5.

The main guideline relevant to the assessment is Infrastructure proposals on rural land (Department of Primary Industries, 2013a). This guideline provides the potential impacts to be considered by consent authorities' in relation to infrastructure proposals, including:

- resource use and fragmentation
- impacts on farming operations and livestock
- increased weed, biosecurity and bushfire risks
- site rehabilitation.

These potential issues were considered as part of the assessment of potential impacts on agricultural land. Consideration was also given conducting a Land Use Conflict Risk Assessment (LUCRA) in accordance with the *Land Use Conflict Risk Assessment Guide* (Department of Primary Industries, 2011). A LUCRA can be used to identify the effects of a proposed land use on neighbouring land uses, and how these effects can be minimised. However, given that the majority of the proposal would involve work within the existing rail corridor and no associated change in land use a LUCRA was not considered necessary. Where the proposal will result in a change in the existing land use, that is at the Camurra bypass, consideration has been given to the impacts of the change in land use as part of this assessment.

20.2 Existing environment

20.2.1 General land use description

An overview of general land use in the study area is provided in Chapter 2. The proposal key features and land uses in the study area (based on the land use zoning from the LEPs) are shown in Figure 20.1. Other specific land uses considered by this chapter are shown in Figure 20.2.

The majority of land within the study area is held in freehold title. This includes properties held in freehold by private owners and various State Government departments. The study area also comprises areas identified as Crown land, including reserves, waterways and public roads.

Table 20.1 provides a summary of the main land uses within the Narrabri, Moree Plains and Gwydir LGAs with calculations based on mapping data provided by OEH. Grazing and cropping land uses account for 77 per cent of the total land area within the region.

Table 20.1 Land use by LGA

Land use	Narrabri (ha)	Moree Plains (ha)	Gwydir (ha)	Total land area (ha)	Percent
Grazing	339,559	962,157	268,290	1,570,006	39
Cropping	430,570	626,775	474,893	1,532,238	38
Conservation area	375,009	79,820	48,489	503,319	13
Tree and shrub cover	104,213	39,431	114,514	258,158	6
Transport and other corridors	19,821	51,000	12,559	83,380	2
River and drainage system	8,268	13,170	4,090	25,529	0.6
Urban	17,534	7,021	967	25,523	0.6
Special category	5,110	4,435	1,119	10,663	0.3
Mining and quarrying	1,011	6,632	1,957	9,600	0.2
Wetland	1,055	472	341	1,868	0.05
Horticulture	198	1,051	416	1,665	0.04
Intensive animal production	51	105	105	262	0.01
Power generation	49	11	30	90	0.002

