APPENDIX K

Matters of National Environmental Significance Technical Report

PART 1 OF 4

Main Report

CALVERT TO KAGARU ENVIRONMENTAL IMPACT STATEMENT

INLAND RAIL

ARTC

IR_1381

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

Inland Rail Calvert to Kagaru EIS

Appendix K - Matters of National Environmental Significance Technical Report

Australian Rail Track Corporation

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Abbreviations

Abbreviation	Explanation
AoLA	Atlas of Living Australia
ARTC	Australian Rail Track Corporation
AUSRIVAS	Australian River Assessment System
BAMM	Biodiversity Assessment and Mapping Methodology
BPA	Biodiversity Planning Assessment
C2K	Calvert to Kagaru
CEMP	Construction Environmental Management Plan
Cth	Commonwealth
DAF	Department of Agriculture and Fisheries
DAWE	Department of Agriculture, Water and Environment
DEHP	Department of Environment and Heritage Protection (former)
DERM	Department of Environment and Resource Management (former) (Qld)
DES	Department of Environment and Science
DEWHA	Department of the Environment, Water, Heritage and the Arts (Cth) (former)
DNRME	Department of Natural Resource Management and Energy
DotE	Department of the Environment (Cth) (former)
DotEE	Department of the Environment and Energy (Cth) (former)
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communities (Cth) (former)
DTMR	Department of Transport and Main Roads
EAM	Environmental Assessment and Management
EIS	Environmental Impact Statement
EPBC Act	*Environment Protection Biodiversity Conservation Act 1999* (Cth)
FFJV	Future Freight Joint Venture
GIS	Geographic information system
H2C	Helidon to Calvert
ha	hectare
HES	High Ecological Significance
ICC	Ipswich City Council
Inland Rail	Melbourne to Brisbane Inland Rail
K2ARB	Kagaru to Acacia Ridge and Bromelton
kg/m	kilogram/metre
km	kilometre
km^2	square kilometre
m	metre
m^2	square metre
mm	millimetre
MNES	Matters of national environmental significance
NSW	New South Wales
OEH	Office of Environment and Heritage (NSW)
PMST	Protected Matters Search Tool

Abbreviation	Explanation
Project	Calvert to Kagaru Project
QLD	Queensland
QR	Queensland Rail
RE	Regional Ecosystem
SDA	State Development Area
SDPWO Act	*State Development and Public Works Organisation Act 1971* (Qld)
SEQ	South-east Queensland
SFRC	Southern Freight Rail Corridor
sp.	species
spp.	multiple species
SPRAT	Species Profile and Threats Database
subsp.	Subspecies
TEC	Threatened Ecological Community
ToR	Terms of Reference
VM Act	*Vegetation Management Act 1999* (Qld)
WoNS	Weeds of national significance

Glossary

Term	Explanation
Acid sulfate soils	Soil that contains oxidised iron sulphides (actual acid sulfate soils) and/or soil that contains iron sulphides or other sulfidic material that has not been exposed to air and oxidised (potential acid sulfate soils). The term acid sulfate soil generally includes both actual and potential acid sulfate soils. Actual and potential acid sulfate soils are often found in the same soil profile, with actual acid sulfate soils generally overlying potential acid sulfate soil horizons.
Adverse impact	Adverse impacts are defined as those impacts that result in an unwanted and/or unanticipated result of taking a particular action. In an environmental context, an adverse impact means any change in the physical or biological conditions of the natural environment that results in a detrimental effect upon flora, fauna, air, water, minerals or other natural characteristic of the area.
Anaerobic	Process taking place in the absence of oxygen.
Anthropogenic	Associated with or relating to human influence (or impact) on the environment.
Aquatic ecosystems	The physical and chemical environment that contains a community of organisms (plants, animals, and microbes) and ecological processes within rivers and their riparian zones and reservoirs, lakes, wetlands and their fringing vegetation.
Arable	Capable of producing crops or grazing land.
Biocondition	The degree to which the attributes of a patch of vegetation differ from the attributes of the same vegetation in its reference (undisturbed) state.
Biodiversity	The biological diversity of life is commonly regarded as being made up of the following three components: ▪ Genetic diversity – the variety of genes (or units of heredity) in any population ▪ Species diversity – the variety of species ▪ Ecosystem diversity – the variety of communities or ecosystems.
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. In Queensland, the term used is ‘environmental offsets’.
Biodiversity Planning Assessments (Qld) (BPAs)	BPAs have been prepared for each of Queensland’s bioregions based on the methodology outlined in the Biodiversity Assessment and Mapping Methodology (BAMM) (Department of Environment and Heritage Protection (DEHP) 2014a). The BPAs draw upon the Department of Environment and Science (DES) certified Regional Ecosystem (RE) mapping, database information, and expert panel reports and incorporate information about threatened ecosystems and/or species, large tracts of habitat in good condition, ecosystem diversity, landscape context and connection, as well as buffers to wetlands or other types of important areas for ecological processes. There are three biodiversity significance levels to which an area can be assigned: ▪ State significance – areas assessed as being significant for biodiversity at the bioregional or State scales ▪ Regional significance – areas assessed as being significant for biodiversity at the sub-bioregional scale ▪ Local significance and or other values – local values that are of significance at the local government scale. All remnant vegetation will qualify into one of the above three categories.
Bioregion	A bioregion as defined in An Interim Biographic Regionalisation of Australia (Thackway and Cresswell (1995)). The region subject to this report is the southeast Queensland bioregion.

Term	Explanation
Biosecurity Act 2014 (Qld) (Biosecurity Act)	The Biosecurity Act lists declared plants and animals that have, or could have, serious economic, environmental or social impacts and are targeted for control. There are legal obligations associated with the control supply, sale, keeping and transport of declared species. Where these exotic pests and weeds are encountered, landholders have an obligation under the Biosecurity Act to control the declared weeds and pest animals, in accordance with relevant guidelines and local government area pest management plans. There are seven categories for restricted matter defined in the Biosecurity Act: - Categories 1 and 2 are restricted matters that have specific urgent reporting requirements - Categories 3, 4, 5, 6 and 7 relate to restricted matter that is in a person's possession, under their control and are also about not feeding restricted matter. Several restriction categories apply to some restricted matter. In such cases, you would need to follow the requirements of all restriction categories for these restricted matter listings.
Controlled action	A proposed action designated under the controlling provisions of the Environment Prote*ction and Biodiversity Conservation Act 1999* (Cth) that is likely to have a significant impact on a matter of national environmental significance, the environment or Commonwealth land (even if the action is taken outside Commonwealth land).
Controlling provision	Under the *Environment Protection and Biodiversity Conservation Act 1999* (Cth), an action that a person proposes to take is a *controlled action* if the taking of the action by the person without approval under Part 9 for the purposes of a provision of Part 3 would be (or would, but for section 25AA or 28AB, be) prohibited by the provision. The provision is a *controlling provision* for the action.
Critical habitat (also referred to as *Habitat critical to the survival of the species*)	The whole or any part or parts of an area or areas of land comprising the habitat of an Endangered species, an Endangered population or an Endangered ecological community that is critical to the survival of the species, population or ecological community. Critical habitat is listed under the EPBC Act.
Critically Endangered	Designated as Critically Endangered under the EPBC Act. Refer to definition of EPBC Act conservation status for meaning of Critically endangered under the Act.
Cumulative impact assessment area	The Inland Rail cumulative impact assessment area encompasses the Inland Rail disturbance footprint and extends 50 km beyond the disturbance footprint boundary.
Cumulative impacts	The impacts that result from the incremental impact of an activity when it is added to past, present and reasonably foreseeable future activities. Cumulative impacts arise when several developments may have insignificant effects but when taken together have a significant effect.
Direct impacts	Impacts that result from a direct interaction between integral Project works and MNES (e.g. land clearing resulting in vegetation and habitat loss).
Disturbance footprint	The disturbance footprint can be described as either permanent or temporary: - Permanent disturbance footprint consists of the rail corridor, its rail tracks and associated infrastructure as well as other permanent works associated with the Project (e.g. where changes to the road network are required) - Temporary disturbance footprint consists of the construction areas required for the Project, including both the area of the permanent disturbance footprint, where the rail infrastructure is proposed to be constructed, and those areas beyond the permanent disturbance footprint, that are proposed for use as temporary storage, haulage and laydown areas." For purposes of the clearing quantitative impact (i.e. assessment of direct impacts), the tunnel footprint within the Teviot Range was excluded as no surface disturbance is proposed.
Ecological community	An assemblage of species occupying a particular area.
Ecologically sustainable development	Using, conserving and enhancing the community's resources so that ecological processes are maintained and the total quality of life, both now and in the future, can be increased.
Ecosystem	An organic community of plants, animals and bacteria and the physical and chemical environment they inhabit.

Term	Explanation
EIS investigation corridor	The EIS investigation corridor is an approximately 2 km wide study area, 1 km either side of the proposed rail alignment. The study area includes the disturbance footprint, which encompasses all areas where works are proposed, including both permanent and temporary works. The study area is slightly wider around Ch 38 km to Ch 45 km to accommodate for the options analysis undertaken for the Teviot Range crossing.
Endangered	Designated as Endangered under the EPBC Act. Refer to definitions of EPBC Act conservation status for meaning of Endangered.
Endemic	Native to a country or a locality, although also found elsewhere.
Environmental values	Desirable characteristics, properties and behaviours or an aspect of the environment.
EPBC Act conservation status	Under the EPBC Act, listed species and threatened ecological communities are assigned a conservation status of Extinct in the wild, Critically Endangered, Endangered or Vulnerable. Definitions of these terms under the Act are as follows: **Extinct in the wild** ▪ It is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range ▪ It has not been recorded in its known and/or expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a timeframe appropriate to its lifecycle and form **Critically Endangered** ▪ It is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria **Endangered** ▪ It is not Critically Endangered ▪ It is facing a very high risk of extinction in the wild in the near future, as determined in accordance with the prescribed criteria **Vulnerable** ▪ It is not Critically Endangered or Endangered ▪ It is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria. **Migratory** Migratory species are those animals that migrate to Australia and its external territories or pass through or over Australian waters during their annual migrations. Examples of migratory species include birds such as albatrosses and petrels, mammals such as whales or reptiles. Listed migratory species appear in the: ▪ Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention) ▪ China-Australia Migratory Bird Agreement (CAMBA) ▪ Japan-Australia Migratory Bird Agreement (JAMBA) ▪ Republic of Korea-Australia Migratory Bird Agreement (ROKAMBA).
Ephemeral	Relates to the amount of time that surface water persists in a watercourse or wetland; ephemeral watercourses flow only during significant rainfall events and for a short time following rainfall events.
Habitat	An area or areas permanently, periodically or occasionally occupied by a species, population or ecological community, including any and all biotic and abiotic features of the area or areas occupied.
High constraint area	The environmental value is at risk from the Project activity. The activity will only be allowed with a specific set of stringent mitigation measures.
High Value Regrowth	According to the DNRME (2018), regulated regrowth vegetation includes vegetation that falls into one of the following categories: ▪ Vegetation identified on a regulated vegetation map as High Value Regrowth vegetation (Category C; light blue) ▪ Vegetation located within 50 m of watercourses in priority reef catchment areas (Category R; yellow) ▪ Vegetation that is a Least concern, Of concern or Endangered RE. High Value Regrowth vegetation is mature native vegetation that has not been cleared in the last 15 years.

Term	Explanation
Indirect impacts	Impacts that are not a direct result of project activities but that occur away from the original impact area, sometimes via a complex pathway.
Intergenerational equity	The principle of intergenerational equity is that the present generation should ensure that the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations.
Matters of national environmental significance (MNES)	The nine MNES protected under the EPBC Act are: ▪ World Heritage properties ▪ National Heritage places ▪ Wetlands of international importance (listed under the Ramsar Convention) ▪ Listed threatened species and ecological communities ▪ Migratory species protected under international agreements ▪ Commonwealth marine areas ▪ The Great Barrier Reef Marine Park ▪ Nuclear actions (including uranium mines) ▪ A water resource, in relation to coal seam gas development and large coal mining development.
Microchiropteran bats	This report uses the term Microchiropteran bats to refer to small, mostly insectivorous bats that use echolocation to navigate and find food.
Migratory	Species listed as Migratory under the EPBC Act.
MNES study area	The MNES study area adopts the EIS investigation corridor, being an approximate 2 km wide study area, 1 km either side of the proposed rail alignment. It includes the disturbance footprint, which encompasses all areas where works are proposed, including both permanent and temporary works, and land within a 1 km radius either side of the proposed rail alignment. The MNES study area is slightly wider around Chainage 38 to Chainage 45 to accommodate for the options analysis that was undertaken for the Teviot Range crossing. It should be noted that for the estimation of direct impacts, the disturbance footprint does not include the surface area associated with the rail tunnel (where the alignment intersects a portion of the Teviot Range) as no surface disturbance is predicted.
Naturalness and ecological condition	The apparent naturalness or health/condition of an ecological community, as assessed against the following criteria: ▪ Disturbance — described in terms of its cause (natural or human), its degree or severity, its extent and distribution within the community ▪ Weed content — description of species abundance, horizontal and vertical distribution of each species ▪ Ecological viability — measure of a community's ability to survive in the longer term ▪ Ecological health — measure of regeneration, size, structure and number of dead or dying plants within a community ▪ Ecological relationships — the sequential relationship of one community to another, such as diurnal systems.
Negative impact	An impact that is considered to result in an unfavourable or adverse change to the MNES.
Non-remnant vegetation	Vegetation that is not mapped as remnant vegetation by DES and/or which fails to meet DESs criteria for remnant vegetation (refer definition of remnant vegetation, below). This includes regrowth, heavily thinned or logged vegetation and significantly disturbed vegetation that fails to meet the structural and/or floristic characteristics of remnant vegetation. It also includes urban and cropping land. Non-remnant vegetation may retain significant biodiversity values (Neldner et al. 2017).
Of concern	Designated as Of concern under the *Vegetation Management Act 1999* (Qld) (VM Act) or Of concern under the *Environmental Protection Act 1994* (Qld). Refer to definition of VM Act status for meaning of Of concern under the Act.
Permanent impact	The impact will last in excess of 21 years.
Pest	Means any species: ▪ Listed as Prohibited or Restricted under the *Biosecurity Act 2014* (Qld) ▪ Declared under local government local laws ▪ That may become invasive in the future.
Polluter pays	Those who generate pollution and waste should bear the cost of containment, avoidance or abatement.

Term	Explanation
Precautionary principle	The precautionary principle stipulates that if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.
Pre-clearing Regional Ecosystems (Pre-clearance REs)	Pre-clearing Regional Ecosystem are defined as the vegetation or regional ecosystems present before clearing. This generally equates to terms such as 'pre-1750' or 'pre-European' used elsewhere
Project works	Project works include early works and pre-construction activities, works described as pre-construction, construction and commissioning works. Project works exclude enabling works.
Qualitative	Relating to or concerned with quality or qualities, rather than quantity or measured value.
Quantitative	An assessment based on quantities or quantifiable data.
Ramsar wetland	An area designated as a wetland of international importance under the Ramsar Convention (also known as the Convention on Wetlands of International Importance signed by Australia in 1971) because of its role in preserving biological diversity, or because it is a representative, rare or unique wetland type.
Rare	Defined as “not occurring very often”.
Regional Ecosystem (RE)	A vegetation community, within a bioregion, that is consistently associated with a particular combination of geology, landform and soil (Young et al. 1999). REs are mapped by the Queensland Government and are defined by the Regional Ecosystem Description Database (REDD) (Queensland Herbarium 2019). The RE codes are applicable to mapping from Remnant vegetation, High value regrowth and pre-clearing REs that are not considered remnant. REs may be classified under schedules 1 to 3 of the Qld Vegetation Management Regulation 2012 as Endangered, Of concern or Least concern. Refer to VM Act conservation status for meaning of Endangered, Of concern and Least concern under the Act. These terms in reference to REs in this report refers to the RE status under the Act.
Regrowth vegetation	As defined under the VM Act (Qld), regrowth is any vegetation that is not 70% of height of an equivalent community of undisturbed vegetation or 50% of what would be undisturbed foliage cover and a mix of species represented in undisturbed communities.
Remnant vegetation	Remnant woody vegetation is defined as vegetation where the dominant canopy has >70% of the height and >50% of the cover relative to the undisturbed height and cover of that stratum and is dominated by species characteristic of the vegetation’s undisturbed canopy (Neldner et al. 2017).
Residual impact	The impact that is remaining or leftover following the implementation of mitigation measures.
Significant impact	In accordance with the intent of the EPBC Act, a significant impact is an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value, and quality of the environment which is impacted, and upon the intensity, duration, magnitude and geographic extent of the impacts.
Significant residual impact	An adverse impact, whether direct or indirect, of a prescribed activity on all or part of a prescribed environmental matter that remains, or will, or is likely to remain (whether temporarily or permanently) despite onsite avoidance and mitigation measures for the prescribed activity; and is, or will, or is likely to be, significant.
Spatial extent	Impacts are considered with respect to the biologically meaningful spatial extents of local, regional, State, and national/international.
Terms of reference (ToR)	Written document developed by the regulatory authority (i.e. Queensland Coordinator-General) that provides the minimum expectations for the scope of an environmental impact statement.
Threatened	A collective term used with reference to species that are listed as Critically endangered, Endangered or Vulnerable under the provisions of the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act) (refer EPBC Act conservation significance for more details).

<table>
<tr><th>Term</th><th>Explanation</th></tr>
<tr><td>Threatening process</td><td>Processes that threaten, or have the capability to threaten, the survival or evolutionary development of species, populations, or ecological communities. According to the Environment Protection and Biodiversity Conservation Act 1999 (Cth), a process is a threatening process if it threatens, or may threaten, the survival, abundance or evolutionary development of a native species or ecological community. Such processes can be listed as a key threatening process if it can:
Cause a native species or ecological community to become eligible for inclusion in a threatened list (other than the conservation dependent category)
Cause an already listed threatened species or threatened ecological community to become more endangered
Adversely affect two or more listed threatened species or threatened ecological communities.</td></tr>
<tr><td>VM Act conservation status</td><td>Under the VM Act, REs may be classified as either Endangered, Of concern or Least concern. Definitions of these terms under the Act are provided below
Endangered
Less than 10% of pre-clearing extent of remnant vegetation (refer following definition) exists in the bioregion, or 10% to 30% of pre-clearing extent remains and the remnant vegetation is less than 10,000 ha
Of concern
10% to 30% of pre-clearing extent of remnant vegetation exists in the bioregion, or more than 30% of pre-clearing extent remains and the remnant vegetation is less than 10,000 ha
Least concern
More than 30% of pre-clearing extent of remnant vegetation exists in the bioregion, and it is greater than 10,000 ha.
In addition, for biodiversity planning purposes DES also classifies a RE as No concern at present if the degradation criteria listed above for Endangered or Of concern REs are not met.</td></tr>
<tr><td>Vulnerable</td><td>Designated as Vulnerable under the EPBC Act. Refer to definitions of EPBC Act conservation status for meaning of Vulnerable under this Act.</td></tr>
<tr><td>Weeds</td><td>Plant species that invade native ecosystems and can adversely affect the survival of indigenous flora and fauna, often competing with indigenous plants for resources such as nutrients, moisture and light. They can prevent natural regeneration, reduce wildlife habitat, alter water flows, increase soil erosion, introduce poisons into the soil or poison animals, change fire behaviour and may introduce foreign genes into local plant populations.
Weed species are not necessarily exotic non-indigenous species, but can also be non-endemic natives that are naturalised to areas outside of their natural distribution.</td></tr>
<tr><td>Weeds of National Environmental Significance (WoNS)</td><td>Thirty-two species of weeds are declared to be weeds of national significance, based on their invasiveness, potential for spread and environmental, social and economic impacts.
The State Government is responsible for the legislation and administration of WoNS in Queensland and landholders are responsible for managing WoNS.
The Australian Weeds Strategy provides a framework for establishing consistency between all stakeholders and identifies priorities for national weed management with the aim of minimizing the environmental, social and economic impacts of weeds. A National Management Group has been established for each of the WoNS to manage the implementation of the respective National Strategic Plans.</td></tr>
<tr><td>Wetland</td><td>Areas shown on the Map of Referable Wetlands which is a document approved by the chief executive on 4 November 2011 and published by the department, as amended from time to time by the chief executive under section 144D of the Environmental Protection Regulation 2008 (Qld); and
Are wetlands as defined under the Queensland Wetlands Program as areas of permanent or periodic/intermittent inundation, with water that is static or flowing fresh, brackish or salt, including areas of marine water, the depth of which at low tide does not exceed 6 m, and possess one or more of the following attributes:
At least periodically, the land supports plants or animals that are adapted to and dependent on living in wet conditions for at least part of their lifecycle; or
The substratum is predominantly undrained soils that are saturated, flooded or ponded long enough to develop anaerobic conditions in the upper layers; or
The substratum is not soil and is saturated with water or covered by water at some time.</td></tr>
</table>

Term	Explanation
Wetland of high ecological significance	Otherwise known as a high conservation value wetland, is a wetland that meets the definition of a wetland (above) and that is shown as a wetland of high ecological significance or high conservation value wetland on the QLD *Map of Referable Wetlands* (Department of Environment and Science (DES)).
Wildlife corridor	Habitat linked to other habitats (often remnant patches) to allow natural migration or movement of wildlife.

Executive summary

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

The Inland Rail route is approximately 1,700 kilometres (km) long and is divided into 13 projects. The Inland Rail Program (Inland Rail) will provide a safe and sustainable solution to Australia's freight challenge. Inland Rail will also provide significant social and economic benefits and opportunities, while implementing mitigation, management and offset measures that result in acceptable environmental, social and economic outcomes.

The Australian Rail Track Corporation (ARTC) proposes to construct and operate the Calvert to Kagaru Project (C2K) (the Project). The Project consists of 53 kilometres (km) of greenfield rail corridor which generally follows the Southern Freight Rail Corridor which connects the existing Queensland Rail's West Moreton Rail Line near Calvert to the existing Interstate Line at Kagaru.

The Project was referred to the then Minister of the Environment in May 2017 (EPBC 2017/7944) for determination under s75 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The Minister for the Environment determined the Project a 'controlled action' on 21 June 2017, requiring assessment and approval under the EPBC Act.

The controlling provision for the controlled action is:

- Listed threatened species and communities.

The Project was declared a coordinated project for which an Environmental Impact Statement (EIS) is required under the *State Development and Public Works Organisation Act 1971* (Qld) (SDPWO Act), as of 16 June 2017. This declaration initiates the statutory environmental impact assessment procedure detailed in Part 4 of the SDPWO Act, which requires a proponent to prepare an EIS for the Project in accordance with the terms of reference.

The SDPWO Act EIS process has been accredited under the bilateral agreement between the State of Queensland and the Commonwealth under the EPBC Act.

This Matters of National Environmental Significance (MNES) Technical Report has been prepared to address section 11 of the *Terms of Reference for an environmental impact statement: Inland Rail - Calvert to Kagaru Project*, issued on Friday 8 December 2017 by the Coordinator-General. The report also identifies the controlling provisions for the Project and describes the particular aspects of the environment that led the 'controlled action' decision under the EPBC Act.

The design development has been based on environmental, social and economic considerations, aimed at: minimising disturbance, meeting engineering design criteria, and achieving the service offering. The design response to key environmental features has been progressively developed and optioneered in line with reasonable and feasible engineering constraints.

The disturbance footprint is situated within the South-east Queensland (SEQ) bioregion. The Project MNES study area has experienced a long history of human disturbance from agricultural practices, urban development and resource development. At a regional level, large tracts of remnant vegetation are typically fragmented, occurring on areas that are generally less attractive to development (i.e. rocky ranges, sloping topography) and roadside vegetation. Small isolated patches of remnant vegetation are also noted, which are subject to edge related impacts.

The disturbance footprint provides habitat for one Threatened Ecological Community (TEC), being Swamp Tea-tree forest, as well as threatened species listed under the EPBC Act and their associated habitat.

The Project assessment framework has been designed to provide an objective approach to identifying the Project's environmental constraints and potential impacts to MNES.

Based on literature review, database searches, and field surveys supporting habitat modelling, habitat for 25 threatened flora and fauna species were confirmed within the disturbance footprint. This includes significant habitat associated with the Teviot Range and critical habitat for a number of species including the Koala. In addition, confirmed stands of Swamp tea-tree TEC were recorded in the vicinity of Paynes Road to the west of the Teviot range.

Informed by the outcomes of the desktop analysis and field assessments, an assessment of potential impacts from Project activities upon the identified MNES was undertaken.

The construction and operation of the Project has the potential to impact on MNES via the following mechanisms (predominantly associated with the construction phase):

- Habitat loss and degradation from vegetation clearing/removal
- Fauna species injury or mortality
- Reduction in biological viability of soil to support growth due to soil compaction
- Displacement of flora and fauna species by invasion of weed and pest species
- Reduction in the connectivity of biodiversity corridors
- Edge effects
- Habitat fragmentation
- Barrier effects
- Noise, dust, and light impacts
- Increase in litter (waste)
- Aquatic habitat degradation
- Erosion and sedimentation.

To determine the significance of potential impacts of the Project upon the identified MNES, sensitivity categories were applied to each of the MNES. The sensitivity of the MNES was grouped into three distinct categories: high, moderate and low. These groupings were based on factors including, but not limited to, legislative status, resilience and representation in the broader landscape. In addition to sensitivity, the magnitude of each potential impact was assigned based on the extent, duration and resultant change to the MNES. The magnitude of impact was grouped into five categories: major, high, moderate, low and negligible. Both the sensitivity of a MNES and the magnitude of the potential impact were used to determine the initial significance of a potential impact.

The proposed mitigation measures for the Project were considered in order to reduce the initial magnitude and ultimately the significance of the potential impacts upon the listed threatened species and communities. Project mitigation measures included (but were not limited to):

- Reducing the disturbance footprint as far as reasonably practical
- Development and implementation of a Flora and Fauna Sub-plan as a component of the Construction Environmental Management Plan (CEMP)
- Development and implementation of a Soil Management Plan, including erosion and sedimentation controls, as a component of the CEMP
- Identification and implementation of fauna movement features to reduce barrier effects associated with the Project and enable fauna passage
- Development and implementation of a Reinstatement and Rehabilitation Plan and a Landscape and Rehabilitation Management Plan
- Development and implementation of the CEMP. A draft Outline Environmental Management Plan (OEMP) has been developed and is part of the Project EIS (refer EIS Chapter 23).

Following the implementation of a range of mitigation measures and management plans including, but not limited to, avoidance, minimisation and mitigation, the magnitude of residual impacts to the listed threatened species and communities were generally reduced, followed by a subsequent reduction in the significance of the impact. However, the loss of habitat from vegetation clearing/removal upon most of the terrestrial MNES was not predicted to significantly reduce in magnitude of impact following the implementation of Project mitigation measures.

Based on assessment against the Significant Impact Guidelines for MNES, a significant residual impact is likely to occur to the following listed threatened species and communities:

- Threatened Ecological Community
  - Swamp tea-tree (*Melaleuca irbyana*) Forest of South-east Queensland – likely impact of up to 30.45 ha
- Flora
  - *Notelaea lloydii* (Lloyd's olive) – likely impact to 26.77 ha of *Habitat critical to the survival of the species*
- Fauna
  - Collared delma (*Delma torquata*) - likely impact to 9.56 ha of *Important habitat*
  - Koala (*Phascolarctos cinereus*) - likely impact to 124.31 ha of *Habitat critical to the survival of the species*.

There are also a number of threatened fauna species of which there is uncertainty as to whether they occur in the area, or if impacts of the Project may be considered as residual impacts. The assessment has followed a conservative approach and assumed there is also potential to have significant residual impacts to the following fauna species:

- Fauna
  - Spotted-tail quoll (*Dasyurus maculatus maculatus*) - potential impact to 6.92 ha of *Habitat critical to the survival of the species*
  - Red goshawk (*Erythrotriorchis radiatus*) - potential impact to 77.25 ha of *Habitat critical to the survival of the species*
  - Swift parrot (*Lathamus discolor*) - potential impact to 11.74 ha of *Habitat critical to the survival of the species*
  - Brush-tailed rock-wallaby (*Petrogale penicillata*) – potential population fragmentation impact (no predicted direct impact to suitable habitat)
  - Grey-headed flying-fox (*Pteropus poliocephalus*) –potential impact to 71.44 ha of *Habitat critical to the survival of the species*
  - Australian painted snipe (*Rostratula australis*) –potential impact to 34.55 ha of *Habitat critical to the survival of the species*.

A key reason for the significant residual impacts is noted to be the potential loss of habitat. Habitat loss may result from the disturbance footprint (primarily temporary construction). The Project may also result in permanent barrier effects and habitat fragmentation. During the detailed design phase, the extent of the clearing will be revised, along with the implementation of design solutions to mitigate barrier effects (e.g. fauna fencing and fauna passageways which will facilitate the movement of wildlife across the alignment).

A cumulative impact assessment was carried out including all relevant projects within a 50 km radius of the disturbance footprint. The significance of the predicted cumulative impact as a result of the Project and other similar projects that occur within 50 km of the Project boundary are likely to be higher on the following ecological MNES:

- Threatened Ecological Communities:
  - Swamp Tea-tree (*Melaleuca irbyana*) Forest of South-east Queensland TEC - cumulative removal of 728.99 ha of which the **Project contributes up to 4.18 per cent**
- Flora and fauna species habitat
  - *Lychnothamnus barbatus* - cumulative removal of 256.19 ha of habitat, of which the **Project contributes up to 2.38 per cent**
  - Lloyd's olive (*Notelaea lloydii*) - cumulative removal of 2,115.79 ha of habitat, of which the **Project contributes up to 1.27 per cent**
  - Australasian bittern (*Botaurus poiciloptilus*) - cumulative removal of 713.92 ha of habitat, of which the **Project contributes up to 5.94 per cent**
  - Curlew sandpiper (*Calidris ferruginea*) - cumulative removal of 839.31 ha of habitat, of which the **Project contributes up to 4.55 per cent**
  - Spotted-tail quoll (*Dasyurus maculatus maculatus*) - cumulative removal of 3,894.03 ha of habitat, of which the **Project contributes up to 1.96 per cent**
  - Red goshawk (*Erythrotriorchis radiatus*) - cumulative removal of 3,356.28 ha of habitat, of which the **Project contributes up to 2.35 per cent**
  - Koala (*Phascolarctos cinereus*) - cumulative removal of 10,915.50 of habitat, of which the **Project contributes up to 5.48 per cent**
  - Australian painted snipe (*Rostratula australis*) - cumulative removal of 806.21 ha of habitat, of which the **Project contributes up to 4.73 per cent**.