Figure 20.1a Land use zoning

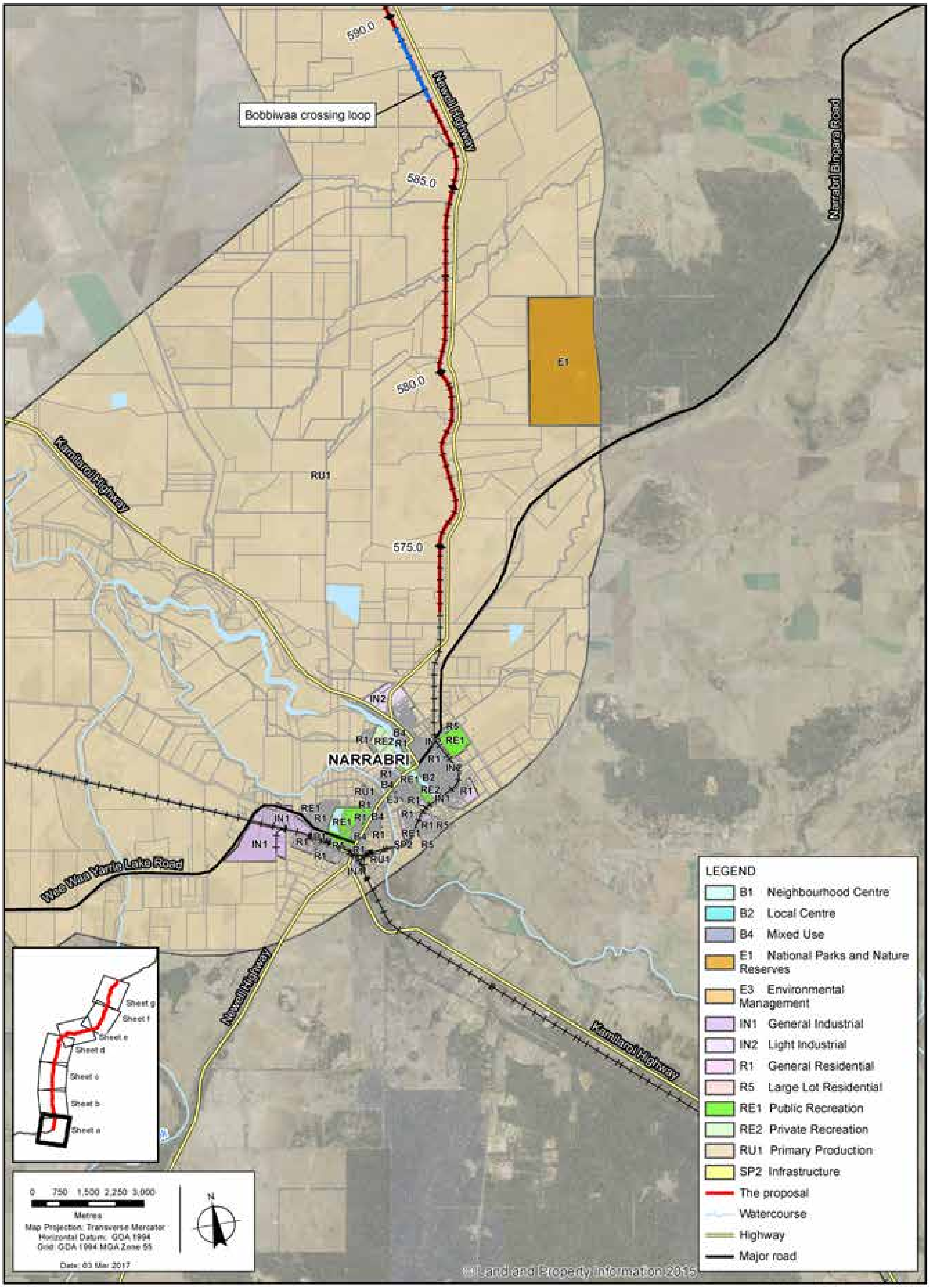


Figure 20.1b Land use zoning

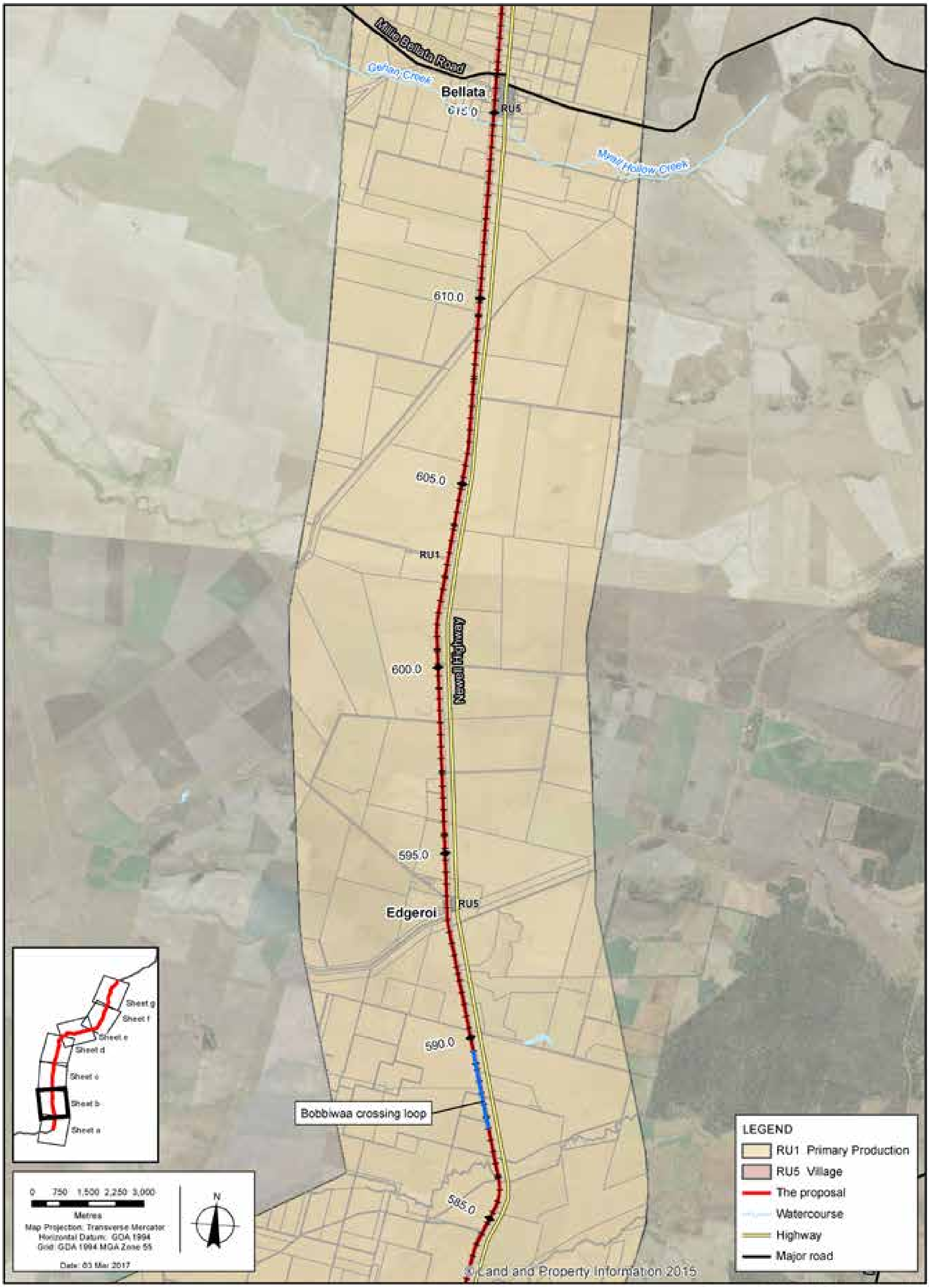


Figure 20.1c Land use zoning

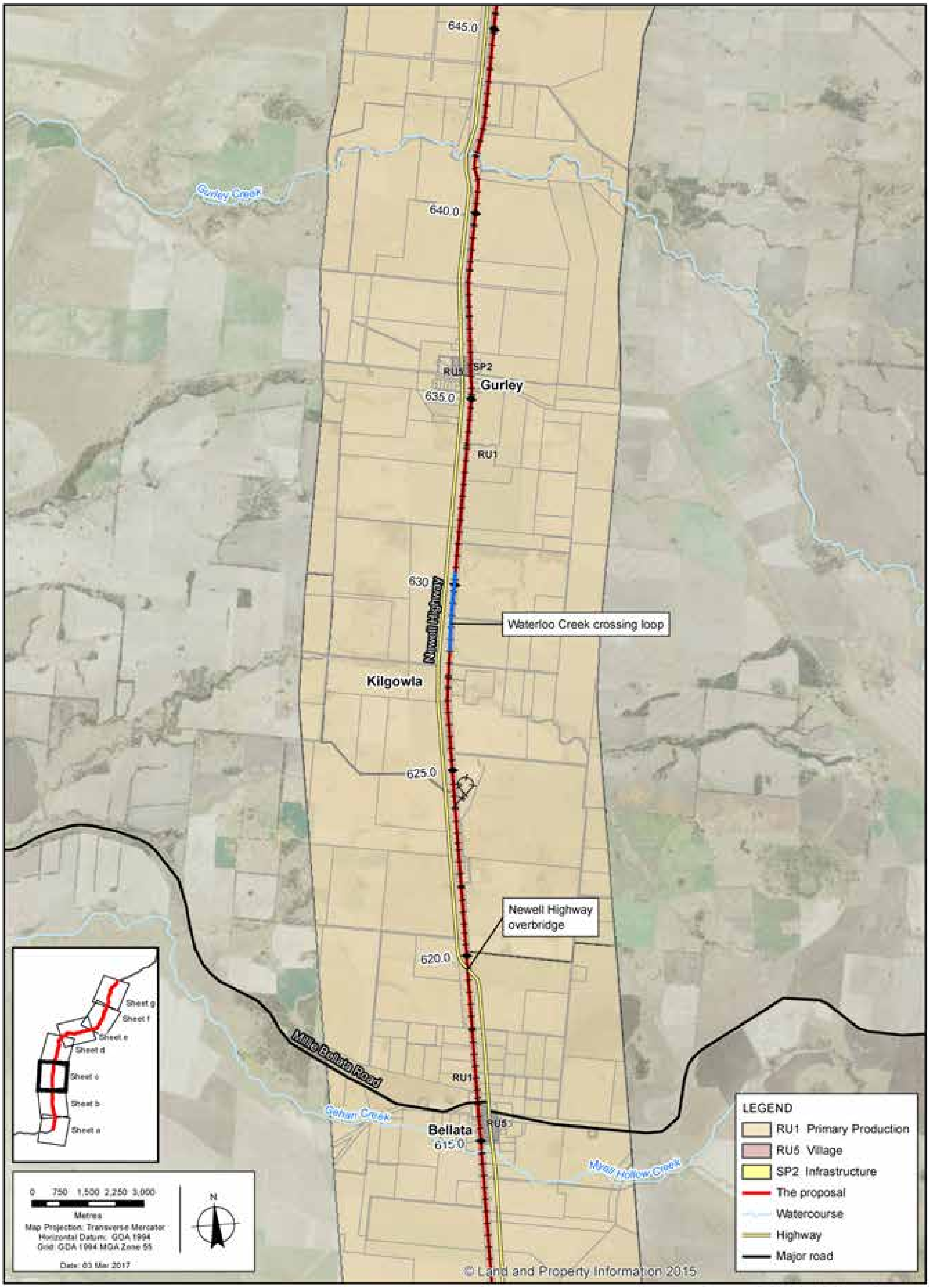


Figure 20.1d Land use zoning

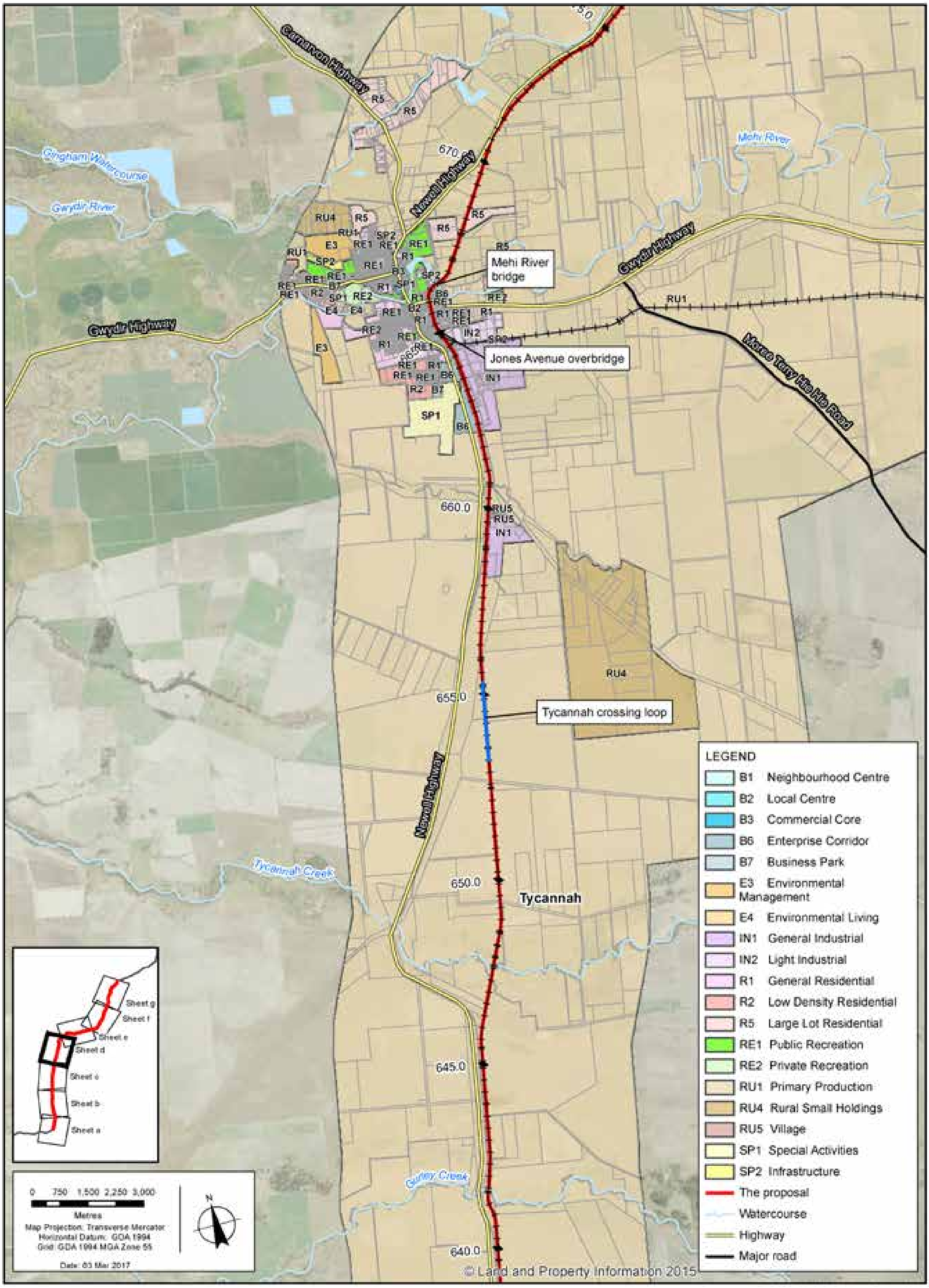


Figure 20.1e Land use zoning

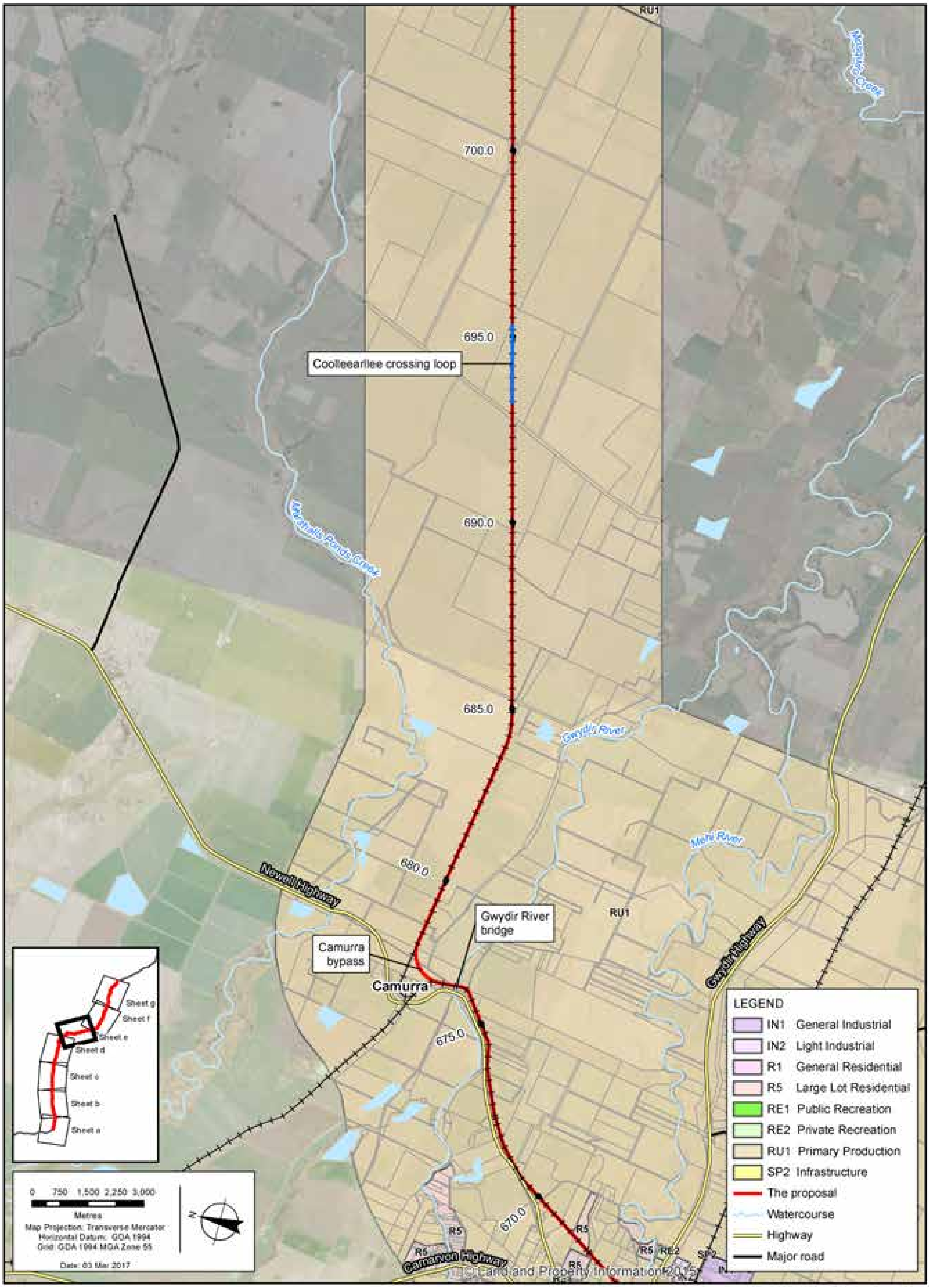


Figure 20.1f Land use zoning

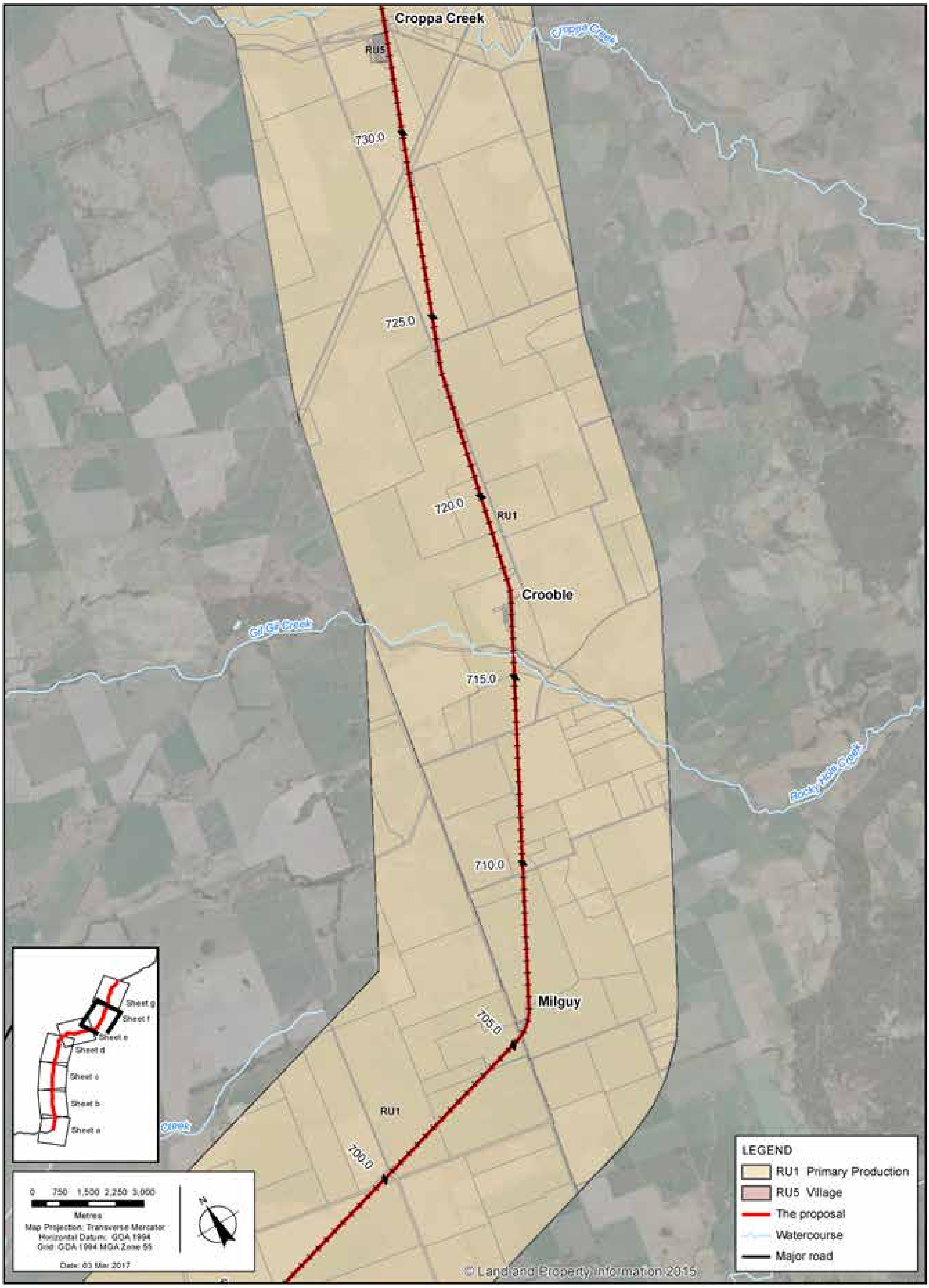


Figure 20.1g Land use zoning

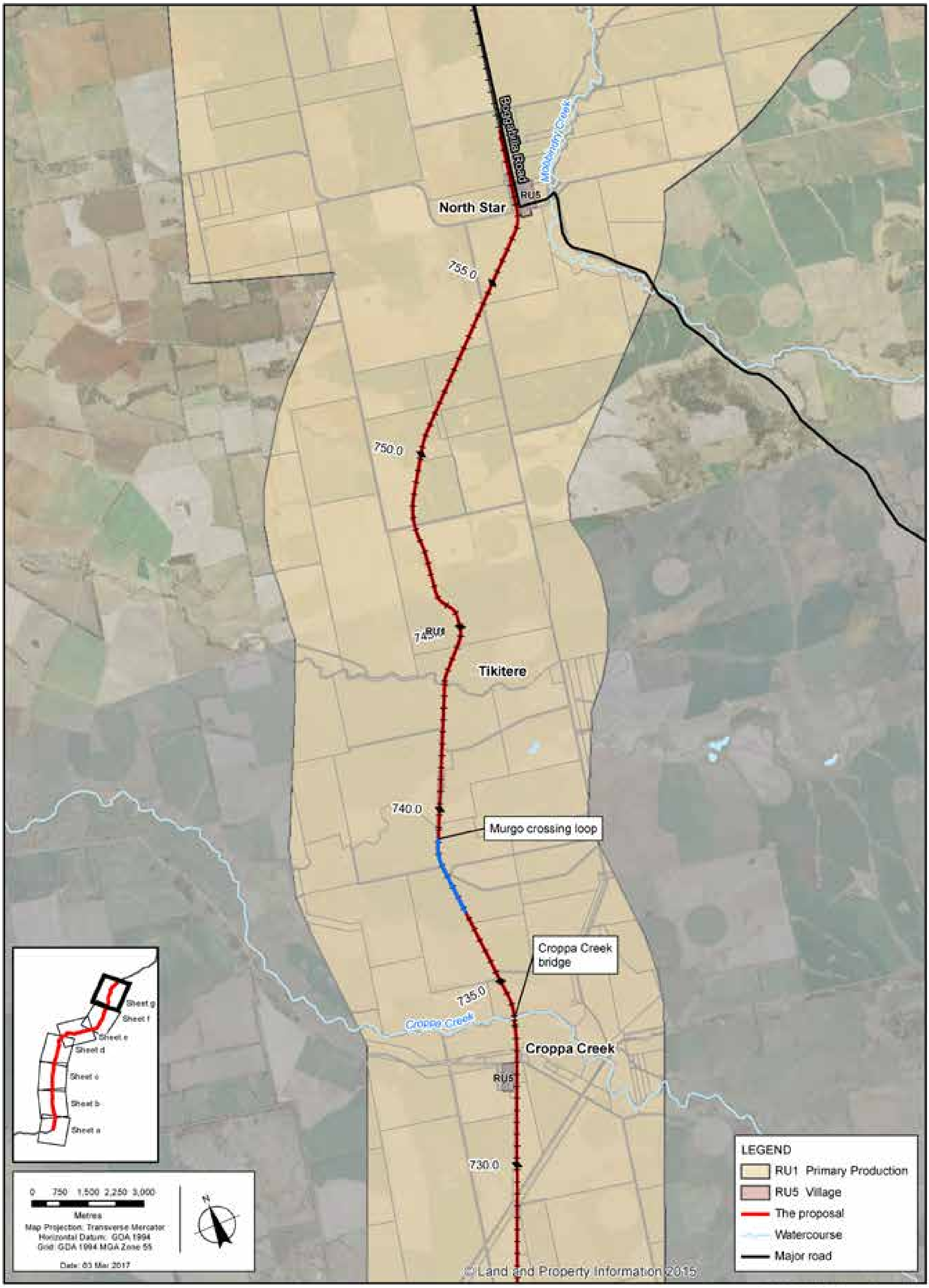


*Figure 20.2a	Specific land uses*

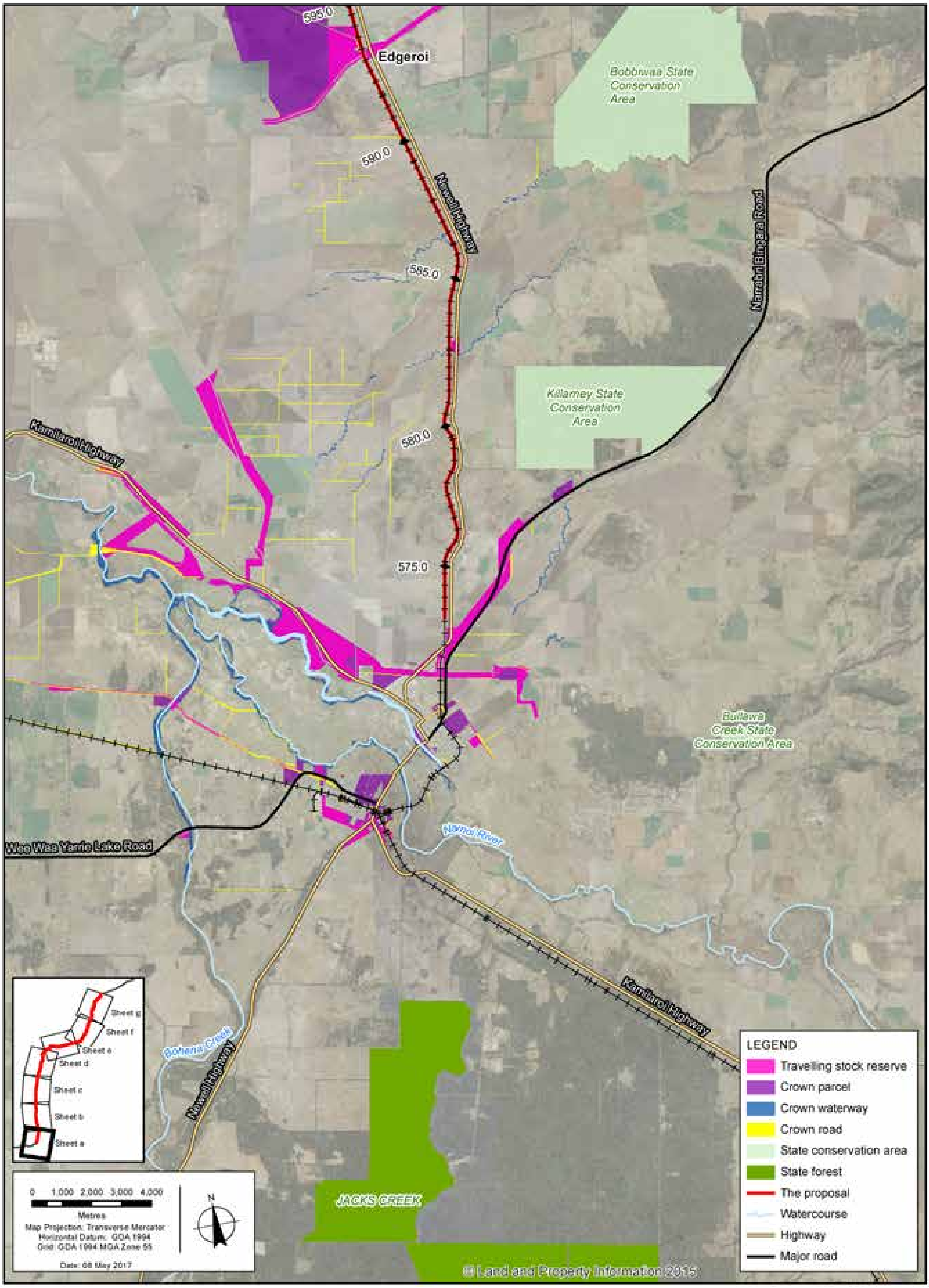


Figure 20.2b Specific land uses

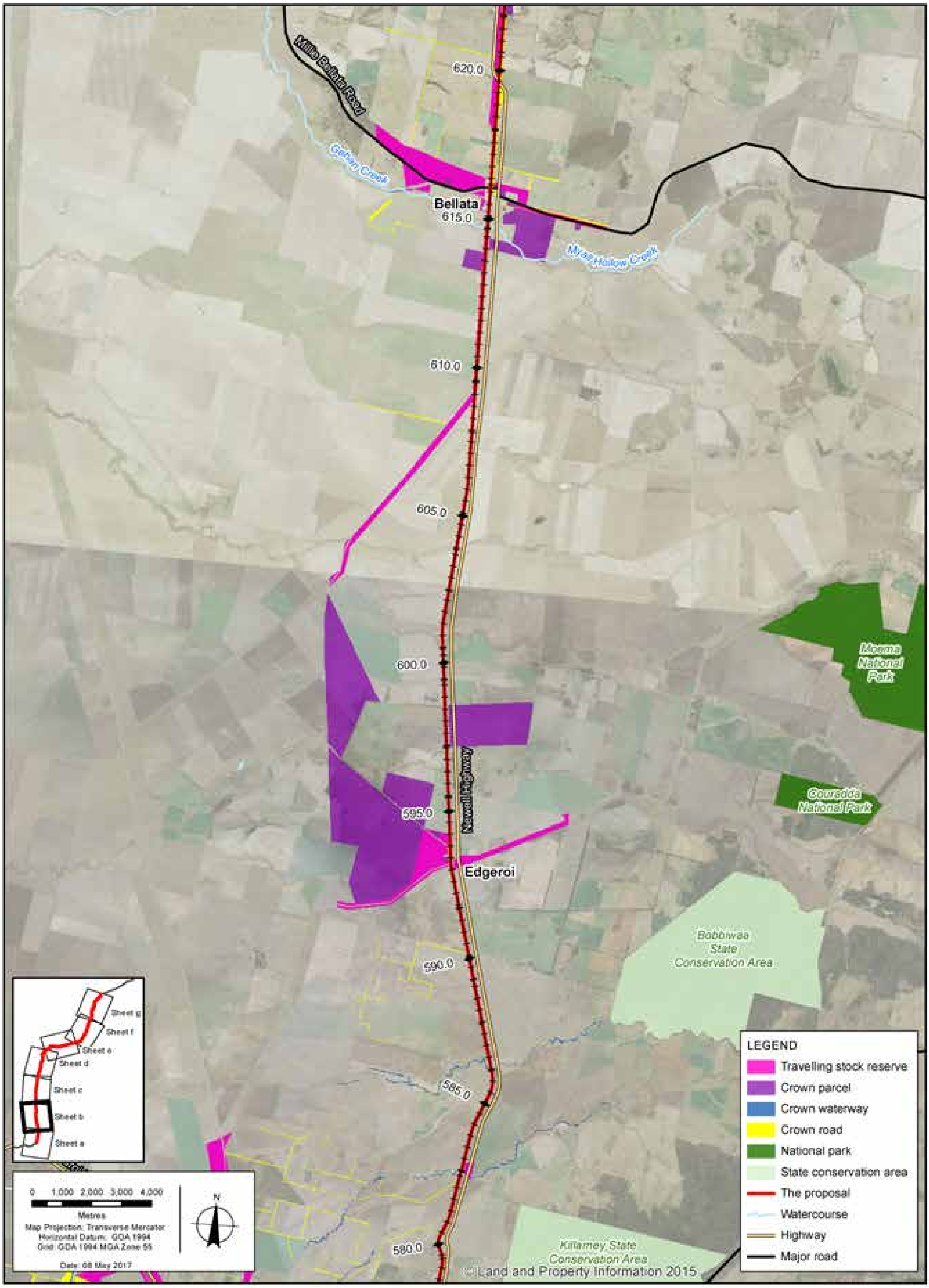


Figure 20.2c Specific land uses

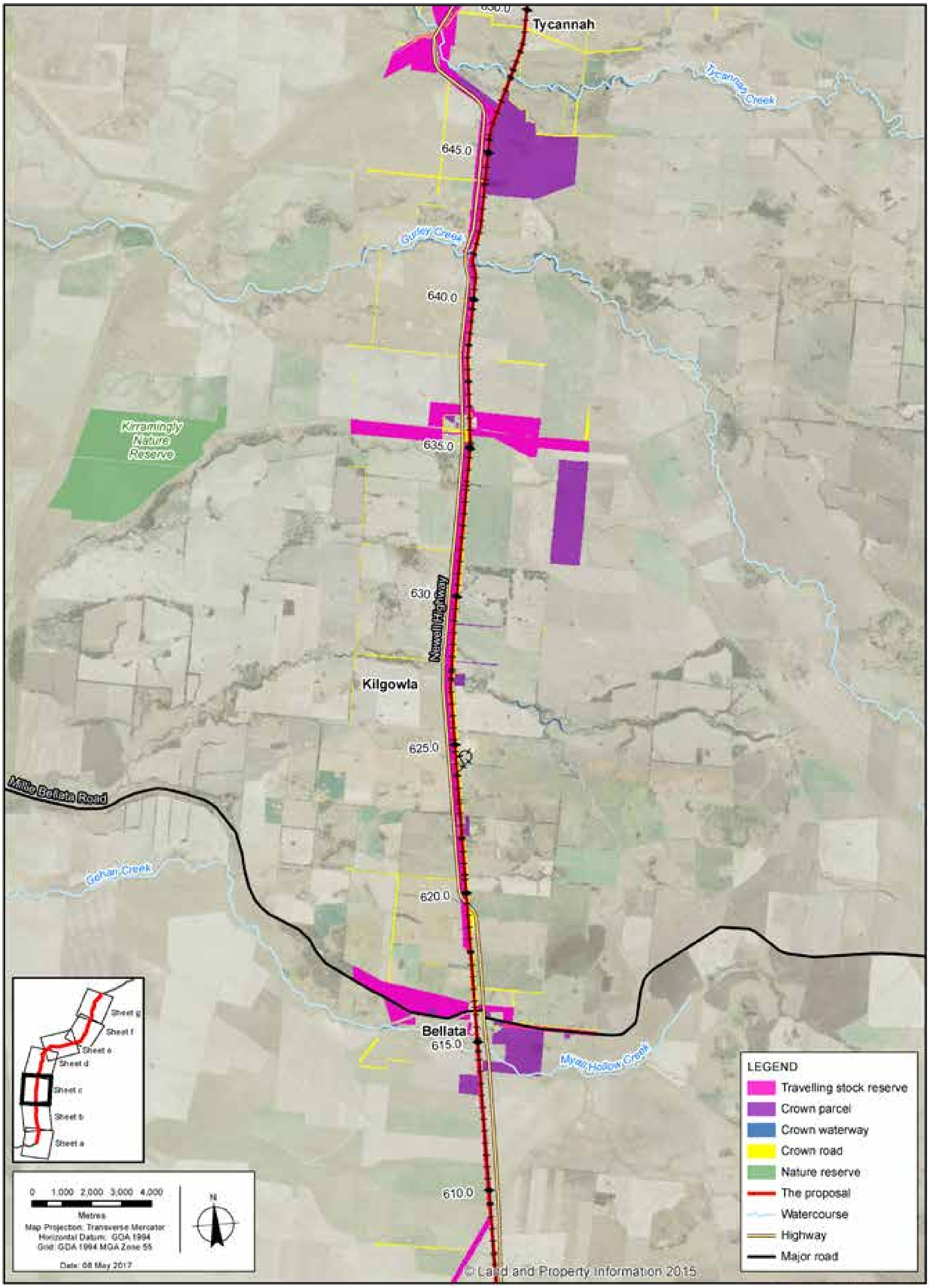


Figure 20.2d Specific land uses

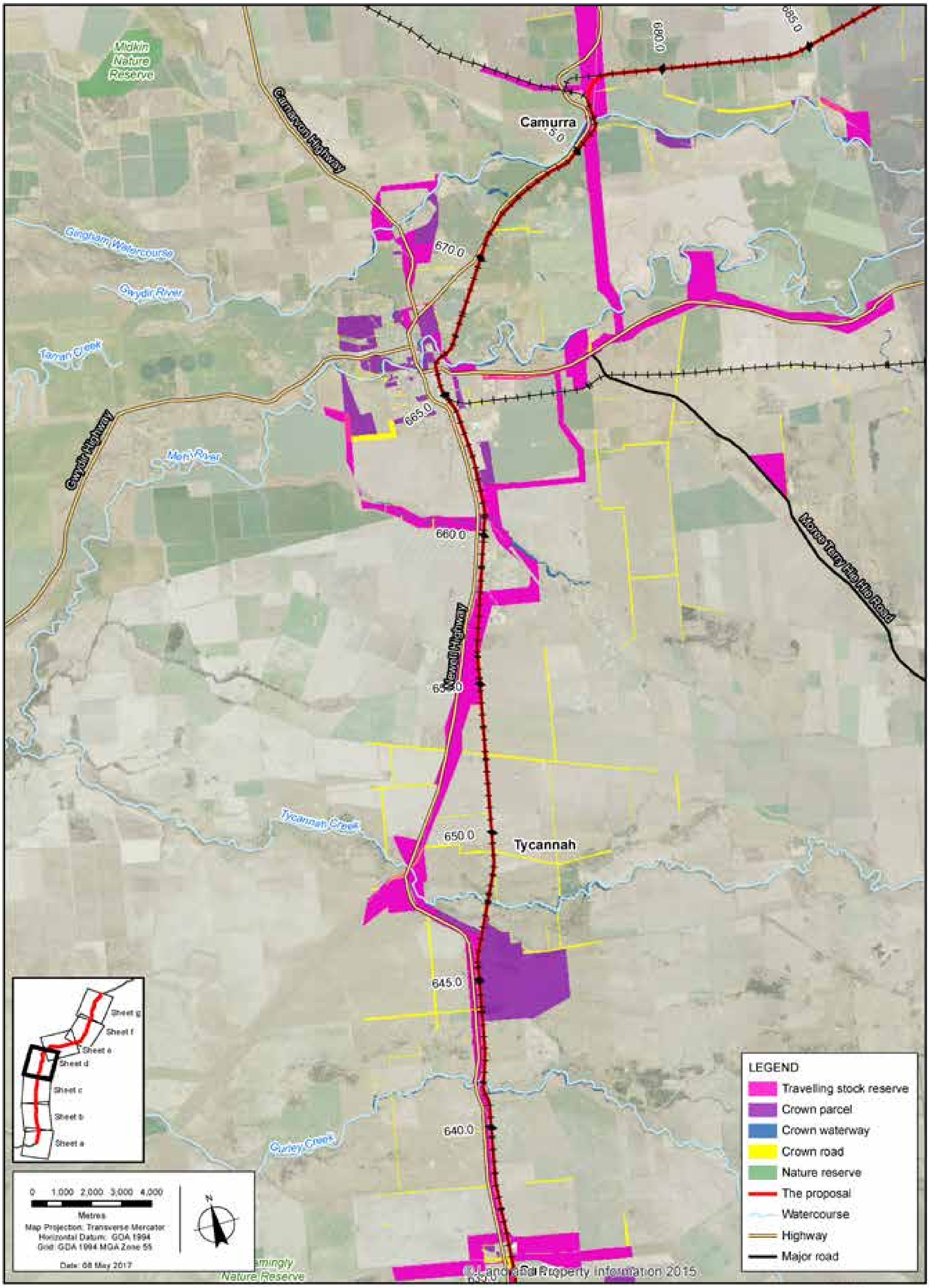


Figure 20.2e Specific land uses

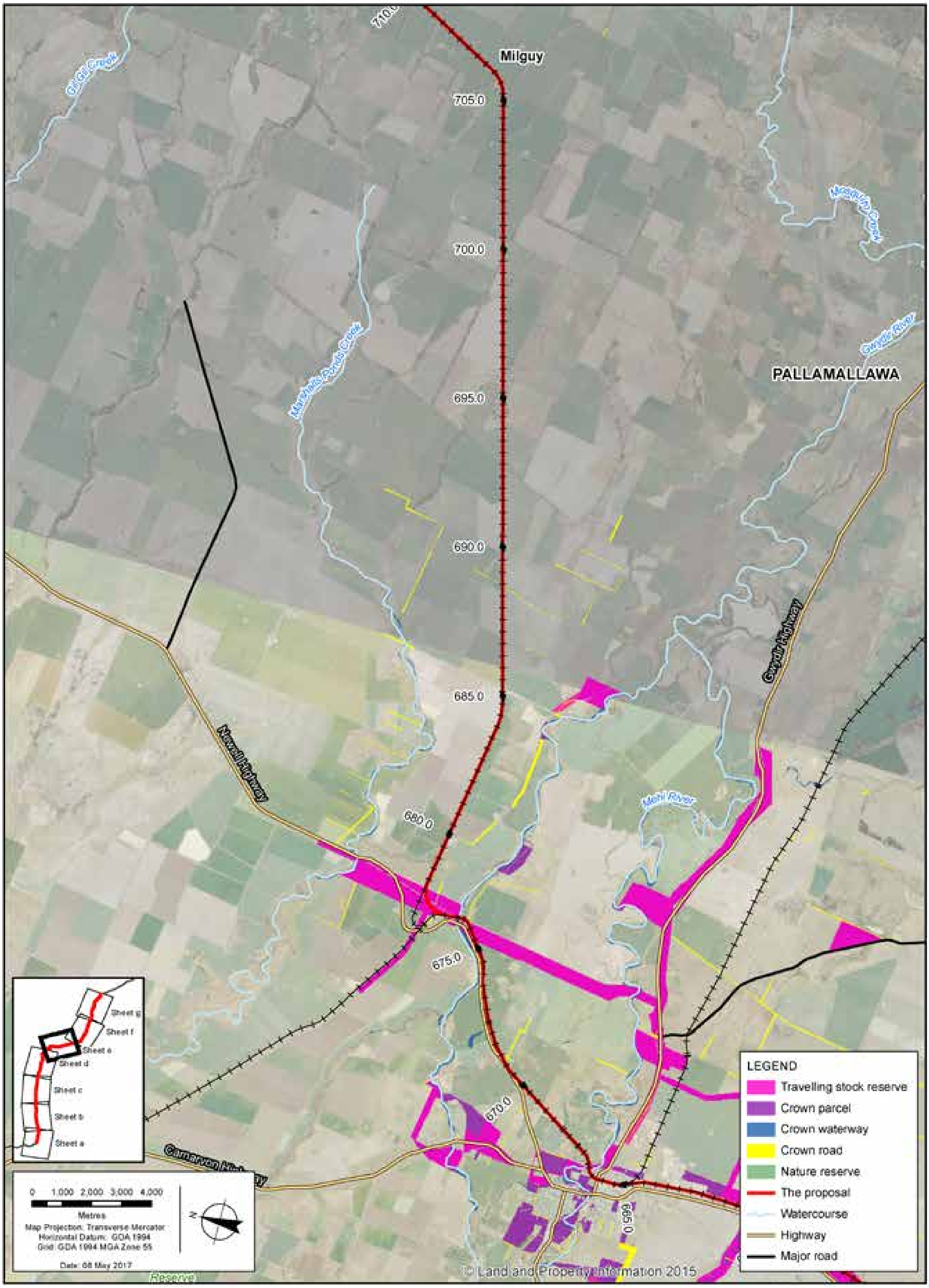


Figure 20.2f Specific land uses

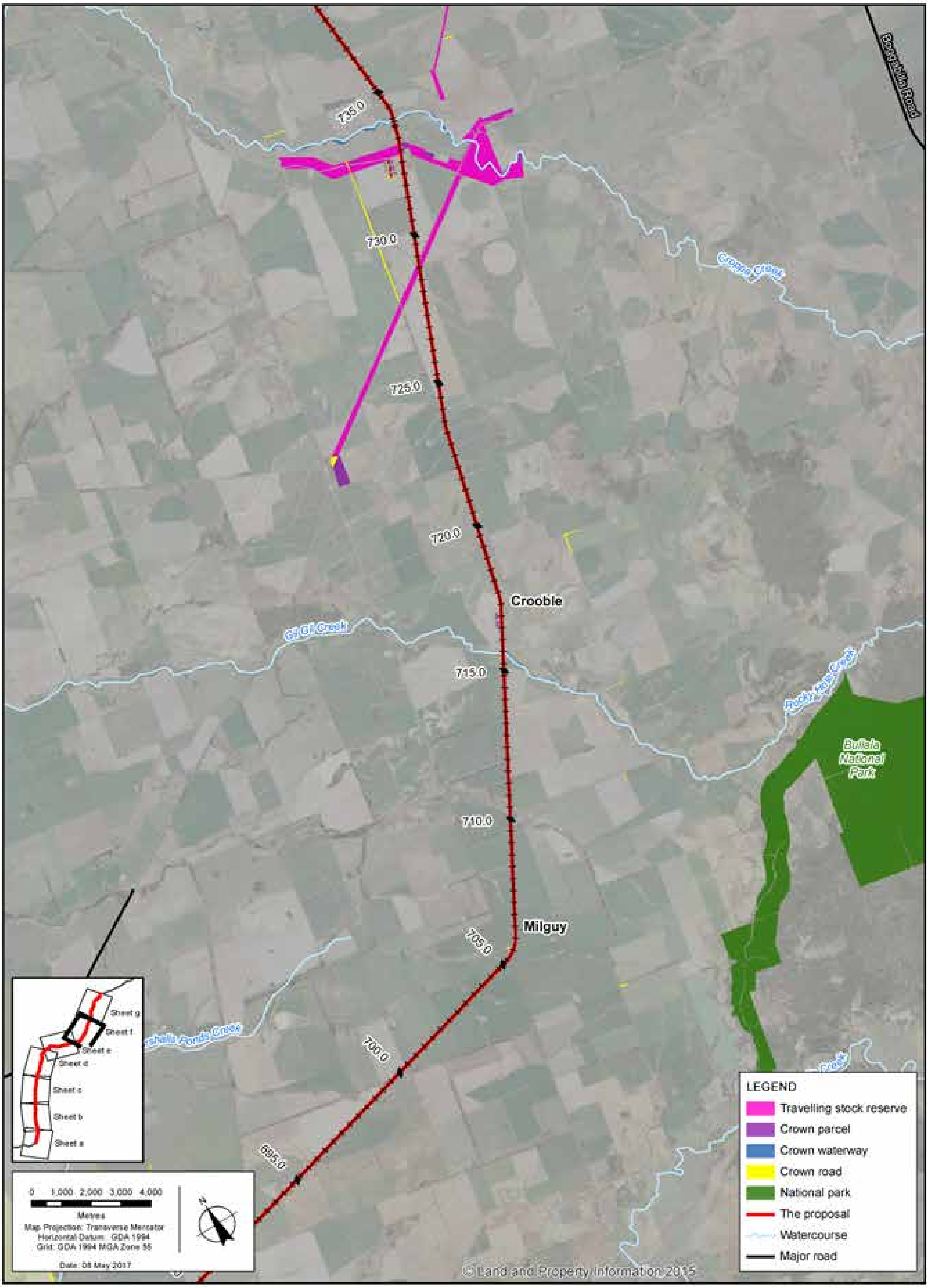
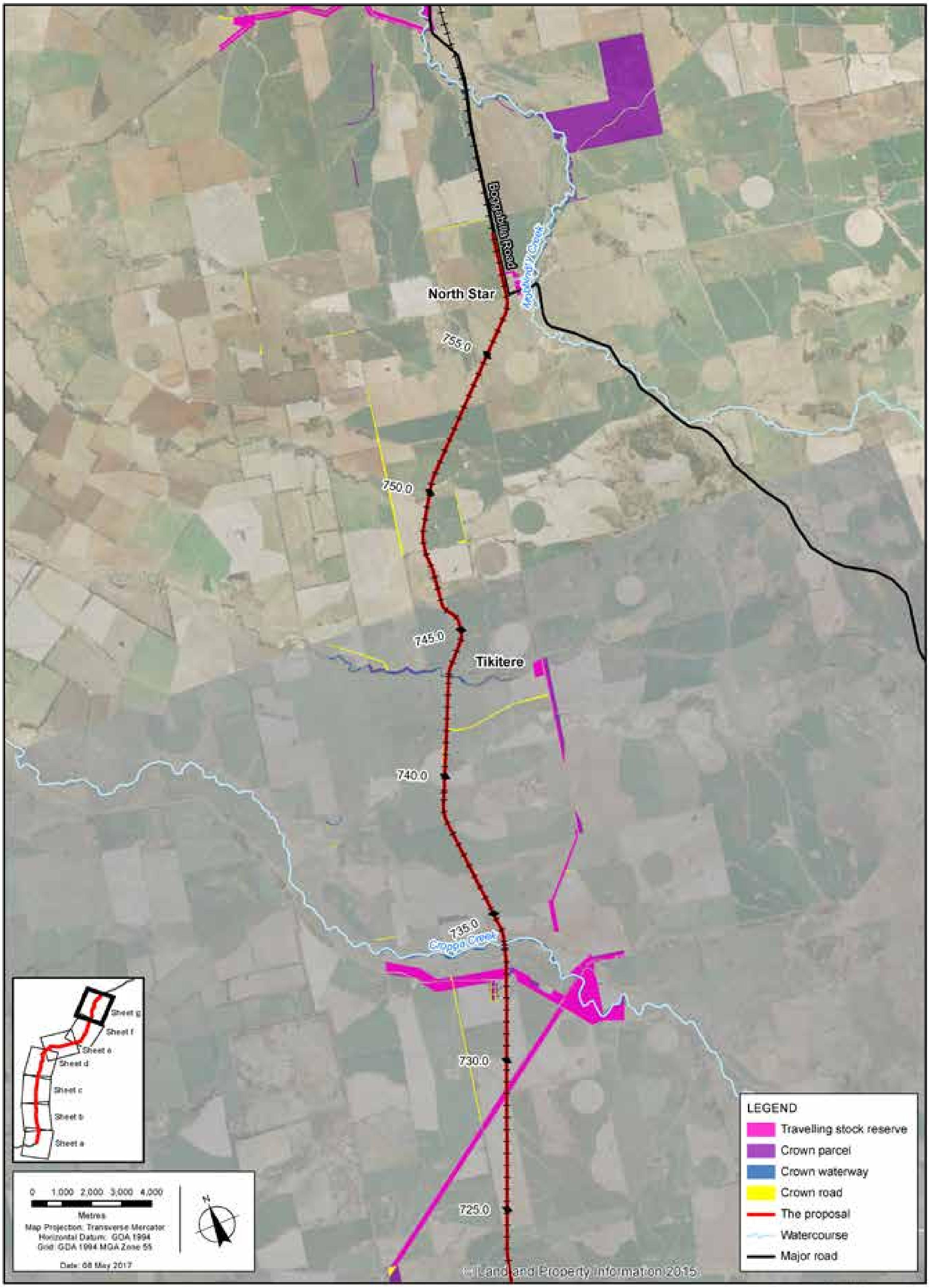


Figure 20.2g Specific land uses



Land use within the proposal site

Existing rail corridor

The majority of the proposal site is located within the existing rail corridor, which is used for infrastructure (transport – rail and supporting infrastructure) purposes. The zoning of the rail corridor is either SP1 – Special Activities (Freight Transport Facility), or SP2 – Infrastructure (Rail Infrastructure).

Existing operations along the corridor are described in more detail in Chapter 2.

Newell Highway overbridge

The proposal site for the Newell Highway overbridge is zoned RU1 – Primary Production.

Camurra bypass

The proposal site for the Camurra bypass is zoned RU1 – Primary Production.

Jones Avenue road overbridge

The proposal site for the Jones Avenue overbridge is zoned SP2 – Infrastructure, IN2 – Light Industrial, and B6 – Enterprise Corridor.

Other areas of the proposal site outside the existing rail corridor

Outside the existing rail corridor, the majority of land in the proposal site is zoned RU1 – Primary Production, with some IN1 – General Industrial and SP2 – Infrastructure zoning for areas where compounds would be located. The existing land use generally is rural/agricultural.

Adjoining/surrounding land uses

The existing rail corridor mainly runs through or in the immediate vicinity of land used for rural/agricultural purposes (zoned RU1 – Primary Production). Properties include open grazing land, land used for cropping, scattered vegetation, residences and other farm buildings. Further information on agricultural land uses is provided in Section 20.2.2.

Other land use zones adjoining the proposal site are:

- Land zoned as RU1 – Primary Production for the significant majority of the alignment.
- Land zoned as E1 – National Parks and Nature reserves to the east of the proposal site at Narrabri, representing Killarney State Conservation Area.
- Land zoned as RU5 – Village at various points along the proposal site, adjacent to Newell Highway.
- Land zoned as SP 2 – Infrastructure such as classified roads, hospitals and rail facilities where the proposal transects a town or road. Further information on the road network in the study area is provided in Chapter 9.
- Land zoned as SP1 – Special Activities in the town of Moree. This zoning allows for uses such as freight transport facilities, heavy industrial storage establishments, high technology industries, rural industries, transport depots and truck depots.
- Various residential, business, industrial, environmental and neighbourhood centre zones where the proposal runs through the town centre of Moree.

20.2.2 Agricultural uses and activities

Within the three LGAs, the major crops grown by area are wheat, cotton, chickpeas, barley, and sorghum (refer to Table 20.2). A rapid expansion of irrigated agriculture coincided with the construction of Copeton Dam in 1968. Copeton Dam, one of the largest dams in inland NSW, provides water to support communities, agriculture and the environment in the Gwydir Valley. Similarly, Keepit Dam was constructed on the Namoi River to boost agricultural production around the towns of Narrabri, Gunnedah, Wee Waa and Walgett. Cotton-gins and grain handling facilities are located through the Namoi and Gwydir valleys.

Table 20.2 Major crops grown in each LGA

Crop variety	Narrabri (ha)	Moree Plains (ha)	Gwydir (ha)	Total (ha)	Per cent
Wheat	145,102	334,403	58,019	537,524	42.6
Cotton	67,350	148,342	9,098	224,790	17.8
Chickpeas	41,570	131,510	27,537	200,617	15.9
Barley	9,962	107,775	33,470	151,207	12
Sorghum	12,209	67,078	26,991	106,278	8.4
Faba Beans	5,527	12,569	318	18,414	1.5
Mung Beans	3,872	7,285	2,548	13,705	1
Canola	3,089	5,944	1,230	10,263	0.8
Total	**288,681**	**814,906**	**159,211**	**1,262,798**	

Source: ABS (2012) *Agricultural Commodities Small Area Data, Australia,* 2010.11, Cat. No. 7121.0

In addition to cropping activities, livestock grazing (sheep and cattle), and cattle feedlotting are major enterprises (Table 20.3). Within the Gwydir LGA, the Myola feedlot at North Star is one of the largest feedlots in NSW, with a capacity of 20,000 head and turnover capacity of around 80,000 head per year.

Table 20.3 Livestock numbers in each LGA

Livestock	Narrabri	Moree Plains	Gwydir	Total
Cattle (beef)	81,707	108,394	140,901	331,002
Sheep	78,982	140,482	119,434	338,898
Lambs	53,592	93,044	37,470	184,106

Source: ABS (2012) *Agricultural Commodities Small Area Data, Australia*, 2010.11, Cat. No. 7121.0

Land and soil capability

Rural lands in NSW are currently being mapped according to two different land classification systems. The first of these classifies land into eight classes known as Land Capability Classes and was developed by the former NSW Soil Conservation Services, while the second system classifies land into five classes known as Agricultural Suitability Classes. The aim of the Land Capability classification is to delineate the various classes of rural land on the basis of the land to remain stable under particular land uses. The Agricultural Suitability classification also uses land capability as a basis but then incorporates other factors such as closeness to markets, availability of water etc. Because the Land Capability system classifies land in terms of inherent physical characteristics or constraints, it consider the optimum use of land rather than the maximum use and in general will not change over time, while the Agricultural Suitability may. Given this, the Land Capability system was considered better to assess how the proposal may have an impact on agricultural land use in the area through physical changes to the landscape such as flooding.

The 8-class classification is shown in Table 20.4 while Figure 20.3 shows the land capability classes in proximity to the proposal site. Land near the proposal site predominantly comprises Class 2 and Class 3 land, which is capable of being regularly cultivated as per the definition in Table 20.4. This is generally consistent with the land uses described in Section 20.2.1 which identified cropping and grazing as the predominant land uses within the three LGAs.

Table 20.4 Land and soil capability

Broad category	Class	Description
Land capable of being regularly cultivated (Slope < 10%)	Class 1	No special soil conservation works or practices necessary.
	Class 2	Soil conservation practices such as strip cropping, conservation tillage and adequate crop rotation.
	Class 3	Structural soil conservation works such as diversion banks, graded banks and waterways, together with soil conservation practices as in Class 2.
Land not capable of being regularly cultivated but suitable for grazing with occasional cultivation (Slope 10% - 25%)	Class 4	Soil conservation practices such as pasture improvement, stock control, application of fertiliser and minimal cultivation for the establishment or reestablishment of permanent pastures.
	Class 5	Structural soil conservation works such as absorption banks, diversion banks and contour ripping, together with the practices as in Class 4.
Land not capable of being cultivated but suitable for grazing (Slope > 25%)	Class 6	Soil conservation practices including limitation of stock, broadcasting of seed and fertiliser, prevention of fire and destruction of vermin. This class may require some structural works.
Other lands	Class 7	Land best protected by green timber.
	Class 8	Cliffs, lakes or swamps and other land incapable of sustaining agricultural or pastoral production.

Source: *Cunningham et al 1988, Systems used to classify rural lands in New South Wale*s.

20.2.3 Reserves

The nearest reserves to the proposal site are listed in Table 20.5.

Table 20.5 Reserves in the study area

Name of reserve	Type of reserve	Distance from proposal site at the nearest point
Killarney	State Conservation Area	1.9 kilometres to the east
Bobbiwaa	State Conservation Area	4.0 kilometres to the east
Bullala	National Park	6.6 kilometres to the east
Kirramingly	Nature Reserve	8.0 kilometres to the west
Bullawa Creek	State Conservation Area	9.9 kilometres to the east
Moema	National Park	10.4 kilometres to the east
Couradda	National Park	10.9 kilometres to the east