MNES identified through the EIS will be subject to further investigations and surveys during the detailed design phase. This will refine the disturbance footprint and confirm the magnitude of the significant residual impacts upon the listed threatened species and communities. The specific mitigation measures will then be applied to ensure that the significance ratings of any potential impacts are classified as low as reasonably practicable.

An offset is likely to be required for MNES that experience a significant residual impact which may include areas containing *Habitat critical to the survival of a species or Important habitat* for EPBC Act listed species any area occupied by an EPBC Act listed TEC. ARTC's Environmental Offset Delivery Strategy is contained as an appendix to this report. This Strategy informs the development of offset delivery components including an Environmental Offset Delivery Plan and Offset Area Management Plans.

1 Introduction

1.1 Project overview

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

The Inland Rail route, which is approximately 1,700 kilometres (km) long, will involve:

- Using the existing interstate rail corridor through Victoria and southern NSW
- Upgrading approximately 400 km of existing corridor, mainly in western NSW
- Providing approximately 600 km of new corridor in northern NSW and SEQ.

Inland Rail has been divided into 13 projects.

The Australian Rail Track Corporation (ARTC) proposes to construct and operate the Calvert to Kagaru (C2K) (the Project) section of Inland Rail, which consists of approximately 53 km of single track dual gauge greenfield railway with four crossing loops to accommodate double stack freight trains up to 1,800 metres (m) long. It will also involve the construction of an approximately 1,015 m long tunnel through the Teviot Range to facilitate the required gradient across the undulating topography. The corridor will be of sufficient width to accommodate future possible upgrades of the track, including a future possible requirement to accommodate trains up to 3,600 m in length.

It is noted that although ARTC are applying for approval to build infrastructure to accommodate trains up to 1,800 m in length, infrastructure will be designed such that the future extension of some crossing loops to accommodate 3,600 m trains is not precluded. ARTC intend to acquire the land for the future 3,600 m crossing loop extension with the initial land acquisition, however, the approval for the construction of future 3,600 m crossing loops will be subject to a separate approval process in the future. This assessment is based on 1,800 m train lengths.

1.2 Project objectives

The objectives of the Project are to:

- Provide rail infrastructure that meets the Inland Rail specifications to enable trains using the Inland Rail corridor to travel between Calvert and Kagaru, connecting with other sections of Inland Rail
- Minimise the potential for adverse environmental and community impacts.

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.

1.3 The proponent

The ARTC was created in 1997 after the Australian and State governments agreed to the formation of a 'one stop shop' for all operators seeking to access the national interstate rail network.

Since its formation, ARTC has focussed on infrastructure investment and the modernisation of the rail network. This has extended to building and upgrade of existing track to allow for the capacity that the market requires.

Today, ARTC plays a critical role in the transport supply chain and in the overall economic development of Australia. The ARTC network supports industries and businesses that are vital to the nation's economy by facilitating the movement of a range of commodities including general freight, coal, iron ore, other bulk minerals and agricultural products.

Across the network, ARTC is responsible for:

- Selling access to train operators
- Developing new business
- Capital investment in the network
- Managing the network
- Infrastructure maintenance.

As the operator and manager of Australia's national rail freight network, ARTC has successfully delivered more than $5 billion in capital upgrades to the national rail freight network. Having emerged from this period of significant investment and network growth, ARTC has now been tasked with developing a program to deliver Inland Rail under the guidance of the Commonwealth Department of Infrastructure, Transport, Cities and Regional Development.

ARTC have incurred two penalties in NSW relating to minor environmental incidents including:

- NSW Environmental Protection Authority Penalty Notice to ARTC dated 29 May 2012 for discharge of sediment-laden water at Allandale (Maitland to Minimbah Third Track Project) = $1,500
- NSW Environmental Protection Authority Penalty Notice to Transport Express Joint Venture (operating under ARTC Environment Protection Licence) dated 5 March 2012 for sediment and erosion control issues at Sawtell = $1,500.

ARTC have not incurred any other environmental prosecutions within the last 10 years.

ARTC has also previously entered into a Voluntary Enforceable Undertaking with the Commonwealth Department of the Environment (DoE) (currently known as the Department of Agriculture, Water and the Environment (DAWE)) under the *Environment Protection Biodiversity Conservation Act 1999* (Cth) (EPBC Act), in 2011.

Contact details for the Inland Rail Program are as follows:

Australian Rail Track Corporation
ABN: 75 081 455 754
Level 16, 180 Ann Street
PO Box 2462 Queen Street
Brisbane QLD 4001
Telephone: 1800 732 761

Further information on ARTC can be found at: **http://www.artc.com.au**.

1.4 Scope and purpose

In May 2017, a referral for the Project was submitted in accordance with the EPBC Act (EPBC 2017/7944). On 21 June 2017, the Commonwealth Minister for the Environment determined the Project is a 'controlled action' with the controlling provision for the Project being:

- Listed threatened species and communities.

The assessment has been conducted under the Bilateral Agreement between the Commonwealth and the State of Queensland. The EIS must address the controlling provision for the Project and describe the particular aspects of the environment and the Project that are subject to the controlled action decision as detailed above. A principal purpose of the EIS is to provide sufficient information to enable the Coordinator-General (QLD) and the Commonwealth Minister for the Environment to evaluate and assess the Project under the *State Development and Public Works Organisation Act 1971* (Qld) (SDPWO Act) and EPBC Act.

The Project proponent is still required to obtain all other secondary approvals from State and local authorities as required (e.g. waterway barrier works permit under the *Fisheries Act 1994* (Qld)). Secondary approvals are listed in EIS Chapter 3: Project Approvals.

This technical report addresses Sections 11.1 – 11.35 of the *Terms of Reference for an environmental impact statement: Inland Rail - Calvert to Kagaru Project* (ToR) issued on 8 December 2017 by the Coordinator-General. It has been prepared for the Commonwealth Environment Minister as a "stand-alone" document that assesses potential impacts on listed threatened species and communities under the EPBC Act during construction of the Project. Furthermore, this report draws on other impact assessments completed for this EIS as relevant to listed threatened species and communities, including air quality, surface water and hydrology, groundwater, and noise and vibration. This technical report has been prepared for the purpose of the EPBC Act assessment for the Project. The assessment of potential impacts was focussed on the disturbance footprint and the matters of national environmental significance (MNES) study area presented in Figure 1.1. The disturbance footprint and MNES study area do not include the surface area associated with the rail tunnel where the alignment intersects a portion of the Teviot Range as no surface disturbance is predicted. The MNES study area adopts the EIS investigation corridor, being an approximate 2 km wide study area, 1 km either side of the proposed rail alignment. It includes the disturbance footprint, which encompasses all areas where works are proposed, including both permanent and temporary works, and land within a 1 km radius either side of the proposed rail alignment. The MNES study area is slightly wider around Chainage (Ch) 38 to Ch 45 to accommodate for the options analysis that was undertaken for the Teviot Range crossing. It should be noted that for the estimation of direct impacts, the disturbance footprint does not include the surface area associated with the rail tunnel (where the alignment intersects a portion of the Teviot Range) as no surface disturbance is predicted. (refer Section 1.7). The MNES study area was used to identify MNES that are located in proximity to the Project and therefore relevant to the assessment of potential impacts.

An impact assessment was undertaken in accordance with the *Significant Impact Guidelines 1.1 - Matters of National Environmental Significance* (MNES Guidelines) (Department of the Environment (DotE) 2013a). MNES potentially subject to significant residual impacts as a result of the Project were determined by:

- Assessing direct impacts from the Project (immediate impacts from Project activities such as vegetation clearing and fauna injury)
- Assessing indirect impacts (offsite and/or longer term impacts resulting from Project activities such as impacts to surface water quality and barriers to fauna movement) on each MNES
- Identification of mitigation measures for each potential impact/MNES and the Project as whole to avoid, minimise and mitigate assessed impacts.

The EPBC Act Offsets Policy states: 'Offsets provide environmental benefits to counterbalance the impacts that remain after avoidance and mitigation measures'. In accordance with this policy, an offset strategy has been developed for the Project for any residual impacts on MNES, where appropriate (as not all impacts can be avoided).

The Project does not relate to water resource in relation to coal seam gas and large coal mining (the water trigger) as an MNES. As such, the Project does not consider water resources under the EPBC Act due to not meeting the 'water trigger'. Water resources are therefore not considered any further within this technical report as they are not a controlling provision.

It is acknowledged that, whist migratory species, as listed under the EPBC Act, are MNES, they are not a controlling provision for the Project. Therefore, migratory species have been excluded from this technical report. However, to suitably inform the EIS, migratory species have been incorporated into EIS Appendix J: Terrestrial and Aquatic Ecology Technical Report (and relevant EIS chapters).

1.5 Terms of reference

Table 1.1 provides a list of the requirements relevant to MNES as outlined in the ToR issued on 8 December 2017 by the Coordinator-General and as they are presented in this report, associated Appendices and related Project Chapters and documents.

Table 1.1 Terms of Reference compliance table relevant to matters of national environmental significance

Flora and fauna Terms of Reference requirement		Report section
Information requirements		
Matters of national environmental significance – background and context		
11.1	This section should provide a stand-alone description and detailed assessment of the impacts of the project on the controlling provision for the project under the EPBC Act inclusive of any avoidance, mitigation and offset measures.	
11.2	The Commonwealth Minister for the Environment and Energy (the Commonwealth Minister) has determined that the project (EPBC 2017/7944) is likely to impact upon listed threatened species and communities (sections 18 and 18A of the EPBC Act).	
11.3	The EIS must be prepared in accordance with the bilateral agreement between the Commonwealth of Australia and the State of Queensland relating to environmental assessment. This will enable the EIS to meet the impact assessment requirements under both Commonwealth and Queensland legislation.	
11.4	The statutory obligations for conduct of the EIS process under the bilateral agreement are set out in Part 13 of the State Development and Public Works Organisation Regulation 2010.	
11.5	Once the draft EIS has been prepared to the satisfaction of the Coordinator-General and MNES addressed to the satisfaction of the Australian Government Department of the Environment and Energy, the draft EIS will be made available for public comment.	
11.6	The proponent may be required by the Coordinator-General or the Department of the Environment and Energy to provide additional material to address matters raised in submissions on the EIS	
11.7	At the conclusion of the environmental assessment process, the Coordinator- General will provide a copy of the report evaluating the environmental impacts of the project to the Commonwealth Minister.	
11.8	After receiving the evaluation report and sufficient information about the relevant impacts of the action, the Commonwealth Minister for the Environment and Energy has 30 business days to consider whether the impacts of the proposal are acceptable, or not, and to decide whether or not to approve each controlling provision.	
11.9	The Commonwealth Minister's decision under Part 9 of the EPBC Act is separate to the approval decisions made by Queensland state agencies and other agencies with jurisdiction on state matters.	
Information Requirements		
11.10	Consideration must be given to any relevant policy statements available from www.environment.gov.au, including: a) Matters of National Environmental Significance: Significant impact guidelines 1.1 b) *Environment Protection and Biodiversity Conservation Act 1999* Environmental Offsets Policy and c) any approved conservation advice, recovery plans and threat abatement plans (as relevant) for listed threatened species and ecological communities.	Guidelines and plans - Sections 2.1, 3.4.4, 5.3.3, 5.3.4 and 5.3.5 Offsets – Section 5.4 EIS Chapter 11: Flora and Fauna, Section 11.3

Flora and fauna Terms of Reference requirement		Report section
11.11	The EIS must: a) assess all the relevant impacts that the action has, will have or is likely to have, including on receiving environments of the project b) provide enough information about the action and its relevant impacts to allow the Commonwealth Minister to make an informed decision on whether or not to approve the action c) address the matters set out in Schedule 4 of the Environment Protection and Biodiversity Conservation Regulations 2000 (Cth) (EPBC Regulations).	Project description – Section 1.8 and EIS Chapter 6: Project Description Impacts – Section 5.1 and throughout relevant EIS Chapters Mitigations – Section 5.2 and 5.3.2 to 5.3.5 and throughout relevant EIS Chapters Information sources – Appendix B and Section 9 EIS Chapter 3: Project Approvals EIS Chapter 1 Introduction EIS Chapter 11: Flora and Fauna, Section 11.7
11.12	The MNES section of the EIS should bring together assessments of impacts from other chapters and produce a stand-alone assessment in a format suited for assessment under the EPBC Act.	Sections 5.1.2, 5.1.3 and 7
11.13	The project should initially be assessed in its own right followed by an assessment of the cumulative impacts related to existing major projects and/or development that is progressing through a publicly available planning and approval process. Cumulative impacts not solely related to the project development should also be described.	Section 7 EIS Chapter 22: Cumulative Impacts, Section 22.5.4 EIS Chapter 11: Flora and Fauna, Sections 11.7 and 11.12
11.14	Predictions of the extent of threat (risk), impact and the benefits of any mitigation measures proposed, should be based on sound science and quantified where possible. All sources of information relied upon should be referenced.	Mitigations – Section 5.2 and 5.3 Information sources – Appendix B and Section 9 EIS Chapter 11: Flora and Fauna, Sections 11.7, 11.8 and 11.9
11.15	An estimate of the reliability of any predictions should be provided.	Appendix A of this technical report
11.16	Any positive impacts of the Project should be identified and evaluated.	Section 1.10 EIS Chapter 2: Project Rationale EIS Chapter 16: Social
11.17	The extent of any new field work, modelling or testing should be commensurate with risk and should be such that when used in conjunction with existing information, provides sufficient confidence in predictions that well-informed decisions can be made.	Section 3.2, 3.3 and 3.4 EIS Chapter 11: Flora and Fauna, Sections 11.4.4 and 11.4.5
11.18	In accordance with Schedule 4 of the EPBC Regulations, feasible project alternatives must be discussed, including: (a) if relevant, the alternative of taking no action (b) a comparative description of the impacts of each alternative on the triggered MNES protected by the controlling provision (c) sufficient detail to make clear why any alternative or option is preferred to another.	Section 1.7 EIS Chapter 2: Project Rationale
11.19	Short, medium and long-term advantages and disadvantages of the alternatives or options must be discussed.	Section 1.7 EIS Chapter 2: Project Rationale
11.20	The information provided must include details of any proceedings under a Commonwealth, State or Territory law for the protection of the environment or the conservation and sustainable use of natural resources against: (a) the person proposing to take the action (b) for an action for which a person has applied for a permit, the person making the application. If the person proposing to take the action is a corporation, details of the corporation's environmental policy and planning framework must also be included.	Section 1.3 EIS Chapter 1 Introduction, Section 1.2 EIS Appendix F: Corporate Policies