Figure 20.3a   Land and soil capabilities

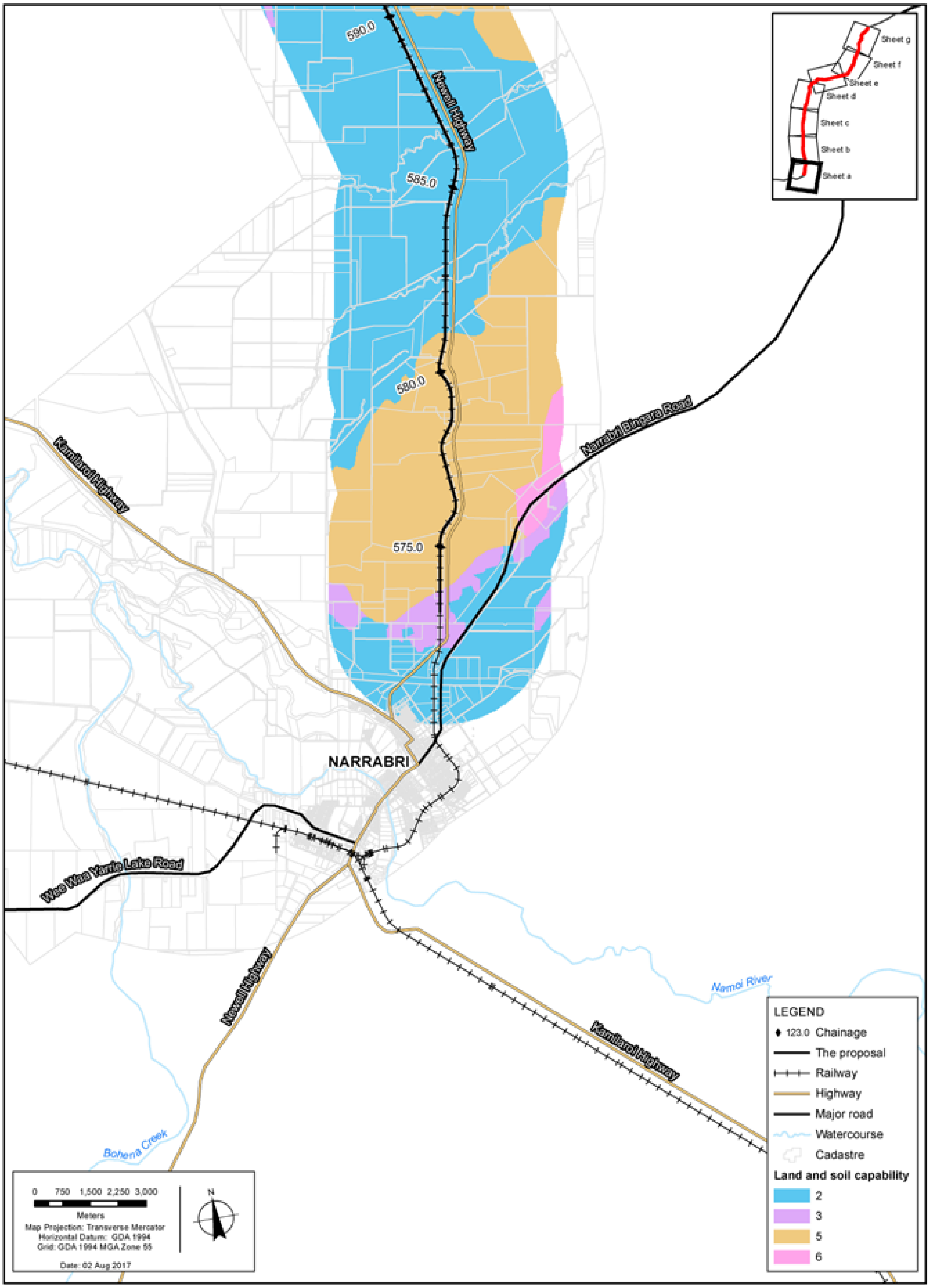


Figure 20.3b Land and soil capabilities

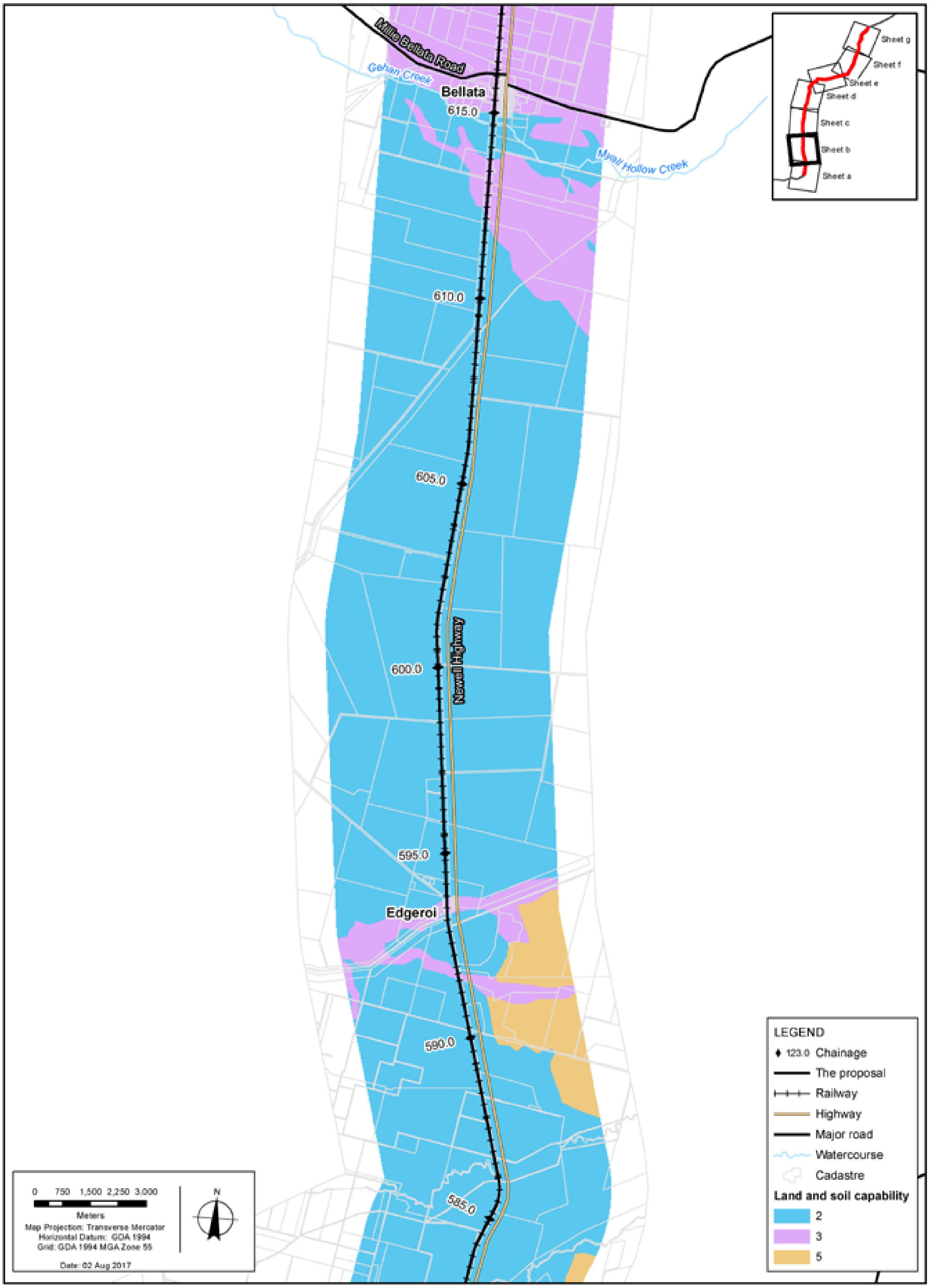


Figure 20.3c Land and soil capabilities

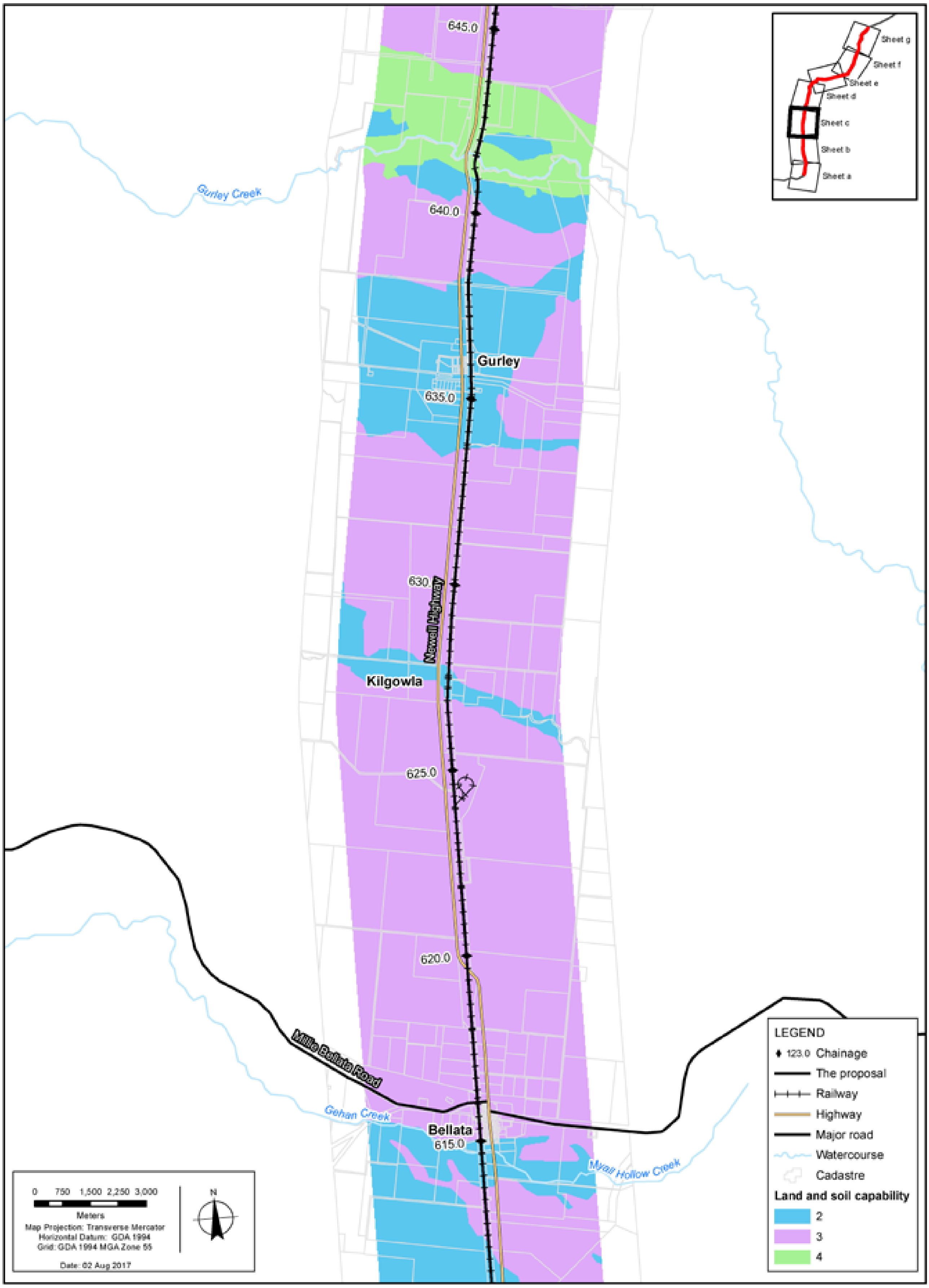


Figure 20.3d Land and soil capabilities

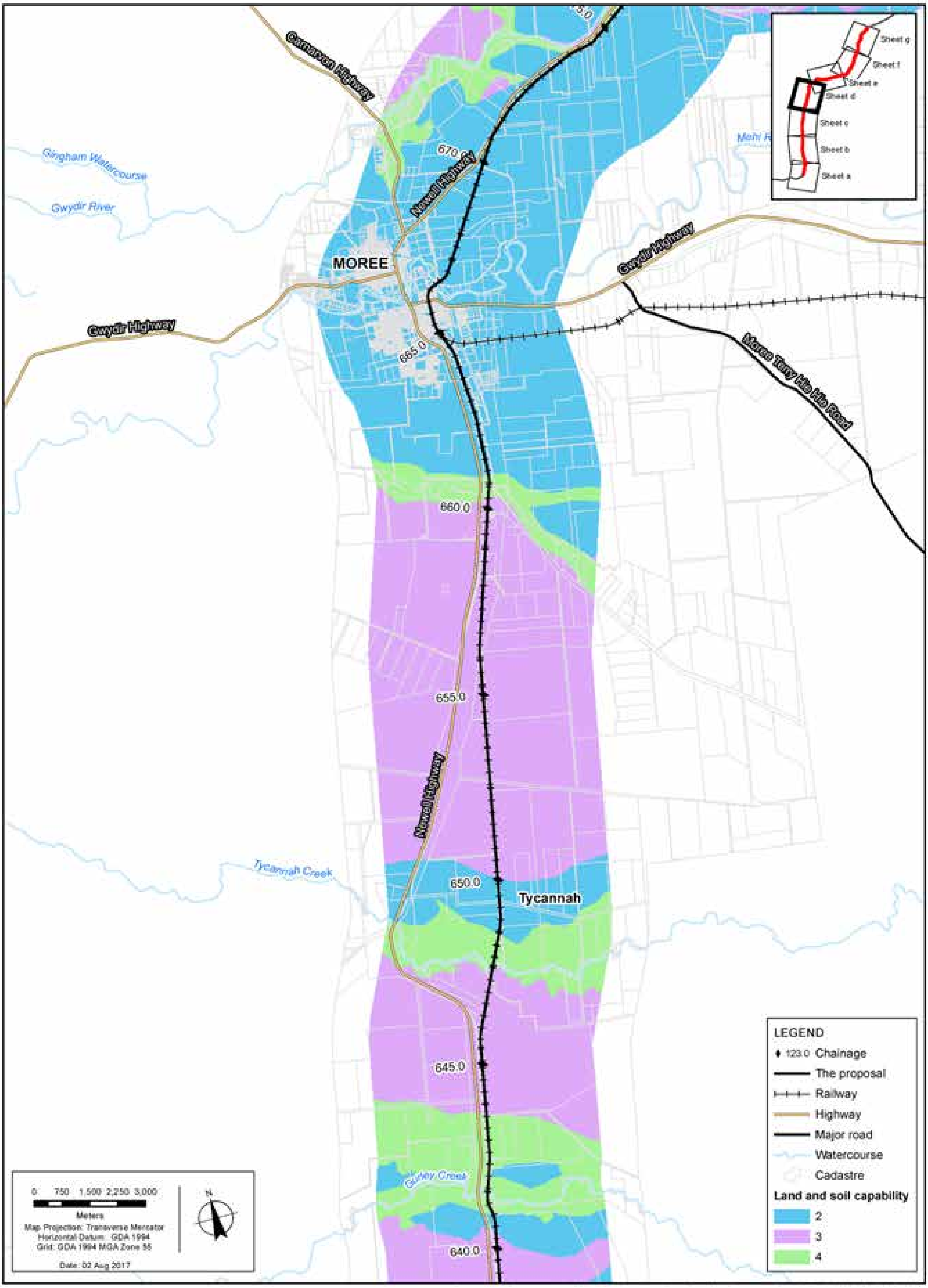


Figure 20.3e   Land and soil capabilities

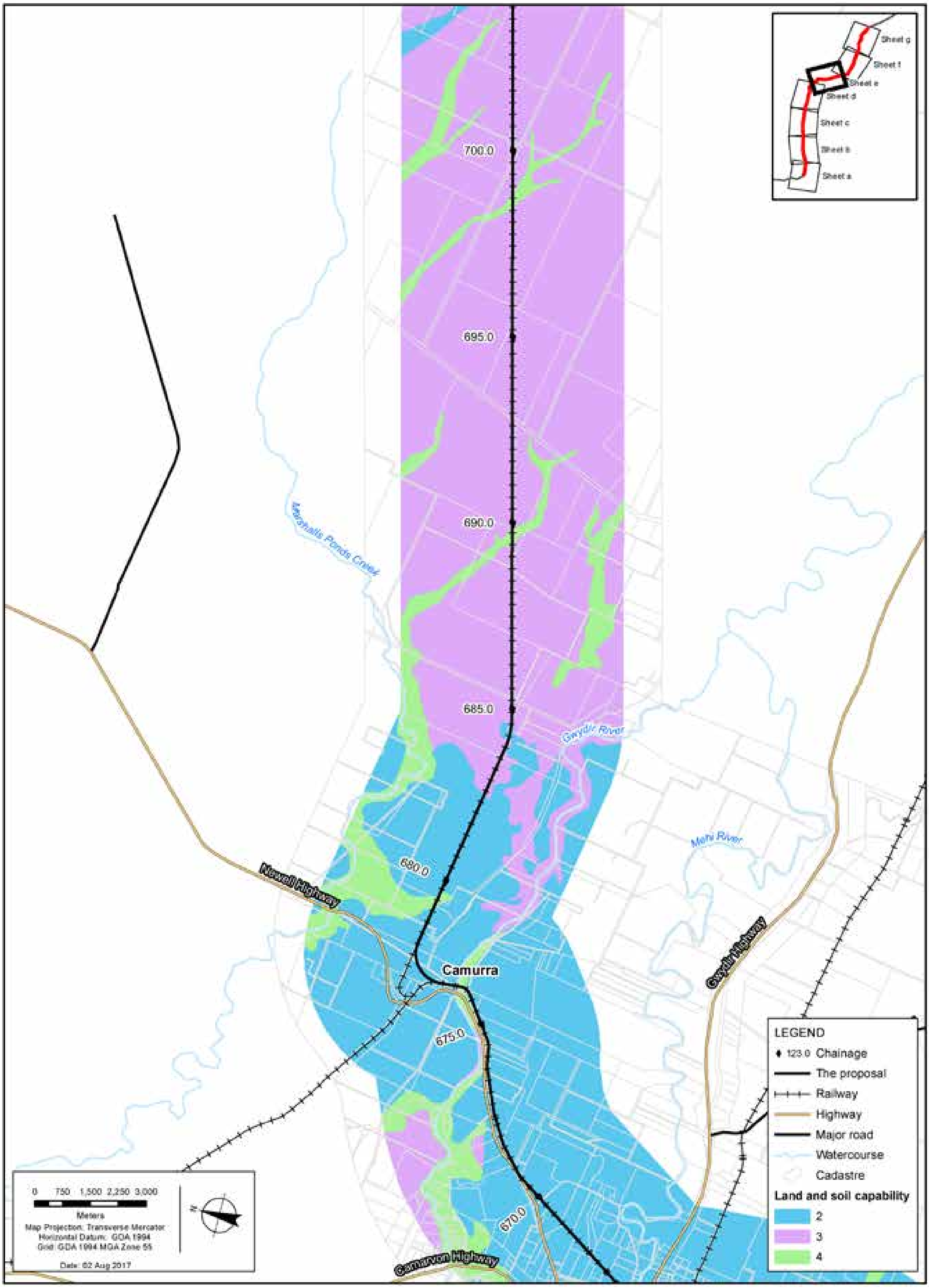


Figure 20.3f   Land and soil capabilities

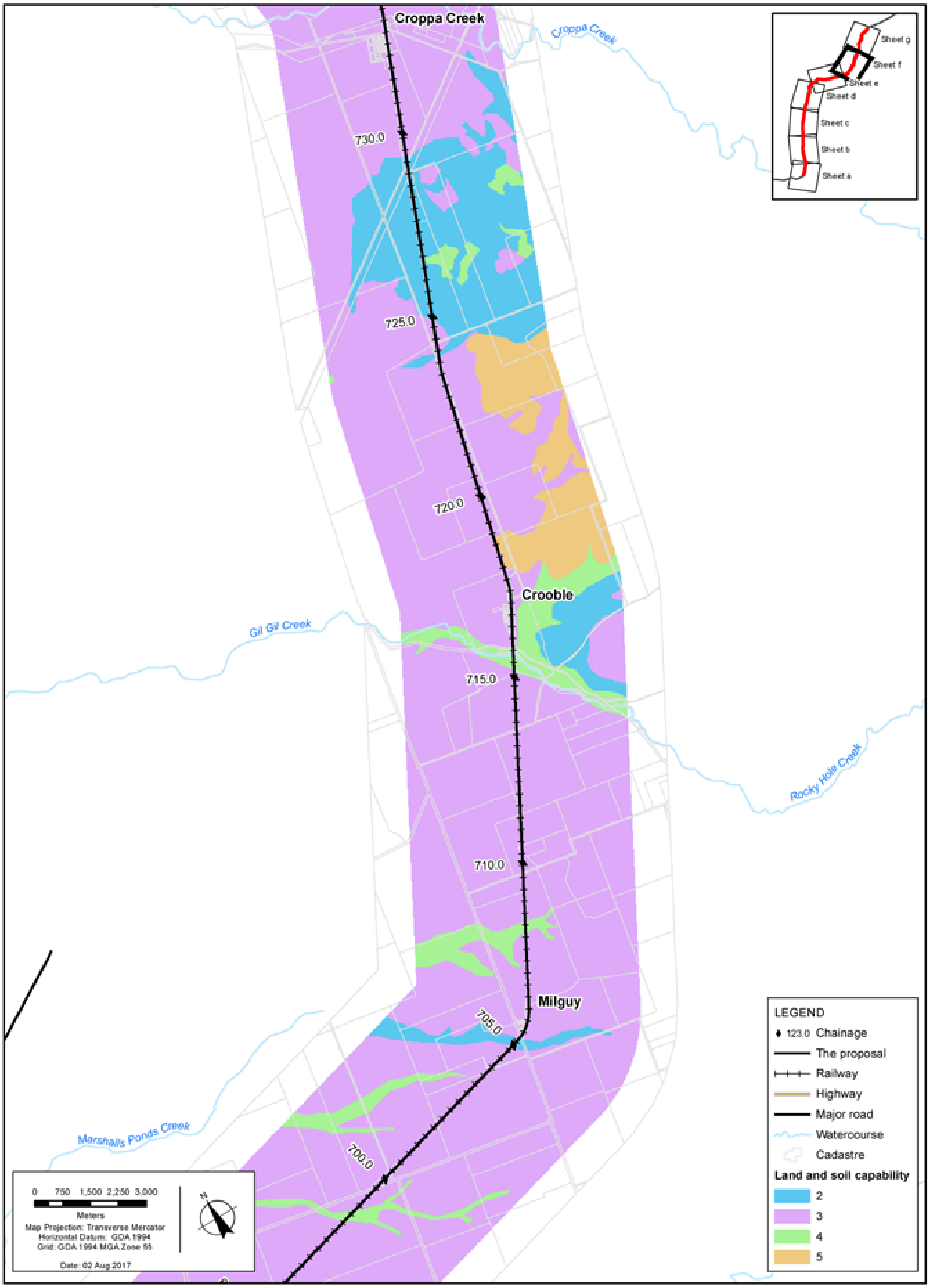
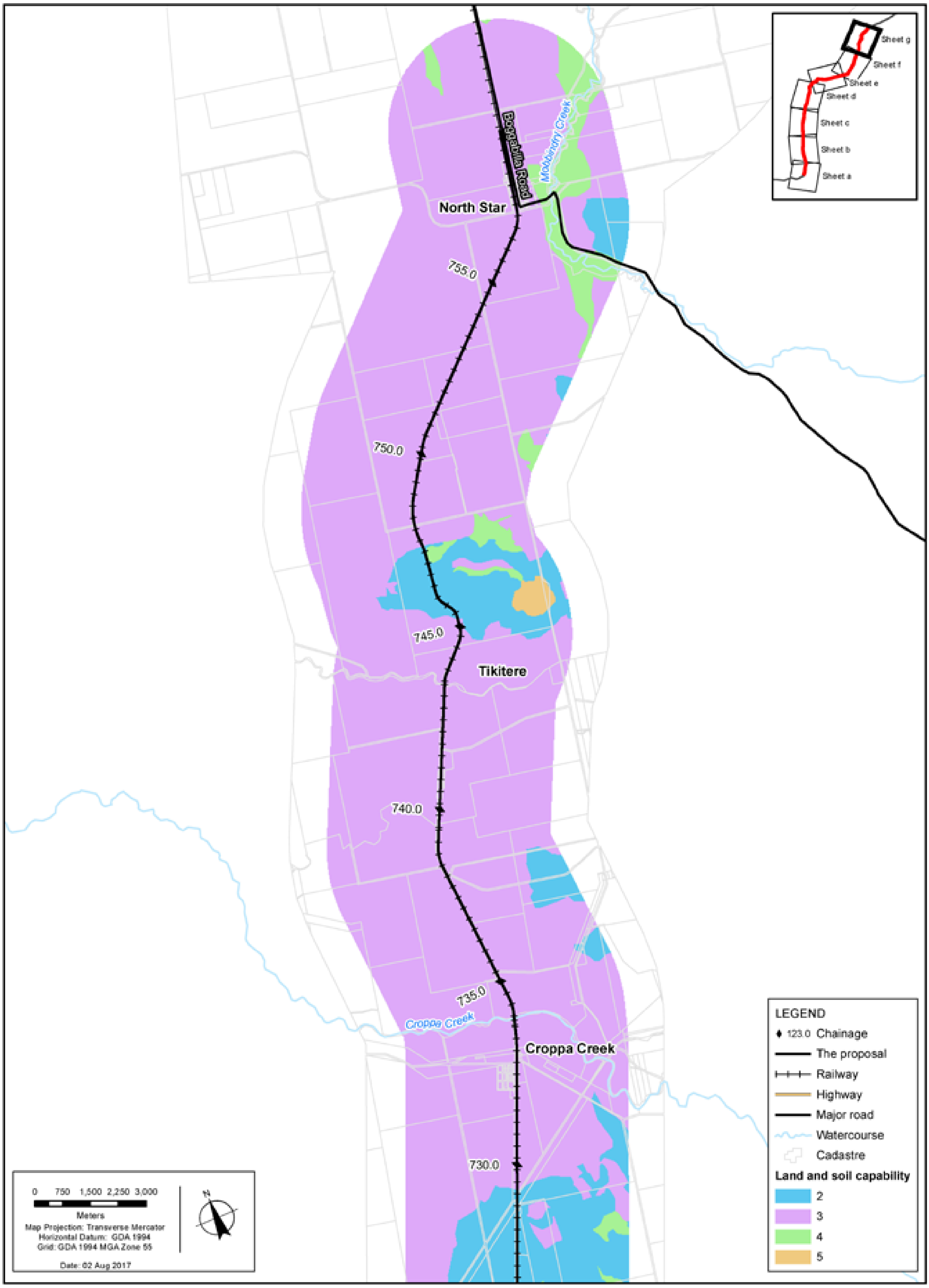


Figure 20.3g Land and soil capabilities



20.2.4 Mining and exploration leases and petroleum licenses

There are no mining or mineral exploration leases within proximity to the proposal.

There are three petroleum licenses within the study area, all of which are expired. Two were licenced to Comet Ridge Gunnedah Pty Ltd (PEL0006) and Comet Ridge Ltd (PEL0427), and one to Santos NSW Pty Ltd (PEL0238). There is one active petroleum licence (Santos NSW (Hillgrove) Pty Ltd – PPL0003), located about 13 kilometres south-west of the Narrabri end of the proposal site.

20.2.5 Crown land and travelling stock reserves

Crown land within 100 metres of the proposal comprises 79 Crown roads, which is inclusive of one shared Crown and council owned road, and 38 undefined lots. Of these, about 25 roads either cross or end at the proposal site. In addition, 12 parcels of Crown land are located directly adjacent to the proposal site.

Travelling stock reserves are parcels of Crown land reserved under legislation for use by travelling stock. They provide pasture reserves for travelling or grazing stock. Travelling stock reserves within 4 kilometres of the proposal site are shown in Figure 20.2 and comprise the following (in addition to the Crown roads and land noted above):

- two Crown waterways, of which one crosses the proposal site
- two Crown roads (neither of which cross the proposal site or are shared Crown and council roads)
- 79 parcels of Crown land, of which about 56 are directly adjacent to the proposal site and 5 cross the proposal site.

The above summary and the Crown land shown on Figure 20.2 differentiates between Crown land that is travelling stock reseves and other Crown land.

The Office of the Registrar did not identify any Registered Aboriginal Owners that should be contacted regarding the proposal. The National Native Title Tribunal advised that there is a registered Native Title claim that includes the entirety of the proposal site. The claim (NC2011/006) is in the name of the Gomeroi People and includes 19 listed applicants, many of whom registered an interest in the proposal as individuals or as part of other organisations. Refer to Chapter 17 and Technical Report 8 for further information regarding the existing Native Title claim.

20.2.6 Land ownership/tenure

The majority of land within the study area is held in freehold title. This includes properties held in freehold by private owners and various State Government departments. The study area also comprises areas identified as Crown land, including reserves, waterways and public roads. The management of Crown land in NSW is the responsibility of the Crown Lands Division within the NSW Department of Primary Industries.

Land within the existing rail corridor is owned/leased by:

- Austgrains Pty Limited, Moree Plains Shire Council and Rail Infrastructure Corporation
- Country Rail Infrastructure Authority
- Department of Commerce
- Rail Infrastructure Corporation
- State Rail Authority - Rail Estate
- State Rail Authority of NSW
- The State of NSW
- Transport for NSW.

Ownership of land within other areas of the proposal site comprises various government departments, the Crown and a number of private owners. Land ownership for land proposed for acquisition is provided in Appendix G.

20.3 Impact assessment

20.3.1 Risk assessment

Potential impacts

The environmental risk assessment for the proposal (summarised in Appendix B) included an assessment of the potential issues and risks associated with land use and property. The assessed risk level for the majority of potential land uses risks was medium to high. Risks with an assessed level of medium or above include:

- temporary impacts on land use during construction
- impacts on agricultural practices during construction activities as a result of changes to access, noise, and air pollution
- impacts on land use as a result of property acquisition.

How potential impacts have been avoided

The approach to avoiding land use and property impacts is similar to that for landscape and visual impacts, as described in Section 19.3. The proposal minimises the potential for direct impacts to land use and properties, as the majority of works would be undertaken within the existing rail corridor. For works outside the corridor (particularly the Camurra bypass), land use and property impacts were included in the list of selection criteria used for the analysis of options.

Potential impacts on land use and property would continue to be avoided by:

- designing, constructing, and operating the proposal to minimise the potential for land take outside the rail corridor
- implementing the mitigation measures provided in Section 20.4.

20.3.2 Land acquisition and leasing

As noted in Section 7.5, a limited amount of property acquisition would be required to construct the proposal. Initial and indicative land acquisition requirements are provided in Appendix G, including initial estimates on the area that would be acquired. The exact area of the lots that would need to be acquired would be confirmed during detailed design. At this stage of the design process, it is estimated that land acquisition would partially affect three privately owned lots, four Crown owned lots, one Roads and Traffic Authority of NSW owned lot (now known as Roads and Maritime Services) and one lot for which the owner is unknown.

The area of privately owned land that is likely to be acquired is about 15,240 square metres, of which about 4,990 square metres is zoned RU1 – Primary Production and the rest is zoned IN2 – Light Industrial and is located within Moree. All acquisitions of privately owned land would be undertaken in consultation with landowners and in accordance with the requirements of the *Land Acquisition (Just Terms Compensation) Act 1991*.

Property acquisition for partial acquisition will be managed in accordance with the following process:

- identification of the land to be acquired and how that affects a landowner
- creation of a preliminary acquisitions plan that defines the land take
- the identification and establishment of property adjustment plans (that identify the affect on any adjustments required, for example, to continue access, severance, dam relocation and fencing relocation)
- eirect consultation on a one-on-one basis with the landowner (and any other party that may have a claim to compensation)
- redesign of the property adjustment plan in consultation with the owner seeking agreement
- costing of those property adjustments including the cost to re-establish those land improvements
- the payment of compensation for the land taken in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991*, including the cost of any adjustments

The identification of these works, the cost estimates, and the compensation forms part of the contract between the acquiring authority and the landowner.

The land use for those areas acquired outside the existing rail corridor, such as for the Camurra bypass, would change from the existing land use (the existing zoning is defined in Appendix G) to an active transport (rail) use. Acquisition would mainly affect land zoned RU1 – Primary Production (83 per cent of the land to be acquired), the majority of which is Crown owned land (discussed below).

Any land required for construction (for the location of construction compounds and site accesses) would be leased from landholders. Leasing requirements are unknown at this stage. Consultation regarding agreements would be undertaken with landowners prior to construction commencing.

Impacts to Crown land

At this stage of the design process, it is estimated that about 88,755 square metres from four parcels of Crown land would be required to construct the proposal (84 per cent of the total land to be acquired). Of this land, about 82,958 square metres consists of travelling stock reserves and has been designated for conservation purposes (refer to Figure 20.4 which shows land uses).

All acquisition of Crown land would be undertaken in consultation with the Department of Finance, Service and Innovation, and in accordance with the requirements of the *Crown Lands Act 1989* and the *Land Acquisition (Just Terms Compensation) Act 1991.*

The acquisition of land designated for travelling stock use could permanently impact access and use of this land. ARTC would liaise with Local Land Services during detailed design to understand how and when the reserves with the potential to be permanently impacted are used, and how impacts could be avoided. Acquisition of land classified as travelling stock reserves would be undertaken in consultation with Local Land Services, to ensure impacts to travelling stock reserves are minimised, where possible.

20.3.3 Construction impacts

Land use

General land use impacts

During construction, temporary changes to the use of some land would occur. Impacts on the use of the land would be mainly related to the temporary change to the existing land use to an active construction site.

For the majority of the rail corridor, the impacts would be temporary and short-term as construction activities would move along the corridor progressively. This would minimise the impacts on the existing land uses at any one point to a relatively short period of time.

Impacts to agricultural land uses and land capability

Potential impacts to agricultural land uses would also include the general property impacts described below and summarised in Table 20.6. Construction activities that may involve temporary change in use of land outside the rail corridor would include access tracks and compounds. As the land surrounding the majority of the proposal site is subject to agricultural land uses, the main potential impact would be to land used for grazing or cropping purposes. It is expected that these would be short-term in duration, and any removal of agricultural production would have a negligible effect on the overall value of agriculture within the region. It would be necessary to ensure that during the construction phase a tailored, risk-based framework approach to biosecurity is considered for each property.

Travelling stock reserves

As described in Section 20.2.5, 6 travelling stock reserves cross the proposal site and 56 are located directly adjacent to the proposal site. The construction of infrastructure and placement of compounds could affect access and use of reserves directly adjacent to the proposal site. ARTC would liaise with Local Land Services during detailed design to understand how and when the reserves with the potential to be impacted are used, and how impacts can be avoided. Alternative access arrangements would be made as required.

Reserves

The proposal would not directly impact any conservation or recreation reserves due to the distance between these uses and the proposal site. The proposal may indirectly impact these land uses due to construction traffic impacts. These are considered further in Chapter 9.

Mining leases and petroleum licences

The proposal would not impact land subject to active mining leases. The proposal would not impact land subject to active petroleum licences given the distance to the nearest active petroleum licence. As a result no consultation has been undertaken with active petroleum licence owners.

Services and utilities

As noted in Section 8.7, construction has the potential to impact on existing utilities and services, including underground services such as electricity, gas, telecommunications; and overhead power lines. Impacts may include temporary disruption as a result of services relocation/upgrade (for example, power outages) or accidental damage. These impacts are considered to be minimal as the disruptions would be short-term, and affected residents and/or business owners would be notified in advance of any disruptions.

Utility and service providers would continue to be consulted during detailed design to identify possible interactions and develop procedures to be implemented to minimise the potential for service interruptions, which have the potential to impact on existing land uses.

Property impacts

Potential property impacts during construction are considered in Table 20.6.

Table 20.6 Potential land use impacts during construction

Potential impacts	Comment
Damage to stock and property	Construction on or immediately adjacent to private properties has the potential to damage or injure property, stock and/or crops if the movement of vehicles occurs on private property, or if stock were to cross the proposal site. Any property/stock disturbance or injury could have social and/or financial impacts, for example, by causing extra time to be expended doing additional tasks, moving stock etc.
Land rehabilitation	Landowners would expect that construction sites are adequately restored to their original condition.
Biosecurity risks, including the spread of weeds and disease	There is the potential for weeds and disease to be transferred from one property to another via construction vehicles or machinery, or construction crew clothing a nd footwear. This potential impact is considered further below.
Disruption of services or utilities to individual properties	Impacts may include temporary disruption as a result of services relocation/upgrade (for example, power outages) or accidental damage. These impacts are considered to be minimal as the disruptions would be short-term, and affected residents and/or business owners would be notified in advance of any disruptions.
Change to property access	Construction activities may temporarily block access to land. This could include livestock not being able to cross the rail corridor or paddocks being temporarily severed with the effect that grazing by livestock is temporarily constrained for example due to the unavailability of drinking water. This impact is considered to be minimal as disruptions would be short-term and affected landholders would be notified in advance of construction. Further information on the potential for access impacts is provided in Chapter 9.
Interrupted management	Construction and operation could cause a delay to land owners completing various crop and livestock husbandry operations (for example weed spraying, harvesting, animal health treatments etc.).
Dust and noise	Construction has the potential to generate dust and noise impacts. Dust could settle on crops and pastures, and noise could affect grazing patterns of livestock. Dust suppression would reduce the risk of dust settling on crops and pasture. Also, any dust accretions would be removed at each rainfall event resulting in negligible impact. Livestock generally become habituated to noise. Although grazing patterns may be altered, productivity is unlikely to be impacted. Further information on the potential for air quality and noise impacts is provided in Chapters 11, 12 and 13.

Increased biosecurity risks – pests, diseases and weeds

The proposal would result in the increased movement of vehicles, machinery, and people to, around and within the proposal site during construction. The main biosecurity risk relates to the spread of weeds. Weed seeds could potentially be transported between properties, or between the existing rail corridor and affected properties via machinery, equipment, vehicles, and/or the site workforce.

If a new pest or disease becomes established, it can affect agricultural properties through increased costs (for monitoring, production practices, additional chemical use, and labour), reduced productivity (in yield and/or quality) or loss of markets.

Existing weed species, and mitigation measures to manage the potential spread are weeds, are described in Chapter 10.

The construction compounds would include rubbish bins which could attract pest animals. This risk would be minimised by fencing compounds and appropriate management of waste as outlined in Chapter 24.

20.3.4 Operation impacts

Land use

General land use

For land within the existing rail corridor, the general land use would remain the same however, use of the rail line would intensify once Inland Rail is operational, as described in Section 7.6. Potential impacts associated with the increase in train movements including access, amenity and safety impacts, are considered in Chapters 9, 21 and 25, respectively.

Outside the existing rail corridor, acquisition of land for the Camurra bypass, Newell Highway overbridge and Jones Avenue overbridge would change the land use from the existing rural or industrial uses to an active transport (rail) use. As described in Section 20.3.2 the majority of land to be acquired is zoned for agricultural purposes (that is, RU1– Primary Production) and is used for travelling stock reserves. The potential impacts to agricultural land use on land that is privately owned are described further below.

Future use and development potential

The acquisition of land for the proposal would potentially result in the reconfiguration of some partially impacted properties. In these cases, there may be potential impacts on future property development due to a reduction in the property size and amount of developable area on each property. This would be taken into account during the acquisition process.

The proposal would not directly impact any local urban release areas identified for future residential or employment land.

Agricultural impacts

As described in Section 20.3.2 about 83 per cent of the land that would be acquired for infrastructure outside of the existing rail corridor is zoned RU1 – Primary Production. Of this land the majority of land is used for conservation, due to its classification as travelling stock reserves (discussed in Section 20.3.2).

Of the private land that would be acquired outside of urban centres the majority is currently used for either grazing (3,202 square metres or 64 per cent) or cropping (574 square metres or 12 per cent). This is consistent with the agricultural land classes of the majority of the land in this area (Class 2 and Class 3 – refer to Figure 20.3). This relates to less than 0.001 per cent of the total land used for grazing and cropping in the Narrabri and Moree LGAs, respectively. Therefore, any removal of agricultural production would have a negligible effect on the overall value of agriculture within the region.

No operational impacts to surrounding agricultural land uses are predicted. Potential impacts associated with the increase in train movements, including access, amenity and safety impacts, are considered in Chapters 9, 11 and 21, respectively.

Travelling stock reserves

With the exception of the acquisition of travelling stock reserves, discussed in Section 20.3.2, the proposal would have minimal impacts on travelling stock reserves, as access would be maintained during operation.

Flooding impacts on land use

As described in Chapter 15, the hydrology and flooding assessment identifies that there would be some changes in flood levels upstream of the proposal site. These changes would largely be a result of the lifting of the level of the rail formation, with this in part being counteracted by the provision of culverts under the rail formation.

An assessment of land use impacts due to a change in flooding has been undertaken. Table 20.7 provides the impact of the existing and design flood events on land use adjacent to the rail corridor. Figure 20.4 shows the changes in the one per cent AEP local flood extents due to the proposal and impacts on existing land use.

As shown in Table 20.7, the proposal would reduce the impact on flooding on adjacent land by 143 hectares across the study area. Table 20.7 indicates that the land uses that would be most impacted by flooding, would be intensive animal production, tree and shrub cover, and mining and quarrying. Figure 20.4 shows other land uses that would be affected by an increase in flooding due to the proposal include cropping and grazing, although overall there has been a reduction in the area of flooding in land used for cropping and grazing as shown Table 20.7.

Where the area of flooding has increased, the duration of flooding in these areas is likely to be in the order of a few hours under most flood events, which would be insufficient to detrimentally affect crops, and flooding would generally only impact properties already affected by flooding (refer to Figure 20.4). The increased extent of flooding equates to less than 0.001 per cent of the total land currently used for intensive animal production and mining and quarrying in the three LGAs. As a result, the temporary removal of these land uses in these areas, although considered unlikely to occur, would have a negligible effect on the overall value of mining and quarrying or intensive animal production within the region.

In those areas where the flood extent has increased, access within the affected properties may be temporarily impacted. Additional discussions would be undertaken with the landowners of the affected properties to determine the consequences of the expected impacts and, where necessary, further refine mitigation measures to reduce the impacts.

The amount of buildings or structures that would be inundated during a one per cent AEP local flood event would increase from 16 to 20, due to the proposal, with an additional 2 houses, 1 shed attached to a petrol station, and 1 agricultural shed being inundated. Further modelling would be undertaken during detailed design to determine how the proposal can be modified so that the existing flooding characteristics with regards to property inundation are not worsened.

Further information on the potential for flooding impacts during operation is provided in Chapter 15.

Property impacts

With the exception of the acquisition discussed in Section 20.3.2, the proposal would not result in direct impacts to properties during operation. Potential impacts associated with the increase in train movements, including access, amenity and safety impacts, are considered in Chapters 9, 21 and 25, respectively.

Table 20.7 Land use impact by flood extents under existing and design conditions

Land use	Existing area impacted by a 1% AEP local flood event (ha)	Area that would be impacted with the proposal (ha)	Increase/ decrease (ha)	Increase/ decrease (%)
Conservation area	186.20	148.03	-38.17	-20
Cropping	1030.95	986.57	-44.38	-4
Grazing	811.56	787.98	-23.58	-3
Intensive animal production	2.09	2.32	0.23	11
Mining and quarrying	58.24	60.79	2.55	4
River and drainage system	0.00	0.00	0.00	0
Special category	194.66	182.03	-12.62	-6
Urban	7.51	7.35	-0.16	-2
Transport and other corridors	207.25	197.40	-9.84	-5
Tree and shrub cover	6.87	7.32	0.45	7
Urban	88.27	70.72	-17.54	-20
Total	**2,593.57**	**2,450.52**	**-143.05**	**-6**