Flora and fauna Terms of Reference requirement		Report section
11.21	The economic and social impacts of the action, both positive and negative, must be summarised. Matters of interest should include: (a) consideration at the local, regional and national levels (b) any public consultation activities undertaken, and their outcomes (c) any consultation with indigenous stakeholders (d) identification of affected parties and communities that may be affected and a description of the views of those parties and communities (e) project economic costs and benefits of the project and project alternatives, including the basis for their estimation through cost/benefit analysis or similar studies; and (f) employment and other opportunities expected to be generated by the project in each of the construction and operational phases.	Sections 1.10 and 1.11 EIS Chapter 2: Project Rationale EIS Chapter 5: Stakeholder Engagement EIS Chapter 16: Social EIS Chapter 17: Economics
11.22	The EIS must provide background to the action and describe in detail all components of the action for example (but not limited to), the construction, operation and (if relevant) decommissioning components of the action. This must include the location of all works to be undertaken (including associated offsite works and infrastructure), structures to be built or elements of the action that may have impacts on MNES.	Section 1.8 and 1.9 EIS Chapter 6: Project Description EIS Chapter 11: Flora and Fauna, Section 11.7.1
11.23	The description of the action must also include details on how the works are to be undertaken (including stages of development and their timing) and design parameters for those aspects of the structures or elements of the action that may have relevant impacts.	Section 1.8 and 5.1.1 EIS Chapter 6: Project Description EIS Chapter 11: Flora and Fauna, Section 11.7 and 11.9
11.24	The EIS must also provide details on the current state of groundwater and surface water in the region as well as any use of these resources.	Section 4.2 EIS Chapter 11: Flora and Fauna, Section 11.5.1 EIS Chapter 13: Surface Water and Hydrology, Section 13.5 EIS Chapter 14: Groundwater, Section 14.5 EIS Appendix M: Surface Water Quality Technical Report, Section 5 EIS Appendix O: Groundwater Technical Report, Section 4
Listed threatened species and communities		
11.25	The EIS must describe the listed threatened species and ecological communities identified below (including EPBC Act status, distribution, life history and habitat).	Sections 4.3.1, 4.4.1 to 4.4.4 and Appendix B
11.26	The EIS must consider and assess the impacts to the listed threatened species and ecological communities identified in section 11.29 and 11.31 (including EPBC Act status, distribution, life history and habitat and any others that are found to be or may potentially be present in areas that may be impacted by the project. Impacts from each component of the project of relevance to each listed threatened species or ecological community should be identified. Impacts may result from: (a) a decrease in the size of a population or a long-term adverse effect on an ecological community (b) reduction in the area of occupancy of the species or extent of occurrence of the ecological community (c) fragmentation of an existing population or ecological community (d) disturbance or destruction of *Habitat critical to the survival of the species* or ecological community (e) disruption of the breeding cycle of a population (f) modification, destruction, removal, isolation or reduction of the availability or quality of habitat to the extent that the species is likely to decline (g) modification or destruction of abiotic (non-living) factors (such as water, nutrients or soil) necessary for the ecological community's survival	Sections 5.1, 5.2 and 5.3 EIS Chapter 11: Flora and Fauna, Sections 11.7.2, 11.9 and 11.10

Flora and fauna Terms of Reference requirement		Report section
	(h) the introduction of invasive species that are harmful to the species or (i) ecological community becoming established (j) interference with the recovery of the species or ecological community.	
11.27	The EIS should describe any mitigation measures proposed to reduce the impact on the listed threatened species and ecological communities and proposed mitigation measures. Supporting evidence should be provided to demonstrate the appropriateness of mitigation measures proposed. Where the likely success of mitigation measures cannot be supported by evidence, identify contingencies in the event the mitigation is not successful.	Sections 5.2 to 5.4 EIS Chapter 11: Flora and Fauna, Section 11.8
11.28	The EIS should describe any offsets proposed to compensate for residual impacts.	Section 5.4 EIS Chapter 11: Flora and Fauna, Section 11.11
List of potential listed threatened species and their status		
11.29	The EIS must address impacts on, but not limited to, the following listed threatened (a) Regent Honeyeater (*Anthochaera phrygia*) – critically endangered; (b) Australasian Bittern (*Botaurus poiciloptilus*) – endangered; (c) Curlew Sandpiper (*Calidris ferruginea*) – critically endangered; (d) Coxen's Fig-Parrot (*Cyclopsitta diophthalma coxeni*) – endangered; (e) Eastern Bristlebird (*Dasyornis brachypterus*) – endangered; (f) Red Goshawk (*Erythrotriorchis radiatus*) – vulnerable; (g) Squatter Pigeon (southern subspecies) (*Geophaps scripta scripta*) – vulnerable; (h) Painted Honeyeater (*Grantiella picta*) – vulnerable; (i) Swift Parrot (*Lathamus discolor*) – critically endangered, marine; (j) Eastern curlew, Far Eastern Curlew (*Numenius madagascariensis*) – critically endangered, marine, migratory; (k) Black-throated Finch (southern) (*Poephila cincta cincta*) – endangered; (l) Australian Painted Snipe (*Rostratula australis*) – endangered, marine; (m) Black-breasted Button-quail (*Turnix melanogaster*) – vulnerable; (n) Mary River Cod (*Maccullochella mariensis*) – endangered; (o) Pink Underwing Moth (*Phyllodes imperialis smithersi*) – endangered; (p) Large-eared Pied Bat (*Chalinolobus dwyeri*) – vulnerable; (q) Northern Quoll (*Dasyurus hallucatus*) – endangered; (r) Spotted-tail Quoll (SE mainland population) (*Dasyurus maculatus*) – endangered; (s) Greater Glider (*Petauroides volans volans*) – vulnerable; (t) Brush-tailed Rock-wallaby (*Petrogale penicillata*) – vulnerable; (u) Koala (*Phascolarctos cinereus*) (combined population of Queensland, New South Wales and the Australian Capital Territory) – vulnerable; (v) Long-nosed Potoroo (SE mainland) (*Potorous tridactylus tridactylus*) – vulnerable; (w) New Holland Mouse (*Pseudomys novaehollandiae*) – vulnerable; (x) Grey-headed Flying-fox (*Pteropus poliocephalus*) – vulnerable; (y) Five-clawed Worm-skink, Long-legged Worm-skink (*Anomalopus mackayi*) – vulnerable; (z) Marlborough blue (*Cycas ophiolitica*)– endangered; (aa) Hairy-joint Grass (*Arthraxon hispidus*) – vulnerable; (bb) A shrub (*Bertya ernestiana*) – vulnerable; (cc) Three-leaved Bosistoa, Yellow Satinheart (*Bosistoa transversa*) – vulnerable; (dd) Miniature Moss-orchid, Hoop Pine Orchid (*Bulbophyllum globuliforme*) – vulnerable; (ee) Boonah Tuckeroo (*Cupaniopsis tomentella*) – vulnerable; (ff) Bluegrass (*Dichanthium setosum*) – vulnerable; (gg) Wandering Pepper-cress (*Lepidium peregrinum*) – endangered; (hh) Macadamia nut, Queensland Nut Tree, (*Macadamia integrifolia*) – vulnerable;	Species relevance to Project - Section 4.3 and 4.4 Impacts relevant to species – Section 5.1 and 5.3.2 EIS Chapter 11: Flora and Fauna, Sections 11.7.2, 11.9, 11.10 and 11.12

Flora and fauna Terms of Reference requirement		Report section
	(ii) Rough-shelled Bush Nut, Rough-leaved Queensland Nut (*Macadamia tetraphylla*) – vulnerable; (jj) Cooneana Olive (*Notelaea ipsviciensis*) – critically endangered; (kk) Lloyd's Olive (*Notelaea lloydii*) – vulnerable; (ll) Lesser Swamp-orchid (*Phaius australis*) – endangered; (mm) Mt Berryman Phebalium (*Phebalium distans*) – critically endangered; (nn) Shiny-leaved Condoo, Black Plum, Wild Apple (*Planchonella eerwah*) – endangered; (oo) Austral cornflower, Native Thistle (*Rhaponticum australe*) – vulnerable; (pp) Quassia (*Samadera bidwillii*) – vulnerable; (qq) Brush sophora (*Sophora fraseri*) – vulnerable; (rr) Austral Toadflax, Toadflax (*Thesium australe*) – vulnerable (ss) Adorned Delma, Collared Delma (*Delma torquata*) – vulnerable; (tt) Dunmall's Snake (*Furina dunmalli*) – vulnerable; (uu) Three-toed Snake-tooth Skink (*Saiphos reticulatus*) – vulnerable;	
11.30	The EIS must address how the impacts to each of the listed species is not inconsistent with relevant recovery plans, threat abatement plans and conservation advices.	Sections 5.3 and Appendix B EIS Chapter 11: Flora and Fauna, Section 11.10
List of potential listed threatened communities		
11.31	The EIS must address impacts on the following listed threatened ecological communities for the proposed action: (a) Swamp Tea-tree (*Melaleuca irbyana*) Forest of South-east Queensland – critically endangered; (b) White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland (also known as Bon-Gum Grassy Woodland and Derived Grassland)– critically endangered; (c) Lowland Rainforest of Subtropical Australia – critically endangered; (d) Brigalow (*Acacia harpophylla* dominant and co-dominant) – endangered.	TEC relevance to Project – Section 4.3.1.2 and 4.4.1.3 Impacts relevant to TEC – Sections 5.1, 5.3.2 and 5.3.3 EIS Chapter 11: Flora and Fauna, Sections 11.9 and 11.10
11.32	The EIS must address how the impacts to each of the listed communities is not inconsistent with relevant recovery plans, threat abatement plans and conservation advices.	Section 5.3.3 and Appendix B EIS Chapter 11: Flora and Fauna, Section 11.10
Offsets		
11.33	The EIS must describe any significant adverse residual impacts of the action for each relevant matter protected by the EPBC Act, after all proposed avoidance and mitigation measures are considered.	Sections 5.3.3, 5.3.4 and 5.3.5, 5.4 EIS Chapter 11: Flora and Fauna, Section 11.10
11.34	The EIS must propose offsets for all residual impacts to matters protected by the EPBC Act consistent with the Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy.	Section 5.4 EIS Chapter 11: Flora and Fauna, Section 11.11
Conclusion		
11.35	The EIS must include an overall conclusion for the action describing the acceptability of the impact of undertaking the action in the manner proposed on the protected matters, in the context of: (a) the requirements of the EPBC Act; (a) the principles of ecologically sustainable development and the precautionary principle; and (b) the proposed avoidance, mitigation measures, and if relevant, offsets (c) measures proposed to address any residual impacts.	Section 8 EIS Chapter 11: Flora and Fauna, Sections 11.3, 11.4.8, 11.8 and 11.11

1.6 Project location and existing land use

The location of the Project and the MNES study area is shown in Figure 1.1. The Project is located within the Ipswich, Logan and Scenic Rim local government areas (LGAs) within the SEQ Bioregion.

Land use in the Calvert area (west of the MNES study area) is typically of a rural nature, with most properties within the study area consisting of large-lot grazing areas. Ebenezer (east of Calvert) is characterised by predominantly rural and rural residential land uses, with a considerable amount of remnant vegetation. Jeebropilly coal mine and the former Ebenezer coal mines are located in proximity to the Project. The Project traverses the Ebenezer industrial development area. An existing high voltage transmission line and the Santos Moonie-Brisbane high pressure oil pipeline also cross the Project.

The area south of Purga towards Peak Crossing contains a mixture of land uses, including a number of rural residential properties and agricultural estates, poultry farms, Purga Quarry, Gibb Brothers farming operations, Ivory's Rock Conventions and Events complex and the township of Peak Crossing. Washpool is characterised by predominantly vegetated mountainous areas in the east and rural land uses in the west. The Purga Nature Reserve is also located within the central portion of the MNES study area.

Throughout the Woolooman area (in the east of the MNES study area) and the Teviot Range, terrain is of a rugged nature and there is minimal development. Wyaralong Dam is located to the south, upstream of the Project. Kagaru is predominantly rural and is located within the Bromelton State Development Area (SDA). Flagstone Priority Development Area (PDA) is located north of the Project.

The intended land use for the Project is rail and associated infrastructure, including road realignments, grade separations and ancillary infrastructure.

1.7 Project alternatives

1.7.1 Alternative locations and route options for Inland Rail

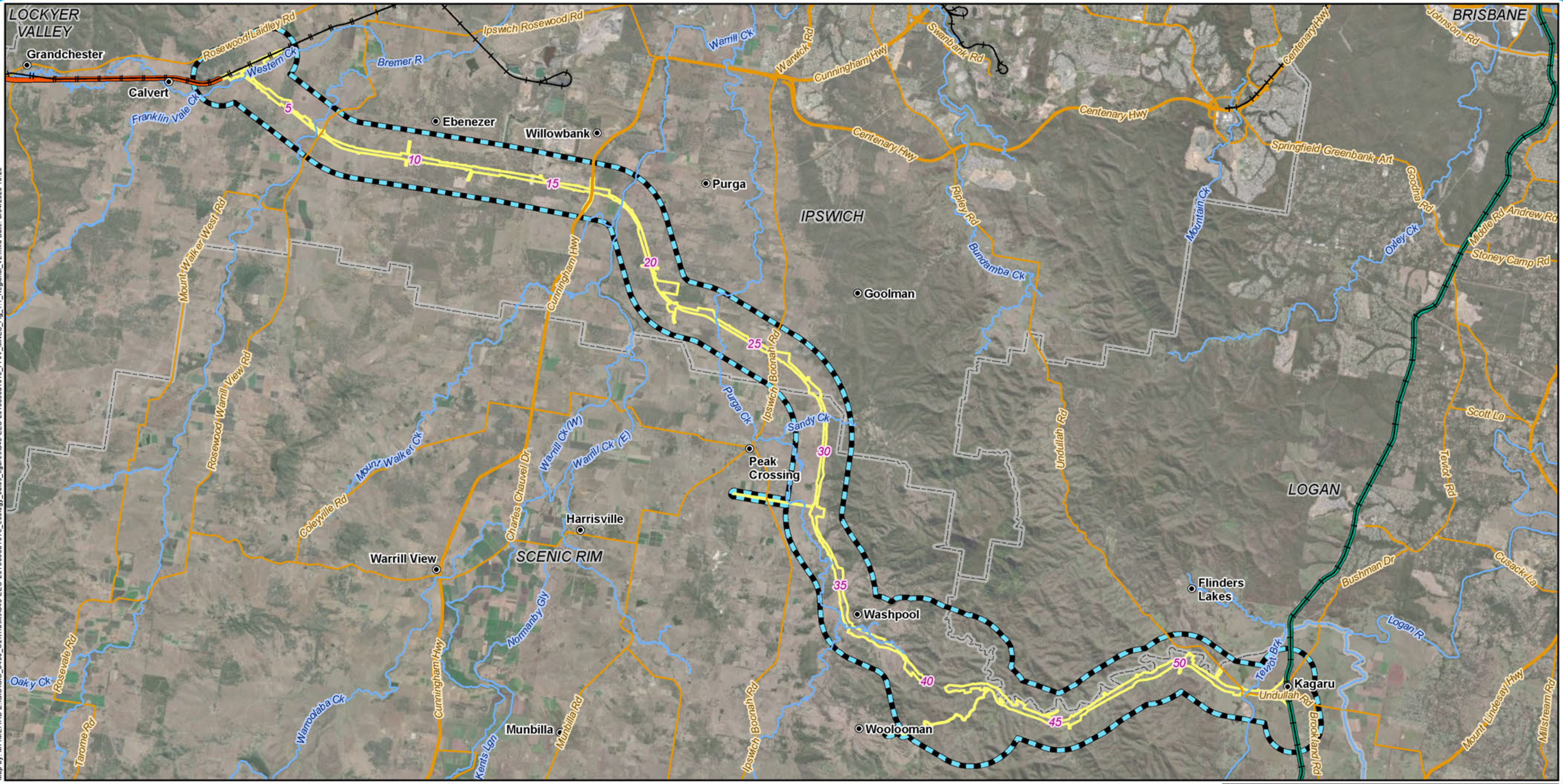
The development of an inland railway between Melbourne and Brisbane has been considered for more than a hundred years, first being formally considered in 1902 (ARTC 2015). The current Inland Rail works were initiated in 2006. Inland Rail will be a catalyst for growth, improve safety, and offer a sustainable solution to the freight challenge that will transform the way freight is moved around the country.