Figure 20.4a Change in flood extents – land uses

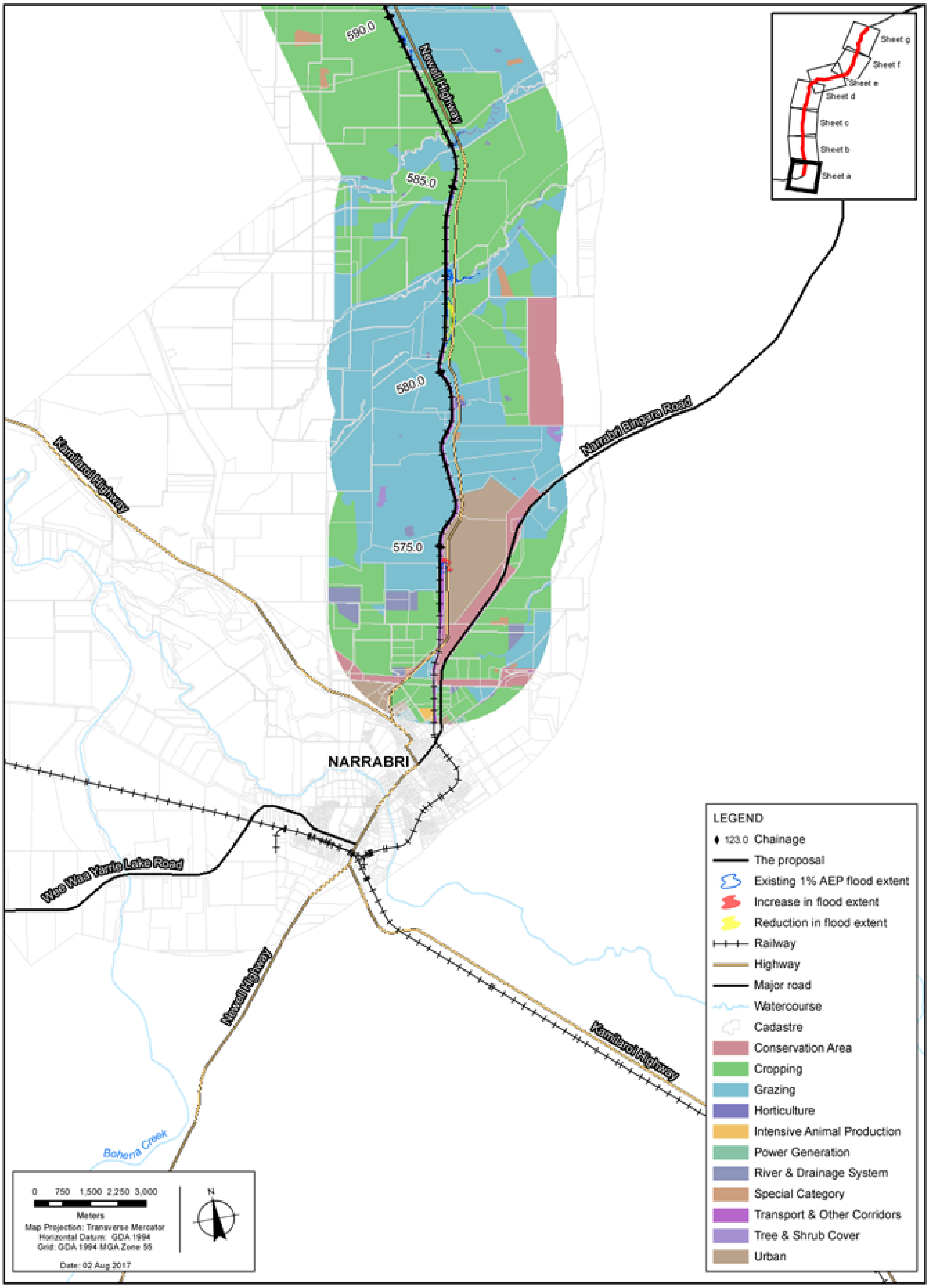


Figure 20.4b Change in flood extents – land uses

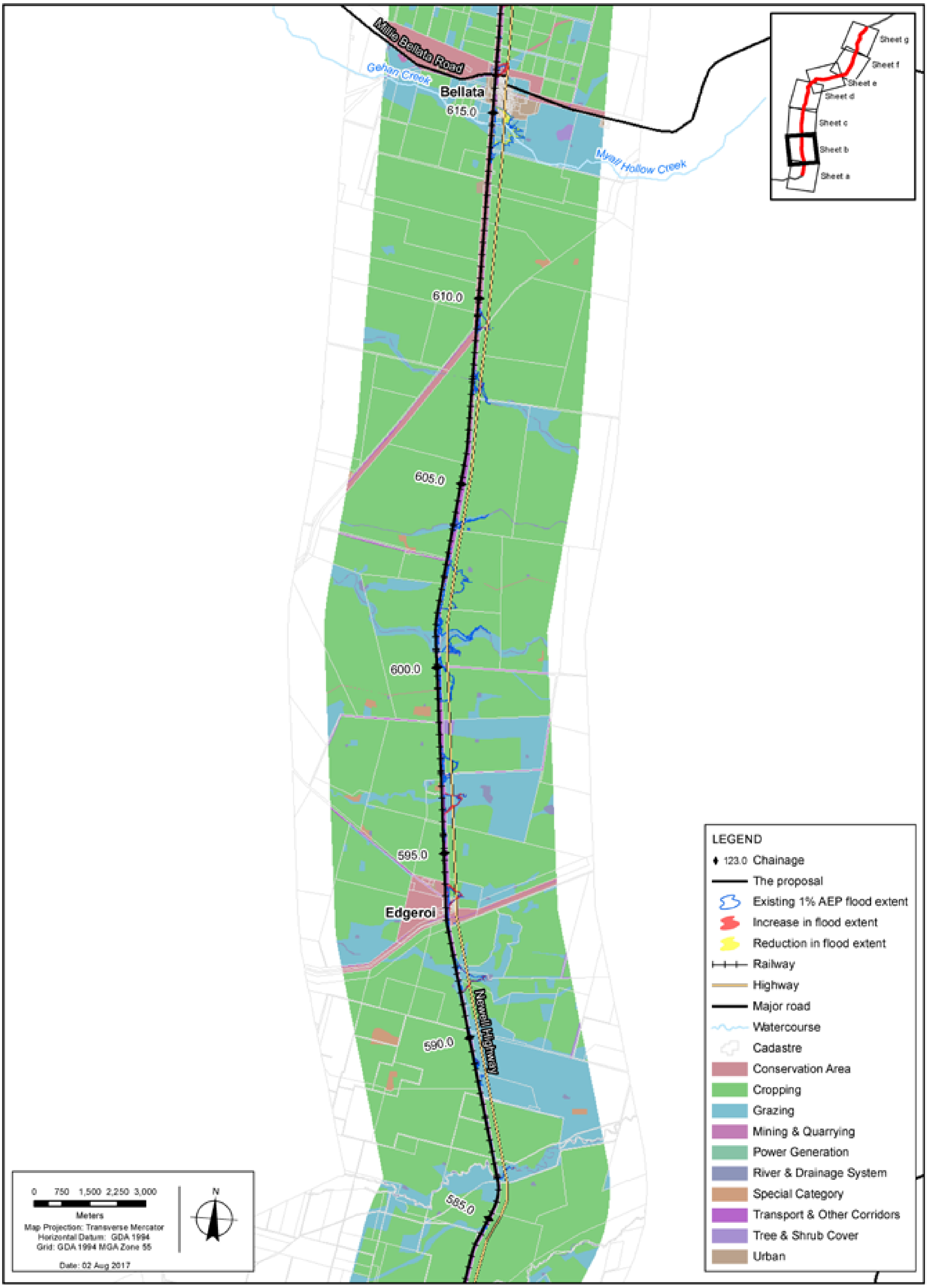


Figure 20.4c Change in flood extents – land uses

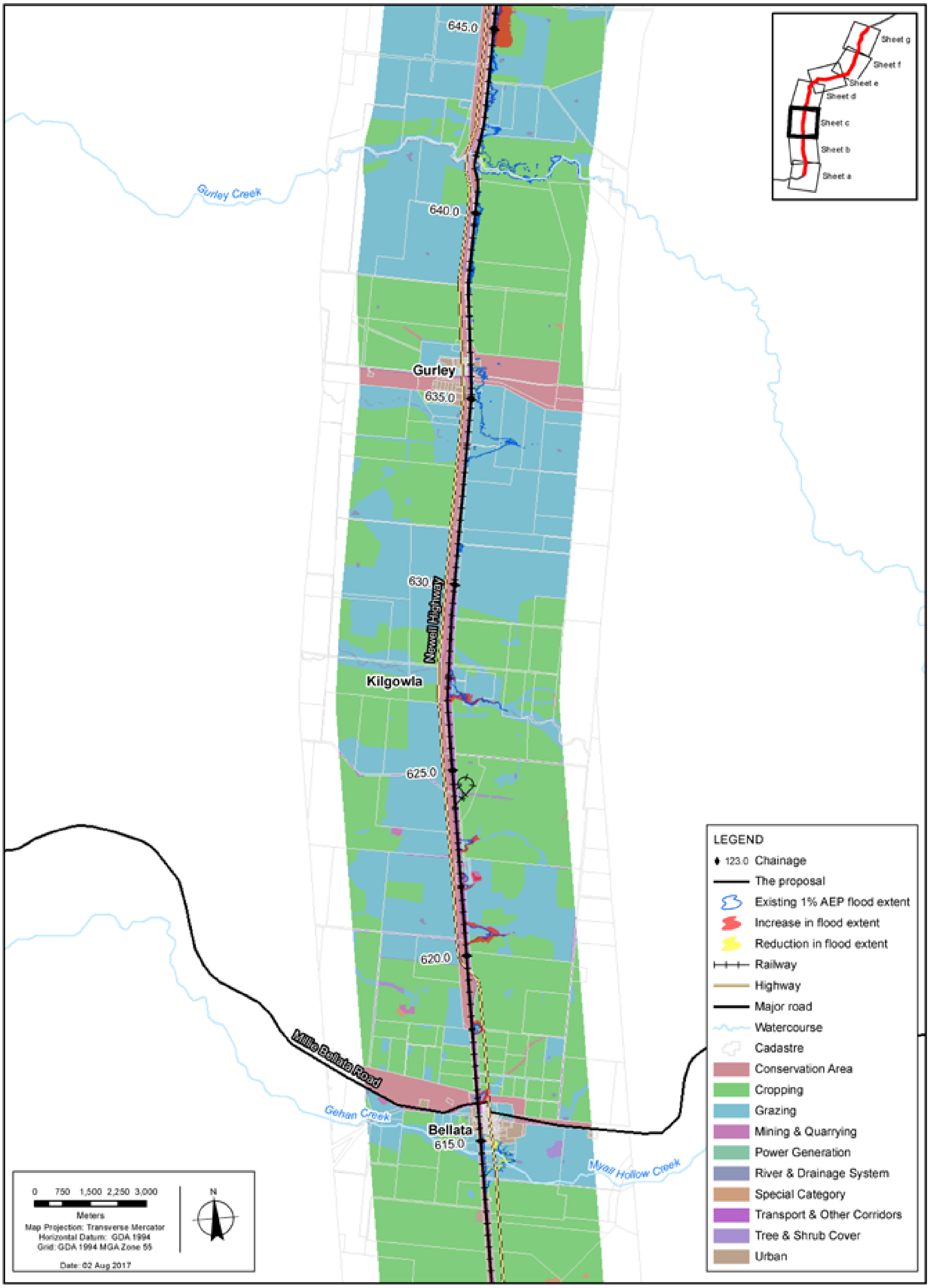


Figure 20.4d Change in flood extents – land uses

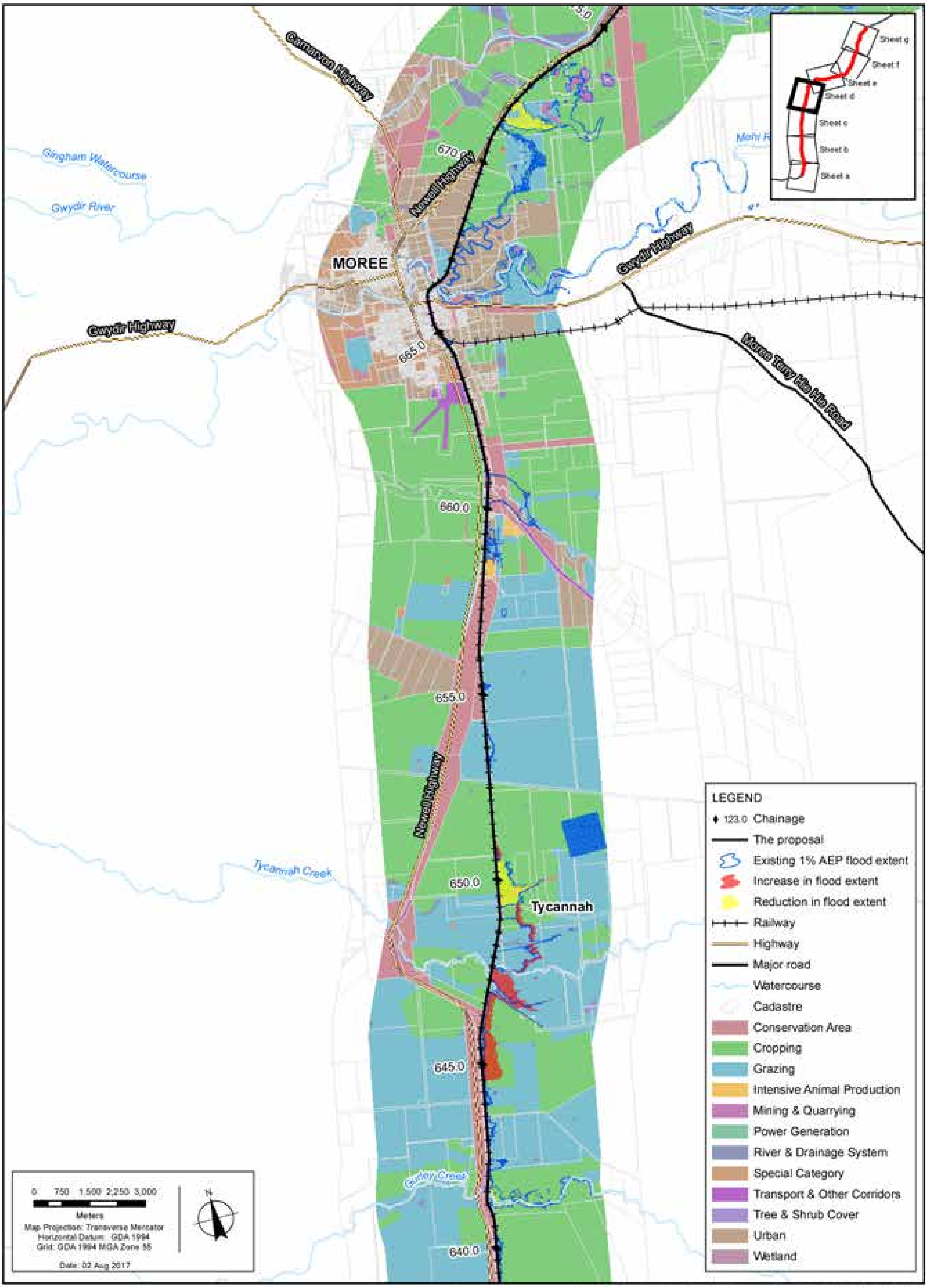


Figure 20.4e Change in flood extents – land uses

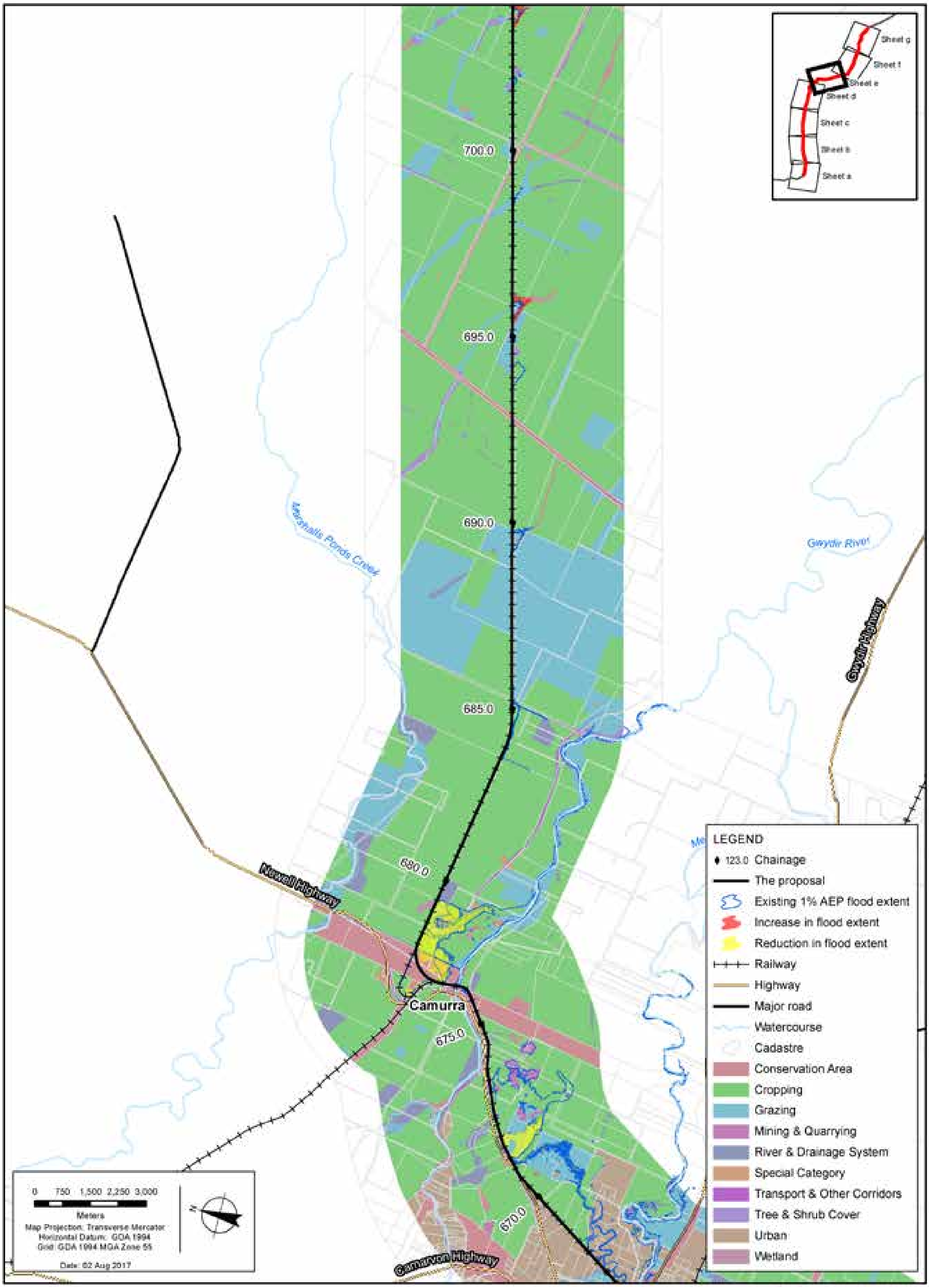


Figure 20.4f Change in flood extents – land uses

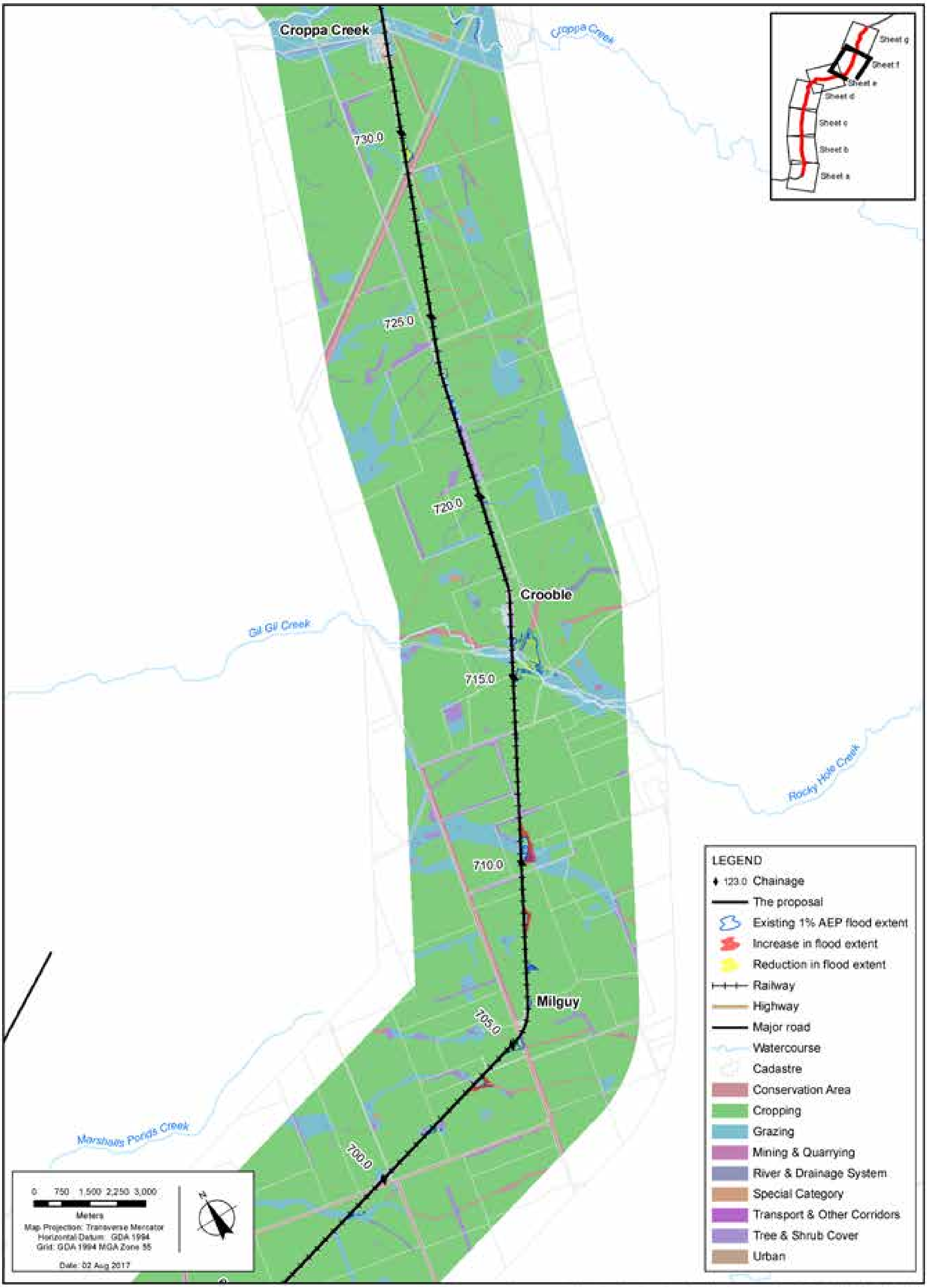
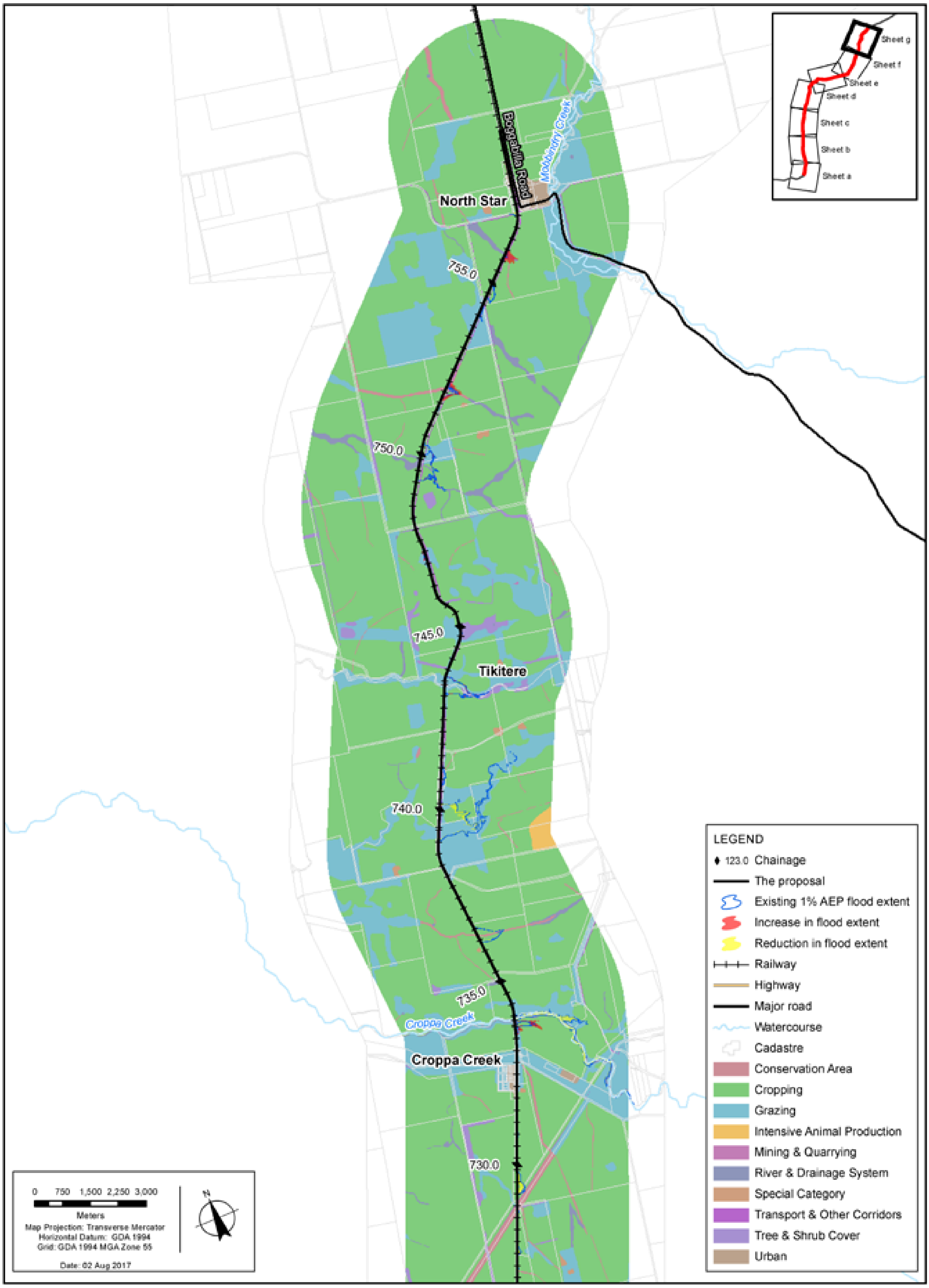


Figure 20.4g Change in flood extents – land uses



20.4 Mitigation and management

20.4.1 Approach to mitigation and management

Overall, the majority of potential construction related impacts would be short-term and temporary in nature. The potential for these impacts would be significantly reduced by:

- effective construction design and planning
- implementation of the mitigation measures provided below
- minimising the need for local road and access closures
- providing alternative access arrangements in the event that closures are necessary
- consultation with individual landowners to identify individual concerns, and develop and document strategies to address these concerns
- ongoing communication.

Key mitigation measures to minimise the potential for land use impacts during construction would be the rehabilitation strategy (included as a mitigation measure in Chapter 10) and individual property agreements. Areas disturbed during construction would be rehabilitated progressively in accordance with the rehabilitation strategy.

Individual property agreements would be developed in consultation with landowners/lessees who would be directly impacted during construction. These would define ARTC's commitments as to how construction would be managed as it impacts individual properties.

20.4.2 Consideration of the interactions between mitigation measures

Mitigation measures to manage the potential air quality, noise, dust, socio-economic, waste, and health and safety impacts would also assist in minimising the potential for land use and property impacts.

The rehabilitation strategy would also assist in mitigating potential biodiversity, and landscape and visual impacts.

20.4.3 Summary of mitigation measures

To mitigate the potential impacts to land use and property, the measures listed in Table 20.8 would be implemented.

Table 20.8 Summary of land use and property mitigation measures

Stage	Impact	Mitigation measures
Detailed design/ pre-construction	Property impacts	Individual property agreements would be developed in consultation with landowners/occupants, with respect to the management of construction on or immediately adjacent to private properties. These would detail any required adjustments to fencing, access, farm infrastructure, and relocation of any impacted structures, as required.
	Acquisitions	All property acquisitions/adjustments would be undertaken in consultation with landowners and in accordance with the requirements of the *Land Acquisition (Just Terms Compensation) Act 1991.*
	Access	Access to properties would be maintained and managed in accordance with the mitigation measures listed in Section 9.4.
	Travelling stock reserves	Local Land Services would be consulted during detailed design to understand how impacts to travelling stock reserves can be avoided during construction and operation. Alternative access arrangements would be made as required.
	Impacts to services and utilities	Utility and service providers would continue to be consulted during detailed design to identify possible interactions and develop procedures to minimise the potential for service interruptions and impacts on existing land uses.
Detailed design/ pre-construction and construction	Consultation and communication	Property owners/occupants would be consulted during the design and construction phases, in accordance with the communication management sub-plan for the proposal (described in Chapter 4), to ensure that owners/occupants are informed about the timing and scope of activities in their area; and any potential property impacts/changes, particularly in relation to potential impacts to access, services, or farm operational arrangements. The results of consultation would be incorporated in the individual property agreements as appropriate. Consultation would be undertaken with landowners affected by level crossing changes and agreement obtained, where required.
	Biosecurity risks	The biodiversity management sub-plan included in the CEMP would detail measures to minimise the potential for biosecurity risks during construction.
Construction	Rehabilitation	The rehabilitation strategy would include measures to restore disturbed sites as close as possible to the pre-construction condition or better, or to the satisfaction of landowners. Rehabilitation of disturbed areas would be undertaken progressively, consistent with the rehabilitation strategy and individual property agreements (where relevant).

21. Socio-economic assessment

This chapter provides a summary of the socio-economic impact assessment undertaken for the proposal. It describes the existing socio-economic environment, assesses the potential impacts from construction and operation of the proposal, and provides recommended mitigation and management measures. The full Socio-economic Assessment report is provided as Technical Report 11.

21.1 Assessment approach

21.1.1 Methodology

The socio-economic impact assessment involved:

- reviewing background information on the proposal and the socio-economic environment of the study area
- analysis of available community survey data, including data and reports from the Australian Bureau of Statistics (ABS) Census 2011, NSW Bureau of Crime Statistics and Research, Bureau of Transport Statistics, and the local councils
- preparing a profile of the existing community that may be impacted by the proposal
- discussions with representatives of the Narrabri Shire, Moree Plains Shire and Gwydir Shire councils in June and July 2016
- analysis of the outcomes of community consultation as summarised in Chapter 4.
- a desktop analysis of the potential impacts and benefits of the proposal, including the potential for both direct and indirect impacts on the community and businesses, in accordance with the principles and guidelines listed in Section 21.1.2
- identifying measures to mitigate and manage the impacts identified.

Further information on the methodology is provided in Technical Report 11.

21.1.2 Legislative and policy context to the assessment

Relevant legislation/guidelines

The *Environmental Planning and Assessment Act 1979* (EP&A Act) establishes the framework for socio-economic impacts to be formally assessed in land use planning and development assessment processes. Under section 4 of the EP&A Act, the definition of 'environment' is 'all aspects of the surroundings of humans, whether affecting any human as an individual or in his or her social groupings'.

The assessment of socio-economic impacts has been undertaken with reference to:

- *International Principles for Social Impact Assessment* (Vanclay, 2003)
- *Social Impact Assessment: Guidance for assessing and managing the social impacts of projects* (Vanclay F, et al, 2015)
- *Environmental Impact Assessment Practice Note - Socio-economic assessment* (Roads and Maritime, 2013b) (the Practice Note).

Economic policy context

The social study area is part of the Northern Inland region and incorporated in the Regional Development Australia *Regional Plan 2016 – 2019*. The plan lists strategic priorities for the region including industry diversification, business growth and job creation. The plan also identifies a series of strengths, opportunities and challenges facing the region.

The NSW Government *Economic Development Strategy for Regional NSW* is relevant to the social study area. The strategy aims toward five goals to enable regional growth including driving regional growth and employment and investing in infrastructure and connectivity.

The *New England North West Regional Transport Plan* (NSW Government, 2013b) is also relevant to the social study area. The plan includes actions to improve economic connectivity, road networks and public transport. Investigating options for an inland rail freight line is one of the key actions of the plan.

Further information on these economic policies is provided in Technical Report 11.

Community planning context

The context for local community planning is provided by the *Narrabri Shire Community Strategic Plan... towards 2023* (Narrabri Shire Council, 2013), *Moree Plains 2030 – The Community Strategic Plan* (Moree Plains Shire Council, 2010) and the *Community Strategic Plan 2014 – 2024* (Gwydir Shire Council, 2015).

21.2 Existing environment

21.2.1 Overview

A general description of the proposal site and surrounds is provided in Chapter 2. The social study area includes the local government areas (LGA) of Narrabri Shire Council, Moree Plains Shire Council and Gwydir Shire Council. The main centres near the proposal in these areas are the towns of Narrabri, Moree and North Star.

Land use in the social study area is primarily agricultural. Grazing and cropping account for about 77 per cent of the land area. Major crops include wheat, cotton, chickpeas, barley, and sorghum. The social study area also includes a large forested area known as the Pilliga, which occupies over 500,000 hectares near Narrabri, Coonabarabran and Baradine.

Key socio-economic indicators (mainly from 2011 ABS census data) are summarised below. Further information on the socio-economic characteristics of the study area is provided in Technical Report 11.

21.2.2 Narrabri local government area

The Narrabri LGA occupies about 13,000 square kilometres and has a population of around 12,925 people (in 2011). Gross regional product is around $939 million.

There is a full-time labour force participation of 66.4 per cent across the LGA. The most common employment industries in the LGA are agriculture at 21.4 per cent, followed by management at 19.7 per cent. The median average income within the LGA is $520 per week.

The town of Narrabri is the main centre in the Narrabri LGA. The town has a population of about 5,890 people of which 12.0 per cent are Indigenous. It has a variety of community facilities including a hospital and district health service, emergency services, schooling and TAFE facilities, showgrounds, and a theatre complex (the Crossing Theatre). Narrabri also has a number of accommodation facilities including 16 hotels and motels, 3 bed and breakfasts and 6 caravan parks and camping grounds as well as a large workers camp (Civeo workforce village) about 2 kilometres from the town centre. The most common employment industries in the town are retail trade (13 per cent) and health care and social assistance (11 per cent).

Both the LGA and the town of Narrabri have a similar age profile. Analysis of the age structure showed that the median age of the population within the LGA was 39 years.

Narrabri Shire Council noted the following during consultation:

- the existing workers camp would potentially have capacity for the proposal
- behavioural issues with workers were not expected based on prior experience
- preservation of access would be a key issue, particularly for farms west of Newell Highway.

21.2.3 Moree local government area

The Moree LGA occupies about 17,930 square kilometres and has a population of around 13,429 people (in 2011). Gross regional product is around $750 million.

There is a full-time labour force participation of 60.1 per cent across the LGA. The most common employment industries in the LGA are agriculture at 26 per cent, followed by management at 22.2 per cent. The median average income within the LGA is $558 per week.

The town of Moree is the main centre in the Moree LGA. The town has a population of about 7,720 people, of which 23.6 per cent are Indigenous. The town has a variety of community facilities including a hospital, emergency services, schooling and TAFE facilities, and spa facilities and thermal pools that are a main tourist attraction. Moree also has a number of accommodation facilities, including 13 motels and 2 caravan parks with camping grounds. The most common employment industries in the town are retail trade (11.9 per cent) and health care and social assistance (10.1 per cent).

Both the LGA and the town of Moree have a similar age profile. Analysis of the age structure showed that the median age for population of the LGA and town was 35 years.

Moree Plains Shire Council noted the following during consultation:

- residents in the east of Moree tend to have lower socio-economic status than in the west
- informal crossing of the rail line is common, including private crossings to the north
- the proposal has the potential to open local industry to wider markets.

21.2.4 Gwydir local government area

The Gwydir LGA occupies about 9,122 square kilometres and has a population of around 4,965 people (in 2011). The dominant industry in the area is agriculture, particularly in North Star where about 7 per cent of the population are employed in this industry. The median average income within the LGA is $387 per week.

The towns of Warialda and Bingara are the main centres in the Gwydir LGA. Warialda has a population of about 1,300 people and Bingara has a population of about 1,093 people. Both centres have a number of community facilities including health care, education, emergency services, and accommodation including motels and camping facilities.

The small town of North Star is in proximity to the proposal and forms part of the “golden triangle” of agricultural production around Gwydir. North Star has a population of about 423 people. As a small town, community facilities in North Star are limited to a primary school, post office, motel, sports club, and caravan park.

The LGA and the town of North Star have a very different age profile. Analysis of the age structure showed that the median age of the population within the LGA is 45 years, while within the town the median age was 34 years.

Gwydir Shire Council noted the following during consultation:

- accommodation capacity would likely be an issue for the proposal workforce
- the proposal would have potential economic and employment benefits for the region
- centrality of agriculture to the local economy, including transport to Moree and Newcastle.

21.3 Impact assessment

21.3.1 Risk assessment

Potential impacts

The environmental risk assessment for the proposal (summarised in Appendix B) included an assessment of the potential socio-economic risks. The assessed risk level for the majority of potential socio-economic risks was between medium and high. Risks with an assessed level of medium or above include:

- impacts to local amenity during operation due to increased frequency of trains
- amenity impacts on community facilities during construction
- increased demand for accommodation during construction
- impacts on access to community facilities during construction.

How potential impacts have been avoided

The option development and assessment process for the Inland Rail location/route options is summarised in Chapter 6. As noted in Chapter 6, the shortlist of route options was subject to a detailed assessment, and the proposed alignment was refined based on evaluation of key considerations, including environmental and land use impacts.

Potential socio-economic impacts would continue to be avoided by:

- designing, constructing and operating the proposal to minimise the potential for amenity impacts arising from traffic, noise and vibration, air quality, and visual amenity, including the implementation of mitigation measures in Chapters 9, 11, 13 and 19.
- minimising the potential for safety issues by implementing the mitigation measures in Chapter 25.
- implementing the socio-economic management and mitigation measures provided in Section 21.5.
- communicating with local residents and other relevant stakeholders (including Narrabri, Moree Plains and Gwydir councils) to provide advance notice of construction activities and associated impacts, and provide information on the operation of the proposal.

21.3.2 Construction impacts

The key potential socio-economic impacts of the proposal during construction include:

- impacts to the local community resulting from property acquisition, changes to traffic, transport and access to land
- community amenity and safety impacts
- access to accommodation and services
- economic impacts and benefits during construction, including employment generation.

Potential land use and property impacts during construction are described in Chapter 20.

Property impacts

During construction it is expected that private landholders would experience some impacts resulting from changes to infrastructure and utilities within the property, establishment of compound sites and the need to gain access to private properties.

Frequent access to properties can disrupt private landholders through impacts to agricultural activities and lifestyles.

As described in Chapter 7, the work associated with the proposal is largely contained within the existing rail corridor, and therefore requires minimal acquisition. Further property acquisition may be required for the Jones Avenue overbridge (due to changes to access). Details of these land acquisition requirements will be determined as the design is refined.

Property acquisition would mostly affect land with existing rural, agricultural or utility uses, however properties adjacent to the Jones Avenue overbridge are also commercial. It is anticipated that the impacts of property acquisition would be minimal for the proposal. Where it is considered that an intolerable impact occurs to a property, then consideration will be given to whole of property acquisition.

All acquisition of private property would be undertaken in consultation with landowners and in accordance with the requirements of the *Land Acquisition (Just Terms Compensation) Act 1991.*

Community access impacts

As described in Chapter 9, construction of the proposal would result in short-term impacts to traffic and access within the study area, and an increase in both heavy and light vehicle movements on the local road network. The extent of impacts would depend on the location of the works, and the origin of material and/or workers. The traffic, transport and access assessment undertaken or the proposal (Chapter 9) concluded that the anticipated maximum hourly volume on expected access roads is within the level of service threshold for these roads, and as a result significant community impacts are not predicted.

The proposal would not directly impact on access to local businesses and social infrastructure, however traffic diversions and delays may impact on community members' access to facilities, services and businesses. These would be short-term, minor impacts for users.

Proposed works on level crossings may result in disruptions to local traffic and short-term access restrictions to private property. Where this occurs, alternative access arrangements would be provided and/or appropriate traffic controls implemented.

Changes to the movement of traffic and access arrangements as a result of the construction of the Jones Avenue overbridge could result in a temporary increase in the distance travelled and delays for some road users. In particular, residents and businesses on the eastern side of Moree are expected to experience these temporary impacts. The Newell Highway overbridge would be constructed off-line to minimise impacts to traffic during construction, and is expected to have limited impacts beyond an increase in construction vehicles in the area.

There will be impacts to the passenger train services while works are underway between Narrabri and Moree, with passenger train movements suspended during track possessions. Coach services would replace trains when rail closures are in place. Management of this process would be subject to specific planning depending on the section of track that is closed, but would be similar to arrangements put in place for track work at other times.

Potential traffic, transport and access impacts, and measures to mitigate and manage these impacts, are described in Chapter 9.

Community amenity impacts

Construction of the proposal may result in the following amenity impacts experienced by members of the local community:

- increase in noise for residents located around the proposal site due to the operation of plant and equipment and construction works
- increase in traffic and associated noise for residents located around the proposal site and construction access routes
- increase in dust generated during construction, which may impact local amenity
- visual impacts.

These issues have been addressed in other sections of this EIS, as follows:

- traffic (Chapter 9)
- noise and vibration (Chapters 11 and 12)
- air quality (Chapter 13)
- visual impacts (Chapter 19).

Amenity impacts would be temporary and appropriately managed with the safeguards provided in these chapters.

Potential community safety issues and impacts are considered in Chapter 25.

The presence of a non-resident workforce also has the potential to disrupt communities through actual or perceived anti-social behaviour. Anti-social behaviour may include crime or the use of drugs and alcohol. Anti-social behaviour is not anticipated and consultation with local councils has indicated behavioural issues with workers are not expected based on prior experience.

Accommodation impacts

The non-resident construction workforce would require temporary accommodation in the region of the proposal. Accommodation arrangements have not been confirmed however, consultation with local councils has served to identify a range of options including temporary housing, hotel or motel accommodation, or accommodation in established workers camps.

Accommodation of the non-resident workforce has the potential to increase demand and competition for accommodation in affected areas, with associated impacts to affordability. The degree of impact would depend on the selected mode of accommodation. For example, utilisation of existing workers camps would mitigate potential impacts to housing availability.

A workers housing and accommodation plan would be developed to reduce any impact to local housing affordability and availability within the study area. Preparation of the plan would include review of available accommodation and further consultation with councils closer to construction. Maximising the employment of local residents would reduce the demand for accommodation.

The non-resident workforce also has the potential to increase demand for services in the region of the proposal. Assuming the non-resident workforce would be largely accommodated in Moree and Narrabri, it is not expected that significant additional demand would result. Furthermore, the utilisation of local resident workers where practicable would minimise additional demand.

Economic impacts and benefits

During construction a variety of skilled workers would be required including labourers, tradespeople, machinery operators, engineers, surveyors and site supervisors. It is estimated that a total of around 180 workers would be required during construction. Some of the workforce may be sourced from within the region and some would be non-residents.

New employment opportunities would also provide the opportunity for training and the development of new skills, which, for local residents, would benefit the local areas/region.

Construction activities, requirements and the needs of the workforce would have the potential to result in increased trade for local businesses, including:

- accommodation
- food services
- retail trade
- bus and coach drivers
- finance
- education and training
- health care
- recreation services.

21.3.3 Operation impacts

The key potential socio-economic impacts of the proposal during operation include:

- community amenity and safety impacts
- access and connectivity impacts, including delays associated with a higher train frequency in Moree
- economic impacts, including potential local/ regional benefits, and the wider benefits of Inland Rail as a whole.

Potential land use and property impacts during operation are described in Chapter 20.

Community amenity impacts

The operation of the proposal would involve an increase in the frequency of train movements with associated potential impacts to community amenity including increased traffic delays, noise from trains, increased emissions to air, and altered visual amenity. These potential impacts are expected to be limited and are discussed in detail in Chapters 9, 11, 13 and 19.

Potential impacts to community safety are discussed in Chapter 25. Impacts to land use due to flooding are discussed in Chapter 20. Social impacts associated with train delays are discussed below.

Community access impacts

An impact to access and connectivity is likely to be experienced in Moree. The increase in the number of trains would cause delays to traffic movement through Moree. This may exacerbate the existing severance of the east side of town from west, with most community facilities and services and other infrastructure located in the west of Moree.

Consultation with Moree Plains Shire Council indicated that residents of the eastern side tend to be from lower socio-economic groups, and there are existing issues associated with illegal and unsafe crossing of the rail line by pedestrians. These impacts could be exacerbated by more frequent trains.

The Jones Avenue overbridge was included in the proposal to allow for continuous and safe access between the east and the west for both vehicles and pedestrians. The overbridge may help to address community concerns regarding the potential for further severance caused by additional trains using the rail corridor.

Regional bus services may experience a small increase in delays at level crossings due to the increased frequency of trains. Emergency vehicles may also experience delays at level crossings. The Jones Avenue overbridge would reduce the likelihood of potential impacts on emergency services in Moree. Outside of Moree, level crossings are primarily local roads outside of each town centre, therefore overall emergency response times are not expected to significantly impacted. Consultation with local emergency services during detailed design would ensure emergency service providers are aware of accessible routes during operation, particularly alternate routes in the case of level crossing delays.

Changes to property access roads and the local road network may be required in some locations as a result of the rationalisation of level crossings. Potential traffic, transport and access impacts, and measures to mitigate and manage these impacts, are described in Chapter 9.

Consultation with potentially affected landowners would continue during detailed design, and closures would only be undertaken following agreement with the owner.

Economic and wider community benefits

Local benefits

During consultation for Inland Rail, stakeholders including local councils, state and federal Members of Parliament identified that the project offers significant potential economic benefits for the local community. These include increased employment and training opportunities for local people, particularly youth and Indigenous groups, as well as potential business attraction.

The *ARTC 2015 Inland Rail Programme Business Case* (ARTC, 2015) notes that Inland Rail will enable farmers to move agriculture products more efficiently for domestic use and for export, as it will pass through some of Australia's most productive farming country. The Business Case also recognises further benefits to supply chain efficiencies for commercial freight and benefits to consumers and to regional areas.

To take advantage of the location of the rail line in the area, Moree Plains Shire Council has developed the Moree Gateway project, a multi-modal transport facility. It is noted that no intermodal terminals for Inland Rail form part of the proposal at this stage. Plans for establishment of intermodal terminals for Inland Rail trains would be finalised in consultation with regional stakeholders, including Moree Plains Shire Council.

Wider benefits

As part of the overall Inland Rail project, the proposal has the potential for wider economic and community benefits, including the following (ARTC, 2015):

- Strong benefit cost ratio - the long-term benefit to Australia is an economic benefit cost ratio of 2.62.
- Boost the Australian economy - Inland Rail is expected to increase Australia's gross domestic product by $16 billion during its construction and first 50 years of operation.
- Create jobs – it is estimated that an average of 700 additional jobs during operation.
- Improve connections within the national freight network – Inland Rail enhances the National Land Transport Network by creating a rail linkage between Parkes in NSW and Brisbane, providing a connection between Queensland and the southern and western States.
- Provide better access to and from our regional markets – It will make it easier for freight to move from farms, mines and ports to national and overseas markets. Two million tonnes of agricultural freight will switch from road to rail, with a total of 8.9 million tonnes of agricultural freight more efficiently diverted to Inland Rail.
- Reduce costs - Rail costs for intercapital freight travelling between Melbourne and Brisbane will be reduced by $10 per tonne.
- Increased capacity of the transport network - Inland Rail will increase capacity for freight and passenger services by reducing congestion along the busy coastal route.
- Improve road safety - Each year, there will be up to 15 fewer serious crashes, avoiding fatalities and serious injuries.

As noted by the *Australian Infrastructure Audit Report* (Infrastructure Australia, 2015) 'Rail offers … societal benefits in terms of lower emissions, reduced road congestion and increased safety per tonne kilometre, particularly over longer distances or when carrying heavy goods.'

21.4 Mitigation management

To manage and mitigate the potential for socio-economic impacts, and enhance the benefits of the proposal, the mitigation measures listed in Table 21.1 would be implemented.

Table 21.1 Summary of socio-economic mitigation measures

Stage	Impact	Mitigation measures
Detailed design/ pre-construction	Communication	Key stakeholders (including local councils, emergency service providers, public transport providers, the general community, and surrounding land owners/occupants) would continue to be consulted regarding the proposal in accordance with the communication management sub-plan described in Chapter 4.
	Local access to Inland Rail	ARTC would continue to work with relevant stakeholders, including Moree Plains Shire Council, to identify opportunities to facilitate local access to Inland Rail via the Moree Gateway.
	Accommodation	A temporary workforce housing and accommodation plan would be developed and implemented during construction. This would include a requirement for consultation to be undertaken with local accommodation providers and councils regarding the availability of accommodation, and the need to maintain some availability for non-workforce accommodation.
Construction	Communication	A communication management sub-plan would be prepared as part of the CEMP including a detailed list of the measures that would be implemented during construction to communicate with and respond to community concerns. The plan would include, as a minimum: ▸ requirements to provide details and timing of proposed activities to affected residents, the local community and businesses, and local bus operators ▸ consultation actions in relation to access arrangements and servicing requirements ▸ complaints handling procedure ▸ procedure to notify adjacent land users for any changed conditions during the construction period such as traffic, pedestrian or driveway access. Local residents, businesses and other stakeholders would be notified before work starts, and would be regularly informed of construction activities.

Stage	Impact	Mitigation measures
Construction	Workforce impacts	Where practicable, the workforce would include workers sourced locally, and opportunities for training potential local employees would be provided. This would include exploring opportunities for local Indigenous participation in consultation with local Indigenous service providers. A zero tolerance policy relating to anti-social behaviour would be adopted for work sites.
	Demands for goods and services	Local suppliers would be identified and approached for procurement of goods and services where practicable in line with a local business and industry procurement plan.
Operation	Community safety	A safety awareness program would be developed and implemented to educate the community regarding safety around trains. This would focus on: ‣ community and rural property operators who cross the rail corridor to access their properties ‣ residents in Moree, particularly those living on eastern side of town, to ensure that residents are aware of the safety concerns associated with trains passing through town, and encourage use of the Jones Avenue overbridge.

22. Sustainability

This chapter provides the sustainability assessment undertaken for the proposal. It describes the overall approach to sustainability, and the specific objectives and initiatives that would be incorporated into the proposal's design, construction and operation.

22.1 Assessment approach

22.1.1 What is sustainability?

Sustainability, or sustainable development, has many different definitions, depending on the application and context. In 1987, the Brundtland Commission defined sustainable development 'as development that meets the needs of the present, without compromising the ability of future generations to meet their own needs' (World Commission on Environment and Development, 1987).

In 1992, ecologically sustainable development (ESD) was defined by the Ecologically Sustainable Development Steering Committee as 'using, conserving and enhancing the community's resources so that ecological processes, on which life depends are maintained, and the total quality of life, now and in the future can be increased' (Commonwealth of Australia, 1992).

In NSW, the concept of ESD was introduced into planning and development legislation by the *Environmental Planning and Assessment Act 1979* (EP&A Act). One of the objectives of the EP&A Act is '(vii) to encourage ecologically sustainability development'. In accordance with Schedule 2, Part 3, section 7 of the EP&A Regulation, an EIS is required to include '(f) the reasons justifying the carrying out of the development, activity or infrastructure in the manner proposed, having regard to … the principles of ecologically sustainable development set out in subclause (4).' Section 6(2) of the *Protection of the Environment Administration Act 1991* states that ESD can be achieved through the implementation of:

- the precautionary principle
- intergenerational equity
- conservation of biological diversity and ecological integrity
- improved valuation, pricing and incentive mechanisms.

For infrastructure projects, 'infrastructure sustainability' is defined by the Infrastructure Sustainability Council of Australia (ISCA) as 'infrastructure that is designed, constructed and operated to optimise environmental, social and economic outcomes of the long-term'. ISCA states that 'Infrastructure sustainability provides an opportunity to go beyond business as usual, or simply mitigating environmental and social impacts. It provides the opportunity to drive and measure performance towards enhanced liveability and productivity and better economic outcomes, in a strategic and holistic fashion' (ISCA, 2016).

Using a tool such as ISCA's infrastructure sustainability rating tool (the 'IS rating tool'), an assessment of the sustainability performance of a proposed infrastructure asset can be undertaken.

22.1.2 Sustainability context for Inland Rail

ARTC is committed to ensuring that its projects are implemented in a manner that is consistent with the principles of ESD. ARTC has applied, and will continue to apply, the principles of ESD throughout the development and assessment of Inland Rail and the proposal. ARTC has developed a Sustainability Implementation Framework for Inland Rail.

The implementation framework identifies that the following themes underpin the sustainability objectives for the delivery and operation of Inland Rail:

- safety
- community
- workforce
- procurement
- materials/waste
- ecology
- greenhouse gas and emissions
- governance.

The implementation framework outlines key recommendations and requirements for embedding sustainability across each of the above themes. It also outlines how monitoring and review of sustainability objectives for Inland Rail would occur.

High performance categories have been identified as part of the framework. The categories are generally consistent with the IS rating tool categories, and reflect the areas of greatest potential impacts and benefits. The high performance categories include:

- management systems
- materials
- discharges to air, land and water
- land
- waste
- stakeholder participation.

A sustainability policy for Inland Rail has been developed as part of the implementation framework, underpinned by the following key commitments:

- put safety at heart of everything we do
- minimise our environmental footprint
- engage early and meaningfully with all stakeholders, including Aboriginal parties in accordance with established practices
- make decisions based on a strong understanding of technical, economic, environmental, and social issues
- future-proof Inland Rail so it is efficient and effective in the long-term
- promote economic benefits within regional communities
- regularly review and audit processes and performance.

22.1.3 Methodology

The assessment summarised in this chapter considers the application of sustainability principles to the proposal, and the opportunities to achieve sustainability targets and outcomes that are aligned with best practice infrastructure projects. The assessment was undertaken using the IS rating tool, and with consideration of the NSW *Sustainable Design Guidelines* (Transport for NSW, 2013c).

By considering the results of the sustainability assessment, the proposal would continue to be designed, constructed, and operated to minimise potential sustainability risks, whilst also optimising environmental, social, and economic outcomes.

ISCA's infrastructure sustainability rating tool

The IS rating tool can be applied to many different infrastructure projects, including rail projects. Ratings can be undertaken on a design, as built drawings, and operation of a project. An infrastructure project is assessed in terms of how it performs in each of 15 categories that are grouped into six themes in infrastructure sustainability. These include:

- management and governance
- using resources
- emissions, pollution and waste
- ecology
- people and place
- innovation.

Depending on the initiatives and performance of a project across each theme, it will achieve a score from 1 to 100 corresponding to a rating level of commended, excellent, or leading.

An assessment was undertaken for Inland Rail using the IS rating tool (version 1.0). The following approach was used:

- the rating that would apply to the proposal under a business as usual approach was determined
- initiatives that could be implemented to provide additional value ('credits') to the proposal were identified
- the rating that could be achieved with the implementation of these initiatives was determined.

Further information on the application of the IS rating tool to the proposal is provided in Appendix I.

NSW Sustainable Design Guidelines

The approach to sustainability detailed in the NSW *Sustainable Design Guidelines* (Transport for NSW, 2013c) is underpinned by a series of themes and objectives, which define the approach to the delivery of sustainable assets. The *Sustainable Design Guidelines* are divided into seven sustainability themes (with several sub-themes), and include compulsory and discretionary initiatives in relation to:

- energy and greenhouse gases
- climate resilience
- materials and waste
- biodiversity and heritage
- water
- pollution control
- community benefit.

Compulsory initiatives may relate to a corporate target or are considered to be fundamental to the delivery of sustainable assets. If a compulsory initiative is considered to apply, then it must be completed. A discretionary initiative may not be practical for a particular project or may not be the most appropriate initiative to meet a sustainability outcome. Written justification must be provided if a discretionary initiative has not been selected for implementation.

Projects can achieve a score of bronze, silver, gold, or platinum based on their selection of discretionary sustainable initiatives.

22.1.4 Legislative and policy context to the assessment

Sustainability considerations have been embedded in a number of legislative and policy mechanisms, particularly in relation to resource use, waste, and energy efficiency. These include:

- *Waste Avoidance and Resource Recovery Act 2001* (the WARR Act)
- *National Greenhouse and Energy Reporting Act 2007*
- *National Strategy for Ecologically Sustainable Development* (Commonwealth of Australia, 1992)
- *National Waste Policy: Less Waste, More Resources* (Australian Government, 2009)
- *Sustainable Procurement Guide* (Department of Sustainability, Environment, Water, Population and Communities, 2013)
- *NSW Government Resource Efficiency Policy* (OEH, 2014d)
- *NSW Sustainable Design Guidelines* (Transport for NSW, 2013c)
- *Infrastructure Sustainability Planning Guidelines* (ISCA, 2016)

The proposal is considered according to the principles of ESD in Chapter 28.

22.2 Assessment results

22.2.1 IS rating tool

The process and results of the assessment undertaken using the IS rating tool are provided in Appendix I. Under a business as usual approach, the proposal would achieve a 'commended' design rating. However, with the implementation of relevant sustainability opportunities that add value to the proposal, an 'excellent' design rating could be achieved. Key opportunities include minimising:

- water usage during construction
- electricity usage during construction and operation
- greenhouse gas emissions from the consumption and burning of fossil fuels
- demand on local and regional resources
- the carbon footprint of construction materials (type, quality, quantity, location, end product)
- waste production.

The sustainability assessment using the IS rating tool would be updated as the development of the proposal progresses.

22.2.2 Sustainability objectives and initiatives

The next stage of the assessment involved translating the Inland Rail IS rating tool results and opportunities into objectives and initiatives that could be potentially implemented during design, construction, and operation of the proposal.

The sustainability objectives and supporting potential initiatives identified for the proposal are listed in Table 22.1 according to the relevant IS rating tool category. Each category has been assessed against the proposal to determine its applicability and value to the proposal. The themes and objectives are consistent with those identified as part of the IS rating tool assessment, required to achieve an 'excellent' rating. The outcomes and initiatives align with those outlined in the Sustainable Design Guidelines and other relevant guidelines.

The potential initiatives outlined in Table 22.1 would be reviewed and refined during the design process and, where practicable, used to develop targets which would be included in contract documents for all detailed design, construction and operation contracts. Contractors would be required to clearly identify how they would ensure that specific initiatives and targets are met.

Implementation of the final sustainability initiatives and targets would be monitored and audited in line with the requirements of Inland Rail's Sustainability Implementation Framework.

Table 22.1 Proposal sustainability objectives, outcomes and potential initiatives

IS rating tool Category	Objectives	Desired outcomes	Potential sustainability initiatives for the proposal
Governance and management of the process	To integrate sustainability into management systems and approach. To demonstrate leadership by embedding sustainability objectives into decision-making. To establish governance arrangements which support resource efficiency, and continuous improvement of sustainability performance. To achieve an 'excellent' rating using the IS rating tool.	Policies, targets, and objectives are integrated in proposal documentation and commitments. The proposal demonstrates a high level of performance against objectives and appropriate benchmarks. A lessons-learnt process is implemented to cover the broad project benefits and values, with consideration to all stakeholders. Sustainability audits of the management systems are conducted. Senior management participate in review of audits.	Ensure the proposal decision-making framework includes sustainability criteria which consider the environment and community. Develop a sustainability management plan for the proposal that incorporates performance targets across all sustainability themes, based on best practice benchmarking and response to policy and regulatory context. Develop an assurance framework and reporting system to assist ARTC and contractors to report against sustainability performance. Monitor sustainability performance and report results at all levels of the ARTC corporate structure. Couple sustainability risk and opportunities with overall project risk processes to drive consistency and improve project outcomes.

IS rating tool Category	Objectives	Desired outcomes	Potential sustainability initiatives for the proposal
Procurement and purchasing	To integrate sustainability into procurement systems. To reduce the adverse environmental, social, and economic impacts of purchased products and services throughout their life. To influence contractors, subcontractors and materials suppliers to adopt procurement objectives in their works and procurement.	Transport-related costs such as fuel, vehicle maintenance and road congestion are reduced. The proposal reduces the NSW Government's operating costs and ensures the effective and efficient use of resources (*SEARs performance outcome*).	Partner with local suppliers where economically and reasonably feasible. Develop and implement a sustainable procurement policy in accordance with the principles and concepts outlined in the *Sustainable Procurement Guide* (2013), to apply to contractors, subcontractors and suppliers.
Climate change adaptation	To assess climate change risks and requirement for climate change adaptation measures. To design infrastructure and operations to be resilient to the impacts of climate change.	Flood impacts on the proposal would be reduced, leading to a reduction on time and cost to restore track operations during a wash out event. Heat stress on rail segments would be reduced. Improved asset durability with cascading improvements to service reliability and maintenance schedules.	Further refine the climate change risk assessment (undertaken as part of the climate change impact assessment – Chapter 23) as the design of the proposal progresses. Incorporate into the design adaption measures as per those provided in Chapter 23 to mitigate extreme and high level climate change risks, and address medium level climate change risks on the proposal.
Energy and carbon	To understand the potential for minimising energy use from non-renewable sources and greenhouse gas emissions across the infrastructure life cycle. To use energy sources more efficiently and reduce greenhouse gas emissions.	Energy use during construction and operation is reduced. Cost-effective and innovative approaches to energy efficiency, energy procurement and low-carbon/renewable sources are supported. There is a shift to lower carbon transport.	Establish energy efficiency targets for the proposal. Monitor and track carbon emissions from construction and operation and reduce emissions through operating practices and design refinements. Target a reduction in materials haulage through more efficient procurement and reduced transport-related emissions. Utilise and incorporate energy efficient construction plant and equipment, methods and practices. Use local sources of materials, where feasible.

IS rating tool Category	Objectives	Desired outcomes	Potential sustainability initiatives for the proposal
Water conservation	To understand the potential for minimising water use from potable sources across the infrastructure life cycle. To reduce water usage during construction and operation.	Potable water usage is minimised. Opportunities for rainwater, groundwater, greywater and blackwater harvesting and re-use are maximised.	Implement design and construction initiatives to minimise potable water consumption. Undertake a water balance study to inform feasibility for re-use efficiencies. Optimise location and logistics for batching plants to influence the extent of potable water replacement.
Resource use and materials	To identify the life cycle environmental impacts of materials throughout the infrastructure asset life cycle. To reduce the construction materials footprint by optimising the use of socially and environmentally responsible materials.	Conservation of natural resources is maximised. (*SEARs performance outcome*). The proposal reduces the NSW Government's operating costs and ensures the effective and efficient use of resources. (*SEARs performance outcome*).	Establish targets to maximise the re-use of existing materials. Optimise the design to minimise volumes of excavation, steel and imported materials. Specify materials that reduce the need for virgin material supply. Source materials from sustainable suppliers.
Discharges to air, land and water	To identify impacts to local receiving water quality, noise, vibration, air quality, and light across the proposal's life cycle. To minimise air, land, and water pollution from the proposal's construction and operation.	Potential sources of pollution are reduced. Control at the source of the pollution is optimised to avoid environmental harm.	Ensure an Environmental Management System and CEMP are in place prior to construction. Avoid the use of dangerous goods and hazardous materials, where possible. Monitor implementation of noise, air, soil, light, and water quality mitigation measures. Target zero major pollution incidents.

IS rating tool Category	Objectives	Desired outcomes	Potential sustainability initiatives for the proposal
Land	To identify land that has previously been developed and where it can be re-used. To identify contamination risks and perform sustainable remediation. To identify risks from flooding.	Remediation of any contaminated sites is undertaken where required. Land use planning and minimisation of impact on critical land resources is considered.	Reduce clearing of vegetation where possible. Optimise the design to minimise volumes of excavation and maximise re-use of topsoil where appropriate. Apply soil management practices to protect and maintain land values, where possible. Undertake appropriate flood design to minimise risk to the proposal resulting from flood risk and impacts on line outages.
Waste	To identify the potential for sustainable waste management plans and practices. To minimise waste throughout the proposal's lifecycle.	The amount of waste disposed to landfill is minimised. The amount of material re-used during construction and operation is maximised.	Provide facilities in all construction compounds to allow for segregation of waste types to facilitate recycling. Adopt waste recycling targets to maximise recycling of construction waste. Balance site works to avoid excess or import of spoil. Re-use ballast and structural fill either during construction or in the formation of spoil mounds. Use prefabricated civil components where possible to reduce construction waste, material usage, pollution risks and travel. Plan for final disposal of operational assets.

IS rating tool Category	Objectives	Desired outcomes	Potential sustainability initiatives for the proposal
Ecology	To identify impacts to local ecological value and habitat connectivity. To enhance environmental outcomes and improve stakeholder/community relations.	Biodiversity would be protected and enhanced through appropriate planning and management.	Prepare and implement a biodiversity management plan as part of construction. Establish and achieve targets for biodiversity conservation and enhancement, where practicable.
Heritage	To enhance heritage outcomes and improve stakeholder/community relations.	Heritage would be protected and enhanced through appropriate planning and management.	Prepare and implement Heritage Management Plans for ongoing management and monitoring of heritage items, where relevant. Develop partnerships with relevant stakeholders to utilise heritage places to promote local heritage values, where practicable.
Community amenity and benefit	To make a positive contribution to community health and well-being. To assess the impact to design and practice in response to the likelihood of crime.	Landholders and community groups are engaged throughout the proposal's construction and operation. Zero harm to the workforce and community is achieved. Inland Rail is integrated with surrounding land uses. Crime prevention is implemented to maximise safety during construction and operation.	Engage with the impacted community when selecting noise attenuation treatments. Engage with landholders and affected communities throughout the proposal in order to reduce future safety incidents. Listen to and act on community concerns. Implement appropriate design practices in public interaction zones to minimise likelihood of crime.
Stakeholder participation	To assess the level of risk attributed to the engagement, and consideration of stakeholders and their concerns, in the context of the proposal's operation and maintenance. To build a shared understanding of Inland Rail and effective working relationships.	Community believe their issues are being heard and addressed. Local businesses are involved during construction and operation.	Provide design information to assist stakeholder consultation and engage the community and stakeholders during design. Involve local business in the sustainable procurement strategy for the proposal.
Urban and landscape design	To identify the potential for adoption of best practice urban design principles.	Visual amenity of the proposal is improved.	Urban design principles are incorporated into aspects of design, where relevant.

22.3 Mitigation and management

22.3.1 Approach to mitigation and management

A Sustainability Implementation Framework has been developed for Inland Rail to guide how Inland Rail would achieve consistency with an ‘excellent’ rating, based on the IS rating tool. The implementation framework underpins the sustainability objectives and targets for Inland Rail. A sustainability management plan would be developed for the proposal to incorporate the proposal specific objectives and outcomes required to achieve an ‘excellent’ rating, including those listed in Table 22.2.

22.3.2 Consideration of the interactions between mitigation measures

The sustainability management plan would be considered during development of the proposal’s CEMP and operational environmental management plan (described in Chapter 27) to ensure consistency with regards to sustainability.

Climate change risk adaptation measures described in Chapter 23 would be incorporated into the sustainability management plan.

22.3.3 Summary of mitigation measures

To optimise the environmental, social, and economic performance of the proposal, the measures listed in Table 22.2 would be implemented.

Table 22.2 Summary of sustainability mitigation measures

Stage	Impact	Mitigation measures
Detailed design/ pre-construction	Sustainability	The potential sustainability initiatives identified for the proposal would be reviewed and updated during detailed design. A sustainability management plan would be developed to guide the design, construction, and operation of the proposal, to achieve an ‘excellent’ rating according to the IS rating tool. The sustainability management plan would incorporate the updated sustainability initiatives, and the review and reporting requirements necessary to demonstrate how sustainability has been incorporated into the proposal during design, construction, and operation.
Construction	Procurement	Procurement would be undertaken in accordance with the *Sustainable Procurement Guide* (Department of Sustainability, Environment, Water, Population and Communities, 2013) and the *NSW Government Resource Efficiency Policy* (OEH, 2014d).
	Reporting	Sustainability reporting (and corrective action where required) would be undertaken during construction in accordance with the sustainability management plan.
Operation	Sustainability management plan	Prior to operation commencing, the sustainability management plan would be reviewed and updated, and relevant initiatives would be implemented during operation.

23. Climate change

This chapter provides the climate change risk assessment undertaken for the proposal. It assesses the impacts of climate change on the proposal, and provides recommended adaptation and mitigation measures.

23.1 Assessment approach

23.1.1 About climate change

Climate change has the potential to alter the frequency, intensity and distribution of extreme weather related natural hazards, including more intense and frequent heat waves, droughts, floods, and storm surges. The risk of climate change impacts on rail infrastructure need to be considered as part of the design process, as structures need to be designed to last for many years, and therefore need to be resilient to climate change.

Climate change adaptation planning and risk management is an evolving field. Responses to reduce the risks of climate change broadly fall into two categories: mitigation and adaptation. Using the definitions of the *Inter-governmental Panel on Climate Change* (IPCC, 2007), mitigation aims to reduce human effects on the climate system by strategies to reduce greenhouse gas sources and emissions, and to enhance greenhouse gas sinks. Adaptation refers to adjustments in response to actual or anticipated climate changes or their effects, to moderate harm or to exploit beneficial opportunities. Infrastructure design and planning needs to incorporate adaptation measures, based on the assessed risk of climate change to a proposal.

23.1.2 Methodology

The purpose of the climate change risk assessment for the proposal is to:

- identify and assess the risks that climate change poses to the proposal
- prioritise risks that require further action as a basis for decision-making and planning.

The overall approach to the assessment involved modelling two potential climate change scenarios for the study area using the Commonwealth Scientific and Industrial Research Organisation's (CSIRO) 'Australian Climate Futures' climate change modelling tool, and assessing the potential risks for the proposal based on these scenarios.

The assessment involved:

- reviewing climate data and climate change projections based on available data from the Australian Bureau of Meteorology (BoM) and the *Climate Change in Australia* web-based data portal (maintained by CSIRO and BoM)
- developing projections of the future climate in the study area and determining the climate projection scenarios for the assessment using global climate models
- undertaking a detailed climate change risk assessment and determining risk ratings
- identifying potential adaptation measures and/ or design strategies based on the identified risks and potential impacts.

The longitudinal nature of climate change assessment makes it difficult to pinpoint potential impacts within a relatively short construction timeframe. Changes to climate over this timeframe would be associated with changes in weather and climate variability, which refers to the 'normal' monthly to decadal variability in the components of climate. As this chapter focuses on the assessment of climate change over the life of the proposal, any potential impacts during the construction phase are considered more appropriate for assessment in a shorter timescale. These impacts are therefore not considered further in this assessment and the chapter focuses on potential operational impacts.

As described in Chapter 25, an emergency response sub-plan would be developed as part of the CEMP. The plan would include measures to mitigate potential impacts from emergency situations, including those associated with climate change such as bushfires and extreme weather.

Further information on the methodology for the climate change risk assessment and the detailed results are provided in Appendix J. A summary of the results is provided in the following sections.

23.1.3 Legislative and policy context to the assessment

Legislation, policies, guidelines and standards relevant to the assessment include:

- *National Greenhouse and Energy Reporting Act 2007*
- *AS 5334:2013 Climate change adaptation for settlements and infrastructure – a risk based approach*
- *AS/NZS ISO 31000:2009 (AS/NZS 2009) Risk management – principles and guidelines*
- *Climate Change Impacts and Risk Management – A Guide for Business and Government* (Department of Environment and Heritage and Australian Greenhouse Office, 2006)
- *Guide to Climate Change Risk Assessment for NSW Local Government* (OEH, 2011b)
- *National Climate Resilience and Adaptation Strategy* (Department of the Environment, 2015)
- *Climate Change in Australia: Projections for Australia's NRM Regions - Central Slopes Cluster Report* (CSIRO and BoM, 2015)
- *Checklist for best practice adaptation planning and implementation* (OEH, undated)

23.2 Assessment results

Key areas that may be at risk for the proposal include:

- track infrastructure
- critical supply infrastructure
- drainage systems, culverts and embankments
- bridges and structures
- electronics and signage
- safe operation of the network.

The key climate variables that may increase risk of impact from climate change are mainly:

- increase in average temperatures and extreme heat events
- changes to rainfall intensity and frequency of rainfall events
- changes to storm intensity and impacts from increased wind.

Potential risks rated high or medium are considered below.

Potential risks

Increasing average and extreme temperatures

Temperatures have increased steadily and climate projections indicate there will be both an increase in average temperatures and extreme temperatures. With climate projections forecasting a potential increase in average daily temperatures of 3 degrees Celsius by 2070, this is likely to result in increasing heat stress on infrastructure assets and the need for design to consider and apply increased temperature ranges to address this increased stress. Common areas that may be impacted by increasing average and extreme temperatures in rail infrastructure include:

- increased derailment from heat stress and buckling of rail lines
- failure of power supply and electronic equipment
- increased frequency of interruptions to mains power supply
- damage or deterioration of external surfaces
- failure of equipment such as ventilation or air conditioning units
- sagging of overhead lines
- failure of signalling and communications equipment.

Increased rainfall intensity

As temperatures increase the water cycle intensifies with more evaporation resulting in more intense rainfall events. This has a very specific impact on rail infrastructure by causing:

- increased water flows through drainage systems and culverts causing potential flooding or inundation
- structural scouring
- wash out of foundations or ballast
- inundation of buildings, electrical equipment and damage from flooding
- hail damage to external surfaces.

Reduced average rainfall/drought

Recent climate data and future projections show longer periods with little rainfall and conversely more intense rainfall events. This leads to more wetting and drying of soils leading to greater ground instability. Impacts on transport infrastructure can include:

- cracking and movement of concrete track form and failure of embankments
- sub-surface soil stability for prolonged periods of heating and drying
- instability and cracking of structural barriers
- movement of sub-surface infrastructure such as water and gas pipes
- cracking and wear of support structures
- increased maintenance and management of landscaped areas.

Storm impact from wind/changes to wind speed

Severe storms have the potential to cause damage not only from rainfall but also high winds and hail which can cause significant disruption and damage to infrastructure. Impacts may include:

- windblown debris (for example trees) contacting tracks or overhead equipment causing safety risks, disruption, and potential power outages
- increased wind loading potentially causing damage to structures or derailment of double stacked trains
- direct wind or hail damage to electronics and signalling equipment.

Other risks

The following potential risks were identified, but are not considered to be relevant to the proposal:

- **humidity**: unlikely to impact upon proposal materially
- **time in drought**: unlikely to impact upon proposal materially
- **solar radiation**: unlikely to impact upon proposal materially
- **sea level rise**: not directly impacting the proposal due to its distance from the coast.

23.3 Mitigation and management

23.3.1 Approach to climate change adaptation and management

The outcome of the climate change risk assessment is a priority list of risks for which a range of possible adaptation responses can be developed. Some identified risks may require immediate practical adaptation response or modifications to design, while others may require further investigation. The suggested adaptation measures for the proposal, developed as an outcome of the climate change risk assessment, are listed in Appendix J.

The sustainability management plan for the proposal (described in Chapter 22) would include the adaption measures actions relevant to the proposal.

These measures would be reviewed as part of the detailed design process, and incorporated into the design and operating procedures as far as practicable.

23.3.2 Summary of mitigation measures

To mitigate the potential impacts to climate change, the measures listed in Table 23.1 would be implemented.

Table 23.1 Summary of climate change mitigation measures

Stage	Impact	Mitigation measures
Detailed design/ pre-construction	Climate change risk management	The climate change risk assessment would continue to be refined as the design of the proposal progresses. The adaptation measures identified for the proposal would be reviewed, and final measures would be incorporated into the design where practicable.
Operation	Climate change risk management	The recommended adaptation measures would be reviewed, and a final list of adaptation measures for implementation during operation would be confirmed and implemented. Operational management and maintenance procedures would include measures relating to potential climate change risks, as listed in Section 23.2. Emerging opportunities to manage potential climate change impacts on the proposal would continue to be monitored.

24. Waste

This chapter provides a summary of the waste impact assessment undertaken for the proposal. It assesses the impacts from construction and operation of the proposal, and provides recommended mitigation and management measures.

24.1 Assessment approach

24.1.1 Methodology

The waste impact assessment involved:

- reviewing the regulatory framework for waste management
- identifying potential waste generating activities
- identifying the likely classification of waste generated by the proposal in accordance with relevant legislation and guidelines
- estimating quantities of waste, where feasible
- identifying available waste management options
- developing a conceptual waste management plan for construction and operation.

The waste types and quantities estimated as an outcome of this assessment are indicative, and have been identified for the purpose of determining potential waste impacts and waste management options. Although the quantities of waste actually generated by the proposal may differ from the estimates made, the identified waste management options are variable and would be appropriate to the final waste quantities.

24.1.2 Legislative and policy context to the assessment

The main legislation relevant to the management of waste are the *Protection of the Environment Opertions Act 1997* (POEO Act), the *Protection of the Environment Operations (Waste) Regulation 2014* (the Waste Regulation), and the *Waste and Resource Recovery Act 2001* (the WARR Act).

The POEO Act establishes the procedures for environmental control, and for issuing environmental protection licences regarding matters such as waste, air, water, and noise. The Waste Regulation regulates matters such as the obligations of consignors (producers and agents), transporters, and receivers of waste in relation to waste transport licensing and tracking requirements.

The WARR Act aims to ensure that waste management options are considered against the following waste management hierarchy:

- avoidance of unnecessary resource consumption
- resource recovery (including re-use, reprocessing, recycling, and energy recovery)
- disposal.

It is an offence under the Waste Regulation to transport waste generated in NSW more than 150 kilometres from the place of generation for disposal, unless the waste is transported to one of the two lawful disposal facilities nearest to the place of generation.

The movement of controlled waste is also regulated by the *National Environment Protection (Movement of Controlled Waste between States and Territories) Measure 1998*, made under the *National Environment Protection Council Act 1994*.

The *Australian Dangerous Goods Code* (National Transport Commission, 2016) defines a set of requirements for the transport of dangerous goods defined in the code. In NSW, the *Dangerous Goods (Road and Rail Transport) Regulation 2009* gives effect to the *Australian Dangerous Goods Code*.

Definition of waste

Schedule 5 of the POEO Act defines waste as:

(a) any substance (whether solid, liquid or gaseous) that is discharged, emitted or deposited in the environment in such volume, constituency or manner as to cause an alteration in the environment

(b) any discarded, rejected, unwanted, surplus or abandoned substance

(c) any otherwise discarded, rejected, unwanted, surplus or abandoned substance intended for sale or for recycling, processing, recovery or purification by a separate operation from that which produced the substance

(d) any processed, recycled, re-used or recovered substance produced wholly or partly from waste that is applied to land, or used as fuel, but only in the circumstances prescribed by the regulations

(e) any substance prescribed by the regulations to be waste.

Waste classification

The classifications that apply to waste in NSW and the descriptions of each are provided by the POEO Act, the Waste Regulation and supporting guidelines, including the *Waste Classification Guidelines* (EPA, 2014b). Many waste types are pre-classified under the POEO Act and do not require testing. However, if a waste is not pre-classified, it may need to be tested to determine its classification.

Other

Consideration was given to the *NSW Waste Avoidance and Resource Recovery Strategy 2014 – 21* (EPA, 2014a). The primary goal of this strategy is to enable NSW to improve environment and community well-being by reducing the environmental impact of waste and using resources more efficiently. This strategy is informed and driven by the waste hierarchy defined in the WARR Act. It is supported by various regulations and policies including the POEO Act and Waste Regulation. To support the primary goal of the strategy the proposal will be constructed and operated with consideration to the waste hierarchy. Additionally, any waste generated from the proposal will be disposed of in accordance with regulatory requirements.

The NSW *Sustainable Design Guidelines* (Transport for NSW, 2013c) were also considered as the guideline includes compulsory and discretionary initiatives in relation to materials and waste. Further discussion regarding these guidelines and the associated initiatives is included in Chapter 22.

24.2 Impact assessment

24.2.1 Risk assessment

Potential impacts

The environmental risk assessment for the proposal (provided in Appendix B) included an assessment of the potential waste risks.

The assessed risk level for the potential risks due to waste was low. This is because the proposal is unlikely to result in significant amounts of waste being generated, with the exception of construction related waste.

How potential impacts would be avoided

In general, with respect to waste, potential impacts would be avoided by:

- managing wastes in accordance with relevant legislative and policy requirements, as described in Section 24.1.2
- designing, constructing and operating the proposal so that wastes are managed according to the waste minimisation hierarchy:
  - avoidance, where possible
  - treated, as required and re-used on-site
  - recycled, either within the process or off-site
  - where other alternatives are not possible, wastes would be disposed of at appropriately licensed waste management facilities
- implementing the waste management and mitigation measures described in Section 24.3
- implementing the dust management and mitigation measures provided in Chapter 13
- managing hazardous wastes in accordance with the mitigation measures provided in Chapter 25.

24.2.2 Construction impacts

Waste generation

The following activities are likely to generate waste during construction:

- site preparation including:
  - clearing and grubbing
  - topsoil stripping
  - site compound establishment
  - haul roads, access roads and laydown construction
  - fencing (temporary and or permanent)
- cut and fill earthworks
- drainage structure demolition, replacement, or construction
- culvert and bridge demolition, replacement, or construction
- welding
- ballasting and tamping
- level crossing upgrading or consolidation
- site compound operation
- plant and equipment operation.

Waste from site preparation may include vegetation, roots, tree stumps, and general rubbish and debris.

Local accommodation at various towns would be utilised for construction staff. No construction camps are proposed, however site compounds would be established – some with office facilities and amenities. The establishment of these site compounds may generate some minor quantities of construction material waste such as metals, wood, concrete etc.

Wastewater generated by site compound operation would include grey water and sewage from site amenities and washdown water used for vehicles and equipment.

Food waste, waste paper and cardboard, plastic, metal (including aluminium cans), glass, and electrical waste would be generated by construction staff, as well as any office facilities included at the site compounds. Maintenance fluids generated during plant and equipment operation include paints, solvents, lubricants, and oils. Hydrocarbon and water mixtures or emulsions would be generated in plant and equipment wash-down areas within site compounds.

Waste generated during construction would include packaging waste such as pallets, plastic film wrap, cable reels, and metal straps / bands.

Classification of waste to be generated

Table 24.1 shows the predicted construction waste types and likely classifications.

Table 24.1 Waste estimates and classification – construction

Activity	Waste	Classification	Estimated quantity (tonnes unless indicated)
Clearing and grubbing	Green waste	General solid waste (non-putrescible)	Zero off-site - stockpiled in bottom layer spoil mounds
	Rubbish and debris	General solid waste (non-putrescible)	250
Topsoil stripping	Topsoil	General solid waste (non-putrescible) or virgin excavated natural material	Zero off-site - placed over top of stockpiled spoil mounds
Rail formation	Sleepers rail	General solid waste (non-putrescible)	Rail - 188 km x 2 and sleepers (186000/.6) mix timber and steel
Site compound establishment	Waste concrete (for hardstand areas)	General solid waste (non-putrescible)	200
	Waste metal	General solid waste (non-putrescible)	20
	Waste wood	General solid waste (non-putrescible)	20

Activity	Waste	Classification	Estimated quantity (tonnes unless indicated)
Site compound establishment	Waste glass	General solid waste (non-putrescible)	<1
	Waste plastic	General solid waste (non-putrescible)	<1
Fencing (temporary and permanent)	Waste metal/ timber posts	General solid waste (non-putrescible)	30 km
Cut and fill earthworks	Contaminated spoil	Special waste	<1 based on existing contamination assessment results (refer Chapter 14)
Drainage structures and culvert/bridge demolition/ construction/ replacement	Waste wood and concrete	General solid waste (non-putrescible)	6,000
	Waste metal	General solid waste (non-putrescible)	500
Welding	Waste metal	General solid waste (non-putrescible)	Rail off-cut kept, other minimal (<1)
Ballasting and tamping	Waste ballast	General solid waste (non-putrescible)	Zero off-site - all ballast used, unsuitable stockpiled into spoil mounds
Site compound operation	Food waste	General solid waste (putrescible)	< 1
	Wastewater	Liquid waste	To be confirmed
	Waste paper	General solid waste (non-putrescible)	1.5
	Waste cardboard	General solid waste (non-putrescible)	2.5
	Waste plastic and glass	General solid waste (non-putrescible)	< 1
	Waste metal	General solid waste (non-putrescible)	30
	Electrical waste	General solid waste (non-putrescible)	2
	Waste from vehicle/plant equipment maintenance	General solid waste (non-putrescible) - drained oil filters (mechanically crushed), rags and oily rags only if they contain non-volatile petroleum hydrocarbons and no free liquids. Hazardous waste - containers holding oil, grease, and lubricants if residues have not been removed by washing (see Appendix 2 of the *Waste Classification Guidelines Part 1: Classifying waste* (EPA, 2014b)).	<1

Approximate waste volumes and the potential classification would be estimated and/or confirmed following finalisation of the detailed design and incorporated into the CEMP prepared for the proposal.

Spoil generation and management

Spoil generation and quantities

Spoil is soil, rock or dirt excavated and removed from its original location. It is estimated that a total of 881,430 cubic metres of spoil would be generated during construction. All spoil is expected to be re-used for either track formation/construction or used to create spoil mounds (as described in Chapters 7 and 8).

Only some minor quantities of contaminated spoil may be generated that could not be re-used on site. This material would require off-site disposal at an appropriately licenced facility.

The estimated quantities of spoil that would be generated and re-used are listed in Table 24.2.

The majority of spoil would be generated during excavation required for the construction of cess drains. Relatively smaller quantities would be generated during site preparation activities, and from other earthworks such as for the formation treatment.

Table 24.2 Preliminary estimate of potential spoil generation

Location/source (start chainage)	Spoil estimate (m^3)	Spoil to be re-used in track formation/ construction	Spoil to be used on site in spoil mounds
573.000	11,517	4,900	6,617
576.500	11,171	5,600	5,571
580.500	10,323	6,300	4,023
585.000	7,334	6,300	1,034
589.500	41,178	6,300	34,878
594.000	38,722	6,300	32,422
598.500	10,685	6,300	4,385
603.000	13,054	6,300	6,754
607.500	8,208	6,300	1,908
612.000	25,235	6,300	18,935
616.500	-8,865	6,300	-15,165
621.000	15,680	6,300	9,380
625.500	7,471	6,300	1,171
630.000	13,494	6,300	7,194
634.500	43,325	6,300	37,025
639.000	30,404	6,300	24,104
643.500	41,198	6,300	34,898
648.000	41,607	6,300	35,307
652.500	32,635	6,300	26,335
657.000	55,435	6,300	49,135
661.500	74,577	6,300	68,277
666.000	2,761	8,425	-5,664
670.000	57,894	10,550	47,344

Location/source (start chainage)	Spoil estimate (m^3)	Spoil to be re-used in track formation/ construction	Spoil to be used on site in spoil mounds
673.500	18,164	12,675	5,489
676.500	10,095	14,800	-4,705
679.000	44,591	6,300	38,291
683.500	44,581	6,300	38,281
688.000	44,559	6,300	38,259
692.500	39,335	6,300	33,035
697.000	43,953	6,300	37,653
701.500	38,948	6,300	32,648
706.000	18,495	6,300	12,195
710.500	22,509	6,300	16,209
715.000	12,756	6,300	6,456
719.500	15,177	6,300	8,877
724.000	27,295	6,300	20,995
728.500	29,419	6,300	23,119
733.000	-7,725	6,300	-14,025
737.500	47,900	6,300	41,600
742.000	50,336	6,300	44,036
746.500	54,989	6,300	48,689
751.000	17,619	6,300	11,319
755.500	13,440	6,300	7,140
Totals	**1,171,480**	**290,050**	**881,430**

As listed in Table 24.2, it is estimated that about 24.8 per cent of the spoil generated (290,050 cubic metres) could be re-used in track formation/construction, with the remainder being used in spoil mounds. This would continue to be refined during detailed design. Consistent with the waste minimisation hierarchy, the approach to spoil management would follow the hierarchy of options listed in Table 24.3.

Waste handling and management

Approach to waste minimisation and re-use

Waste management measures have been developed for the identified types of waste in accordance with the waste management hierarchy (refer Table 24.6). Although the waste management hierarchy has been considered for each waste type, not all waste management options are applicable to a given waste type. For example, some types of waste are non-recyclable. As such, only the applicable waste management options are applied.

Recycling and disposal

The following waste management facilities are located in the study area:

- Narrabri Landfill (Yarrie Lake Road, Narrabri) – accepts general waste, scrap metal, green waste, used oil, recycling, and electronic waste.
- Narrabri rural transfer stations – large vehicles (over 3 tonne) not accepted.
- Moree Waste Management Facility (Evergreen Road, Moree) – accepts general waste, scrap metal, green waste, concrete, used oil, recycling, electronic waste, and asbestos.
- Moree Plains Shire rural landfills – Boggabilla Landfill, Boomi Landfill, Garah Landfill, Gurley Landfill, Mungindi Landfill, Terrie Hie Hei Landfill, Weemelah Landfill.
- Bingara Waste Recovery Centre (Narrabri Road, Bingara) – accepts general waste, green waste, scrap metal, and asbestos.
- Warialda Waste Recovery Centre (Rubbish Depot Road, Warialda) – accepts general waste, green waste, scrap metal, and asbestos.
- Gwydir Shire rural landfills – Coolatai Landfill, Croppa Creek Landfill, Gravesend Landfill, Upper Horton Landfill, Warialda Rail Landfill.

The majority of the rural landfills or transfer stations are operated by local councils for use by residents. However, the larger landfills and transfer stations are able to accept commercial waste. Arrangements would be made with landfill operators prior to the delivery of waste and recycling to any rural facility to ensure that the waste types and quantities could be accepted.

The approach to waste management during construction is described in Section 24.3. The waste management measures proposed to align with the waste management hierarchy are listed in Table 24.6. This table also outlines the contingency measures (disposal) for wastes that cannot be avoided, re-used, recycled or treated. Measures to facilitate segregation and prevent cross contamination are also provided.

Table 24.3 Spoil management hierarchy for the proposal

Priority	Re-use options	Approach
1	Avoid	Detailed design would include measures to minimise spoil generation.
2	Re-use for construction of the proposal	There would be a focus on the re-use of material, and optimisation of the design to minimise spoil volumes. Spoil generated during construction would be re-used for the proposal, including: - re-use spoil for fill, embankments and mounds within a short haulage distance of the source - re-use spoil to restore any pre-existing contaminated sites within the proposal site.
3	Re-use on other projects	Re-use spoil for fill, embankments and mounds on other projects within a financially feasible transport distance of the proposal site.
4	Disposal	Excess spoil would be disposed of in accordance with the waste management plan prepared as part of the CEMP (refer Section 24.3).

24.2.3 Operation impacts

Operation waste generating activities

The main waste generating activity during operation would be track maintenance. Small quantities of green waste may be generated during maintenance activities as a result of vegetation control, herbicide use, and maintenance of the entire rail corridor. Other general debris and litter are also expected to be collected during maintenance. These activities already occur under existing operational conditions.

Maintenance of plant and vehicles would be undertaken back at ARTC's existing provisioning centres, therefore waste from maintenance of plant and vehicles during operation has not been considered further.

Classification and estimates/details of the quantity of each classification of waste to be generated

The anticipated waste types, likely classifications, and estimated quantities during operation are listed in Table 24.4.

Waste handling and management

Approach to waste minimisation and re-use

The approach to waste management during operation is described in Section 24.3. The waste management measures proposed to align with the waste management hierarchy are listed in Table 24.8. This table also outlines the contingency measures (disposal) for wastes that cannot be avoided, re-used, recycled or treated. Measures to facilitate segregation and prevent cross contamination are also provided.

24.3 Mitigation and management

24.3.1 Approach to mitigation and management

The waste management strategy for the proposal would continue to be developed and refined during detailed design and would include:

- the procurement plan
- construction waste management plan
- operation waste management plan
- waste auditing and monitoring.

A construction waste management plan would be developed for the proposal as part of the CEMP. Operational procedures would continue to consider waste management in accordance with regulatory requirements. Waste management during construction and/or operation would also be undertaken in accordance with ARTC's existing procedures and the relevant environment protection licences. Implementation of these measures would help ensure that waste from the proposal is managed in an environmentally sound manner, and in accordance with any legislated requirements for waste disposal and waste tracking.

In addition, waste auditing and monitoring would be undertaken to ensure that the construction waste management plan is scaled with actual waste volumes. The proposed approach to environmental management during construction and operation is described in Chapter 27.

Table 24.4 Waste estimates and classification - operation

Activity	Waste	Classification	Quantity (tonnes per year)
Track maintenance	Green waste	General solid waste (non-putrescible)	<1
	Rubbish and debris	General solid waste (non-putrescible)	250

24.3.2 Consideration of the interactions between mitigation measures

All mitigation measures would be consolidated and described in the environmental management plans for construction and operation. The plans would identify measures that are common between waste types and or impact categories. Common impacts and common mitigation measures would be consolidated to ensure consistency.

24.3.3 Summary of mitigation measures

To manage and mitigate the potential for waste impacts, the mitigation measures listed in Table 24.5 to Table 24.8 would be implemented.

Table 24.5 Summary of waste mitigation measures

Stage	Impact	Mitigation measures
Detailed design	Excess waste generation	Detailed design would include measures to minimise excess spoil generation. This would include a focus on optimising the design to minimise spoil volumes, and the re-use of material on-site.
Pre-construction/ construction	Waste management	A construction waste management plan would be prepared and implemented as part of the CEMP. It would include measures to minimise the potential for impacts on the local community and environment, including those listed in Table 24.6.
Construction	Waste management	Waste segregation bins (colour coded as listed in Table 24.7) would be located at key construction compounds where practicable, to facilitate segregation and prevent cross contamination.
Operation	Waste management	The waste management measures listed in Table 24.8 would be implemented where practicable during operation.

Table 24.6 Waste management measures – construction

Waste	Hierarchy	Management
Green waste	Avoid	Clearing would be minimised by placing temporary infrastructure in areas that have been previously cleared, degraded or have naturally lower above ground biomass.
	Reduce	Areas to be cleared would be marked to reduce incidental clearing.
	Re-use	As far as practicable, cleared material would be chipped, mulched, and stockpiled for re-use during finishing works. Materials with special habitat value, such as hollow-bearing logs or trees, would be selectively removed for re-use, or placed in nearby bushland.
	Dispose	Noxious weeds would be disposed of in accordance with relevant guidelines/requirements.
Rubbish and debris	Recycle	Where recycling is considered feasible, rubbish and debris would be stored for collection by an authorised contractor for off-site recycling.
	Dispose	Where rubbish and debris is not recyclable, the waste would be removed to a storage location for collection by an authorised contractor for off-site disposal.
Food waste	Disposal	Putrescible waste would be stored at allocated bins at each site compound, for collection by an authorised contractor, and disposed of off-site.

Waste	Hierarchy	Management
Wastewater	Dispose	Wastewater/sewage from site compound amenities/ablutions would be removed by an authorised contractor for disposal in accordance with regulatory requirements.
Spoil	Reduce	The proposal is designed to adhere to the natural ground profile, where practicable, in order to reduce earthworks.
	Re-use	All spoil is expected to be re-used either for track formation/construction or used to create spoil mounds.
	Recycle	Surplus material that cannot be re-used would be stockpiled on site. Options to recycle spoil would be investigated where practicable.
	Dispose	Only minor quantities of contaminated spoil will require off-site disposal at an appropriately licenced facility.
Topsoil	Re-use	Topsoil would be stockpiled for re-use during rehabilitation. Stockpiles would be managed to maintain soil structure and fertility.
	Treat	Low quality topsoil would be treated with ameliorants to improve structure and fertility.
	Dispose	Surplus or unusable topsoil would be disposed at locations within the rail corridor.
Waste concrete	Avoid	Procurement of surplus concrete powder would be avoided by adhering to the *Sustainable Procurement Guide* and the *NSW Government Resource Efficiency Policy*.
	Re-use	Sleepers would be re-used where appropriate.
	Recycle	Waste concrete would be crushed and recycled where practicable.
	Dispose	Waste concrete that cannot be recycled would be collected and stored in designated storage areas for off-site disposal by an authorised contractor.
Waste ballast	Avoid	Procurement of surplus ballast would be avoided by adhering to the *Sustainable Procurement Guide* and the *NSW Government Resource Efficiency Policy.*
	Disposal	All unusable ballast would be placed into spoil mounds.
Waste metal	Avoid	Procurement of surplus metal, including rail, would be avoided by adhering to the procurement plan.
	Reduce	Waste metal would be reduce by limiting offcuts.
	Recycle	Suitable rail offcuts or scrap metal (including metal bands from packaging of construction materials and hot waste from welding) would be stored for collection by an authorised contractor and recycled off-site. Market demand for this recyclable waste would also be considered.
Waste wood	Avoid	Procurement of surplus wood would be avoided by adhering to the *Sustainable Procurement Guide* and the *NSW Government Resource Efficiency Policy*.
	Re-use	Waste wood would be stored on site for re-use, where practicable.
	Recycle	Waste wood that cannot be re-used on site (including cable reels from packaging) would be collected in designated recycling containers for offsite disposal by an authorised contractor, where recycling is considered feasible. Market demand for this recyclable waste would be considered.

Waste	Hierarchy	Management
Waste glass	Recycle	Waste glass would be stored at recycling bins at each site compound, for collection by an authorised contractor and recycled off-site, where feasible.
	Dispose	Where recycling is not considered feasible, the waste would be collected and stored in designated waste storage areas for collection by an authorised contractor for off-site disposal.
Waste plastic	Avoid	Procurement of surplus plastic would be avoided by adhering to the *Sustainable Procurement Guide* and the *NSW Government Resource Efficiency Policy*.
	Recycle	Waste plastic would be stored at recycling bins at each site compound, for collection by an authorised contractor and recycled off-site.
	Dispose	Where recycling is not considered feasible, the waste would be collected and stored in designated waste storage areas for collection by an authorised contractor for off-site disposal.
Waste rubber	Avoid	Procurement of surplus rubber (for example gloves, earplugs, tyres) would be avoided by adhering to the *Sustainable Procurement Guide* and the *NSW Government Resource Efficiency Policy*.
	Recycle	Waste rubber would be stored at recycling bins for collection by an authorised contractor and recycled off-site.
	Dispose	Where recycling is not considered feasible, or is contaminated, waste would be collected and stored in designated waste storage areas for collection by an authorised contractor for off-site disposal.
Waste paper	Avoid	Procurement of surplus paper would be avoided by adhering to the *Sustainable Procurement Guide* and the *NSW Government Resource Efficiency Policy*.
	Reduce	Waste paper from office/administration facilities would be minimised by enabling 'secure print' feature on all printers and by encouraging double-sided printing.
	Recycle	Waste paper would be stored at recycling bins at each site compound, for collection by an authorised contractor, and recycled off-site, where feasible.
	Dispose	Where recycling is not considered feasible, the waste would be collected and stored in designated waste storage areas for collection by an authorised contractor for off-site disposal.
Waste cardboard	Avoid	Procurement of surplus cardboard would be avoided by adhering to the *Sustainable Procurement Guide* and the *NSW Government Resource Efficiency Policy*.
	Recycle	Waste cardboard would be stored at recycling bins at each site compound, for collection by an authorised contractor, and recycled off-site, where feasible.
	Dispose	Where recycling is not considered feasible, the waste would be collected and stored in designated waste storage areas for collection by an authorised contractor for off-site disposal.
Waste aluminium cans	Recycle	Waste aluminium would be stored at recycling bins at each site compound, for collection by an authorised contractor, clubs or charities, and recycled off-site.