Since 2006, two major studies have been commissioned in relation to the development of an inland rail route between Melbourne and Brisbane. The first study, the *North-South Rail Corridor Study* (Ernst & Young 2006) examined the adequacy of the existing Melbourne to Sydney to Brisbane rail corridor to meet future freight demand. The study considered enhancements to the existing coastal route and alternative inland routes. A financial and economic analysis was undertaken on each of the route options. The study identified the 'far western corridor' through Parkes as the preferred corridor.

The purpose of the second study, the *Melbourne-Brisbane Inland Rail Alignment Study* (ARTC 2010), was to evaluate route options within the 'far western sub-corridor'. Two key criteria – capital cost and journey time – were used to shortlist route options between Melbourne and Parkes, Parkes and Moree, and Moree and Brisbane. The shortlist of route options was then subject to technical, financial and economic assessment, focussing on:

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

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

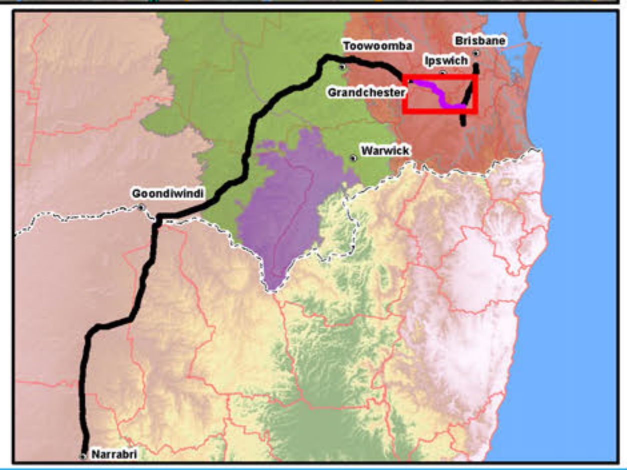


Legend

- 5 Chainage (km)
- Localities
- Existing rail
- H2C project alignment
- K2ARB project alignment
- Watercourses
- Major roads
- Minor roads
- MNES study area
- EIS disturbance footprint (surface disturbance only)
- Local Government Areas

SEQ Bioregions

- Brigalow Belt South
- Nandewar
- South Eastern Queensland



A3 scale: 1:150,000

0 1 2 3 4 5km

Future Freight
Integrating Community, Environment and Engineering

Issue date: 8/04/2020 Version: 2

Coordinate System: GDA 1994 MGA Zone 56

Calvert to Kagaru

Figure 1.1: Project and Regional context and MNES study area

The preferred alignment for Inland Rail, between South Dynon in Melbourne and Acacia Ridge in Brisbane, incorporated:

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

This alignment for Inland Rail was endorsed by the Inland Rail Implementation Group as the base case alignment.

More detail on alternative locations and route options for Inland Rail is provided in EIS Chapter 2: Project Rationale.

1.7.2 Alternative locations and route options for the Project

Just over half of the Project alignment (refer Figure 1.1) is generally located within the existing Southern Freight Rail Corridor (SFRC) which connects the West Moreton Rail Line to the Interstate Standard Gauge Route. The SFRC was protected in November 2010 as future railway land under Section 242(1) of the *Transport Infrastructure Act 1994* (Qld).

The SFRC was first investigated in 2005. Eight route options for connecting the West Moreton Rail Line to the Interstate Standard Gauge Route were investigated by Maunsell Australia. Then, in 2010, a 55 km long and 2 km wide corridor of interest based on the 2005 investigation was subject to the following studies:

- Topography, geology, soils and groundwater
- Nature conservation
- Surface water
- Hydraulic study
- Land use and planning
- Air quality, climate and climatic trends
- Visual impact assessment
- Noise and vibration
- Aboriginal cultural heritage
- European cultural heritage
- Social impact assessment
- Economic analysis.

The findings of the above studies provided an understanding of the onsite constraints within the corridor of interest that ultimately influenced the final location of the SFRC. Of particular note is that measures were taken to minimise clearing of koala bushland habitat by realigning the SFRC corridor for 12 km through Ebenezer and Willowbank.

Although the Project is generally located within the SFRC, the Project extends outside the SFRC in the following areas:

- The Teviot Range
- Washpool Road
- Mount Flinders Road
- Connection to the interstate line at Kagaru end heading south

- Connection to the Helidon to Calvert (H2C) and the Queensland Rail (QR) West Moreton Rail Line at Calvert end heading west.

Multi-criteria analysis and comparative cost estimate were undertaken as part of the EIS to inform the alignment is these areas. Various factors were considered during design, including:

- The nature of the terrain in these areas (e.g. steep grades and/or the need to wind through such areas are not desirable due to the size and weight of the trains)
- Flooding and hydrology (e.g. ensure a 98 per cent level of serviceability for Inland Rail, so the corridor needs to be developed to withstand flood conditions)
- Environmental, social and heritage constraints (e.g. vegetation communities, sensitive receptors, waterway crossings, registered heritage sites)
- Cost (e.g. due to the physical construction requirements in some locations, critical construction constraints exist)
- Travel time (e.g. ARTC has a service offering requirement of less than 24 hours between Melbourne and Brisbane express)
- Constructability (e.g. some locations will make construction more difficult)
- Easement setback requirements (e.g. a number of minimum clearances required from road, power and other public utility easements must be met).

Additional site-specific information on alternative locations and route options for the Project is provided in EIS Chapter 2: Project Rationale.

1.8 Project description

Key elements of the Project design have responded to environmental and engineering constraints to produce a feasible rail design. The Project design is based on minimising environmental and social impacts, minimising disturbance to existing infrastructure and meeting engineering design criteria. Further refinement of the Project will occur during detailed design.

Key components of the Project design include:

- Approximately 53 km of single-track dual-gauge rail line with four crossing loops initially constructed for 1,800 m long double stacked trains, and designed such that the future extension of some crossing loops to accommodate 3,600 metre trains is not precluded
- The approximately 1,015 m Teviot Range tunnel, and bridges to accommodate topography and Project crossings of waterways and other infrastructure
- Tie-ins to the existing West Moreton Rail Line at the western project boundary
- Allowance for a future connection to the Ebenezer Industrial Area at Willowbank
- The construction of associated rail infrastructure including maintenance sidings and signalling infrastructure to support the Safeworking System for train management
- Rail crossings, including level crossings, grade separations, road overbridges, occupational/private crossings and fauna crossing structures
- Tie-ins to the existing operational Sydney to Brisbane interstate railway line at the eastern end
- Significant embankments and cuttings which will be required along the length of the alignment
- Ancillary works, including road and public utility crossings, and realignments (excluding those undertaken as enabling works)
- Construction workspace and access roads.

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

The land requirement for the Project will comprise a corridor with minimum width of 40 m, widened to accommodate earthworks, drainage structures, rail infrastructure, access tracks and fencing. The corridor will be of sufficient width to accommodate the infrastructure currently proposed for construction, as well as future expansion (subject to future approvals), including possible future requirement for 3,600 m trains.

Subject to procurement, detailed design and obtaining all the necessary environmental approvals for the Project, construction of the Project is anticipated to start in 2021 and completed in 2026.

1.8.1 Rail line

The Project is greenfield, with a new single line of track, standard (1,435 millimetre (mm)) and narrow (1,067 mm) gauge, connecting the QR West Moreton Rail Line with the ARTC interstate coastal line. The track structure consists of continuously welded 60 kilogram/metre (kg/m) rail, resilient fasteners, rail pads and concrete dual gauge full-depth sleepers at minimum 600 mm centres. For the initial phase of operation, design is for 21 total axle load intermodal trains and 25 total axle load coal trains.

1.8.2 Tunnel infrastructure

The Project proposes a tunnel through the Teviot Range. The tunnel portal areas will require a substation building for power supply and distribution to electrical equipment, fire water tanks and a pump station for the tunnel hydrant system and an emergency services staging area. A tunnel control centre will be required at one of the portals and will be predominantly unmanned.

The alignment grades are currently such that stormwater runoff in the portal areas will be directed away from the tunnel. Any water collected inside the tunnel (e.g. groundwater, washdown, firefighting, etc.) will be collected in sumps at each end of the tunnel. This water will likely be processed through a water treatment plant which will include hydrocarbon separation.

The tunnel will have internal jet fans near the portal that will provide forced ventilation for maintenance activities only. No other ventilation requirements are proposed.

In case of the train stopping in the tunnel due to fire or other emergency, a fire rated longitudinal egress passage will be provided with access every 120 m. Communication facilities to the operator will be provided.

The tunnel will likely have minimal internal lighting, with only low-level lighting and emergency lighting expected.

1.8.3 Crossing loops

Four crossing loops are proposed for the Project. The loops would be constructed as new sections of track parallel to the main track. They will range in length to accommodate the surrounding area, topography and to accommodate the design length of the trains (1,800 m).

1.8.4 Turnouts

Turnouts allow the train to be guided from one track to another. A narrow-gauge turnout (1 in 16 proposed) will be provided to connect the Project to the QR West Moreton Rail Line between Calvert and Rosewood in an easterly direction towards Rosewood.

Two turnouts will be incorporated into existing track near Kagaru where the Project joins into the ARTC Sydney to Brisbane coastal line. A 1 in 16 dual gauge turnout will join the Project to the ARTC line heading north towards Acacia Ridge. A standard gauge turnout will be installed for a connection in the southerly direction towards Bromelton. There will be a 1 in 16 dual gauge turnout at each end of the four crossing loops. An additional turnout (1 in 10) will be required for a maintenance siding at each crossing loop.

1.8.5 Bridges

No existing bridges require reinstatement or reconstruction along the alignment as a result of the Project.

The Project requires 27 new bridges over waterways and/or floodplains. The bridges are of various lengths and spans to suit the alignment and topography.

1.8.6 Drainage infrastructure

A number of waterway crossings span over 'QLD Waterways for Waterway Barrier Works' as identified by the Department of Agriculture and Fisheries (DAF) (DAF 2018). These waterways for waterway barrier works are classified along their length according to the risk of adverse impact from instream barriers on fish movement. There are 17 marked waterways for water barrier works waterways which are intersected 34 times by the Project. These intersections (made up of culvert crossings and bridge crossings) include:

- Eight major risk crossings
- Four high risk crossings
- Eleven moderate risk crossings
- Eleven low risk crossings.

There are no existing culverts along the Project alignment. Culverts are structures that allow water (in a watercourse or drain) to pass under the rail line. Culverts will be used to maintain the existing flow paths and minimise the potential impact to flood depths upstream and downstream of the culverts. The culverts have been designed in accordance with relevant industry standards.

The design of the culverts has been informed by a hydrologic and hydraulic (flooding etc) assessment of the Project, a geotechnical assessment and a preliminary assessment of the existing structures.

The drainage features at cuttings have been designed in accordance with relevant industry standards. Existing drainage paths above cuttings have been diverted to the nearest cross drainage structure, through a catch drain where practical, to minimise flow into the cutting and subsequent size of cutting drainage. This minimises the size of the cuttings and higher flows to reduce the risk of scour on the cutting benches and batter chutes. There are drainage channels connected to batter chutes along the cutting benches which flow to the base of the cutting. There is a larger cutting drain in the base of each cut adjacent to the rail embankment.

1.8.7 Level crossings

The Project proposes six active crossings and one passive level crossing along the alignment.

1.8.8 Fencing

Fencing will be provided for the extent of the rail corridor (excepted where noted otherwise) and its primary purpose is to limit access to the railway during operations. Fencing is to extend between the corridor and lands of owners or occupiers adjoining the railway, with any specific requirements to be designed in consultation with the adjoining landholder.

The Project alignment will be fenced with three-strand or four-strand barbed-wire fencing where the alignment occurs within the existing rail corridor. The barbed-wire fencing is reflective of the largely agricultural land use of this section of the alignment and seeks to ensure that stock and people do not enter the rail corridor. The barbed-wire fencing will maintain the current barriers of the existing landscape will also allow animals to move along the alignment, maintaining current movement opportunities across the existing corridor. Most of the Project alignment will maintain this style of fencing.

1.8.9 Fauna fencing

Fauna fencing is constructed in association with fauna crossings to facilitate safe and effective movement of fauna to maintain existing movement corridors and animal behaviours within the vicinity of infrastructure where it is deemed that there is a risk of population fragmentation. Fencing and tie-ins with fauna crossings are designed to deter or effectively prevent animals entering the operating rail environment, and is an important aspect aimed at guiding animals towards the preferred fauna-crossing structure or passage. The elevation of fencing to fauna exclusion fencing is proposed where the alignment is considered likely to represent a moderate to high risk of fauna entering the rail alignment and become trapped within the active track area. A 3 m buffer clear of vegetation on the habitat side of the fauna exclusion fence is required to ensure that species cannot use vegetation to climb onto the exclusion fencing. Vegetation within the alignment will also be removed in these areas identified as moderate to high risk to ensure that fauna is not encouraged into the active track area.

The fauna corridor fencing strategy seeks to focus on areas of greenfield development where existing fauna movement may be impacted by the Project. All proposed fauna crossings are within areas of greenfield development for the Project. Three options for fauna fencing are:

- General fauna exclusion fencing where relevant
- Koala fencing only where koalas are considered likely to occur following completion of fauna surveys
- Barbed-wire fencing where relevant and consistent with existing landscape features of alignment.

1.8.10 Fish passage

Fish passage is an essential requirement for the survival and productivity of many species of QLD fish. Due to the construction of instream structures (such as dams and culverts) on waterways, the loss of access to habitat has caused the decline in distribution of native fish populations.