Waste	Hierarchy	Management
Electrical waste	Avoid	Procurement of surplus appliances and cabling would be avoided by adhering to the *Sustainable Procurement Guide* and the *NSW Government Resource Efficiency Policy*.
	Re-use	Product stewardship arrangements would be sought, with a view to some electrical appliances being re-used under return to supplier arrangements.
	Recycle	Electrical waste would be stored at recycling bins at each site compound, for collection by an authorised contractor, and recycled off-site, where feasible. Market demand for this recyclable waste would also be considered.
	Dispose	Where recycling is not considered feasible, the waste would be collected and stored in designated waste storage areas for collection by an authorised contractor for off-site disposal.
Waste oil, grease, lubricants, oily rags and filters	Avoid	Procurement of surplus oil, grease, and lubricants would be avoided by adhering to the *Sustainable Procurement Guide* and the *NSW Government Resource Efficiency Policy*.
	Recycle	Only waste oil and oil filters to be recycled through storage in recycling bins at each site compound, collection by an authorised contractor, and recycling off-site, where feasible.
	Dispose	The waste would be collected and stored in designated waste storage areas for collection by an authorised contractor for off-site disposal. Where feasible, containers holding oil, grease, and lubricants would be washed prior to disposal or stored separately for disposal as hazardous waste.
Waste pallets	Avoid	Procurement of surplus pallets would be avoided by adhering to the *Sustainable Procurement Guide* and the *NSW Government Resource Efficiency Policy*.
	Reduce	Delivery of material on pallets would be limited wherever possible. If materials have to be delivered to site on pallets, ensure that pallets are returned to the supplier at time of delivery, where practicable.
	Re-use	Product stewardship arrangements would be sought, with a view to pallets being re-used under the stewardship of the supplier.
	Recover	Options to recover wood from pallets by chipping, for re-use as mulch, would be pursued where practicable.

Table 24.7 Colour-coding scheme for waste segregation bins

Waste type	Colour
General waste	RED
Paper, cardboard, cans, bottles	BLUE
Metal	GREY
Plastics	ORANGE
Green waste, organics	GREEN

Table 24.8 Waste management measures – operation

Waste	Hierarchy	Management
Green waste	Re-use	As far as practicable, green waste generated from maintenance activities would be chipped, mulched, and re-used for vegetation management or collected by an authorised contractor and recycled off-site.
	Dispose	Noxious weeds would be disposed of in accordance with relevant guidelines/requirements.
Rubbish and debris	Recycle	Rubbish and debris includes any unexpected waste encountered during general track and corridor maintenance, and may include scrap metal, plastic, wood, and other litter. Such wastes would be would be collected by an authorised contractor and recycled off-site, where recycling is considered feasible.
	Dispose	Where rubbish, debris and litter is not recyclable, the waste would be collected by an authorised contractor and disposed off-site at a suitably licenced facility.
Waste metal	Avoid	Procurement of surplus metal, including rail, would be avoided by adhering to the *Sustainable Procurement Guide* and the *NSW Government Resource Efficiency Policy*.
	Reduce	Waste metal would be reduced by limiting offcuts.
	Recycle	Suitable rail offcuts or scrap metal (including metal bands from packaging of materials for maintenance and hot waste from welding) would be collected by an authorised contractor and recycled off-site. Market demand for this recyclable waste would also be considered.

25. Health and safety (including hazardous materials)

This chapter provides an assessment of the potential health and safety impacts associated with the proposal on the surrounding community and the environment. It assesses the potential impacts from construction and operation of the proposal, and provides recommended mitigation and management measures.

25.1 Assessment approach

25.1.1 Methodology

A desktop level assessment was undertaken to identify potential impacts to the health and safety of the surrounding community and environment as a result of the construction and operation of the proposal. The assessment involved:

- reviewing the relevant regulatory framework and applicable guidelines
- identifying construction and operational activities with the potential to cause health and safety impacts to off-site receivers
- considering the potential impacts associated with hazardous materials, as defined by the guidelines to *State Environmental Planning Policy No 33 – Hazardous and Offensive Development* (SEPP 33) developed under the *Environmental Planning Assessment Act 1997* (EP&A Act)
- reviewing bushfire prone land maps for the proposal site, where available
- qualitatively assessing potential impacts to public health and safety
- providing mitigation measures for implementation during construction and operation.

The assessment focuses on those construction and operational activities with the potential to result in health and safety impacts on surrounding communities, land uses, and the environment (also known as 'off-site receivers'). The assessment does not take into account potential health and safety risks to on-site workers associated with normal construction operations, as these are regulated by workplace health and safety legislation (including the *Work Health and Safety Act 2011*), and are not relevant to approval of the proposal under Part 5.1 of the EP&A Act. Site management would be the responsibility of the construction contractor, who would be required (under the *Work Health and Safety Act 2011*) to manage the site in accordance with relevant regulatory requirements.

25.1.2 Legislative and policy context to the assessment

The assessment gave consideration to the following relevant legislation, policies and guidelines:

- *Rural Fires Act 1997*
- *Dangerous Goods* (*Road and Rail Transport) Regulation 2009*
- *Planning for bush fire protection* (NSW Rural Fire Service, 2006)
- *Australian Code for the Transport of Dangerous Goods by Road & Rail (*National Transport Commission, 2016) ('the Australian Dangerous Goods Code')
- *Hazardous and Offensive Development Application Guidelines: Applying SEPP 33* (Department of Planning, 2011) ('Applying SEPP 33').

Dangerous goods and hazardous materials

Hazardous materials are classified based on their health effects, while dangerous goods are classified according to their physical or chemical effects, such as fire, explosion, corrosion, and poisoning, affecting property, the environment or people.

As the proposal is State significant infrastructure, SEPP 33 does not apply to the proposal (refer to Section 3.3). However, applying SEPP 33 provides a process of identifying a potentially hazardous development by identifying storage and transport screening thresholds. The thresholds in applying SEPP 33 represent the maximum quantities of hazardous materials that can be stored or transported without causing a significant off-site risk.

Hazardous materials are defined by applying SEPP 33 as substances falling within the classification of the Australian Dangerous Goods Code. Dangerous goods are substances that, because of their physical, chemical (physicochemical) or acute toxicity properties, present a risk to people, property or the environment. Types of substances classified as dangerous goods include explosives, flammable liquids and gases, corrosives, chemically reactive or acutely (highly) toxic substances. Dangerous goods are defined by the Australian Dangerous Goods Code.

25.2 Existing environment

25.2.1 Sensitive receivers

The proposal would generally be located more than 200 metres from most sensitive receivers. Sensitive receivers and land uses close to the proposal site are described in Chapters 11 and 20. In total, 243 sensitive receivers, consisting of residences only, were identified within 200 metres of the proposal site.

25.2.2 Existing goods transport arrangements

Existing operations along the rail lines in the study area are described in Chapter 2.

25.2.3 Bushfire

Bushfire presents a threat to public safety and environmental (biodiversity) values. Lightning, carelessness, acts of vandalism, and other phenomena which create ignition in the proximity of dry vegetation cause the majority of bushfires in Australia. The major ignition sources in the Narrabri/Moree and Gwydir LGAs are:

- lightning (large storm cells, usually in the summer months)
- arson
- escapes from legal burning or campfires
- farm machinery (for example during harvest).

The risk of bushfire can be considered in terms of environmental factors that increase the risk of fire (fuel quantity and type, weather patterns, and topography), as well as specific activities or infrastructure components that can exacerbate ignition risks. Environmental factors are considered in this section while potential ignition sources which may be generated by the proposal are described in Section 25.3.2 and Section 25.3.3.

Existing risk

Bushfire prone areas are those areas that can support a bushfire or are likely to be subject to bushfire attack. Bushfire prone land maps have been prepared by most local councils across NSW and certified by the Commissioner of the NSW Rural Fire Service. The maps identify bushfire hazards and associated buffer zones within a LGA.

No bushfire prone land maps were publically available for the Narrabri, Moree Plains and Gwydir LGAs. However, bushfire risk management plans have been prepared by the Narrabri/Moree Bush Fire Management Committee and by the Gwydir Bush Fire Management Committee.

The Narrabri/Moree area has on average 230 bushfires per year of which about 10 could be considered to be major fires. In the Gwydir LGA the average is 70 bushfires per year of which five are usually major fires.

Vegetation

The majority of the proposal site has been modified by uses and activities associated with rail transport and surrounding agricultural land uses. Vegetation within and in the vicinity of the proposal site is described in Chapter 10.

Topography

The slope of a site can also influence the rate of spread of fire, with a doubling of the rate of spread for every slope increase of 10 degrees. As a consequence, a bushfire hazard downslope of a site would pose a greater risk as the bushfire would travel upwards, with a corresponding increase in flame height and intensity. The proposal site generally consists of gentle rises and falls with areas of near level to undulating terrain. Between Narrabri to Moree South the rail corridor is located within an alluvial floodplain. Between Moree and North Star the rail corridor is located within an alluvial floodplain in the Gunnedah Basin, crossing the Goondiwindi thrust fault east of Camurra, and passing into the New England Fold Belt.

Climate

The climate of the proposal site ranges from temperate in the Narrabri / Moree LGAs to subtropical in the Gwydir LGA. Rainfall conditions vary from 595 millimetres annual average in Narrabri to 718 millimetres in the Gwydir area. Rainfall occurs predominantly in the summer months. The fire season generally runs from October to March.

Prevailing weather associated with the bushfire season near the proposal site are high daytime temperatures and low relative humidity with winds from the north-west. Dry lightning storms are also common during this period. November is typically the worst month for larger fires.

25.3 Impact assessment

25.3.1 Risk assessment

Potential impacts

The environmental risk assessment for the proposal (summarised in Appendix B) included an assessment of the potential health and safety risks. The assessed risk level for the majority of potential risks to health and safety was between medium and high. Risks with an assessed level of medium or above are as follows:

- impacts from the transport, storage and use of hazardous substances and dangerous goods
- emissions from vehicles or plant during construction
- reduced safety for road users and pedestrians during construction
- health impacts from noise and air pollution during construction and operation
- potential for the proposal to exacerbate bushfire risk (as a result of the storage of dangerous goods, and construction site issues such as smoking or hot works)
- impacts from spills or accidents during the transport, storage, and use of hazardous substances and dangerous goods
- potential for train strike for pedestrians and vehicles crossing the rail corridor.

How potential impacts would be avoided

In general, with respect to health and safety, potential impacts would be avoided by:

- managing construction and operation activities in accordance with relevant legislative and policy requirements, as described in Section 25.1.2
- designing, constructing and operating the proposal to minimise impacts to health and safety
- implementing the management and mitigation measures provided in Section 25.4.

25.3.2 Construction impacts

Storage, handling and transport of dangerous goods and hazardous materials

The storage and handling of dangerous goods and hazardous materials have the potential to impact the surrounding community and environment if leaks and spills occur, resulting in the potential contamination of air, soils, surface water, and/or groundwater.

Dangerous goods that may be used during construction are listed in Table 25.1. These are compared to the storage and transport thresholds in applying SEPP 33. These thresholds represent the maximum amounts of dangerous goods that can be stored or transported to and from a proposal site without causing a significant risk to off-site receivers.

In general, low volumes of dangerous goods would be stored in construction compounds adjacent to the rail corridor. The quantity of goods stored would be commensurate with the demand for those goods so that excess goods are not sitting idle.

Table 25.1 Dangerous goods volumes and thresholds

Dangerous good	Australian Dangerous Good Code Class	Storage method	Applying SEPP 33 thresholds		
			Storage volume	Minimum distance from sensitive recievers	Transport (weekly)
Petrol	C1[1]; 3 PG III[2]	20 litre drums	Greater than 5 tonnes if stored with other Class 3 flammable liquids	5 m	NA if not transported with Class 3 dangerous goods
Diesel	C1[1]; 3 PG III[2]	20 litre drums	Greater than 5 tonnes if stored with other Class 3 flammable liquids	5 m	NA if not transported with Class 3 dangerous goods
Lubricating and hydraulic oils and greases	C2	20 litre drums	NA	NA	NA if not transported with Class 3 dangerous goods
Cement	NA	Bags or pallets	NA	NA	Not subject to thresholds
Acetylene	2.1	Cylinders (up to 55 kg)	Greater than 100 kg	15 m	2 tonnes, 30 times per week
Epoxy glue	3 PG III	Small containers	Greater than 5 tonnes	5 m	10 tonnes, 60 times per week
Premix concrete	NA	Bags or pallets	NA	NA	Not subject to thresholds
Shotcrete accelerator	3 PG III	1,000 litre intermediate bulk containers (IBCs)	Greater than 5 tonnes	5 m	3 tonnes, 45 times per week
Acids	8 PG II	1,000 litre IBCs	Greater than 25 tonnes	NA	2 tonnes, 30 times per week
Bases	8 PG II	1,000 litre IBCs	Greater than 25 tonnes	NA	2 tonnes, 30 times per week
Disinfectant	8 PG II	500 litre IBCs	Greater than 50 tonnes	NA	2 tonnes, 30 times per week

Notes: 1: Classified as C1 if not stored with other Class 3 flammable liquids
2: Classified as 3PGIII if stored with other Class 3 flammable liquids

Bushfire

Potential ignition sources relevant to the proposal's construction include the discarding of cigarettes and domestic rubbish (such as glass bottles) by construction workers and the generation of sparks through hot works such as welding or the excavator bucket making contact with rock or the rail track.

Fuel leaks and spills from plant and machinery and the storage of flammable goods during construction could also provide a fuel source for bushfires if ignited.

Underground and aboveground utilities

The potential rupture of underground utilities during excavation or collision of plant and equipment with aboveground services could pose risks to public safety. Rupture or contact with services during works could also result in short-term outages, as could relocation of utilities and services.

Health and safety impacts associated with encountering utilities would be minimised by undertaking utilities investigations, including intrusive investigations, and consultation with service providers during detailed design.

Potential contamination

Contaminants of potential concern that could potentially be exposed during excavation include hydrocarbons and asbestos. Exposure to these contaminants could cause health and safety impacts to the community through inhalation and/or direct contact, or impacts to the environment due to contamination of land.

Health and safety impacts associated with potential exposure to contaminated and hazardous materials would be minimised through implementation of an unexpected finds protocol and waste management plan that would be prepared as part of the CEMP.

Further information on contamination and associated mitigation measures is provided in Chapter 14.

Risk of subsidence

As described in Chapter 15, the potential for dewatering during construction is low, due to the shallow depth of excavation and the low potential for groundwater to be encountered in significant volumes at these depths. The proposal would also not involve the excavation of any tunnels or other subsurface cavities. Based on the nature of the works being undertaken and the existing environment, the risk of subsidence as a result of construction is considered negligible.

Emergency vehicle movements

As described in Chapter 9, construction of the proposal would result in temporary impacts to traffic and access within the proposal site, and an increase in both heavy and light vehicle movements on the local road network. The proposed works on level crossings may also result in disruptions to local traffic. This could cause delays and/or potential access restrictions to emergency vehicle movement in the study area. However, the traffic, transport and access impact assessment concluded that the road network performance would not decline as a result of construction. Therefore, any delays would likely be minor.

Impacts from delays and potential access restrictions would be managed through the implementation of a traffic, transport and access management sub-plan as part of the CEMP and appropriate traffic controls, which would consider emergency vehicle access and movements. Ongoing liaison with local councils, Roads and Maritime Services and emergency services would be undertaken as part of the detailed design to identify additional measures to mitigate any potential impacts to emergency vehicle movements due to construction traffic.

Other health and safety risks

A number of other construction activities could result in impacts to the health and safety of site workers, users, visitors, and the local community if improperly managed. These include:

- working within an operating rail environment
- the operation of vehicles and construction equipment on-site
- the transportation of equipment, excavated spoil and material to and from site
- construction failures or incidents resulting in flooding, inundation or excavation collapse.

In addition to the above, there is the potential for risks to pedestrian/public safety resulting from unauthorised access to construction work areas.

The potential for the above activities to cause health and safety impacts to the local community is considered to be minimal, based on the remote nature of the majority of the proposal site.

NSW workplace safety laws require construction sites to have adequate site security, which includes appropriate fencing. All construction work would be isolated from the general public. The construction contractor would need to ensure that construction sites are secure at all times, and take all possible actions to prevent entry by unauthorised persons.

Health and safety risks during construction would be managed by the implementation of standard workplace health and safety requirements.

A work health and safety management plan and safe work method statements would be developed in accordance with regulatory requirements.

25.3.3 Operation impacts

Bushfire

The potential for bushfire during operation of the proposal would be similar to that during construction, although the likelihood of a bushfire occurring during operation as a result of operational activities may be somewhat reduced.

Operation of the proposal also has the potential to cause ignition sources through littering, rail grinding, welding, and the mechanical failure of infrastructure components that can exacerbate ignition risks. This could include failure of metal components at high speeds.

Storage, handling and transport of dangerous goods and hazardous materials

The amount of hazardous materials and dangerous goods that would be used during maintenance activities would be much smaller than the volumes required during construction. Hazardous materials and dangerous goods required during maintenance would be similar to those listed in Table 25.1, and would be transported in vehicles/trucks to areas requiring maintenance.

Transport of hazardous materials and dangerous goods via rail during freight operations has the potential to cause impacts to the surrounding community and the environment through leaks and spills. The transport of hazardous materials and dangerous goods would be the responsibility of the freight operator/s and would be undertaken in accordance with relevant standards and regulatory requirements (including the Australian Dangerous Goods Code (National Transport Commission, 2015) and ARTC's standard operating procedures).

Emergency vehicle movements

As described in Chapter 15, the proposal may increase the extent or duration of flooding of public roads at some locations, which could lead to road closures and restrict movement of emergency vehicles. However, flooding would only occur at the same public road locations as that where it is currently occurring. No additional public roads would be closed due to flooding from the proposal. Therefore, there would be no additional impacts to emergency vehicle movements as a result of the proposal.

Other health and safety risks

Potential impacts to the health and safety of the local community include:

- risks to pedestrians and road vehicles as a result of collisions with trains at stops and level crossings
- other safety risks, such as security risks, unauthorised access etc
- general worker health and safety issues for drivers and maintenance staff.

These potential impacts would be managed by undertaking the design with an appropriate emphasis on safety according to relevant design standards and requirements.

Community education programs would be implemented prior to and during operation to provide information about Inland Rail operation and safety, particularly at level crossings.

Works within the rail corridor would be undertaken in accordance with ARTC's standard operating procedures, thereby reducing the potential for impacts to the health and safety of workers, visitors and users.

25.4 Mitigation and management

25.4.1 Approach to mitigation and management

Bushfire and emergency response

An emergency response sub-plan would be developed as part of the CEMP in consultation with state and regional emergency service providers. The plan would include protocols and procedures to be followed during emergency situations associated with construction (including bushfires, explosions, vehicle and rail collisions, spillage, or flooding events). Inn addition it will also outline:

- roles and responsibilities
- traffic management/control systems in the case of emergency
- training programs to ensure that all staff are familiar with the plan
- design and management measures to address the potential environmental impacts of an emergency situation.

Response to bushfire and other emergencies during operation would be undertaken in accordance with ARTC's existing Safety Management System and associated procedures.

Storage, handling and transport of dangerous goods and hazardous materials

The CEMP and operational procedures for Inland Rail as a whole would include requirements for the storage, handling, and transport of dangerous goods and hazardous materials in accordance with relevant regulatory requirements and ARTC's standards.

A spill response procedure would also be developed as part of the CEMP and would include notification and clean-up requirements in the event of a spill.

Community safety

As listed in Table 21.1, a safety awareness program would be developed and implemented to educate the community regarding safety around trains. This would focus on:

- community and rural property operators who cross the rail corridor to access their properties
- residents in Moree, particularly those living on eastern side of town, to ensure that residents are aware of the safety concerns associated with trains passing through town, and encourage use of the Jones Avenue overbridge.

25.4.2 Consideration of the interactions between mitigation measures

Mitigation measures to control impacts to health and safety of workers, visitors, and the public may replicate mitigation measures proposed for the control of impacts associated with noise, air quality, water quality, traffic and access, and waste management.

All mitigation measures for the proposal would be consolidated and described in the CEMP. The plan would identify measures that are common between different aspects. Common impacts and common mitigation measures would be consolidated to ensure consistency and implementation.

25.4.3 Summary of mitigation measures

To mitigate any potential health and safety impacts during construction or operation, the mitigation measures listed in Table 25.2 would be implemented.

Table 25.2 Summary of health and safety mitigation measures

Stage	Impact	Mitigation measures
Detailed design/ pre-construction	Public safety	A hazard analysis would be undertaken during detailed design to identify risks to public safety from the proposal, and how these can be mitigated through safety in design.
	Services and utilities	The location of utilities, services, and other infrastructure would be identified prior to construction to determine requirements for access to, diversion, protection and/or support.
Pre-construction/ construction	Public safety from bushfires, fires, explosions, flooding and inundation	An emergency response sub-plan would be developed and implemented as part of the CEMP in consultation with relevant stakeholders. It would include measures to minimise the potential for health and safety impacts on the local community and environment.
Construction	Storage and handling of dangerous goods	Hazardous materials and dangerous goods would be stored, handled and transported in accordance with relevant regulatory requirements and relevant Australian Standards, including SEPP 33 thresholds. This would include a requirement to provide a minimum bund volume of 110% of the largest single stored volume within the bund. A risk management strategy would be developed to manage the potential for risks in situations where the minimum distance from sensitive receivers cannot be achieved, or the quantity of hazardous materials exceed SEPP 33 threshold levels.

26. Cumulative and residual impacts

This chapter provides an assessment of the potential cumulative impacts from the proposal. It describes other projects in the study area, and identifies where there is the potential for cumulative impacts to occur. It also provides an assessment of the potential for residual impacts following implementation of the mitigation measures provided in Chapters 9 to 25.

26.1 Overview

For an EIS, cumulative impacts can be defined as the successive, incremental, and combined effect of multiple impacts, which may in themselves be minor, but could become significant when considered together.

The SEARs for the proposal (item 2.1(n)) requires 'an assessment of the cumulative impacts of the project taking into account other projects that have been approved but where construction has not commenced, projects that have commenced construction, and projects that have recently been completed'.

The assessment of potential cumulative impacts has been undertaken in accordance with the SEARs, and considers the potential for impacts taking into account other projects in the study area. The assessment draws on the findings of Chapters 9 to 25, and environmental impact assessments of other projects. The cumulative impact assessment is provided in Section 26.2.

The SEARs also require an assessment of the potential for residual impacts, including consideration of how these would be managed or offset. For the purpose of the EIS, residual impacts are considered to be the impacts of the proposal that may remain in the medium to long-term, even after the implementation of the mitigation measures provided in Chapters 9 to 25. The residual impact assessment is provided in Section 26.3.

26.2 Cumulative impact assessment

26.2.1 Methodology

The following tasks were undertaken to assess the potential for cumulative impacts:

- identifying existing or proposed projects in the study area (either proposed or approved) based on information available in the public domain
- screening identified projects for their potential to interact with the proposal
- identifying and assessing the significance of potential cumulative impacts.

The study area for the cumulative impact assessment was the Narrabri, Moree Plains and Gwydir LGAs. Projects in the study area were identified based on a search of the following data sources undertaken in April 2017:

- the Department of Planning and Environment's online major projects database
- proponent websites
- local council websites/DA tracking databases
- the public register under the *Protection of the Environment Operations Act 1997* (POEO Act).

The projects identified were screened in relation to their potential for cumulative impacts with the proposal, based on their nature, size, and proximity to the proposal site.

Screening of potential cumulative impacts was undertaken by comparing the extent and duration of impacts, and their potential to occur in the same place and at the same time as the proposal. The significance of these cumulative impacts was then assessed, with consideration of the extent, magnitude, and duration of the impact and the sensitivity of the environment.

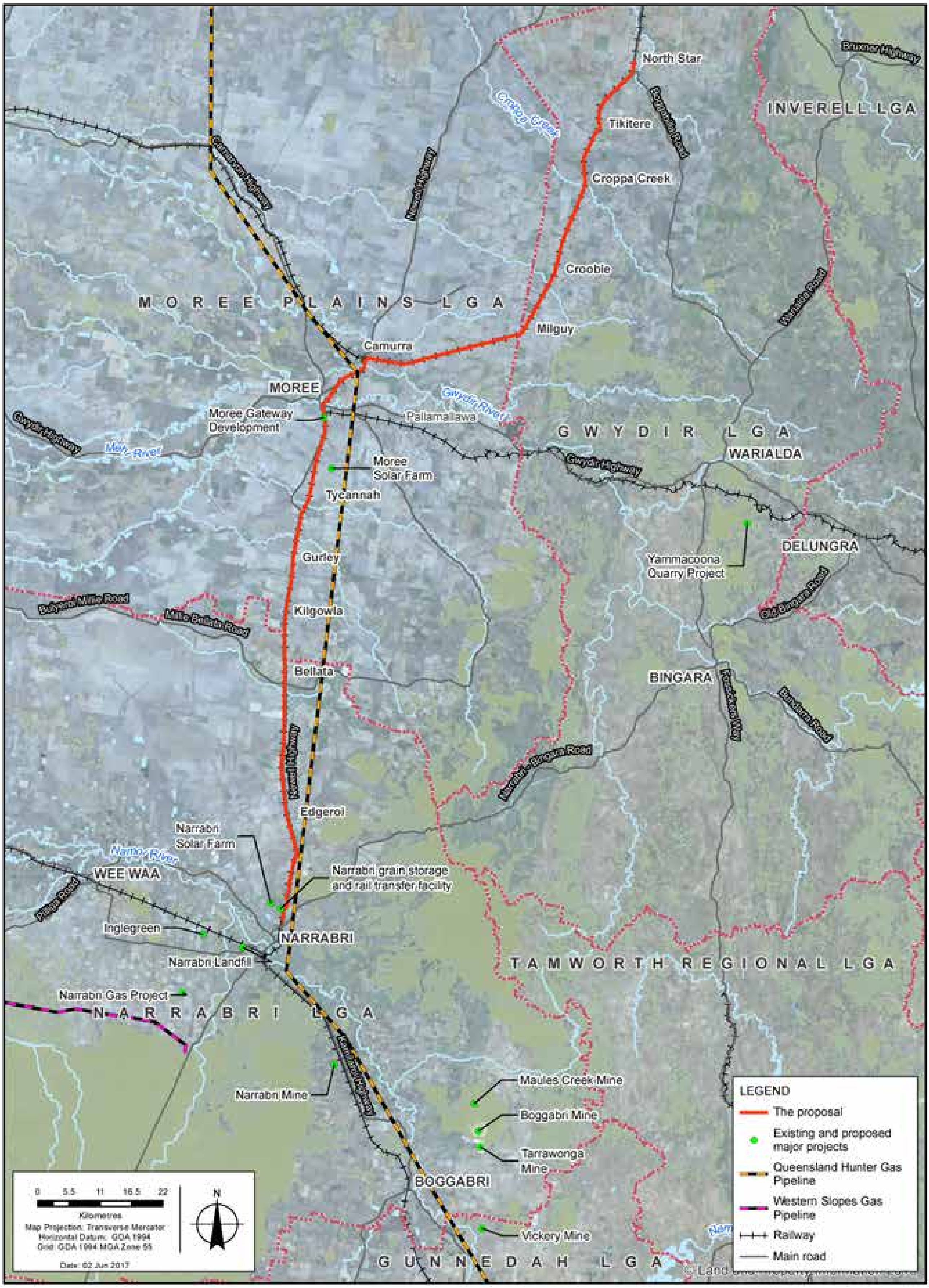
26.2.2 Other projects in the study area

Existing and proposed projects in the study area considered to have the potential for cumulative impacts with the proposal are listed in Table 26.1 and are shown in Figure 26.1. Further information on these projects is provided on the following pages.

Table 26.1 Existing and proposed projects

Project	Proponent	Type	Status	LGA	Approximate distance from the proposal site (km)
Existing projects					
Boggabri Mine	Idemitsu Australia	Coal mining	Existing	Narrabri	51
Maules Creek Mine	Whitehaven Coal	Coal mining	Existing	Narrabri	47
Narrabri Mine	Narrabri Coal Operations	Coal mining	Existing	Narrabri	27
Tarrawonga Mine	Whitehaven Coal	Coal mining	Existing	Narrabri	53
Vickery Mine	Whitehaven Coal	Coal mining	Existing	Narrabri	64
Moree Solar Farm	Infigen Energy Pty Ltd	Electricity generation (solar)	Existing	Moree Plains	2.9
Moree Gateway Development	Moree Plains Shire Council	Urban renewal	Existing	Moree Plains	0.2
Proposed and approved projects					
Inglegreen	Power Partners Generation	Electricity generation (biogas)	Proposed	Narrabri	14
Narrabri Solar Farm	CleanGen	Electricity generation (solar)	Proposed	Narrabri	2.6
Narrabri Gas Project	Santos	Coal seam gas	Proposed	Narrabri	10
Narrabri Grain Storage and Rail Transfer Facility	CBH Group	Grain storage and rail transfer facility	Proposed but currently on hold	Narrabri	0.6
Western Slopes Gas Pipeline	APA Group	Gas pipeline	Proposed	Narrabri	28
Queensland-Hunter Gas Pipeline	Hunter Gas Pipeline Pty Ltd	Gas pipeline	Proposed	Narrabri / Moree Plains	Crosses proposal site
Yammacoona Quarry Project	Gwydir Shire Council	Sand mining	Former transitional Part 3A project - Lapsed	Gwydir	52

Figure 26.1 Projects in the study area



Existing projects

Boggabri Mine

Boggabri Mine is an open-cut coal mine approximately 15 kilometres north-east of the township of Boggabri, and around 51 kilometres from the proposal. It forms part of the mining precinct around Leard State Forest, which includes Maules Creek Mine and Tarrawonga Mine.

Boggabri Mine was originally approved for development in August 1989 and coal mining commenced in May 2006. The approval allowed the extraction of 5 million tonnes of run-of-mine coal each year. A subsequent modification in July 2012 increased the production rate to 7 million tonnes of run-of-mine coal each year until 2033.

Boggabri Mine employs in the order of 500 workers to support the operation of the mine. Coal is processed at an on-site coal handling and processing plant, before being transported by rail to Newcastle via the Werris Creek Mungindi Railway Line (Parsons Brinckerhoff, 2015).

Maules Creek Mine

Maules Creek Mine is an operational open-cut coal mine approximately 18 kilometres north-east of the township of Boggabri and around 47 kilometres from the proposal. Maules Creek Mine forms part of the mining precinct around Leard State Forest, which includes Boggabri Mine and Tarrawonga Mine.

Maules Creek Mine was originally approved in October 2012 with subsequent modifications approved for a transmission line in June 2013, a pump station and water pipeline in March 2014, and transport arrangements to and from the mine in January 2017.

Maules Creek Mine is approved to extract up to 13 million tonnes of run-of-mine coal each year for 21 years. Coal is approved to be processed at an on-site coal handling and preparation plant, before being transported by rail to Newcastle.

The operating mine is intended to employ approximately 470 workers on an ongoing basis (NSW Planning Assessment Commission, 2012).

The project is expected to generate a substantial number of heavy and light vehicle movements including private vehicles, worker shuttle buses and coal haulage to Whitehaven Siding.

Narrabri Mine

Narrabri Mine is an underground coal mine approximately 30 kilometres south-east of the township of Narrabri, and approximately 27 kilometres from the proposal. The project is split into two stages, with Stage 1 approved in November 2007 and Stage 2 approved in July 2010. Subsequent modifications include modifications to stockpiles and water management.

Stage 1 involved production of 2.5 million tonnes of run-of-mine coal each year for 50 years using underground continuous mining methods. Stage 2 introduced longwall mining methods and increased production up to 8 million tonnes of run-of-mine coal each year for 21 years. A subsequent modification increase production up to 11 million tonnes each year until 2031.

Narrabri Mine also includes a water pipeline to source raw water and/or discharge treated water to the Namoi River. The Namoi River is a secondary source of water, where insufficient water is available from underground mine workings and associated storages.

Narrabri Mine employs approximately 370 workers to support operation of the mine. Coal is processed at the mine before being hauled by rail to Newcastle via the Werris Creek Mungindi Railway with an average of 3 – 4 trains per day (Resource Strategies, 2015).

Tarrawonga Mine

Tarrawonga Mine is an open-cut coal mine approximately 16 kilometres north-east of Boggabri and around 53 kilometres from the proposal. Tarrawonga Mine forms part of the mining precinct around Leard State Forest, which includes Boggabri Mine and Maules Creek Mine.

Tarrawonga Mine was originally approved in November 2005 as East Boggabri Mine, with expansions approved in 2010 and 2013, as well as modifications for road haulage in 2014 and 2016 and modification for rejects management in 2017. The original approval allowed the extraction of up to 2 million tonnes of run-of-mine coal each year for 8 to 10 years. The subsequent expansions allowed the extensions of the open-cut areas and increased extraction to up to 3 million tonnes of coal each year until 2030.

Tarrawonga Mine employs in the order of 120 operational staff based on assessment documentation for the last major expansion (NSW Planning and Infrastructure, 2012a).

The coal produced at the mine is transported by road to the Whitehaven Siding coal handling and processing plant in Gunnedah, before being hauled by rail to Newcastle.

In accordance with a recent modification, reject material is returned by road from Whitehaven Siding coal handling and processing plant.

Vickery Mine

Vickery Mine is an open-cut coal mine approximately 15 kilometres south-east of Boggabri and around 64 kilometres from the proposal.

The mine was originally approved as the Namoi Valley Coal Project with small-scale mining commencing in 1986. The expanded Vickery Mine was subsequently approved in 2014 and approval to expand the mine further is currently being sought.

The Vickery Mine approval allows the extraction of up to 4.5 million tonnes of run-of-mine coal each year for 30 years. The approval that is currently being sought would allow for the extension of open-cut areas and increased extraction to up to 10 million tonnes each year.

Vickery Mine employs in the order of 250 workers based on assessment documentation for the original approval (NSW Department of Planning and Environment, 2014).

Coal produced at the mine is transported by road to the Whitehaven Siding coal handling and processing plant in Gunnedah, before being hauled by rail to Newcastle. Reject material is returned by road from Whitehaven Siding coal handling and processing plant.

The approval that is currently being sought would involve a peak construction workforce of about 500 workers and peak operational workforce of about 450 workers.

Moree Solar Farm

Moree Solar Farm is an electricity generation (solar) project about 10 kilometres south of Moree and 2.9 kilometres west of the proposal. The project involves the installation of solar panels over about 400 hectares generating about 56 megawatts and associated a substation and transmission line. Construction was completed in 2016 with the project commencing operation early 2017. The project is planned to operate for 30 years.

Moree Gateway Development

The Moree Gateway Development is an urban renewal project situated at the southern entry to Moree about 3 kilometres south of the Moree town centre and about 0.2 kilometres from the proposal. The development precinct is intended to establish a regionally significant transport, logistics and tourism hub.

The Moree Gateway Development is expected to become operational progressively depending on the commercial negotiation and sale of precinct lots to developers.

Proposed and approved projects

Inglegreen

Inglegreen is a proposed biogas harvesting and electricity generation facility approximately 9 kilometres west of Narrabri and about 14 kilometres south-west of the proposal.

The project would involve establishing a biogas harvesting facility approximately 6 hectares in size and a switching station approximately 2 hectares in size 2 kilometres to the north, connected by an overhead power line (Power Partners Generation, 2012).

The SEARs for the project were issued in May 2012

Narrabri Gas Project

The Narrabri Gas Project is a coal seam gas project over 10 kilometres south-west of the proposal. The project would involve development of about 850 wells, a gas processing facility, a water treatment facility, a compression facility, supporting workers accommodation facilities, infrastructure corridors, access roads, and gas and water gathering lines.

The project was assessed to occur over a 25-year project life with a peak construction period in the first three to four years. The workforce is estimated to reach about 1,300 workers during the peak construction period reducing to about 350 for the remainder of the project life.

The project would generate in the order of 310 vehicle movements per day during peak construction and significantly fewer for the remainder of the project life. The workforce may be accommodated at a combination of a proposed workers camp, existing workers accommodation facilities in Narrabri, and existing dwellings in Narrabri and the surrounding region.

An EIS for the Narrabri Gas Project was submitted to the NSW Department of Planning and Environment in February 2017 for public exhibition. The Narrabri Gas Project is scheduled to start construction in early to mid-2018.

Narrabri Solar Farm

Narrabri Solar Farm is an electricity generation (solar) project about 4 kilometres north of Narrabri and about 2.6 kilometres west of the proposal. The project would involve the installation of solar panels over about 300 hectares generating about 120 megawatts.

The project is planned to employ 280 workers during peak construction and around 10 to 14 workers during operation. Construction and operation of the project would also generate relatively small numbers of heavy and light vehicle movements.

The SEARs for the project were issued in 2016.

Narrabri Grain Storage and Rail Transfer Facility

The Narrabri Grain Storage and Rail Transfer Facility is a proposed facility including grain silos and stockpiles, rail loop and siding ,and supporting infrastructure about 5 kilometres north of Narrabri and about 0.6 kilometres from the proposal.

The facility is planned to employ about 30 workers during construction and about 12 workers during operation. Construction and operation of the project would also generate a relatively small number of heavy and light vehicle movements. During peak harvesting season it is expected the facility would operate up to 24 hours per day.

The SEARs for the project were issued in December 2014. It is understood that the plans for the facility are currently on hold.

Western Slopes Gas Pipeline

The Western Slopes Gas Pipeline is a proposed high pressure gas pipeline connecting the Narrabri Gas Project near Narrabri to the Moomba to Sydney Pipeline near Bundure. At its nearest point it is over 28 kilometres south of the proposal.

The project would involve construction of the gas pipeline and temporary facilities such as construction workers camps, and laydown areas. During operation the pipeline would transport gas from the Narrabri Gas Project to the Moomba to Sydney Pipeline and broader network.

The project is planned to employ about 250 – 350 workers during construction (which would take between eight to ten months) and about 4 – 5 long-term jobs during operation. The project would also generate a number of heavy and light vehicle movements during construction and to a far lesser extent during operation.

The SEARs for the project were issued in May 2017.

Queensland-Hunter Gas Pipeline

The Queensland-Hunter Gas Pipeline is a proposed 820 kilometre high pressure gas pipeline connecting gas facilities in Wallumbilla, Queensland and Hexham, NSW. The pipeline crosses the proposal north of Moree (refer Figure 26.1).

The project would involve construction of the gas pipeline and temporary facilities such as construction workers camps and laydown areas.

The project is planned to employ about 800 workers during construction and 150 workers during operation. The project would also generate a number of heavy and light vehicle movements during construction and to a far lesser extent during operation.

The project was approved in February 2009. However, construction has yet to commence. The project approval will lapse in February 2019 unless works have commenced.

Yammacoona Quarry Project

The Yamacoona Quarry is an existing sand quarry near Koloona, NSW about 52 kilometres south-east of the proposal. The Yamacoona Quarry Project involved the proposed expansion of operations at the quarry to produce 500,000 tonnes per annum. The SEARs for the project were issued in January 2011. The assessment of the project has now lapsed and no approval has been given.

26.2.3 Cumulative impacts

The potential for cumulative impacts between the proposal and the projects listed in Section 26.2.2 is considered below, according to the key environmental issues listed in the project SEARs.

Traffic and transport

The greatest potential for cumulative traffic and transport impacts are associated with the construction traffic from the following projects: Narrabri Gas Project, Narrabri Solar Farm, and Western Slopes Gas Pipeline. The main potential areas of interaction between the proposal and these projects is the Newell Highway and Kamilaroi Highway, as the main haulage routes, as well as the Narrabri township. The traffic and transport assessment indicates that the increase in construction traffic from the proposal is significantly below the capacity of these roads. It is expected that total traffic would also remain well below the capacity of these roads even with the additional traffic generated from these projects.

A number of existing projects also utilise the rail network including the Tarrawonga Mine, Vickery Mine, Maules Creek Mine, Narrabri Mine and Boggabri Mine. These mines utilise the rail network primarily for coal haulage to Newcastle via the Mungindi Line. This existing use of the rail line has been considered in the definition of the proposal and as part of the existing environment through the EIS and is therefore not considered a cumulative impact.

Biodiversity

The existing rail corridor and surrounding lands have been subject to a range of historic disturbances from land clearing, agriculture, urban development, and rail infrastructure development. This cumulative loss of habitat has placed further pressure on local threatened flora and fauna species and ecological communities.

The proposal will involve the clearing of native vegetation within the proposal site, including vegetation within the rail corridor, and in areas of the proposal site located outside the rail corridor. The proposal would further increase fragmentation in an already fragmented landscape for those vegetation communities and habitats directly impacted by the proposal. However, the proposal would not significantly change the overall connectivity of habitats in the region, as the vast majority of the proposal site is located in an existing rail corridor. Fragmentation and connectivity considerations have been taken into account as part of the biodiversity assessment and the biodiversity offsets calculations.

Noise and vibration

Projects awaiting construction that have considerable potential to interact with the proposal include the Narrabri Gas Project, Narrabri Solar Farm, and Western Slopes Gas Pipeline. Although construction of these projects has the potential to occur at the same time as the proposal, , the potential for cumulative noise and vibration impacts is considered to be negligible due to the separation distances between the construction areas for the proposal and these other projects.