The *Fisheries Act 1994* and the *Planning Act 2016* legislate that works within waterways that are considered to be the development of new, or raising of existing waterway barriers, in addition to maintenance of existing structures, must be designed, constructed, maintained and operated to provide adequate fish passage.

Confirmation of the design of culverts, bridges (under both rail and road) and any other cross drainage structures and how they meet fish passage requirements is to be undertaken for the detailed design.

1.9 Proposed timing

1.9.1 Pre-construction and construction phases

Subject to procurement, detailed design and obtaining the necessary approvals, it is anticipated that the construction phase will commence in 2021. The construction program defines several stages and activities. These comprise:

- Pre-construction activities and early works, including detailed design, land acquisition, obtaining environmental planning approvals, surveys and geotechnical investigations, establishment of access tracks, and utility and service relocations
- Site preparation, including site clearance, establishment of site compounds and facilities, installation of temporary and permanent fencing, installation of drainage and water management controls and construction of site access, including temporary haul roads
- Civil works including bulk earthworks, construction of cuts and embankments, construction of tunnel portals and the tunnel, installation of permanent drainage controls, bridge and watercourse crossing construction
- Track works, including the installation of ballast, sleepers and rails

- Rail systems infrastructure and wayside equipment, including signals, turnouts and asset monitoring infrastructure
- Commissioning, integration testing and handover process to achieve operational readiness.

1.9.1.1 Site preparation

Vegetation clearing and installation of construction infrastructure

The site clearing includes the sequential removal of vegetation and debris. Site clearing will occur prior to mobilisation of the main earthworks construction teams. The clearing of vegetation will be undertaken in accordance with the Construction Environmental Management Plan (CEMP). All turf, topsoil and other organic and unsuitable material will be stripped from the site. Wherever possible and appropriate, such material will be stockpiled and recycled within the immediate construction footprint. Potential weed incursion or proliferation resulting from vegetation clearing activity will be managed under the Project's Biosecurity Management Plan.

Access roads will be required along the alignment to allow drainage, earthworks and bridge structure crews to access work locations. The primary access roads to the alignment will be designed and constructed/upgraded with due consideration to minimising disruption to landholders and public infrastructure.

Direct construction access is proposed to be provided adjacent to all rail works along the Project corridor and will be sized to allow free flow and unhindered access for all construction and support traffic vehicles. These access points will also be utilised for the transport of water, personnel, fuel and materials for maintenance purposes.

A series of temporary construction site compounds and facilities will be established along the Project corridor.

The clearing and grubbing activities would commence on multiple work fronts and will be ahead of the primary earthworks operations, but not so far ahead that exposed soil is left open for long periods of time. Clearing and grubbing activities will be preceded by:

- Development of a Project-specific Environmental Offset Proposal
- Development of an Environmental Offset Delivery Plan and Offset Area Management Plans prior to commencement of construction
- Obtaining any required vegetation clearing approvals
- Threatened flora and fauna surveys
- Appropriate flora and fauna treatments/re-locations (e.g. spotter catcher works under the Project Flora and Fauna Sub-plan, relevant damage mitigation permit and Species management programs
- Identification of any underground utilities
- Appropriate utility works (i.e. protection/re-location)
- Clear demarcation of required clearing limits to avoid unnecessary vegetation/habitat clearing
- Any requirements under the Cultural Heritage Management Plans.

The clearing and grubbing operation shall be performed within the disturbance footprint. Protective measures shall be enabled around creek and riverbanks to ensure that the existing profiles are preserved. Cleared vegetation ready for mulching will be stockpiled within the disturbance footprint ready for mulching. The mulched material will be stockpiled and managed to facilitate re-use, and to prevent combustion. Possible alternatives to mulching of vegetation matter will be considered and appropriately assessed as part of the detailed design and construction phases.

Utility relocations

Site preparation also includes modification, diversion or realignment of any utilities and associated infrastructure. Utilities and services such as water, sewer, electricity and telecommunications will need to be supplied to each of the laydown areas and construction compounds for use in site offices and amenities.

Consultation has commenced with the various utility owners regarding their requirements for relocation or protection of the utilities impacted by the Project. Where feasible, the Project will share power, water, sewage, construction materials and communications infrastructure with the adjacent H2C and Kagaru to Acacia Ridge and Bromelton (K2ARB) projects. These works may be undertaken under a separate contract, or by the relevant asset owner, and are required to comply with the relevant environmental/regulatory framework applicable to the particular works or public utility.

Corridor acquisition and access

The Project traverses multiple lots that are identified as future railway land having been gazetted under the *Transport Infrastructure Act 1994* by the Queensland Government in 2010 following Queensland Transport's SFRC study. Refer EIS Chapter 8: Land Use and Tenure for details of the properties traversed by the disturbance footprint.

The acquisition and resumption of land and interests will be undertaken by the nominated Constructing Authority (with ARTC continuing to work closely with landholders, stakeholders and relevant State government agencies) prior to construction.

To reduce severance of land parcels, the alignment of the Project has been chosen to align with roads and property boundaries where possible, to reduce potential property impacts. Furthermore, the alignment has been deliberately designed to utilise the SFRC where feasible.

1.9.1.2 Civil works

The activities that will be undertaken during Project civil works include:

- Bulk earthworks, such as the construction of embankments and excavating cuttings
- Permanent drainage controls
- Bridge construction
- Roadworks
- Rail corridor works.

Bulk earthworks

The construction of the foundation of the railway line will require earthworks and engineering fill to provide a platform designed for the rail construction. The earthworks will predominantly be made up of constructing embankments and excavating cuttings. This work will be carried out using heavy earthmoving plant and equipment.

Where required, material stockpiles will be located within the disturbance footprint, outside flood prone areas, and will be neatly formed to prevent erosion. Spoil management, reuse and disposal will be addressed in accordance with the Project spoil management strategy.

Permanent drainage controls

The proposed rail alignment crosses a number of drainage features of different catchment areas that contribute flows to the cross-drainage structures. Cross drainage structures will be constructed where the rail intercepts existing drainage lines. The type of cross drainage structure depends on various factors such as the natural topography, rail formation levels, design, design flow and soil type. Cuts and embankments will also require drainage treatments such as catch drains, diversion drains and culverts.

The cross-drainage structures will incorporate the installation of permanent drainage controls as they cross the floodplain areas and drainage lines. Longitudinal drainage including embankment drains and catch drains will be constructed to protect the rail formation from surface runoff.

The construction will be a mix of installation before and after the bulk earthworks, so as not to delay the overall earthmoving program. It will also be necessary to capture overland flow and transfer it to the cross-drainage structures. The sizing of the longitudinal drainage will be dependent upon the hydrology and it is important that these drains are capable of efficiently moving overland flow to dedicated drainage lines to reduce the likelihood of water ingress to the permanent works.

Bridge construction

Bridges are proposed at all major waterway crossings to minimise disturbance to the existing riverine system. Bridge structures will also be constructed to allow for road, farm track or stock crossings. Design indicates the need to construct 27 bridges of which 21 are over waterways. The remaining are road rail grade separations. As a number of these bridges also interact with public roads, the construction will be subject to traffic management and temporary works restrictions to ensure the safety of the travelling public.

All bridge structures proposed will be formed from precast prestressed concrete and in-situ concrete with galvanised steel ancillary elements. Bridge foundations are proposed as either bored cast in place or driven piles based on the anticipated subsurface profiles. It is envisaged that all materials for concrete bridge structures will be delivered by road.

The anticipated methodology and approach is outlined as follows:

- Establishment of bridge construction laydown areas
- Construction of working platforms for access, piling rigs and cranes
- Substructures: Large diameter bored cast in place or driven piles to be installed. Plant required will include trucks, excavators and roller compactors for working platforms for pilling and piling rigs, cranes and concrete delivery trucks for cast in-situ piles.
- Pile caps and piers: Conventional construction of reinforced concrete structures in successive lifts using re-usable forms, cranes, concrete pumps and trucks
- Headstock and abutment construction using re-usable forms and conventional reinforced concrete
- Bridge superstructure and deck construction
- Deck structures are expected to be constructed via lifting pre-cast beams into place with a conventional crawler crane.
- Erosion and sediment controls in accordance with the site specific Erosion and Sediment Control Plans will be installed prior to commencement of works.

Road works

Due to the location of the rail alignment, there are a high number of road rail interfaces identified that will require consideration. The road managers are either the local council (Scenic Rim Regional Council) or Ipswich City Council (ICC)) or the Department of Transport and Main Roads (DTMR). Construction works on these roads will comply with the asset owner’s approved safety requirements and temporary works procedures. The highest standard to be complied with will be the DTMR Manual of Uniform Traffic Control Devices. For works on, over or adjacent to DTMR roads, such as the railway crossing of the Cunningham Highway, the proposed construction methodology and traffic management arrangements will be approved by DTMR prior to works commencing.

Rail corridor works

Interface with the existing QR West Moreton Rail Line corridor is required at the western end of the Project. The staging of the works, and their associated impacts will be the subject of an interface agreement between the Inland Rail Program and QR, including short term rail possessions. Coordination with QR will be required to maintain access to existing assets for maintenance.

There is also an interface with the existing ARTC Brisbane to Sydney Interstate Line at the eastern end of the Project. The staging of these works and their impacts will require coordination with the ARTC possession calendar so that the short-term works can be carried out with minimal disruption to the existing operational network.

1.9.1.3 Tunnel construction

The proposed tunnel will be constructed through the Teviot Range. The tunnel will be approximately 1,015 m long and has a maximum cover of approximately 90 m. The tunnel excavated cross section is approximately 135 square metres (m^2) and the internal space requirements are driven by ventilation requirements.

Two construction techniques are likely for excavation/rock-breaking:

- Roadheaders and/or
- Drill and blast.

A roadheader is a track mounted machine with a cutting head using tungsten carbide picks mounted on a boom to cut the rock. Roadheader excavation offers considerable versatility and flexibility as a tunnelling technique in suitable conditions and is used to excavate tunnels of various shapes and sizes. It is anticipated that multiple roadheaders would commence excavation from a single portal or both portals simultaneously. If construction from both portals is undertaken, the roadheaders would excavate simultaneously from both the eastern and western portals and head westwards and eastwards respectively meeting somewhere near the midpoint of the tunnel.

The drill and blast method of excavation may also be suitable. Drill and blast is a controlled use of explosives to break rock for excavation. Drill and blast for tunnels relies on the precise drilling of a collection of holes into the face and the precise detonation of the blasting agent. After blasting the loose pieces of rock that have been dislodged from the working face are removed from the tunnel.

The excavated material from either the roadheaders or drill and blast will be loaded into dump trucks and taken from the tunnel to an outside stockpile area. The material will then either be reused onsite or transported via trucks from the site for re-use or disposal.

The design of the tunnel includes a flexible sheet type membrane which is constructed to waterproof the tunnel. For a drained tunnel, the purpose of this waterproof membrane is to control groundwater inflows over the crown and walls of the tunnel down to invert level, where the water would be collected by drainage systems. The other purpose of the waterproof membrane is to assist with the long-term durability of the concrete secondary lining, including all fixings installed into the concrete.

A two-staged support construction sequence is likely to be adopted that uses sheet waterproof membranes – consisting of temporary support (primary) and permanent support (secondary). Once the temporary support is constructed, a waterproof membrane can be installed.

During construction, a temporary water treatment facility will be constructed to support the tunnelling operations. The water treatment facilities design is likely to include, but is not limited to:

- Screening treatment
- Detention tanks
- Aeration/flocculation tanks
- Chemical treatment, where required

- Water pumping facilities
- Sludge storage.

1.9.1.4 Trackwork

Track works construction could be undertaken using two different methods - track laying machine or excavators with 'octopus' attachments. The preferred option for the construction of the Project would be excavators with octopus attachments, however either of the construction methods may be utilised. In this instance the bottom ballast layer would be installed followed by sleepers positioned and spaced to their designed alignment by a tracked excavator using an octopus attachment. This will be closely followed by placement/threading of the rail in 27.5 m shorts or up to 400 m strings. The rail will then be clipped up followed by top ballasting prior to commencing tamping activities.

1.9.1.5 Construction workforce and hours

The Project is part of the Inland Rail Program. The Inland Rail Program is expected to generate 16,000 jobs with an average of 800 jobs per annum over the 10-year construction period. The Project is expected to generate 620 full time equivalent construction jobs over the five-year construction period.

Construction work will typically be undertaken during the following primary Project construction hours:

- Monday to Friday 6.30 am to 6.00 pm
- Saturday 6.30 am to 1.00 pm
- No work Sundays and public holidays.

Track possessions, when the construction contractor has control over an operating railway, will proceed on a 7 day/24 hour period. Track possession of QR assets will generally be allocated over weekend periods, with extended track possession occurring over holiday periods.

Works outside of primary Project construction hours may occur throughout the duration of the construction program and may involve:

- Delivery of concrete, steel, and other construction materials delivered to site by heavy vehicles
- Movements of heavy plant and materials
- Spoil haulage
- Tunnelling activities
- Arrival and departure of construction staff during shift change-overs
- Roadworks to arterial roads
- Traffic control crews, including large truck mounted crash attenuator vehicles, medium rigid vehicles, and lighting towers
- Incident response including tow-trucks for light, medium, and heavy vehicles.

Where work outside the standard hours, including night works, will be required, for example, the delivery of materials, the works will only be proceed where consultation with the local community has been undertaken. Furthermore, a site-specific noise risk assessment will be undertaken to identify the environmental risks associated with the works, action required to mitigate these risks and justification as to why the works are required out of standard hours.

Further information on the hours of work is discussed in EIS Chapter 23: Draft Outline Environmental Management Plan.

1.9.2 Commissioning and reinstatement phase

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

All Project construction sites, compounds and access routes will be rehabilitated. Site reinstatement and rehabilitation will be undertaken progressively during the works and will include the following activities:

- Demobilise site compounds and facilities
- Remove all materials, waste and redundant structures from the works sites
- 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 will be undertaken in accordance with the Project's Reinstatement and Rehabilitation Plan and Landscape and Rehabilitation Management Plan.

1.9.3 Operational phase

Operational processes to be carried out during the operational phase will include the use of the railway for freight purposes, potential future use for passenger services, operation and maintenance of tunnel ventilation and safety systems, signalling, and general track and infrastructure maintenance.

An average of 20 additional jobs per annum is anticipated over 50 years of operation (2026 to 2075).

The workforce required during the operational phase will likely be sourced locally or given accommodation in the Logan/Ipswich region.

1.9.3.1 Train operations

The Project will form part of the rail network managed and maintained by ARTC. Train services will be provided by a variety of operators.

Inland Rail will be operational once all 13 sections are complete, which is estimated to be in 2026.

The Project will involve operation of a single rail track with crossing loops, to accommodate double stacked freight trains up to 1.8 km long and 6.5 m high. Train design speeds will vary according to axle loads and track geometry ranging from 80 kilometres per hour (km/h) to a maximum of 115 km/h. It is estimated that the operation of Inland Rail will involve an annual average of about 33 train services per day (northbound and southbound) in 2026. This is likely to increase to approximately 47 train services per day in 2040.

During the operational phase, tunnel operations will require power and water supplies for maintenance, ventilation and fire safety. Electricity supply will also be needed for points, signalling and other infrastructure. It is anticipated that these services will be delivered by relevant providers under the terms of their respective approvals and/or assessment exemptions.

1.9.3.2 Operational maintenance

Standard ARTC maintenance activities will be undertaken during operations. Typically, these activities include minor maintenance works, such as bridge and culvert inspections, sleeper replacement, rail welding, rail grinding, ballast dropping and track tamping, through to major periodic maintenance, such as ballast cleaning and reconditioning of track.

1.9.4 Project decommissioning and rehabilitation

The Project is expected to be operational for in excess of 100 years. The design life of structures is 100 years to support operational objectives. The decommissioning of the Project cannot be foreseen at this point in time. If the Project, or elements of it, were subject to plans for decommissioning it is envisaged that the works would be undertaken in accordance with a decommissioning plan, which would be developed in consultation with relevant stakeholders and regulatory authorities.

1.10 Social and economic impacts and benefits

Development of the Project would result in social and economic benefits, primarily in relation to employment, training and business supply opportunities. Local benefits as a result of the Project include:

- **Employment** - Employment opportunities would extend to up to 620 workers across the Project region and nearby local government areas, and would be available to both experienced construction industry workers and people who are currently unemployed. The availability of long periods of employment in Project construction is likely to be a strong positive opportunity for those personnel and their families.

  Once operational, a workforce of approximately 20 personnel is expected for the Project's operation. This is likely to include a mix of local personnel, mobile crews moving between sections of Inland Rail (e.g. for major track and ballast maintenance) some of whom may be from the Project region, and personnel based in operations centres.

  Employment opportunities in the Project region during the construction and operation stage will have positive mental health benefits for the individuals employed, particularly if they are exiting a period of unemployment or commencing their career. This would be particularly important in communities with high levels of unemployment such as Rosewood, Ebenezer and Willowbank, and for population groups where unemployment rates are high (such as Indigenous people and young people).

- **Business opportunities** - local and regional businesses will benefit from the construction phase. Opportunities to supply the project may include supply of fuels, equipment, quarried material, and services including fencing, electrical installation, rehabilitation, landscaping, maintenance and trades services.

  Local transport or logistics businesses may also have significant opportunities to service the construction phase.

  The Project's local supply arrangements will provide an opportunity to develop and grow local businesses, with some possible benefits in nearby communities, but with regional benefits of greater significance.

  The expansion in construction activity in the vicinity of the Project will support additional flow-on demand and additional spending by the construction workforce, and therefore business trading levels in the region.

  The Project will improve the connection between local produce such as bulk grain, containerised cotton and other agricultural products, and markets; through to both domestic markets in cities and international markets via the Port of Brisbane.

- **Crash reduction** - Crash cost savings represent the reduced costs associated with fatal and serious injuries resulting from both road and rail incidents.

- **Environmental externalities** - Reduced environmental externality costs represent reductions in air pollution and greenhouse gas emissions due to the Project. Most of these benefits can be attributed to the mode shift from road freight to rail freight.

- **Road decongestion benefits** - As the Project encourages greater movement of freight by rail, the reduced truck movements that are projected upon completion of the Project result in reduced congestion in urban areas.

Development of the Project would also result in social and economic impacts. As for all major projects located near human settlements, negative impacts are more likely to be experienced by those living closest, whilst Project benefits usually accrue at a broader regional level. This has been noted by residents who anticipate negative impacts but are uncertain that significant benefits in the form of employment or business opportunities will result during construction, and of the potential for local communities to benefit during the Project's operation.

Distributional equity (the effect of differing impacts across groups, areas and time) considerations for the Project include:

- An estimated 60 households within the EIS investigation corridor would need to relocate to enable the Project's construction
- The Project travels through areas with high potential for social disadvantage, where particular care will be needed to support residents through the changes resulting from the Project
- The operations and management of farms and agribusinesses could be affected whilst landholders adjust to land acquisition impacts
- Residents living near the EIS investigation corridor would experience noise, travel delays and changes to local character during construction
- The Project will introduce a significant freight route through rural areas with potential for rail noise to affect amenity in proximity to the rail corridor.

Current residents will experience the most significant impacts during the construction phase, however there is potential for rail operational noise to have long term effects on the amenity of areas closest to the rail corridor.

Communities in the MNES study area have experienced a long period of severe drought, with effects on mental health and financial wellbeing, community resilience and business vitality. It is therefore particularly important that the Project's impacts are minimised and benefits maximised.

The social and economic impacts and benefits of the Inland Rail Program and the Project are detailed in EIS Chapter 2: Project Rationale, EIS Chapter 16: Social, EIS Chapter 17: Economics, EIS Appendix R: Social Impact Assessment and EIS Appendix S: Economic Impact Assessment.

1.11 Stakeholder engagement

1.11.1 Identification of stakeholders

During the development of the EIS, ARTC has engaged with a wide range of stakeholders across local, regional and national levels as identified in Table 1.2.

Table 1.2 Identified stakeholders associated with the Project

Type	Stakeholders
Commonwealth Government	
Elected representatives	▪ Deputy Prime Minister and Minister for Infrastructure – the Hon Michael McCormack MP ▪ Assistant Minister for Road Safety and Freight Transport and Federal Member for Wright – the Hon Scott Buchholz MP ▪ Shadow Minister for Veterans' Affairs and Defence Personnel and Federal Member for Blair– the Hon Shayne Neumann MP
Departments and agencies	▪ Department of Infrastructure, Transport, Regional Development and Communications ▪ Department of Agriculture, Water and the Environment (DAWE) ▪ Regional Development Australia ▪ National Transport Commission

Type	Stakeholders
Queensland State Government	
Departmental Ministers	▪ The Hon Mark Bailey MP, Minister for Transport and Main Roads
State Elected Representatives	▪ State Member for Scenic Rim— Jon Krause MP ▪ State Member for Ipswich West — Jim Madden
State Government Departments	▪ Office of Coordinator-General ▪ Department of Aboriginal and Torres Strait Islander Partnerships ▪ Department of Agriculture and Fisheries ▪ Department of Education ▪ Department of Employment, Small Business and Training ▪ Department of Environment and Science ▪ Department of Housing and Public Works ▪ The former Department of Innovation, Tourism Industry Development and the Commonwealth Games (now part of the Department of State Development, Tourism and Innovation) ▪ Department of Local Government, Racing and Multicultural Affairs ▪ Department of Natural Resources, Mines and Energy ▪ Queensland Health ▪ The former Department of State Development, Manufacturing, Infrastructure and Planning (now the Department of State Development, Tourism and Innovation) ▪ Department of Transport and Main Roads ▪ Economic Development Queensland
Government Owned Corporations/Organisations	▪ Queensland Rail
Local Government	
Local government elected representatives	▪ Scenic Rim Regional Council Mayor—Greg Christensen and Councillors ▪ Ipswich City Council and Logan City Administrators
Local government officers	▪ Ipswich City Council ▪ Logan City Council ▪ Scenic Rim Regional Council
Local communities	
Directly Affected Landholders	▪ Landholders located within both the permanent and temporary disturbance footprint
Indirectly Affected Landholders	▪ Landholders that have the potential for change to existing conditions on their property
Businesses	▪ Bentonite Resources ▪ Boral Purga Quarry ▪ Edwards Rural ▪ E.J. Cooper Pty. Ltd ▪ Flinders Land Holdings ▪ Flinders Peak Winery ▪ Ipswich Motorsports Precinct ▪ Ivory’s Rock Conventions and Events ▪ J.N.J. resources Bentonite Quarry ▪ Klan Bros. Earthmoving ▪ Mount Marrow Blue Metal Quarries ▪ Strawberry Fields ▪ The Neilsen Group Bromelton Quarry ▪ The Peak Pub ▪ TransGroup Australia ▪ Willowbank Raceway ▪ Zanows’ Sand and Gravel

Type	Stakeholders
Other key stakeholders	
Emergency and Health Providers	▪ Queensland Police Service ▪ Queensland Ambulance Service ▪ Queensland Fire and Emergency Services ▪ Queensland Rural Fire Services ▪ Rosewood Police Station ▪ Harrisville Police Station ▪ Boonah Police Station
Utilities	▪ Seqwater ▪ Powerlink Queensland ▪ Queensland Urban Utilities ▪ Telstra ▪ Optus ▪ APA ▪ Santos ▪ Energex ▪ Ergon ▪ TPG/AAPT/Powertel
Spoil and Waste providers	▪ Wanless Waste Management ▪ New Hope Group ▪ Ti Tree Bioenergy ▪ Cleanaway New Chum ▪ Remondis Australia Pty Ltd Swanbank Landfill ▪ Nu Grow Ipswich ▪ Lantrak Waste Management ▪ Greenbank Waste and recycling facility ▪ Logan Village Waste and recycling facility
Gas and petroleum pipeline owners	▪ APA ▪ Santos
Resource tenure holders	▪ Arrow Energy
Indigenous groups and representatives	▪ Yuggera Ugarapul ▪ Jagera Daran ▪ Liworaji Aboriginal Corporation
Business and Industry Groups	▪ Chamber of Commerce and Industry Queensland ▪ Beaudesert Chamber of Commerce ▪ Boonah District Chamber of Commerce ▪ Ipswich Chamber of Commerce and Industry ▪ Regional Development Australia – Ipswich and West Moreton ▪ Regional Development Australia – Logan and Redlands
Peak Bodies	▪ National Road Transport Association ▪ Queensland Transport and Logistics Council ▪ Australian Trucking Association ▪ QLD Farmers Federation ▪ National Farmers Federation ▪ Agforce ▪ Queensland Resources Council ▪ Queensland Outdoor Recreation Federation

Type	Stakeholders
Community Groups	▪ Families Against Inland Rail GO (FAIR GO) ▪ Harrisville & District Historical Museum ▪ Ipswich Housing and Support Services ▪ Ipswich Railway Museum ▪ Rosewood Agricultural and Horticultural Association ▪ Rosewood District Protection Organisation ▪ Royal Agricultural Society of Queensland ▪ Scenic Rim Community Consultative Committee ▪ Willowbank Area Residents Group
Environmental Groups	▪ Australian Rescue and Rehabilitation of Wildlife Association Inc. ▪ Birdlife Australia ▪ Birds Queensland ▪ Boonah Organisation for a Sustainable Shire ▪ Greening Australia ▪ Healthy Land and Water ▪ Ipswich Koala Protection Society ▪ Ipswich Native Plants Queensland ▪ Karawatha Forest Protection Society ▪ Keep the Scenic Rim Scenic ▪ Koala Foundation ▪ Logan and Albert Conservation Association Inc. ▪ Protect the Bush Alliance ▪ Queensland Conservation Council ▪ Return to the Wild ▪ SEQ Catchments ▪ Wildlife Queensland
Education and Training	▪ Rosewood State School ▪ Rosewood State High School ▪ St Brigid's Catholic Primary School ▪ Rosewood State High School ▪ Mutdapilly State School ▪ Harrisville State School ▪ Peak Crossing State School ▪ Woodhill State School ▪ Flagstone State Community College ▪ Boonah State School
Media	▪ ABC Southern Queensland ▪ Albert and Logan News ▪ Beaudesert Times ▪ Fassifern Guardian ▪ Ipswich Queensland Times ▪ Jimboomba Times ▪ Moreton Border News ▪ The Brisbane Times ▪ The Courier Mail ▪ Queensland Times ▪ Queensland Country Life ▪ ABC Radio ▪ The Australian

1.11.2 Stakeholder engagement activities

Consultation activities have been structured to provide multiple opportunities for both targeted stakeholders and the wider community to participate in the Project. Stakeholders have been engaged using a range of communication channels, including presentations and briefings, newsletters, drop in sessions, web-based material and face-to-face discussions. These were supported by feedback mechanisms, including comment forms, interactive mapping, workshops and project specific contact channels (1800 phone number, email, interactive ‘Frequently Asked Questions’).

1.11.3 Consultation themes

Table 1.3 provides the key themes of community concern that were identified over the course of consultation activities for the Project’s key stakeholders.

Table 1.3 Key themes raised during Project consultation activities

Stakeholder	Key themes raised
Department of Transport and Main Roads	▪ Impacts on road corridor widths ▪ Accommodation of future upgrades to the Cunningham Highway ▪ Impacts to intermodal facility at Ebenezer ▪ Maintain legal access to property
Ipswich City Council	▪ Impacts on future of Willowbank Industrial Precinct ▪ Changes to current flooding patterns ▪ General traffic and transport access concerns ▪ Level crossings ▪ Impacts on Waters Road
Logan City Council	▪ Changes to current flooding patterns ▪ General traffic and transport access concerns ▪ Impacts on local roads
Scenic Rim Regional Council	▪ Impacts to Washpool Wild Pig Creek RoadAdherence to planning policy and maintaining property lot sizes ▪ Changes to current flooding patterns ▪ Traffic concerns, including realignment of Dwyers Road, the Teviot Brook rail bridge design, impacts to Brennan’s Dip Road ▪ Preference for no level crossings ▪ General traffic and transport access concerns
Landholders	▪ Exceedances and mitigation of noise ▪ Impacts on visual amenity ▪ Adherence to the SFRC ▪ Traffic concerns, including proposed realignment of Washpool Road, realignment of Paynes Road, realignment of Dwyers Road, proposed level crossings at Middle Road and Washpool Road ▪ Impacts on Peak Crossing community ▪ Fragmentation and impacts on connectivity between land holdings ▪ Coal residue in water tanks ▪ Risk and spread of fire ants ▪ Impacts to koala habitat ▪ Fauna crossings ▪ Retaining Melaleuca trees ▪ Changes to current flooding patterns, including increased debris during flooding events ▪ Potential impacts on groundwater users

Stakeholder	Key themes raised
Office of Coordinator-General	▪ EIS' compliance with required guidelines ▪ Social impact assessment methodology – integration of environmental matters, nature of scale of project, identification of impacts and benefits, consideration of vulnerable communities ▪ Potential impacts of housing supply and affordability ▪ Assessment of impacts and opportunities for local industry to participate in potential procurement and supply opportunities
Queensland Fire and Emergency Services	▪ Access to Teviot tunnel in case of emergency
Queensland Police Service	▪ Access to the fenced alignment ▪ Changes to road rail interfaces
Queensland Rail	▪ Impacts to existing QR operations (current traffic for freight, coal and passengers) and access for maintenance and operation of QR infrastructure
Scenic Rim Community Consultative Committee	▪ Noise impacts on Peak Crossing community and Ivory's Rock Conventions and Events centre ▪ Concerns about alignment's proximity to Peak Crossing Strategies to build employment and upskill people; visibility and implementation of skills requirements ▪ Level crossings ▪ Economic impacts during operation ▪ Risk and spread of fire ants ▪ Fauna crossings ▪ Pressure on local roads during construction and operation
Traditional Owners	▪ Provisions for managing accidental discovery of cultural material; contingency planning for finds ▪ Clear documentation process and dispute resolution process ▪ Development of appropriate cultural heritage awareness training and inductions
Rosewood State Primary School and Rosewood State High School	▪ Managing construction traffic impacts
Seqwater	▪ Access to water for construction ▪ Water storage capacities and transportation considerations
Landfill and waste operators	▪ Confirmation of spoil receiving options and status of proposed waste and recycling sites
Utility companies	▪ Clashes with existing utilities and easements
Pipeline asset owners	▪ Managing impacts to existing pipelines through design and construction
Resource Tenement Holders	▪ Managing impacts to Authorities to Prospect (ATP) permits.