The main source of noise and vibration from the operation of the proposal would be additional train movements on the rail network. As discussed above, a number of existing projects utilise the rail network primarily for coal haulage to Newcastle via the Mungindi Line. This existing use of the rail line has been considered in the definition of the proposal and as part of the existing environment through the EIS and is therefore not considered a cumulative impact.

Air quality

Air quality impacts from the proposal are predominately associated with construction dust. The assessment found that the predicted particulate levels from construction of the proposal would unlikely extend farther than 150 metres from work areas, and would have insignificant cumulative impacts with other projects. Predicted particulate increments from construction would be localised to within a few hundred metres of construction works, and unlikely to impact on regional air quality. Cumulative impacts are therefore very unlikely considering the separation distances between the construction areas for the proposal and other projects.

Operational air quality impacts are not expected at distances greater than 20 metres from the proposal site. There are no identified significant sources of air pollutants, namely nitrogen oxides and particulates, within 20 metres of the proposal site, and cumulative impacts are not expected.

Soils

The potential for erosion and sedimentation as a result of the proposal is mainly associated with construction. These potential impacts would be readily managed with the implementation of standard erosion and sedimentation control measures. As such, it is not expected that the proposal would have a material impact on erosion and sedimentation at the scale that cumulative impacts could occur.

The overall risk of encountering or generating land contamination is low, and the proposal would be unlikely to generate impacts at a scale that would interact with other projects.

Hydrology and flooding

It is predicted that the proposal would result in a small increase in the area and duration of flooding in the immediate vicinity of the proposal site, and that impacts are highly localised. None of the existing or proposed projects will have a significant influence on hydrology and flooding. As such, no cumulative impacts are expected to occur.

Water quality

Water quality impacts from the proposal would be associated with construction and would be highly localised. There are no anticipated cumulative impacts.

Aboriginal heritage

A number of listed and new Aboriginal heritage sites may be impacted by the proposal. While some of the existing and proposed projects may also impact Aboriginal heritage items, due to the relatively low density of development in the region there are no anticipated cumulative impacts.

Non-Aboriginal heritage

Three locally heritage listed items are located within the proposal site and would potentially be directly impacted by the proposal – Moree Station, the Mehi River bridge, and the Gwydir River bridge. Elements of the existing rail line and associated infrastructure would be removed impacting items considered to be potential heritage items of generally local significance. In addition indirect impacts, as a result of vibration generated by construction, may affect Moree Station, the former Edgeroi Woolshed (a potential heritage item considered to be of local significance), and remaining structures associated with Edgeroi, Bellata, and Gurley stations.

While some of the existing and proposed projects may also impact heritage items, they will not generally impact rail heritage items or items immediately adjacent to the existing rail corridor. Narrabri Grain Storage and Rail Transfer Facility would be situated in close proximity to the rail corridor but is uncertain whether this project will proceed (refer Section 26.2.2) and is not planned to affect listed heritage items (CBH Group, 2014). As such, no cumulative impacts are expected to occur.

Landscape and visual impacts

Given the low profile and horizontal form of most of the proposal, the level of visual modification would be confined to a distance relatively close to the area subject to change. The magnitude of the impacts for the proposal are low, as the visibility of the proposal is reduced by the typical flat topography and lack of sensitive receivers.

The combination of the proposal with the other projects proposed would result in a change in the visual landscape, if the other projects proceed.

Land use and property

As the proposal would be undertaken mainly within the existing rail corridor, land use impacts are generally limited. Acquisition of privately owned land would be required for construction of the Camurra bypass and the Newell Highway and Jones Avenue overbridges.

While there will be a slight increase in the number of buildings inundated during a one per cent AEP year flood event when compared to existing conditions, the overall extent of flooding will decrease and significant impacts due to flooding are not anticipated.

Given the relatively limited land use and property impacts of the proposal and the separation distances with other projects, there is limited potential for cumulative impacts.

Socio-economic

The proposal has the potential to compete with other projects and industries (including mining related) for employees, due to similar skill requirements – particularly during the peak construction period. Projects that are under construction would generate higher volumes of demand for labour and accommodation facilities than operational projects.

As discussed above, the projects awaiting construction that have considerable potential to interact with the proposal include the Narrabri Gas Project, Narrabri Solar Farm, and Western Slopes Gas Pipeline. These projects, particularly the Narrabri Gas Project and potentially the Western Slopes Gas Pipeline, would require a substantial workforce during construction.

The non-residential workforce generated by the simultaneous construction of the proposal and other projects has the potential to increase demand for accommodation in regional centres. The demand for accommodation in Narrabri specifically has the potential for cumulative impacts given its proximity to the proposal and other identified projects.

Waste

The generation of waste as a result of the construction would be minimised by implementing a waste management plan. Only licensed facilities would be used for waste disposal. The following waste management facilities are located in the study area:

- Narrabri Landfill (Yarrie Lake Road, Narrabri) – accepts general waste, scrap metal, green waste, used oil, recycling and electronic waste.
- Narrabri rural transfer stations – large vehicles (over 3 tonne) not accepted.
- Moree Waste Management Facility (Evergreen Road, Moree) – accepts general waste, scrap metal, green waste, concrete, used oil, recycling, electronic waste, and asbestos.
- Moree Plains Shire rural landfills – Boggabilla Landfill, Boomi Landfill, Garah Landfill, Gurley Landfill, Mungindi Landfill, Terrie Hie Hei Landfill, Weemelah Landfill.
- Bingara Waste Recovery Centre (Narrabri Road, Bingara) – accepts general waste, green waste, scrap metal, and asbestos.
- Warialda Waste Recovery Centre (Rubbish Depot Road, Warialda) – accepts general waste, green waste, scrap metal, and asbestos.
- Gwydir Shire rural landfills – Coolatai Landfill, Croppa Creek Landfill, Gravesend Landfill, Upper Horton Landfill, Warialda Rail Landfill.

Other projects in the study area have the potential to generate waste that may be disposed at the same waste management facilities include the Narrabri Gas Project, Narrabri Solar Farm, and Western Slopes Gas Pipeline.

Potential cumulative impacts would be avoided in the first instance through development of a waste management plan and engagement with waste management facilities to ensure that sufficient capacity is available to manage the received waste.

Given the range of waste management facilities identified in the area, and the relatively conventional nature of the waste predicted to be generated by the proposal, it is expected that appropriate waste management facilities with sufficient capacity will be identified and utilised. No significant cumulative impacts as a result of waste generation are anticipated.

Other issues

The potential for cumulative impacts for the ther issues listed in the SEARs are considered in Table 26.2.

Table 26.2 Cumulative impacts – other issues

Key Issue	Cumulative impact assessment
Protected and sensitive lands	The proposal would not impact protected lands as defined by the SEARs. There would be limited impacts to waterfront land during construction, mainly as a result of the replacement of culverts and bridges. Due to the minimal impact as a result of the proposal, the potential for cumulative impacts to protected and sensitive lands is negligible.
Biosecurity	Biosecurity risks associated with other projects are relatively low with the exception of the Western Slopes Gas Pipeline. This is as a result of the projects being confined to discrete sites. There is a greater risk associated with biosecurity for the Western Slopes Gas Pipeline due to the linear nature of the project. The Western Slopes Gas Pipeline and the proposal do not intersect and are 28 kilometres apart at their nearest point. The greatest risk for all identified projects occurs during construction, but given the proposed mitigation measures, this risk is considered to be very low. Due to the distance between projects and the fact that the proposal is an upgrade and not a new rail line, no cumulative impacts to biosecurity are predicted.
Sustainability and climate change	Cumulative sustainability and climate change assessments are not relevant to the proposal. The sustainability assessment required by the SEARs is for an assessment of the sustainability of the proposal using the Infrastructure Sustainability Rating Tool and current guidelines and targets. This cannot be applied to a cumulative assessment. In relation to climate change, the SEARs requires an assessment of the impacts of climate change on the proposal, not an assessment of the influence the proposal would have on climate change.
Health and safety	Potential health and safety impacts associated with other approved and proposed projects are not anticipated to increase the risks to public safety when combined with the proposal.

26.2.4 Summary of results

The potential for cumulative impacts between the proposal and other existing or proposed projects is low. Despite the extent of the area included in this cumulative impact assessment, a relatively small number of major projects were identified for inclusion in the assessment. The assessment considered all existing projects as part of the baseline assessment, and proposed changes to these projects were also considered.

The assessment concludes that the impacts from the proposal, combined with other existing and proposed projects in the study area, would not result in significant cumulative impacts.

26.3 Residual Impacts

A summary of the potential residual impacts for the proposal is provided in Table 26.3, together with a description of how these potential residual impacts would be managed.

Table 26.3 Residual impact assessment

Potential residual impacts	Comment	Approach to mitigation and management
Traffic and transport		
There is the potential for permanent traffic and transport impacts associated with the changes to level crossings and changes to roads.	The extent of impact would be determined during detailed design and through a process of consultation in regards to potential level crossing and road closures. There would be no forced closure of level crossings.	Consultation would be undertaken with relevant stakeholders prior to changes to access or level crossings in accordance with ARTCs processes. The operation of level crossings that have been subject to change would be reviewed after the proposal commences to ensure appropriate protection is provided, and that they are appropriate for the traffic conditions.
Biodiversity		
The proposal would involve the permanent removal of native vegetation and fauna habitat during construction, including removal of threatened ecological communities and habitats for threatened species.	Construction of the proposal would involve permanent removal of about 411 hectares of native vegetation of which 247 hectares is threatened ecological communities listed under the TSC and/or EPBC Act. *It is noted that the estimate of potential clearing would continue to be refined as the design of the proposal progresses, with the aim of reducing the potential clearing required.*	These potential impacts would be mitigated by the proposed mitigation measures, including: ▸ implementation of a biodiversity offset strategy to offset permanent removal of native vegetation ▸ detailed design and construction planning would minimise the construction footprint and avoid impacts to native vegetation as far as practicable ▸ implementation of the flora and fauna management sub-plan (as part of the CEMP), including weed control, fauna habitat management and monitoring ▸ pre-clearance surveys would be undertaken, and a tree felling procedure would be implemented to avoid injury and mortality of native fauna during construction ▸ native vegetation temporarily disturbed during construction would be rehabilitated.

Potential residual impacts	Comment	Approach to mitigation and management
Noise		
It is anticipated that, without mitigation, noise levels during operation in 2025 would exceed relevant criteria at about 110 sensitive receivers.	During detailed design the noise modelling would be updated and further assessment undertaken to identify reasonable and feasible noise mitigation measures to achieve appropriate noise levels.	A range of potential design and mitigation measures would be considered and assessed during the detailed design, including: - rail dampers - noise barriers - architectural treatment. Noise monitoring would be undertaken at representative locations after the commencement of operation to verify the effectiveness of the applied mitigation measures with respect to the determined trigger levels.
Hydrology and flooding		
A reduction in inundation for all local flooding events, excluding the 0.2 per cent AEP event is anticipated. An additional four buildings/structures would potentially be inundated during the one per cent AEP local flood event, when compared to the existing situation.	Impacts are anticipated to be localised. The additional four buildings consist of two houses, one shed connected with a petrol station, and one agricultural shed/outbuilding. Three of these structures (one house, the shed and agricultural shed/outbuilding) are located to the north of Narrabri, while one house is located at the northern extent of Bellata.	Further modelling would be undertaken during detailed design to determine how the proposal can be modified so that the existing flooding characteristics are not worsened. Flood modelling to support detailed design would be ongoing. Consultation would be undertaken with local councils and emergency services to ensure that the flood-related outcomes of the proposal are consistent with local planning and any future floodplain risk management plans.
Aboriginal heritage		
Construction of the proposal may result in the disturbance/ destruction of identified and unidentified Aboriginal archaeological sites.	Works within the proposal site have the potential to directly or indirectly disturb identified Aboriginal sites and areas of archaeological potential. A number of listed sites were identified within or adjacent to the proposal site. The proposal may directly or indirectly disturb these sites during construction.	Potential impacts to Aboriginal heritage would be mitigated by the proposed mitigation measures, including: - detailed design and construction planning would minimise direct impacts to items/sites of Aboriginal heritage significance - implementation of the Aboriginal cultural heritage management plan - sites within the proposal site would be avoided where practicable - collection of artefacts according to recommended protocols if the sites cannot be avoided.

Potential residual impacts	Comment	Approach to mitigation and management
Visual amenity		
The visual character of the proposal would be generally consistent with the existing use of the rail corridor and therefore has limited residual impacts however more noticeable structures such as grade separations or bridges may have greater residual impacts.	Operational impacts of the proposal would occur as a result of the introduction of new structures in the rural/natural landscape. The significance of these impacts is mitigated by the lack of receivers and relatively flat environment. Visual amenity impacts of the Newell Highway overbridge would be limited given the relatively few visual sensitive recievers in the area. Visual impacts on the Jones Avenue overbridge would be high given its location in the township of Moree and the increase number of visual sensitive receivers as a result. Visual amenity impacts of Mehi River, Gwydir River and Croppa Creek bridges would be initially high given the presence of visual sensitive receivers in the area however residual impacts would reduce with time once vegetation is re-established.	Detailed design would consider building materials and treatments to minimise the potential visibility of the proposal. Landscaping, vegetation rehabilitation, and replanting would be undertaken in accordance with the CEMP.
Land use		
Some properties would be acquired to construct the proposal. Currently it is anticipated that in the order of 9 lots may be acquired or partially acquired.	Property acquisition is required for construction of the Jones Avenue overbridge. The details of acquisition would be refined in detailed design	All acquisitions/adjustments would be undertaken in consultation with landowners and in accordance with the requirements of the *Land Acquisition (Just Terms Compensation) Act 1991*.
Socio-economic		
Potential for community amenity and safety impacts as a result of the increase in train movements along the proposal site. Potential for increased accommodation demand for non-resident workforce. Potential economic and employment benefits at the local and wider scale.	Changes to noise levels, air pollution, and visual changes from the presence of the proposal may impact on the amenity for the surrounding community. These have been discussed above where appropriate.	A safety awareness program would be designed and implemented prior to the commencement of operation to provide information about Inland Rail operation and safety, particularly at level crossings. ARTC would develop a workers housing and accommodation plan, which would be applicable to the proposal.

Part D: **EIS Synthesis and Conclusion**

Image: Railway and Newell Highway north of Narrabri, NSW

27. Approach to environmental management and mitigation

This chapter, together with Chapter 28, provides a synthesis of the EIS. This chapter compiles the key potential impacts that have not been avoided, and the measures proposed to avoid, minimise, manage or offset the impacts identified in Part C. The chapter also provides the outcomes the proponent is seeking to achieve through the implementation of the mitigation measures.

27.1 Compilation of impacts

Part C of the EIS provides an assessment of the potential impacts of the proposal during construction and operation. The key potential impacts during construction and operation requiring mitigation and management are summarised in Table 27.1 and Table 27.2 respectively. The approach to mitigating and managing potential impacts is described in Section 27.2. Further information on these impacts is provided in Chapters 9 to 25.

Table 27.1 Summary of key potential construction impacts

Issue	Key potential construction impacts
Traffic, transport and access	▸ Temporary impacts to traffic and access, and an increase in heavy and light vehicle movements on the local road network, including in the vicinity of the proposed Newell Highway and Jones Avenue overbridges. ▸ Works on level crossings may result in local traffic disruptions and short-term access restrictions. ▸ New temporary access tracks may be required in some locations. ▸ Construction activities would result in temporary impacts on existing rail operations.
Biodiversity	▸ Permanent removal or modification (clearing) of about 411 hectares of native vegetation, and temporary disturbance of about 72 hectares of native vegetation, which includes threatened ecological communities listed under the TSC Act and/or the EPBC Act. ▸ Impacts on aquatic ecological systems as a result of works to culverts, bridges, and across watercourses.
Noise and vibration	▸ Potential for construction noise to exceed the relevant criteria at various sensitive receivers along the proposal site.
Air quality	▸ Generation of dust from construction works and the movement of equipment and machinery.
Soils and contamination	▸ Erosion and sedimentation during construction could result in the contamination of soils and surface waters. ▸ The main contaminants that could be exposed during excavation are hydrocarbons and asbestos. ▸ Contamination associated with any leaks and spills.
Hydrology and flooding	▸ Potential for inundation during flood events. ▸ Changes in flows as a result of construction activities.
Water quality	▸ Erosion and the generation of sediment, particularly during watercourse crossings and the construction of new bridges and culverts. ▸ Impacts on downstream water quality if management measures are not implemented, monitored, and maintained.

Issue	Key potential construction impacts
Aboriginal heritage	‣ Potential to impact two listed Aboriginal heritage sites, and 12 unlisted sites. ‣ Impacts on any unexpected finds.
Heritage	‣ Removal of two items listed on ARTC's section 170 heritage register (the rail bridges over the Mehi and Gwydir rivers) and a potential heritage item (the rail bridge over Croppa Creek). ‣ Impacts on the existing rail line, which is a potential heritage item considered to be generally of local significance. ‣ Potential for vibration impacts on Moree Station (a locally listed heritage item) and other potential heritage items, including the former Edgeroi Woolshed, and remaining structures associated with Edgeroi, Bellata, and Gurley stations. ‣ Potential to impact any remains associated with a former Aboriginal fringe camp site located near the Mehi River bridge (considered to be a site with archaeological potential). ‣ Impacts on any unexpected finds.
Visual and landscape	‣ Visual impacts during construction as a result of the presence of construction works, plant, and disturbance.
Land use and property	‣ Temporary disturbance to land use along the proposal site. ‣ Temporary impacts to agricultural/farming practices. ‣ Limited acquisition of privately owned land, with resultant changes in land use.
Socio-economics	‣ Beneficial impacts during construction including employment (an estimated average workforce of 180 people), training opportunities, and flow on local and regional economic benefits. ‣ Impacts on the amenity of the local community. ‣ Impacts associated with the inflow of the workforce into the local area, including a requirement for temporary accommodation.
Sustainability and climate change	‣ Material consumption and associated carbon footprint. ‣ Emissions of greenhouse gases. ‣ Discharge to surrounding environment including waste production. ‣ Clearing and land excavations. ‣ Demand for fuel (diesel), water, sand, and aggregate.
Waste	‣ Indicatively, the proposal would generate about 1,171,480 cubic metres of spoil, which would be re-used for track formation/construction (about 25%) and for spoil mounds. ‣ Other waste material would include green waste, sleepers, rail tracks, formation material, fencing, and general soil waste.
Health and safety	‣ Introduction of potential ignition sources and fuel sources could increase bushfire risks. ‣ If inadequately managed, the storage and handling of dangerous goods and hazardous materials could cause leaks and spills, with resultant contamination and health impacts. ‣ Potential rupture of underground utilities during excavation or collision of plant and equipment with aboveground services. ‣ Public health and safety risks during construction.

Table 27.2 Summary of key potential operation impacts

Issue	Key potential operation impacts
Traffic, transport and access	‣ Impacts on travel time as a result of increased train activity at level crossings. ‣ Improved access across the rail corridor in Moree as a result of the Jones Avenue overbridge. ‣ An increase in traffic volumes on Jones Avenue and Tycannah Street in Moree.
Biodiversity	‣ Increase in train strikes on fauna species.
Noise and vibration	‣ Noise levels at a number of residential receivers have the potential to exceed the redeveloped rail line criteria for operational rail noise by the year 2040.
Air quality	‣ Increase in the number of diesel freight trains has the potential to increase levels of pollutants such as nitrogen oxides and particulate matter. ‣ Decreasing the number of heavy vehicles using major transport routes such as the Newell Highway would have a positive impact on air quality for sensitive receivers along these routes.
Soils and contamination	‣ If inadequately managed, maintenance could result in erosion of soils. ‣ Contamination of soils as a result of any accidental spills.
Water quality	‣ Surface runoff, which may contain sediment, traces of fuel, dissolved metals, and other contaminants deposited in the corridor from operation activities, could impact water quality. ‣ Impacts on water quality as a result of any accidental spills.
Hydrology and flooding	‣ Raising the height of the rail formation would impact surface water flows across the floodplain, changing the upstream flooding regime, and resulting in more concentrated flows through culverts that discharge to downstream waterways. ‣ Flood modelling predicts that the proposal would: • reduce the length of overtopping of the existing rail corridor in the proposal site during a one per cent AEP, local flood event from about 11,124 metres to 1,338 metres • reduce the area of upstream flooding for all flood events except the 0.2 per cent AEP event • reduce the extent of flooding in a one per cent AEP local flood event by about six per cent.
Visual and landscape	‣ Introduction of new structures in the landscape, mainly associated with the Newell Highway and Jones Avenue overbridges, and the new rail bridges over the Mehi and Gwydir rivers and Croppa Creek.
Land use and property	‣ Use of the rail line would intensify once Inland Rail is operational in 2025. ‣ Flood modelling predicts that the proposal would result in: • an increase in the number of buildings and structures subject to temporary inundation • an overall decrease in the area of land subject to temporary inundation, with the exception of land used for intensive animal production, mining and quarrying and tree and shrub cover.
Socio-economics	‣ Beneficial impacts would include better access to and from regional markets, enabler for regional economic development along the Inland Rail corridor, and safety and amenity benefits as a result of the reduction of freight transport on major road corridors.

Issue	Key potential operation impacts
Sustainability and climate change	- Potential risk of asset damage or failure in extreme weather events. - Emissions of greenhouse gases from operational energy use and embodied energy in materials. - Reduction in greenhouse gas emissions from transfer of freight from trucks to rail. - Demand for fuel (diesel) and water.
Waste	- Small quantities of green waste, general debris, and litter may be generated during maintenance.
Health and safety	- Introduction of potential ignition sources could increase bushfire risks. - If inadequately managed, transport of hazardous materials and dangerous goods via rail has the potential to impact the surrounding community and the environment through leaks and spills. - Public health and safety risks including risks to pedestrians and road vehicles as a result of collisions with trains at level crossings, and other safety risks, such as security risks and unauthorised access.

27.2 Approach to environmental management

The approach to environmental mitigation and management for the proposal involves:

- Project design – as described in Section 7.1, the proposal incorporates measures to avoid and minimise impacts.
- Mitigation measures – mitigation measures provided in Chapters 9 to 25 are identified as an outcome of the environmental impact assessment, and are consolidated in Section 27.3.
- ARTC's environmental management system – would be used to manage the construction and operation of Inland Rail, including the proposal. The management system would provide the framework for implementing the construction and operation environmental management plans described below, and any conditions of other approvals, licences, or permits.
- Inland Rail NSW Construction Noise and Vibration Management Framework – describes how ARTC proposes to manage construction noise and vibration for Inland Rail in NSW as a whole, including management measures, processes, and the approach to additional assessment where required. A copy of the framework is provided in Appendix H.
- Proposal specific CEMP and operational environmental management plan (OEMP) – prepared to guide the approach to environmental management during construction and operation, as described in Sections 27.2.1 and 27.2.2. The CEMP and OEMP would:
  - outline the environmental management practices and procedures to be followed
  - document processes for demonstrating compliance with the commitments made in this EIS, the submissions report (to be prepared), and relevant approval conditions
  - be prepared in consultation with relevant agencies and in accordance with the *Guideline for the Preparation of Environmental Management Plans* (Department of Infrastructure, Panning and Natural Resources, 2004a).
- Environmental performance outcomes – establishes the intended outcomes to be achieved by the proposal. The environmental performance outcomes are provided in Section 27.4.

27.2.1 CEMP

The CEMP would include:

- ARTC's environmental policy, objectives, and performance targets for construction
- reference to all relevant statutory and other obligations, including consents, licenses, approvals, and voluntary agreements required
- management policies, procedures, and review processes to assess the implementation of environmental management practices and the environmental performance of the proposal against the objective and targets
- requirements and guidelines for management in accordance with:
  - the conditions of approval for the proposal
  - the mitigation measures specified in this EIS
  - relevant construction management guidelines (including those listed in Appendix K)
- requirements in relation to incorporating environmental protection measures and instructions in all relevant standard operating procedures and emergency response procedures
- roles and responsibilities of all personnel and contractors to be employed on site
- incident and contingency management procedures
- procedures for complaints handling and ongoing communication with the community
- a monitoring and auditing program, as defined by this EIS and the conditions of the approval.

An outline of the CEMP, including the required sub-plans and a guide to the general construction management measures required in each, is provided in Appendix K.

27.2.2 OEMP

The OEMP would include:

- a description of activities to be undertaken during operation
- an environmental risk analysis to identify the key environmental performance issues associated with the operation phase
- statutory and other obligations that the proponent is required to fulfil during operation, including approvals, consultations and agreements required from authorities and other stakeholders under key legislation and policies
- a description of ARTC's Environmental Management System, and the environment protection licence relevant to the proposal
- overall environmental policies, guidelines and principles to be applied to operation
- roles and responsibilities for relevant employees involved in operation, including relevant environmental training and induction requirements
- incident and contingency management procedures
- details of how environmental performance would be managed and monitored to meet acceptable outcomes, including what actions would be taken to address identified potential adverse environmental impacts.

27.2.3 Approach to design refinements

The design of the proposal as described in the EIS would be subject to ongoing refinements during detailed design. Refinements may be made to:

- avoid ground conditions or services that present significant construction difficulties in terms of logistics, time and/or cost
- reduce the construction timeframe
- avoid areas of environmental sensitivity identified following approval
- reduce impacts on local residents
- improve the operation of the proposal without increasing the potential environmental impacts.

Such refinements may include, for example:

- minor changes to the location of construction compounds and construction site access routes
- minor changes to access roads as a result of changes to level crossings within the assessment area described in Chapter 2
- changes to culvert upgrade proposals within the assessment area described in Chapter 2
- changes to the level crossing upgrade proposals
- minor changes to the location of key infrastructure, refinement or reorientation of site boundaries
- minor changes in technology or the features of key proposal components.

Refinements would not include significant changes to the proposal.

For design refinements a consistency review would be undertaken to consider whether the refinement:

- would result in any of the conditions of approval not being met
- be consistent with the objectives and operation of the proposal as described in the environmental assessment
- result in a significant change to the approved project
- would trigger the requirement for additional Aboriginal heritage assessment and mitigation measures as described in Technical Report 8
- would result in any potential environmental or social impacts of a greater scale or different nature than that considered by the EIS.

A refinement that does not meet these criteria would be considered a design modification. Approval would be sought from the Minister for Planning for any such modifications in accordance with the requirements of Part 5.1 of the EP&A Act.

27.3 Compilation of mitigation measures

Table 27.3 to Table 27.5 provide a summary of the measures proposed to mitigate and manage the potential impacts of the proposal, as detailed in Part C. The measures listed may be revised in response to submissions raised during public exhibition of the EIS and/or any design changes made following exhibition. The final list of mitigation measures would be provided in the submissions/preferred infrastructure report. If the proposal is approved, the conditions of approval, which would include reference to the finalised mitigation measures, would guide subsequent phases of the proposal. The construction contractor would be required to undertake all works in accordance with the conditions of approval and the final list of mitigation measures.

Table 27.3 Compilation of proposal specific mitigation measures for detailed design/pre-construction

No.	Issue	Detailed design/pre-construction mitigation measure
D1	Environmental management	
D1.1	*CEMP*	▸ A CEMP would be prepared to detail the approach to environmental management during construction, as described in Section 27.2.1 and in accordance with the conditions of approval.
D2	Traffic, transport and access	
D2.1	*Traffic, transport and access*	▸ Detailed design would minimise the potential for impacts to the surrounding road and transport network, and property accesses. ▸ Where any legal access to a property is permanently affected and a property has no other legal means of access, alternative access to and from a public road would be provided to an equivalent standard, where feasible and practicable. Where an alternative access is not feasible or practicable, and a property is left with no access to a public road, negotiations would be undertaken with the relevant property owner for acquisition of the property in accordance with the provisions of the *Land Acquisition (Just Terms Compensation) Act 1991.*
D2.2	*Consultation*	▸ Input would be sought from relevant stakeholders (including Narrabri Shire Council, Moree Plains Shire Council, Gwydir Shire Council, and Roads and Maritime Services) prior to finalising the detailed design of those aspects of the proposal that impact on the operation of the road and transport infrastructure under the management of these stakeholders. ▸ The traffic, transport, and access management sub-plan would be developed in consultation with (where relevant) local councils, Roads and Maritime Services, and local public transport/bus operators.
D2.3	*Level crossings*	▸ Level crossings would be provided with warning signage, line marking and other relevant controls; in accordance with the relevant national and ARTC standards.

No.	Issue	Detailed design/pre-construction mitigation measure
D3	**Biodiversity**	
D3.1	*Biodiversity offset strategy*	‣ The biodiversity offset strategy for the proposal would be finalised, in accordance with the requirements of the *Framework for Biodiversity Assessment* (OEH, 2014b) and the *NSW Biodiversity Offsets Policy for Major Projects* (OEH, 2014c). ‣ The offset strategy would be approved by the Department of Planning and Environment prior to the commencement of construction work that would result in the disturbance of relevant ecological communities, threatened species, or their habitat, unless otherwise agreed.
D3.2	*Direct impacts to biodiversity*	‣ Detailed design and construction planning would minimise the construction footprint and avoid impacts to native vegetation as far as practicable.
D3.3	*Riparian vegetation*	‣ Compounds and stockpile sites would be located an appropriate distance from riparian vegetation to avoid indirect impacts on aquatic habitat. This includes a minimum of 100 metres for type 1 class 1 watercourses (the Mehi River and Gwydir River), 50 metres for type 2 class 2 and 3 watercourses (such as Boobiwaa, Gurley and Tycannah creeks), and 10 to 50 metres for type 3 class 2 to 4 watercourses (including Croppa Creek). ‣ Direct impacts to in-stream vegetation and native vegetation on the banks of watercourses would be avoided as far as practicable.
D3.4	*Fish passage*	‣ Detailed design and construction planning would minimise the potential for impacts to fish passage. To ensure that fish passage is maintained, watercourse crossing structures would be designed in accordance with the guideline *Why do fish need to cross the road? Fish passage requirements for waterway crossings* (Fairfull and Witheridge, 2003) and the minimum design requirements specified in Table 5.1 of Technical Report 3.
D3.5	*Rehabilitation strategy*	‣ A rehabilitation strategy would be prepared to guide the approach to rehabilitation of disturbed areas following the completion of construction. The strategy would include: • clear objectives and timeframes for rehabilitation works (including the biodiversity outcomes to be achieved) • details of the actions and responsibilities to progressively rehabilitate, regenerate, and/or revegetate areas, consistent with the agreed objectives • identification of flora species and sources • procedures for monitoring the success of rehabilitation • corrective actions should the outcomes of rehabilitation not conform to the objectives adopted.
D3.6	*Pre-clearing surveys*	‣ Pre-clearing surveys would be undertaken prior to construction. The surveys and inspections, and any subsequent relocation of species, would be undertaken and in accordance with the biodiversity management sub-plan in the CEMP.

No.	Issue	Detailed design/pre-construction mitigation measure
D4	**Noise and vibration**	
D4.1	*Noise and vibration control*	▸ The proposal would be designed with the aim of achieving the operational noise and vibration criteria identified by the noise and vibration assessment. ▸ Track features such as crossovers, turnouts, and rail joints would be avoided near vibration sensitive structures where practicable.
D4.2	*Construction vibration*	▸ Where vibration levels are predicted to exceed the screening criteria, a more detailed assessment of the structure and vibration monitoring would be carried out in accordance with the Inland Rail NSW Construction Noise and Vibration Management Framework, to ensure vibration levels remain below appropriate limits for that structure.
D4.3	*Operational noise and vibration review*	▸ An operational noise and vibration review would be undertaken as described in Section 11.5.1 to guide the approach to identifying feasible and reasonable mitigation measures to incorporate in the detailed design.
D5	**Soils**	
D5.1	*Structural integrity*	▸ Foundation and batter design would include measures to minimise operational risks from shrink swell, dispersive and/or low strength soils.
D6	**Hydrology and flooding**	
D6.1	*Flooding*	▸ The design features listed in Section 15.3.1 would continue to be refined to not worsen existing flooding characteristics, where feasible and reasonable, up to and including the one per cent AEP event. Detailed flood modelling would consider potential changes to: • building and property inundation • level crossing and road flood levels and extent • overland flow paths and storage effects due to spoil mounds and other proposal infrastructure • flood evacuation routes. ▸ Flood modelling to support detailed design would be carried out in accordance with the guidelines listed in Section 15.1.2. ▸ Flood modelling and mitigation would consider future floodplain risk management plans, and would be undertaken in consultation with the relevant local council, the OEH, and State Emergency Services.
D6.2	*Emergency routes*	▸ Where feasible, facilities and routes identified as being critical to emergency response operations would be protected from the probable maximum flood level.
D6.3	*Downstream watercourse stability*	▸ Further modelling would be undertaken during detailed design to confirm the locations downstream of culverts that require erosion protection, and the extent and type of protection required.

No.	Issue	Detailed design/pre-construction mitigation measure
D7	**Water quality**	
D7.1	*Water quality*	▸ The design features listed in Section 16.3.1 would continue to be refined and implemented to minimise the potential impacts of the proposal on water quality.
D7.2	*Surface water monitoring framework*	▸ A surface water monitoring framework would be developed as part of the soil and water management sub-plan in the CEMP. It would identify monitoring locations at discharge points, and selected watercourses where works are being undertaken. ▸ The monitoring framework would include the relevant water quality objectives, parameters, and criteria from Technical Report 7, and specific monitoring locations which have been identified based on the hydrological attributes of the receiving watercourse, in consultation with DPI (Water) and the EPA.
D8	**Aboriginal heritage**	
D8.1	*Avoiding and minimising impacts to Aboriginal heritage*	▸ Detailed design and construction planning would avoid direct impacts to the identified items/sites of Aboriginal heritage significance where practicable. ▸ An Aboriginal cultural heritage management plan (CHMP) would be prepared and would include measures to minimise the potential for impacts, manage Aboriginal heritage, and procedures for any unexpected finds. ▸ The plan would be prepared in consultation with registered Aboriginal parties, incorporate the recommendations of the Aboriginal Cultural Heritage and Archaeological Assessment, and take into account the outcomes of further investigations following detailed design. ▸ The location of all construction compounds would be reviewed to ensure they are not located in areas of more than low archaeological potential.
D8.2	*Impact to the following sites within the proposal site:* ▸ *Steel Bridge Camp site (10-3-0032)* ▸ *Duffys Creek site (10-3-0035)* ▸ *NNS IA6 to IA13* ▸ *NNS AS1 and NNS AS5 to NNS AS7*	▸ Impacts to these sites would be avoided where possible. The sites would be fenced prior to construction and their locations marked on all plans. A buffer of 10 metres around the sites would be applied for fencing. ▸ If these sites cannot be avoided, salvage of artefacts would be undertaken prior to construction in accordance with the procedures detailed in the Aboriginal Cultural Heritage and Archaeological Assessment (Technical Report 8) .
D8.3	*Impacts to site 10-6-0048 (scarred tree)*	▸ Impacts to the scarred tree (site 10-6-0048) and the dripline of the tree would be avoided. The site would be fenced prior to construction and marked on all plans.

No.	Issue	Detailed design/pre-construction mitigation measure
D8.4	*Impacts to areas of moderate to high archaeological potential within the proposal site:* - *Gwydir River terraces (survey area 42)* - *Croppa Creek and adjoining slopes and terraces (survey area 55)* - *Mehi River and terraces (survey area 56)*	- If the detailed design identifies the potential for disturbance below the depth of existing disturbance, further consideration would be given to the potential for archaeological impacts. - If required, a detailed methodology for any subsequent archaeological excavation would be developed in consultation with Aboriginal parties for inclusion within the Aboriginal cultural heritage management plan.
D8.5	*Impacts to survey area 15 (Lower slopes - Newell Highway overbridge)*	- Consideration will be given to undertaking a program of archaeological subsurface testing within this area. Salvage excavations may be required depending on the results of any testing undertaken.
D8.6	*Unexpected finds*	- An unexpected finds procedure would be developed and included in the CEMP to provide a consistent method for managing any unexpected Aboriginal heritage items discovered during construction, including potential heritage items or objects, and human skeletal remains.
D9	**Non-Aboriginal heritage**	
D9.1	*Impacts to Moree Station*	- Detailed design would minimise the potential for impacts to Moree Station, and would have regard to, and be sympathetic with, its heritage significance.
D9.2	*Impacts to the bridges over the Mehi and Gwydir rivers and Croppa Creek, underbridges, former stations, Edgeroi Woolshed*	- A photographic/archival recording would be undertaken of bridges proposed for removal, former rail station sites, and Edegeroi Woolshed in accordance with ARTC's Archival Recording Standard. - The photographic recording would include contextual photographs showing the relationship between the rail line and these items.
D9.3	*Impacts to the Anzac Day crossing*	- Where practicable, detailed design would provide a level crossing at the same or a similar location as the Anzac Day Crossing south of Crooble.

No.	Issue	Detailed design/pre-construction mitigation measure
D9.4	*Impacts to the former Aboriginal fringe camp near the Mehi River bridge*	▸ A heritage management sub-plan would be prepared as part of the CEMP to define the measures to be implemented during construction at the former Aboriginal fringe camp site (Steel Bridge Camp site) near the Mehi River bridge. The plan would provide requirements for archaeological management, including a research design methodology.
D9.5	*Potential vibration impacts to heritage structures*	▸ For listed and potential heritage items where screening vibration levels are predicted to be exceeded, the detailed assessment referred to under item D4.2 would specifically consider the heritage values of the structure, in consultation with a heritage specialist, to ensure sensitive heritage fabric is adequately monitored and managed.
D9.6	*Unexpected finds*	▸ An unexpected finds procedure would be developed and included in the CEMP to provide a consistent method for managing any unexpected heritage items or human skeletal remains discovered during construction.
D10	**Landscape and visual**	
D10.1	*Landscape character and visual impacts*	▸ Detailed design would be undertaken in accordance with the design vision, objectives, and principles which underpin the concept design, and would take into account the guidelines listed in Section 19.1.2.
D10.2	*Artist impressions*	▸ Following completion of detailed design of the Mehi River bridge, and the Jones Avenue overbridge, artist impressions and perspective drawings would be developed for consultation purposes.
D11	**Land use and property**	
D11.1	*Property impacts*	▸ Individual property agreements would be developed in consultation with landowners/occupants, with respect to the management of construction on or immediately adjacent to private properties. These would detail any required adjustments to fencing, access, farm infrastructure, and relocation of any impacted structures, as required.
D11.2	*Acquisitions*	▸ All property acquisitions/adjustments would be undertaken in consultation with landowners and in accordance with the requirements of the *Land Acquisition (Just Terms Compensation) Act 1991.*
D11.3	*Access to properties*	▸ Access to properties would be maintained and managed in accordance with the mitigation measures listed under item D2.
D11.4	*Travelling stock reserves*	▸ Local Land Services would be consulted during detailed design to understand how impacts to travelling stock reserves can be avoided during construction and operation. Alternative access arrangements would be made as required.
D11.5	*Impacts to services and utilities*	▸ Utility and service providers would continue to be consulted during detailed design to identify possible interactions and develop procedures to minimise the potential for service interruptions and impacts on existing land uses.

No.	Issue	Detailed design/pre-construction mitigation measure
D11.6	*Consultation and communication*	▸ Property owners and occupants would be consulted during the design and construction phases, in accordance with the communication management sub-plan for the proposal (described in Chapter 4), to ensure that owners/occupants are informed about the timing and scope of activities in their area; and any potential property impacts/changes, particularly in relation to potential impacts to access, services, or farm operational arrangements. ▸ The results of consultation would be incorporated in the individual property agreements as appropriate. ▸ Consultation would be undertaken with landowners affected by level crossing changes and agreement obtained, where required.
D11.7	*Biosecurity risks*	▸ The biodiversity management sub-plan included in the CEMP would detail measures to minimise the potential for biosecurity risks during construction.
D12	**Socio-economics**	
D12.1	*Communication*	▸ Key stakeholders (including local councils, emergency service providers, public transport providers, the general community, and surrounding land owners/occupants) would continue to be consulted regarding the proposal in accordance with the communication management plan described in Chapter 4.
D12.2	*Local access to Inland Rail*	▸ ARTC would continue to work with relevant stakeholders, including Moree Plains Shire Council, to identify opportunities to facilitate local access to Inland Rail via the Moree Gateway.
D12.3	*Accommodation*	▸ A temporary workforce housing and accommodation plan would be developed and implemented during construction. This would include a requirement for consultation to be undertaken with local accommodation providers and councils regarding the availability of accommodation, and the need to maintain some availability for non-workforce accommodation.
D13	**Sustainability**	
D13.1	*Sustainability management plan*	▸ The potential sustainability initiatives identified for the proposal would be reviewed and updated during detailed design. ▸ A sustainability management plan would be developed to guide the design, construction, and operation of the proposal, to achieve an 'excellent' rating according to the ISCA infrastructure sustainability rating tool. ▸ The sustainability management plan would incorporate the updated sustainability initiatives, and the review and reporting requirements necessary to demonstrate how sustainability has been incorporated into the proposal during design, construction, and operation.
D14	**Climate change**	
D14.1	*Climate change risk management*	▸ The climate change risk assessment would continue to be refined as the design of the proposal progresses. ▸ The adaptation measures identified for the proposal would be reviewed, and final measures would be incorporated into the design where practicable.

No.	Issue	Detailed design/pre-construction mitigation measure
D15	**Waste**	
D15.1	*Waste management*	▶ Detailed design would include measures to minimise excess spoil generation. This would include a focus on optimising the design to minimise spoil volumes, and the re-use of material on-site.
D16	**Health and safety**	
D16.1	*Public safety*	▶ A hazard analysis would be undertaken during detailed design to identify risks to public safety from the proposal, and how these can be mitigated through safety in design.
D16.2	*Services and utilities*	▶ The location of utilities, services, and other infrastructure would be identified prior to construction to determine requirements for access to, diversion, protection, and/or support.

Table 27.4 Compilation of proposal specific mitigation measures for construction

No.	Issue	
C1	**Environmental management**	
1.1	*CEMP*	▶ Construction of the proposal would be undertaken in accordance with the approved CEMP.
C2	**Traffic, transport and access**	
C2.1	*General impacts of construction activities on traffic, transport, access, pedestrians and cyclists.*	▶ A traffic, transport and access management sub-plan would be prepared and implemented as part of the CEMP. It would include measures to minimise the potential for impacts on the community and the operation of the surrounding road and transport environment. It would address all the aspects of construction relating to the movement of vehicles, pedestrians and cyclists, and the operation of the surrounding road network, including: • construction site traffic control, parking and access arrangements • construction material, equipment and spoil haulage, including arrangements for oversize vehicles • road pavement and access road condition management • management of impacts to public transport, including school buses, pedestrian and cyclist access, and safety • management of impacts to access for surrounding residents and business owners/operators • arrangements for level crossings during construction • road and driver safety. ▶ The traffic, transport and access management sub-plan would be developed in consultation with (where relevant) Narrabri Shire Council, Moree Plains Shire Council, Gwydir Shire Council, Roads and Maritime Services, and public transport/bus operators.
C2.2	*Access*	▶ Access to individual residences, services and businesses, and access for livestock across the rail corridor, would be maintained during construction. Where alternative access arrangements need to be made, these would be developed in consultation with affected property owners/occupants.
C2.3	*Emergency vehicle access*	▶ Access for emergency vehicles would be maintained along key emergency access routes throughout the construction period, with suitable alternative access arrangements provided where required.

No.	Issue	
C2.4	*Rail traffic diversions*	▸ Diversions of existing rail traffic would be undertaken in consultation with relevant stakeholders, and alternative arrangements would be provided.
C2.5	*Consultation*	▸ Consultation with relevant stakeholders would be undertaken regularly to facilitate the efficient delivery of the proposal and to minimise congestion and inconvenience to road users. Stakeholders would include the relevant local council, bus operators, Roads and Maritime Services, emergency services, and affected property owners/occupants. ▸ The community would be notified in advance of any proposed road and pedestrian network changes through signage, the local media, and other appropriate forms of communication. ▸ Where changes to access arrangements are required, ARTC would advise property owners/occupants and consult with them in advance regarding alternative access arrangements.
C3	**Biodiversity**	
C3.1	*General biodiversity impacts*	▸ A biodiversity management sub-plan would be prepared and implemented as part of the CEMP. It would include measures to minimise the potential for biodiversity impacts. The sub-plan would address, as outlined below: • a pre-clearing survey and tree-felling procedure • procedures to manage micro-bats • avoiding impacts on surrounding vegetation (item C3.2) • weed management (item C3.3) • dewatering of standing pools in watercourses • measure to minimise impacts on aquatic ecology.
C3.2	*Avoidance of impacts – terrestrial and aquatic biodiversity*	▸ Areas of biodiversity value outside the proposal site would be fenced or signposted, where appropriate, to prevent the unnecessary disturbance during the construction phase.
C3.3	*Weed management*	▸ Noxious weeds would be managed in accordance with the *Noxious Weeds Act 1993*. Weeds of national environmental significance would be managed in accordance with the *Weeds of National Significance Weed Management Guide.* ▸ Any herbicides would be applied such that impacts on surrounding agricultural properties are avoided.
C3.4	*Rehabilitation*	▸ Rehabilitation of disturbed areas would be undertaken progressively and in accordance with the rehabilitation strategy.
C4	**Noise and vibration**	
C4.1	*Noise and vibration management*	▸ The Inland Rail NSW Construction Noise and Vibration Management Framework would be implemented, and the proposal would be constructed, with the aim of achieving the construction noise management levels and vibration criteria identified by the noise and vibration assessment. ▸ All feasible and reasonable noise and vibration mitigation measures would be implemented. ▸ Any activities that could exceed the construction noise management levels and vibration criteria would be identified and managed in accordance with the Inland Rail NSW Construction Noise and Vibration Management Framework and the CEMP. ▸ Notification of impacts would be undertaken in accordance with the communication management sub-plan for the proposal.

No.	Issue	
C5	**Air quality**	
C5.1	*General air quality impacts*	An air quality management sub-plan would be prepared and implemented as part of the CEMP. It would include measures to minimise the potential for air quality impacts on the local community and environment, and would address all aspects of construction, including: • spoil handling • machinery operating procedures • soil treatments • stockpile management • haulage • dust suppression • monitoring.
C5.2	*Construction activities and earthworks that may cause dust impacts*	Where sensitive receivers are located within 150 metres of construction works, or visible dust is generated from vehicles using unsealed access roads, road watering would be implemented.
C6	**Soil and contamination**	
C6.1	*General soil and erosion management*	A soil and water management sub-plan would be prepared as part of the CEMP. It would include a detailed list of measures that would be implemented during construction to minimise the potential for soil and contamination impacts, including: • allocation of general site practices and responsibilities • material management practices • stockpiling and topsoil management, including prompt stabilisation of spoil mounds (for example, through mixing of gypsum) • surface water and erosion control practices that take into account site specific soil types (for example, dispersive soils).
C6.2	*Contamination*	A contamination and hazardous materials sub-plan would be prepared and implemented as part of the CEMP. It would include: • measures to minimise the potential for contamination impacts on the local community, workers, and environment • procedures for incident management and managing unexpected contamination finds (an unexpected finds protocol).
C7	**Hydrology and flooding**	
C7.1	*Flooding*	Construction planning and the layout of construction work sites and compounds would be carried out with consideration of overland flow paths and flood risk, avoiding flood liable land and flood events where possible.
C7.2	*Water usage (private bores and surface water)*	Consultation would be undertaken with relevant stakeholders (including landowners/occupants) prior to construction, and appropriate approvals and agreements would be sought for the extraction of water. Monitoring would be undertaken during extraction to ensure volumes stipulated by licence requirements and/or private landholder agreements are not exceeded.

No.	Issue		
C8	**Water quality**		
C8.1	*Discharge to surface water*	▸	Discharge to surface water would be undertaken in accordance with the environment protection licence for Inland Rail, and would consider the hydrological attributes of the receiving waterbody.
C8.2	*Monitoring*	▸	Water quality would be monitored during construction in accordance with the surface water monitoring framework (item D.8.2).
C9	**Aboriginal heritage**		
C9.1	*Unexpected finds and human skeletal material*	▸	If potential Aboriginal items, objects, or human remains are uncovered, works within the immediate area of the item would cease, and the unexpected finds procedure would be implemented.
		▸	During pre-work briefings, employees would be made aware of the unexpected finds procedures and obligations under the NPW Act.
C10	**Non-Aboriginal heritage**		
C10.1	*Accidental impacts*	▸	To minimise the potential for accidental impacts, the boundary of Moree, Edgeroi, Bellata, and Gurley stations, Edgeroi Woolshed, and the surveyor's trees, would be marked on plans and clearly defined during construction.
C10.2	*Unexpected finds and human skeletal material*	▸	In the event that unexpected archaeological remains, relics, potential heritage items, or human remains are discovered during construction, all works in the immediate area would cease, and the unexpected finds procedure would be implemented.
C11	**Landscape and visual**		
C11.1	*Light spill*	▸	Temporary and any permanent lighting would designed and sited to comply with: • AS 4282-1997 *Control of the Obtrusive Effects of Outdoor Lighting* • *Dark Sky Planning Guideline: Protecting the observing conditions at Siding Spring* (Department of Planning and Environment, 2016).
C11.2	*Spoil mounds*	▸	Spoil mounds would be shaped to reduce their angular profile and ensure that they are integrated within the landscape. Sharp transition angles in the surface profile would be avoided, and rounded profiles would be used to provide a more natural form. Grass cover would be established over the surface area in accordance with the rehabilitation strategy.
C12	**Land use and property**		
C12.1	*Communication*	▸	Property owners/occupants would continue to be consulted during construction, in accordance with the requirements of item D11.6.

No.	Issue	
C12.2	*Rehabilitation*	▸ The rehabilitation strategy (item D3.5) would include measures to restore disturbed sites as close as possible to the pre-construction condition or better, or to the satisfaction of landowners. ▸ Rehabilitation of disturbed areas would be undertaken progressively, consistent with the rehabilitation strategy and individual property agreements (where relevant).
C13	Socio-economics	
C13.1	*Communication*	▸ A communication management sub-plan would be prepared as part of the CEMP including a detailed list of the measures that would be implemented during construction to communicate with and respond to community concerns. The plan would include, as a minimum: • requirements to provide details and timing of proposed activities to affected residents, the local community and businesses, and local bus operators • consultation actions in relation to access arrangements and servicing requirements • complaints handling procedure • procedure to notify adjacent land users for any changed conditions during the construction period such as traffic, pedestrian or driveway access. ▸ Local residents, businesses, and other stakeholders would be notified before work starts in accordance with the communication management sub-plan, and would be regularly informed of construction activities.
C13.2	*Workforce*	▸ Where practicable, the workforce would include workers sourced locally, and opportunities for training potential local employees would be provided. This would include exploring opportunities for local Indigenous participation in consultation with local Indigenous service providers. ▸ A zero tolerance policy relating to anti-social behaviour would be adopted for work sites.
C13.3	*Demands for goods and services*	▸ Local suppliers would be identified and approached for procurement of goods and services where practicable.
C14	Sustainability	
C14.1	*Procurement*	▸ Procurement would be undertaken in accordance with the *Sustainable Procurement Guide* (Department of Sustainability, Environment, Water, Population and Communities, 2013) and the *NSW Government Resource Efficiency Policy* (OEH, 2014).
C14.2	*Reporting*	▸ Sustainability reporting (and corrective action where required) would be undertaken during construction in accordance with the sustainability management plan.

No.	Issue	
C15	**Waste**	
C15.1	*Waste management*	▸ A construction waste management plan would be prepared and implemented as part of the CEMP. It would include measures to minimise the potential for impacts on the local community and environment, including those listed in Table 24.6. ▸ Waste segregation bins (colour coded as listed in Table 24.7) would be located at key construction compounds where practicable, to facilitate segregation and prevent cross contamination.
C16	**Health and safety**	
C16.1	*Storage and handling of dangerous goods*	▸ Hazardous materials and dangerous goods would be stored, handled, and transported in accordance with relevant regulatory requirements and relevant Australian Standards, including SEPP 33 thresholds. This would include a requirement to provide a minimum bund volume of 110% of the largest single stored volume within the bund. ▸ A risk management strategy would be developed to manage the potential for risks in situations where the minimum distance from sensitive receivers cannot be achieved, or the quantity of hazardous materials exceed SEPP 33 threshold levels.
C16.2	*Public safety from bushfires, fires, explosions, flooding and inundation*	▸ An emergency response sub-plan would be developed and implemented as part of the CEMP in consultation with relevant stakeholders. It would include measures to minimise the potential for health and safety impacts on the local community and environment.

Table 27.5 Compilation of proposal specific mitigation measures for operation

No.	Issue	Operation mitigation measure
O1	**Environmental management**	
O1.1	*OEMP*	▸ An OEMP would be prepared to detail the approach to environmental management during operation, as described in Section 27.2 and in accordance with the conditions of approval. ▸ The proposal would be operated in accordance with the approved OEMP.
O2	**Traffic, transport and access**	
O2.1	*Level crossings*	▸ The operation of the level crossings that have been subject to changes as part of the proposal would be reviewed after the proposal commences operation to confirm: • that the level of protection continues to be appropriate • that the infrastructure is appropriate for the traffic conditions.
O3	**Biodiversity**	
O3.1	*Fish passage*	▸ Culverts would be regularly inspected and maintained to minimise blockage of fish passage.
O3.2	*Weed management*	▸ Annual inspections would be undertaken for weed infestations and to assess the need for control measures. ▸ Any outbreak of noxious and/or weeds of national environmental significance would be managed in accordance with the *Noxious Weeds Act 1993*, the *Weeds of National Significance Weed Management Guide*, and the requirements of relevant authorities.

No.	Issue	Operation mitigation measure
O4	Noise and vibration	
O4.1	*Operational noise and vibration*	▸ The proposal would be operated with the aim of achieving the operational noise and vibration criteria identified by the noise and vibration assessment, the requirements of the conditions of approval, and the relevant environment protection licence.
O4.2	*Monitoring*	▸ Once Inland Rail has commenced operation, operational noise and vibration compliance monitoring would be undertaken at representative locations to compare actual noise performance against that predicted by the noise and vibration assessment. ▸ Compliance monitoring requirements would be defined as part of the operational noise and vibration review. ▸ The results of monitoring would be included in an operational noise and vibration compliance report, prepared in accordance with the conditions of approval.
O5	Air quality	
O5.1	*Rail vehicle emissions*	▸ The proposal would be managed in accordance with the air quality management requirements specified in the environment protection licence.
O5.2	*Impacts during maintenance*	▸ Maintenance service vehicles and equipment would be maintained and operated in accordance with the manufacturers specifications.
O6	Soils and contamination	
O6.1	*Soil erosion and sedimentation*	▸ During any maintenance work where soils are exposed, sediment and erosion control devices would be installed in accordance with *Managing Urban Stormwater: Soils and Construction*.
O6.2	*Contamination*	▸ ARTC's existing spill response procedures would be reviewed to determine applicability and suitability during operation. The adopted procedure would include measures to minimise the potential for impacts on the local community and the environment as a result of any leaks and spills.
O7	Water quality	
O7.1	*General water quality management*	▸ The proposal would be managed in accordance with the water quality management requirements specified in the environment protection licence.
O8	Socio-economics	
O8.1	*Community safety*	▸ A safety awareness program would be implemented to educate the community regarding safety around trains. This would focus on: • community and rural property operators who cross the rail corridor to access their properties • residents in Moree, particularly those living on eastern side of town, to ensure that residents are aware of the safety concerns associated with trains passing through town, and encourage use of the Jones Avenue overbridge.
O9	Sustainability	
O9.1	*Sustainability*	▸ Prior to operation commencing, the sustainability management plan would be reviewed and updated, and relevant initiatives would be implemented during operation.

No.	Issue	Operation mitigation measure
O10	Climate change	
O10.1	*Climate change*	‣ The recommended adaptation measures would be reviewed, and a final list of adaptation measures for implementation during operation would be confirmed and implemented. ‣ Operational management and maintenance procedures would include measures relating to potential climate change risks, as listed in Chapter 23. ‣ Emerging opportunities to manage potential climate change impacts on the proposal would continue to be monitored.
O11	Waste	
O11.1	*Waste management*	‣ The waste management measures listed in Table 24.8 would be implemented where practicable during operation.

27.4 Compilation of performance outcomes

The SEARs identify a number of desired performance outcomes for the proposal. These desired performance outcomes outline the broader objectives to be achieved in the design, construction, and operation of the proposal. Based on the outcomes of the environmental impact assessment summarised in Part C of the EIS, and the implementation of the mitigation measures compiled in Section 27.3, environmental performance outcomes have been established for the proposal. These are listed in Table 27.6. The first and second columns provide the key issue and desired performance outcome from the SEARs, and the third column provides the proposal specific environmental performance objectives to achieve the desired outcome.

Design development and any design changes would be considered against these environmental performance outcomes.

Table 27.6 Compilation of environmental performance outcomes

Key issue (as listed in the SEARS)	SEARS desired performance outcomes	Proposal specific environmental performance outcomes
5. Air quality	The project is designed, constructed and operated in a manner that minimises air quality impacts (including nuisance dust and odour) to minimise risks to human health and the environment to the greatest extent practicable.	‣ The proposal is designed to minimise the potential for vegetation clearance and associated dust impacts. ‣ The proposal is constructed and operated in accordance with the requirements of the POEO Act and relevant environmental protection licences. ‣ Dust generated during construction will not exceed the relevant criteria in the *National Environment Protection (Ambient Air Quality) Measure* and the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (Department of Environment and Conservation, 2005).

Key issue (as listed in the SEARS)	SEARS desired performance outcomes	Proposal specific environmental performance outcomes
6. Biodiversity	The project design considers all feasible measures to avoid and minimise impacts on terrestrial and aquatic biodiversity. Offsets and/or supplementary measures are assured which are equivalent to any remaining impacts of project construction and operation.	▸ The proposal is designed to minimise the surface footprint and impacts on biodiversity. ▸ Potential impacts on biodiversity are managed in accordance with relevant legislation, including the EP&A Act, TSC Act, FM Act, EPBC Act, and the *Noxious Weeds Act 1993.* ▸ The biodiversity outcome is consistent with the *Framework for Biodiversity Assessment* (OEH, 2014b). ▸ Offsets are provided in accordance with the *NSW Biodiversity Offsets Policy for Major Projects* (OEH, 2014c).
7. Climate change risk	The project is designed, constructed and operated to be resilient to the future impacts of climate change.	▸ Climate change risks are considered throughout the design and development process. ▸ The proposal is designed to maximise climate change resilience while minimising costs, community, and environmental impacts. ▸ The climate change risk assessment is maintained in line with updated global climate models and regional projection data. ▸ The proposal is designed, constructed, and operated in accordance with relevant climate change legislation and guidelines.
8. Flooding	The project minimises adverse impacts on existing flooding characteristics. Construction and operation of the project avoids or minimises the risk of, and adverse impacts from, infrastructure flooding, flooding hazards, or dam failure.	▸ Construction is undertaken in a manner that minimises the potential for adverse flooding impacts, through staging of works and the implementation of mitigation measures. ▸ The proposal makes a positive contribution to local flooding characteristics by replacing existing drainage infrastructure. ▸ Structures such as spoil mounds are designed and located such that flows are not significantly impeded. ▸ The proposal reduces the length of overtopping of the existing rail corridor. ▸ The proposal reduces or does not significantly increase the area subject to flooding.
9. Health and safety	The project avoids, to the greatest extent possible, risk to public safety.	▸ Construction targets zero safety incidents. ▸ All dangerous goods are stored, handled and transported in accordance with relevant regulatory requirements and Australian Standards.

Key issue (as listed in the SEARS)	SEARS desired performance outcomes	Proposal specific environmental performance outcomes
10. Heritage	The design, construction and operation of the project facilitates, to the greatest extent possible, the long term protection, conservation and management of the heritage significance of items of environmental heritage and Aboriginal objects and places. The design, construction and operation of the project avoids or minimises impacts, to the greatest extent possible, on the heritage significance of environmental heritage and Aboriginal objects and places.	▸ The proposal is designed to minimise the surface footprint. ▸ The design is sympathetic to the historic significance of the existing rail corridor and the heritage significance of surrounding listed heritage items, and where practicable, avoids and minimises impacts to heritage. ▸ Impacts on heritage are managed in accordance with relevant legislation, including the EP&A Act, the *Heritage Act 1977*, and relevant guidelines. ▸ The potential impacts identified are mitigated by photographic/archival recording.
11. Noise and vibration – amenity	Construction noise and vibration (including airborne noise, ground-borne noise and blasting) are effectively managed to minimise adverse impacts on acoustic amenity. Increases in noise emissions and vibration affecting nearby properties and other sensitive receivers during operation of the proposal are effectively managed to protect the amenity and well-being of the community.	▸ The proposal minimises impacts to the local community by: • controlling noise and vibration at the source • controlling noise and vibration on the source to receiver transmission path • controlling noise and vibration at the receiver • implementing practicable and reasonable measures to minimise the noise and vibration impacts of construction activities on local sensitive receivers.
12. Noise and vibration – structural	Construction noise and vibration (including airborne noise, ground-borne noise and blasting) are effectively managed to minimise adverse impacts on the structural integrity of buildings, items including Aboriginal places and environmental heritage, and nearby road infrastructure. Increases in noise emissions and vibration affecting environmental heritage as defined in the Heritage Act 1977 during operation of the proposal are effectively managed.	▸ The proposal minimises impacts to structures by: • controlling vibration at the source • controlling vibration on the source to receiver transmission path • implementing practicable and reasonable measures to minimise vibration impacts of construction activities on structures.
13. Protected and sensitive lands	The project is designed, constructed and operated to avoid or minimise impacts on protected and sensitive lands.	▸ The proposal does not impact on protected and sensitive lands as defined by the SEARs.

Key issue (as listed in the SEARS)	SEARS desired performance outcomes	Proposal specific environmental performance outcomes
14. Socio-economic, land use property, agriculture and biosecurity	The project minimises adverse social and economic impacts and capitalises on opportunities potentially available to affected communities. The project minimises impacts to property and business and achieves appropriate integration with adjoining land uses, including maintenance of appropriate access to properties and community facilities, and minimisation of displacement of existing land use activities, dwellings and infrastructure.	‣ The proposal minimises impacts to the local community and businesses. ‣ As part of Inland Rail as a whole, the proposal provides for the development of an efficient and sustainable route for the transport of freight between Brisbane and Melbourne. ‣ The proposal provides opportunities for regional economic development, by enabling local and regional businesses to access Inland Rail via regional transport hubs. ‣ Impacts to existing land use and properties are minimised. ‣ The proposal is appropriately integrated with adjoining land uses, and access to private properties is maintained. ‣ The proposal is appropriately integrated with local and regional land use planning strategies.
15. Soils	The environmental values of land, including soils, subsoils and landforms, are protected. Risks arising from the disturbance and excavation of land and disposal of soil are minimised, including disturbance to acid sulfate soils and site contamination.	‣ Site-specific soil, subsoil and landform characteristics are taken into consideration during detailed design and construction. ‣ Any contamination is managed in accordance with relevant regulatory requirements. ‣ Any soil waste is assessed, classified, managed and disposed of in accordance with the *Waste Classification Guidelines* (EPA, 2014).
16. Sustainability	The project reduces the NSW Government's operating costs and ensures the effective and efficient use of resources. Conservation of natural resources is maximised.	‣ The design process targets an 'excellent' rating in accordance with the ISCA rating tool. ‣ Sustainability considerations are integrated throughout the design, construction, and operation phases of the proposal. ‣ The proposal contributes to one of the desired outcomes of Inland Rail – to have more than 750,000 fewer tonnes of carbon, one-third less fuel consumption, and reduced truck volumes in over 20 regional towns.

Key issue (as listed in the SEARS)	SEARS desired performance outcomes	Proposal specific environmental performance outcomes
17. Traffic, transport and access	Network connectivity, safety and efficiency of the transport system in the vicinity of the project are managed to minimise impacts. The safety of transport system customers is maintained. Impacts on network capacity and the level of service are effectively managed. Works are compatible with existing infrastructure and future transport corridors.	▸ The proposal provides for more efficient and productive freight rail operations. ▸ Impacts to traffic and transport are minimised. ▸ Motorist, pedestrian and cyclist safety will be maintained or improved. ▸ The proposal contributes to one of the desired outcomes of Inland Rail – to have reduced truck volumes on the road network, improving road safety. ▸ Safe access to properties is maintained. ▸ The proposal is integrated with existing and future local and regional transport infrastructure and planning strategies.
18. Visual amenity	The project minimises adverse impacts on the visual amenity of the built and natural environment (including public open space) and capitalises on opportunities to improve visual amenity.	▸ Vegetation providing screening to the rail corridor is retained where practicable. ▸ The proposal is designed to have regard to the surrounding landscape and visual environment. ▸ The proposal incorporates features to minimise the potential visual impacts where visual receptors are concentrated. ▸ The proposal makes a positive contribution to the quality of the visual environment in the vicinity of the Newell Highway and Jones Avenue overbridges, and the new bridges over the Mehi and Gwydir rivers and Croppa Creek. ▸ The proposal is visually integrated with its surroundings.
19. Waste	All wastes generated during the construction and operation of the proposal are effectively stored, handled, treated, reused, recycled and/or disposed of lawfully, and in a manner that protects environmental values.	▸ Waste is managed in accordance with the POEO Act and the WARR Act. ▸ Waste is assessed, classified, managed, and disposed of in accordance with the *Waste Classification Guidelines* (EPA, 2014). ▸ Reusable spoil is beneficially reused in accordance with the project spoil reuse hierarchy.

Key issue (as listed in the SEARS)	SEARS desired performance outcomes	Proposal specific environmental performance outcomes
20. Water - hydrology	Long term impacts on surface water and groundwater hydrology (including drawdown, flow rates and volumes) are minimised. The environmental values of nearby, connected and affected water sources, groundwater and dependent ecological systems including estuarine and marine water (if applicable) are maintained (where values are achieved) or improved and maintained (where values are not achieved). Sustainable use of water resources.	▸ The proposal avoids long-term impacts to surface water. ▸ Opportunities to reuse water resources are considered during the design process. ▸ The use of water during construction is minimised.
21. Water - quality	The project is designed, constructed and operated to protect the NSW Water Quality Objectives where they are currently being achieved, and contribute towards achievement of the Water Quality Objectives over time where they are currently not being achieved, including downstream of the project to the extent of the project impact including estuarine and marine waters (if applicable).	▸ The proposal is designed and constructed such that changes to water flows in watercourses are minimised. ▸ Water discharged does not exceed the ANZECC 2000 guidelines for protection of aquatic ecosystems or water quality trigger values. ▸ Impacts to water quality during construction and operation are minimised.

28. Conclusion

This chapter provides the conclusion to the EIS. It summarises the proposal for which approval is sought; the uncertainties that still exist and how these will be resolved; and provides the justification for the proposal, having regard to biophysical, economic and social considerations.

28.1 Summary description of the proposal for which approval is sought

This EIS considers the potential impacts from construction and operation of the Narrabri to North Star section of Inland Rail. It has been prepared to support ARTC's application for approval of the proposal in accordance with the requirements of Part 5.1 of the *Environmental Planning and Assessment Act 1979* (EP&A Act), and as a controlled action under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The EIS addresses the environmental assessment requirements of the Secretary of the Department of Planning and Environment, dated 8 November 2016.

28.1.1 Proposal features

The proposal consists of 188 kilometres of upgraded track and associated facilities, and is generally located within the existing rail corridor between Narrabri and the town of North Star, via Moree. Some works would also be undertaken outside the rail corridor, including works at Bellata, Moree, and Camurra.

The key features of the proposal involve:

- upgrading the track, track formation, culverts, and underbridges within the existing rail corridor, for a distance of 188 kilometres, between Narrabri and North Star via Moree
- realigning the track within the existing rail corridor at Bellata, Gurley, and Moree stations to minimise tight curves
- providing five new crossing loops within the existing rail corridor at Bobbiwaa, Waterloo Creek, Tycannah Creek, Coolleearllee, and Murgo
- providing a new section of rail line at Camurra about 1.6 kilometres long, to bypass the existing hairpin curve
- removing the existing bridges and providing three new rail bridges over the Mehi and Gwydir rivers and Croppa Creek
- realigning about 1.5 kilometres of the Newell Highway near Bellata, and providing a new road bridge over the existing rail corridor
- providing a new road bridge over the existing rail corridor at Jones Avenue in Moree.

Ancillary work would include works to level crossings, signalling and communications, signage, fencing, and services and utilities within the proposal site.

Further information on the design features of the proposal is provided in Chapter 7.

28.1.2 Operation

The proposal would form part of the rail network managed and maintained by ARTC. Train services would be provided by a variety of operators.

Prior to the opening of Inland Rail as a whole, the rail line would be used by existing rail traffic, which includes trains carrying grain and ore at an average rate of about four trains per day.

It is estimated that the operation of Inland Rail would involve an annual average of about 10 trains per day travelling north of Moree (between North Star and Moree) and 12 trains per day travelling south of Moree (between Moree and Narrabri) in 2025. This would increase to about 19 trains per day north of Moree (between North Star and Moree) and 21 trains per day south of Moree (between Moree and Narrabri) in 2040. In the proposal site, this would be additional to the existing rail traffic using the rail line.

The trains would be a mix of grain, bulk freight, and other general transport trains. Total annual freight tonnages would be about 11.8 million tonnes in 2025, increasing to about 19 million tonnes in 2040 (from the existing 2 million tonnes of grain per year).

Train speeds would vary according to axle loads, and range from 80 to 115 kilometres per hour (for 21 tonne trains). Trains would operate 24 hours per day. They would be up to 1,800 metres long; carry double stacked containers; and have a height of 6.5 metres.

Further information on how the proposal would be operated is provided in Chapter 7.

28.1.3 Construction

Construction of the proposal would commence once all necessary approvals are obtained, and the detailed design is complete. It is anticipated that construction would take about 24 months, commencing in mid-2018, and concluding in mid-2020.

Construction along the existing rail corridor would depend on the possession strategy. However, it is anticipated that it would involve four main stages:

- stage 1 – Camurra to North Star
- stage 2 – Narrabri to Bellata
- stage 3 – Bellata to Moree South.
- stage 4 – Moree South to Camurra.

Construction of the Newell Highway overbridge, the bridges over the Mehi and Gwydir rivers and Croppa Creek, the Camurra bypass, and the Jones Avenue overbridge would be undertaken in parallel with the above stages.

Further information on how the proposal would be constructed is provided in Chapter 8.

28.2 Proposal uncertainties

The EIS is based on the feasibility design for the proposal. Given the current level of design development, there remain some uncertainties relating to technical requirements, how the proposal would be constructed, and how it would operate as part of Inland Rail overall. These details would be resolved as the design of the proposal, and Inland Rail as a whole, progresses.

A summary of the main uncertainties around the design, construction and/or operational methodologies of the proposal, and how these will be resolved, is provided in Table 28.1.

Table 28.1 Main proposal uncertainties

Category	Uncertainty	How uncertainties will be resolved
Design	Property acquisition – exact areas that need to be acquired.	Refining the amount and location of property acquisition will involve a detailed survey of the proposal site and surrounding properties, and confirmation of the final detailed design.
	Spoil mounds – location and design.	The location, sizing and design of the spoil mounds will be determined during detailed design, with consideration given to the results of hydraulic modelling.
	Final level crossing strategy.	The next stage in the level crossing strategy involves reviewing the proposed arrangements for each crossing in detail, and confirming the preferred approach, taking into account input from affected land owners and stakeholders, and opportunities for alternative access.
	Utilities – impacts to utilities to be defined in detail.	Site utilities investigations will be completed during detailed design to validate current assessments and confirm relocation/ protection requirements.
	Existing sidings – horizontal distances, loading points and mainline impacts.	A detailed survey will be completed during detailed design to assist in defining the specific locations and operational requirements of existing sidings, as well as impacts to loading infrastructure at these sidings.
	Culverts – erosion protection.	Further modelling will be undertaken during detailed design to confirm the locations downstream of culverts that require erosion protection, and the extent and type of protection required.

Category	Uncertainty	How uncertainties will be resolved
Construction methodology	Haul routes – exact routes and haulage methods.	A detailed haulage program will be developed based on the detailed design.
	Compound sites – location, layout and facilities.	The final selection of identified compound locations and final layout of compound sites will be confirmed based on the detailed design, taking into account the criteria and requirements specified in Chapter 8.
Operational methodology	Stop locations between Narrabri and North Star for freight trains using Inland Rail.	Train stopping patterns and associated infrastructure requirements will continue to be refined as the design of the other sections of Inland Rail progresses. Train stopping patterns will be developed in consultation with potential users of Inland Rail and key stakeholders, including the agencies responsible for intermodal terminals along the route (such as Moree Plains Shire Council).

28.3 Justification of the proposal

28.3.1 Summary of proposal justification

Australia's freight task is set to experience significant growth over the coming decades. The existing freight infrastructure cannot support this projected growth, with increasing pressure on already congested roads and rail lines through Sydney, and increasing use of heavy trucks such as B-doubles and, potentially, B-triples along the Hume-Pacific and Newell highway corridors.

Inland Rail will address the growing freight task by helping to move freight off the congested road network, and moving interstate freight off the congested Sydney suburban rail network. It provides a reliable road-competitive solution to the freight task, and enables the commercial and social benefits of rail to be leveraged to meet Australia's long-term freight challenge.

Inland Rail will connect key production areas in Queensland, NSW and Victoria with export ports in Brisbane and Melbourne, and provide linkages between Melbourne, Brisbane, Sydney, Adelaide and Perth. It will reduce freight transit times, reduce congestion on rail and road networks, and enable the movement of larger freight volumes via rail, by making the movement of longer and double stacked trains possible.

Inland Rail will provide the backbone infrastructure necessary to significantly upgrade the performance of the east coast rail freight network to better serve future freight demands, while also diverting demand from the constrained road freight and rail passenger network.

In summary, as described in Chapter 5, Inland Rail is needed to respond to the growth in demand for freight transport, and address existing freight capacity and infrastructure issues. The analysis of demands undertaken by ARTC indicated that there would be sufficient demand for Inland Rail.

The proposal is a critical component of Inland Rail, and has been designed to maximise use of the existing rail corridor, while still contributing to the overall efficiency of Inland Rail.

The proposal also facilitates safe access for vehicles across the rail corridor in Moree by means of the proposed Jones Avenue overbridge.

28.3.2 Summary of proposal benefits

The proposal is a key component of Inland Rail, which would:

- **Boost the Australian economy** – Inland Rail is expected to increase Australia's gross domestic product by $16 billion during its construction and first 50 years of operation.
- **Create jobs** – it is estimated that construction of Inland Rail would require a workforce of up to 16,000 people at the peak of construction, and an average of 700 additional jobs per year over the construction period.
- **Improve connections within the national freight network** – Inland Rail will enhance the National Land Transport Network by creating a rail linkage between Moree, Brisbane, and Melbourne, providing a connection between Queensland and the southern and western states, and a connection to the east–west trans-continental line (at Parkes).
- **Provide better access to and from regional markets** – Inland Rail will make it easier for freight to move from farms, mines, and ports to national and overseas markets.
- **Reduce costs** – it is estimated that rail costs for intercapital freight travelling between Melbourne and Brisbane will reduce by $10 per tonne. Highway maintenance costs will reduce.
- **Offer better transit time and reliability** – Inland Rail will allow a transit time of less than 24 hours between Melbourne and Brisbane and a reliability of 98 per cent – matching current road levels.
- **Increase the capacity of the transport network** – Inland Rail will increase the capacity for freight and passenger services by reducing congestion along the busy coastal transport route, and allow for growth in passenger services, particularly in the Sydney region.
- **Reduce distances travelled** – with Inland Rail, the rail distance between Melbourne and Brisbane will reduce by 200 kilometres, and the distance between Brisbane and Perth, and Brisbane and Adelaide will reduce by 500 kilometres.
- **Improve road safety** – it is estimated that each year, there will be up to 15 fewer serious crashes, avoiding fatalities and serious injuries.
- **Improve sustainability** – carbon emissions will reduce by 750,000 tonnes.
- **Improve community amenity** – truck volumes and road congestion on some of Australia's busiest highways will reduce, which will also mean a reduction in trucks travelling through more than 20 regional towns. This will lead to corresponding reduction in amenity impacts associated with the movement of freight by road, including noise and air emissions.
- **Provide an alternative north-south freight link** – Inland Rail will provide a second link between Queensland and the southern states, making Australia's national freight rail network less vulnerable to disruptions, for example from extreme weather events.
- **Promote complementary supply chain investments** – Inland Rail will be a catalyst for complementary private sector investments, such as fleet upgrades, new metropolitan and regional terminals, and integrated freight precincts.

28.3.3 Consequences of not proceeding

The proposal is a section of Inland Rail as a whole, and Inland Rail cannot proceed if the proposal does not proceed. This would mean that the benefits of Inland Rail would not be realised.

28.3.4 Environmental considerations

Environmental investigations were undertaken during preparation of the EIS to assess the potential impacts of the proposal. These included specialist assessments of terrestrial and aquatic biodiversity; heritage; traffic and transport; hydrology, flooding and water quality; noise and vibration; soils; landscape and visual amenity; air quality; sustainability and climate change; socio-economics; and waste management. The EIS has documented the potential environmental impacts of the proposal, considering both potential positive and negative impacts, and identifies mitigation and management measures to protect the environment where required.

Biophysical

The main potential impacts of the proposal on the biophysical environment include:

- direct impacts to biodiversity as a result of clearing of areas of native vegetation
- potential indirect flora and fauna impacts
- water quality impacts during construction
- geomorphological impacts to watercourses as a result of the construction of new culverts/ crossing structures.

Social and economic

The main potential impacts of the proposal on the cultural environment (including land use, heritage, and socio-economics) include:

- minor changes to access arrangements as a result of the proposed changes to level crossings
- impacts to heritage listed items and items with potential heritage significance
- visual impacts as a result of the introduction of new permanent structures in the landscape
- amenity related impacts during construction and operation (for example, noise, dust, traffic)
- acquisition of land
- minor impacts to surrounding agricultural land uses
- employment and associated economic benefits during construction
- contribution to the benefits of Inland Rail, as summarised in Section 28.3.2
- local and regional benefits via the potential for local and regional connections to Inland Rail.

Addressing the potential impacts

As described in Chapters 7, 8 and 27, the proposal would incorporate construction management measures and design features to ensure that potential impacts are managed and mitigated as far as practicable. The majority of the potential construction related impacts would be effectively managed by the implementation of best practice construction management, including the implementation of the environmental management approaches described in Section 27.2.

The biodiversity offset strategy would be finalised and implemented to address the residual impacts of the proposal on biodiversity values, according to the requirements for Part 5.1 projects under the EP&A Act, and to offset impacts on EPBC Act matters.

28.3.5 Ecologically sustainable development

The EP&A Act adopts the definition of ecologically sustainable development contained in the *Protection of the Environment Administration Act 1991*. An assessment of the proposal against the principles of ecologically sustainable development as per clause 7(4) of Schedule 2 of the *Environmental Planning and Assessment Regulation 2000* is provided below.

Precautionary principle

A range of environmental investigations, as described in Part C of the EIS, have been undertaken during the development of the proposal and the environmental assessment process, to ensure that potential impacts are understood with a high degree of certainty. The assessment of the potential impacts of the proposal is considered to be consistent with the precautionary principle. The assessments undertaken are consistent with accepted scientific and assessment methodologies, and have taken into account relevant statutory and agency requirements. The assessments have applied a conservative approach with regard to construction and operational arrangements, and the modelling used.

The proposal has evolved to avoid impacts where possible and to reflect the findings of the studies undertaken. The route for the proposal has been selected to minimise the potential environmental impacts, particularly the amount of vegetation clearing that would be required, by maximising the use of existing rail corridors.

A number of safeguards have been proposed to minimise potential impacts. These safeguards would be implemented during construction and operation of the proposal. No safeguards have been postponed as a result of lack of scientific certainty.

Principle of inter-generational equity

Construction of a long linear infrastructure project such as the proposal has the potential for some degree of environmental and social disturbance. These disturbances include the clearing of vegetation; some disturbance to private properties during construction; potential disturbance of some heritage sites; and localised impacts. However, the potential for environmental and social disturbance as a result of construction has to be balanced against the long-term benefits of the overall Inland Rail proposal.

Should the Inland Rail project not proceed, the principle of intergenerational equity may be compromised, as future generations would experience the increased environmental and safety impacts associated with the transport of large volumes of freight via the Newell Highway. The strategic planning studies summarised in Chapter 5 have identified a strong need and justification for Inland Rail. The proposal would, as part of Inland Rail, benefit future generations by providing a safer, more efficient, means of freight transport.

Conservation of biological diversity and ecological integrity

Ecological studies have been undertaken to identify potential adverse impacts on biodiversity. Where potential impacts cannot be avoided, mitigation measures would be implemented to reduce the impact as far as possible.

The proposal would result in the clearing of some vegetation associated with threatened plant communities. Mitigation measures are proposed to minimise and manage the significance of the impact on native vegetation and flora and fauna. Biodiversity offsets would be implemented to address the impacts that cannot be avoided.

Improved valuation and pricing of environmental resources

The assessment has identified the environmental and other consequences of the proposal and identified mitigation measures where appropriate to manage adverse impacts. If approved, the construction and operation of the proposal would be in accordance with relevant legislation, the conditions of approval and the construction and operation environmental management plans. These requirements would result in an economic cost to the proponent. The implementation of mitigation measures would increase both the capital and operating costs of the proposal. This signifies that environmental resources have been given appropriate valuation.

The concept design for the proposal has been developed with an objective of minimising potential impacts on the surrounding environment. This indicates that the concept design has been developed with an environmental objective in mind.

28.4 Concluding statement

The proposal involves upgrading the existing rail line and associated works between Narrabri and North Star, and operating the new/upgraded section of rail line as part of Inland Rail. The proposal is needed to support the development of Inland Rail.

Potential impacts resulting from the proposal are considered manageable through the implementation of the proposed mitigation and management measures.

The detailed design for the proposal would be developed with the objective of minimising potential impacts on the local and regional environment, and the local community. The design and construction methodology would continue to be developed with this overriding objective in mind, taking into account the input of stakeholders.

To manage the potential impacts identified by the EIS, and in some cases remove them completely, the assessment chapters outline a range of mitigation measures that would be implemented during construction and operation of the proposal. Chapter 27 summarises the environmental mitigation and management measures that would be implemented. The environmental performance of the proposal would be managed by the implementation of the CEMP and OEMP. These plans would also ensure compliance with relevant legislation and any conditions of approval.

With the implementation of the proposed mitigation and management measures the potential environmental impacts of the proposal would be adequately managed.

29 Reference list

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