1.11.4 Consultation outcomes

Consultation with individuals and groups at workshops, community consultation sessions, via the interactive online map, community committee meetings and face to face meetings have assisted in highlighting issues and identifying potential impacts and benefits to inform the EIS. These interactions have also helped to shape the project design and inform proposed mitigation measures for implementation in future stages of design, construction, commissioning and operation. In summary, the key issued raised were:

- Adhering to the SFRC route within which the Project is proposed to be located
- Permanent and temporary impacts on the road network
- Level crossings across the project
- Location of Peak Crossing passing loop
- Noise impacts to landholders and businesses

- Realignment of Paynes Road and Washpool Road
- Impacts to fauna, in particular Koalas
- Waste and spoil management
- Stress and anxiety potentially caused by property acquisition
- Impacts on property values and connectivity
- Construction water sources
- Impacts on groundwater bores.

Stakeholder engagement activities have resulted in the following information being considered in the development of the Project design and mitigation measures included during the development of the EIS as identified in Table 1.4.

Table 1.4 Key consultation outcomes

EIS component	Consultation outcome
Flooding and hydrology	Landholder consultation was undertaken to obtain specific photographic records and anecdotal evidence of existing flooding impacts and extents through a series of workshops. Based off primary feedback this information was validated and shared again with landholders to verify the modelling outcomes and findings of the Project's hydrology and flooding assessment.
Traffic, transport and access	Consultation is ongoing with local councils, DTMR, QR, QPS and Rosewood State Primary and High Schools, about the road network, construction traffic management and expectations with regards to temporary and permanent road network changes. Concerns regarding access to agricultural properties, access to the fenced alignment and the proposed level crossings, in particular Middle Road, have been raised by landholders, QPS and Ipswich and Scenic Rim Regional council. The project has undertaken additional works to explore these road rail interfaces and identify appropriate management measures with respect to school bus routes and construction traffic in the vicinity of schools. Consultation will continue through the next phase of the Project.
Land use and tenure	The SFRC project, by DTMR was completed in 2010. It resulted in the identification of several directly affected landholders. As 10 years has passed since the approval of that project, there was a proportion of landholders who had not yet sold their property to DTMR or were unaware of the project requirements and extents. Consultation was undertaken to inform residents of the Inland Rail Project objectives, proposed timescale, to request land access for field studies, and to also understand their concerns and issues around their land being acquired for the construction and operation of the Project.
Cultural heritage – Native title claimants	As a direct result of this consultation the Project was able to identify where the alignment should be altered to avoid important cultural heritage sites (specifically in the Teviot Range). Negotiation and agreement of Cultural Heritage Management Plans were undertaken with the aim of identifying: ▪ A process for undertaking cultural heritage surveys for the Project ▪ A process for including relevant Traditional Owners in assessing Indigenous cultural heritage values and the protection and management of Indigenous cultural heritage ▪ A process for mitigating, managing and protecting identified cultural heritage and objects during both construction and operational phases of the Project.
Landscape and visual amenity	One on one meetings and discussions were held with residents (directly affected and nearby) to understand their concerns about the impact of the project on their views and the visual amenity of the area. A newsletter with before and after illustrations of the Project was sent to 4,500 residents to share what the landscape would look like if the project was approved and operational. Concerns about the visual environment have been captured and addressed via the online interactive map, community consultation sessions and community consultative committee meetings. There are specific concerns on the views within the Scenic Rim area being disrupted with the introduction of new infrastructure.

EIS component	Consultation outcome
Waste and spoil management	Consultation with councils was undertaken to ascertain current and forecast landfill capacities and waste transport service providers to appreciate operational capacities and industry processes. ARTC have engaged with other landfill and waste operators to review and confirm the feasibility of the proposed spoil receiving sites described in EIS Chapter 21: Waste and Resource Management and EIS Appendix V: Spoil Management Strategy. This consultation has identified that there are numerous options, with sufficient capacity to accept the spoil volumes identified in this EIS. These options will be evaluated in future design and construction planning. The Project team also consulted with DTMR regarding spoil management transport, acknowledging the key issues of safety for road users, traffic management, and pavement life.
Flora and fauna	Consultation with individuals and groups such as Rosewood District Protection Organisation, Ipswich Koala Protection Society, Native Plants Queensland and Karawatha Forest Protection Society took place to present project findings, understand key concerns, provide face to face access to EIS technical specialists and provide an opportunity for stakeholder input into mitigation and design. Environmental groups requested the Project team to source a technical specialist to meet with and show them how to use the Wildlife Online database. ARTC sourced an independent facilitator to run Wildlife Online database training in recognition of environmental concerns regarding koalas and other protected fauna. The feedback provided by stakeholders and the community to the project team has continuously reinforced the importance of ecological values to the community and driven the project team to seek opportunities to avoid, minimise and manage impacts to species and their habitats wherever feasible in this stage of project development.
Social	Consultation to inform the social impact assessment was undertaken with various groups including education providers, Aboriginal representative groups Jagera Daran and Yuggera Ugarapul People and community groups. A partnership with Lifeline was developed to provide key mental health support services, including a workshop with Scenic Rim community consultative committee meetings members.
Air quality and noise	Landholders shared concerns about coal dust contaminating water tanks in face to face consultation sessions. Operational noise for landholders and businesses is another concern due to the current rural quietness in the area.
Construction water sources	Seqwater has been consulted in relation to construction water estimates, water storage capacities, water access and transportation considerations. Potential water supply options are discussed in EIS Chapter 6: Project Description and EIS Chapter 13: Surface Water and Hydrology, however discussions with Seqwater will be ongoing as the project progresses. Other landholders may be contacted about the potential use of their bores or other private water sources for construction purposes, if required. Confirmation of private water sources that will be made available to the Project by landholders will be covered under private agreement.
Location of groundwater bores	A number of landholders were consulted as part of the groundwater investigations about property water supply (ie bores) to enable the Project team to understand the potential for impacts to current uses if access to bores is affected as a result of construction. Once detailed design has occurred, further consultation will be undertaken with landholders including TMR to confirm locations, use and quality of bores within the disturbance footprint and to ensure that potential damage to, destruction of, or loss of access to, bores is addressed.

For a detailed discussion of consultation activities and outcomes refer to EIS Appendix C: Consultation Report.

1.12 Principles of ecologically sustainable development

Ecologically sustainable development refers to using, conserving and enhancing the community's resources so that ecological processes are maintained and the total quality of life, both now and in the future, can be increased. There are four principles of ecologically sustainable development:

- Precautionary principle
- Principle of inter-generational equity

- Conservation of biological diversity and ecological integrity
- Improved valuation and pricing of environmental resources.

It is impossible to construct major transport infrastructure, such as this Project, without causing environmental, social and/or economic impacts (positive and negative). During Project development, the four principles of ecologically sustainable development were used as a guide to identify potential impacts and develop mitigation measures that afford equal weighting to environmental, social, economic and engineering opportunities and constraints.

1.12.1 Precautionary principle

The precautionary principle stipulates that if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. In applying the precautionary principle, decisions should be guided by:

- Careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment
- An assessment of the risk-weighted consequences of various options.

The Project is aligned with the precautionary principle in the following ways:

- The assessment of potential impacts is based on best practice, using the best available information. The assessment has involved key stakeholders and the relevant government agencies.
- The impact assessment considered the maximum potential area of disturbance
- The Project alignment was first investigated in 2005. Since 2005, the Project alignment has been the subject of numerous desktop and field investigations, as well as wide-reaching stakeholder consultation. Knowledge gained over this period will ensure that the Project is designed, constructed and operated in a way that minimises potential impacts.
- The EIS draws attention to aspects of the Project that may cause serious and/or irreversible environmental damage, especially if the nature and extent of the damage is uncertain. Where environmental damage cannot be avoided, mitigation and management measures to protect the receiving environment are proposed. This includes securing offsets for impacts to biodiversity values.
- Lack of full scientific certainty has not been used as a reason for postponing measures to prevent environmental damage. For example, threatened species that could potentially occur but were not observed within the MNES study area during field surveys are still assumed present (rather than absent). Measures to avoid and/or mitigate impacts on threatened species are proposed, on the basis that these threatened species could be present within the MNES study area.
- The detailed design will aim to further minimise impacts and site and species-specific mitigation measures will then be applied to ensure that the significance ratings of any potential impacts are classified as low as reasonably practicable and the significant residual impacts are offset.
- During development of the Project, the alignment has been refined to:
  - Avoid sensitive vegetation, areas with known threatened flora and fauna communities, and key habitat areas
  - Avoid known items/areas of cultural heritage significance
  - Minimise flooding impacts
  - Minimise impacts on existing agricultural land and infrastructure, while also considering potential future land uses.

1.12.2 Intergenerational equity

The principle of intergenerational equity is that the present generation should ensure that the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations.

The Project is aligned with the principle of intergenerational equity in the following ways:

- When developing the proposed alignment, minimising potential environmental impacts was a key consideration. This will ensure that environmental values (hydrological regimes, water quality, habitat connectivity, cultural heritage sites.) are conserved for existing and future generations.
- Climate change projections were factored into flood modelling for the Project, and climate change-specific mitigation measures are proposed
- Sustainability initiatives and measures have been identified and captured in Project designs and proposed mitigation measures where relevant. A Sustainability Management Plan will be developed for the delivery of the design and construction of the Project. Further details are provided in EIS Chapter 7: Sustainability.

The need for Inland Rail is well documented. As part of the Inland Rail Program, the Project would benefit existing and future generations by providing a safer, more efficient, means of transporting freight between Melbourne and Brisbane.

Conversely, should the Project (and therefore Inland Rail) not proceed, the principle of intergenerational equity may be compromised. Future generations would experience increasingly worse safety and environmental impacts due to continued growth in road transport between Melbourne and Brisbane, particularly along the Newell Highway.

1.12.3 Conservation of biological diversity and ecological integrity

A broad range of sustainability initiatives were identified and incorporated into the Project during the development of the design which included protecting the environment by minimising the environmental footprint.

Impacts on biological diversity and ecological integrity have been avoided to the greatest extent possible. For example, investigations to verify the presence of threatened species and ecological communities within the MNES study area were completed. The results were used to inform the design and location of fauna crossings, fauna exclusion fencing, and landscaping, revegetation and rehabilitation works.

Other ways in which the Project contributes to the conversation of biological diversity and ecological integrity include:

- A crossing structure hierarchy was adopted during design development. Preference was given to bridges over culverts as, on the whole, bridges result in less severe impacts to fauna passage.
- Close attention was paid to the DAF *Accepted development requirements for operational work that is constructing or raising waterway barrier works* when designing bridges and culverts across mapped Queensland Waterways for Waterway Barriers Works
- A Reinstatement and Rehabilitation Plan will be developed to guide the approach to rehabilitating disturbed areas. Rehabilitation will occur progressively throughout the construction phase.
- Other plans that will be developed to minimise potential impacts on biodiversity during the construction phase include: Erosion and Sediment Control Plans; Biosecurity Management Plan, Flora and Fauna Sub-plan, and Soil Management Plan as part of the CEMP.

Where impacts cannot be avoided (e.g. clearing of remnant vegetation or habitat for a threatened species), mitigation and management measures will be implemented. In instances where a significant residual impact as identified by the relevant EPBC Act significant assessment criteria, biodiversity offsets will be secured. An Environmental Offset Delivery Strategy for the Project has been prepared in consultation with the Queensland and Commonwealth Governments (refer Appendix J: Environmental Offset Delivery Strategy-QLD).

1.12.4 Improved valuation, pricing and incentive mechanisms

The principle of improved valuation, pricing and inventive mechanisms requires that environmental factors should be included in the valuation of assets and services, such as:

- Polluter pays, that is, those who generate pollution and waste should bear the cost of containment, avoidance or abatement
- The users of goods and services should pay prices based on the full life cycle costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste
- Environmental goals, having been established, should be pursued in the most cost-effective way, by establishing incentive structures, including market mechanisms, that enable those best placed to maximise benefits or minimise costs to develop their own solutions and responses to environmental problems.

It is difficult to place a monetary value on the Project's environmental impacts. However, the value placed on environmental resources within and surrounding the alignment is apparent in the breadth and depth of environmental investigations undertaken to inform the Project design and mitigation measures.

The estimated costs associated with environmental design and mitigation measures have been built into the overall Project cost. For example:

- Reasonable steps have been taken to avoid impacts of the project upon biodiversity values including MNES
- The disturbance footprint has been designed to minimise the clearing of native vegetation as far as is reasonably practical. Where required, offsets will be secured to ensure a neutral or net beneficial biodiversity outcome for the region is achieved.
- A range of mitigation measures will be implemented to ensure that, during construction and operation, waste is avoided, reused or recycled wherever possible. Waste mitigation measures will be documented in a Waste Management Sub-plan to the CEMP, including:
  - The management of waste activities associated with the Project will be underpinned by the *National Waste Policy* and *Waste Reduction and Recycling Act 2011* (Qld) waste and resource management hierarchy, as listed below in the preferred order to be considered:
    - Avoid or reduce
    - Reuse
    - Recycle
    - Recover energy
    - Treat
    - Dispose.
- Increased economic growth and reduced freight transport costs as a result of Inland Rail have been recognised. As stated in EIS Chapter 17: Economics, Inland Rail is expected to increase Australia's gross domestic product by $16 billion during construction and the first 50 years of operation, while decreasing freight transport costs by an estimated $10 per tonne.

2 Legislative, policy standards and guidelines

2.1 Commonwealth legislation

This section describes the legislative, policy and management framework for the Project to describe the legislative framework which applies to the assessment of MNES applicable to the Project at the Commonwealth level and to provide the statutory context in which the MNES assessment has been undertaken.

An overview of Commonwealth legislation that is relevant to MNES aspects of the Project, outlining the intent of the legislation and applicability to the Project, is presented in Table 2.1. Post primary approval requirements are outlined in Section 8.1.

In addition, the threatened species survey guidelines for bats, birds, fish, mammals and reptiles were considered during planning for the field assessment. This included survey effort, timing and techniques along with ecological information relevant to a species (refer Section 3).

Table 2.1 Commonwealth legislation and policies relevant to the Project

Legislation/ policy/plans	Legislative jurisdiction	Intent	Applicability
Commonwealth			
Environment Protection and Biodiversity Conservation Act 1999 (Cth)	Australia and its Territories. Specifically, projects that involve or have the potential to impact upon nationally and internationally important flora, fauna, ecological communities and heritage places – defined under the Act as MNES.	The EPBC Act is the Australian Government's central piece of environmental legislation and provides the legal basis for the management and protection of nationally and internationally important flora, fauna, ecological communities and heritage places. Under Section 45 of the EPBC Act, the Australian Government and Queensland Government have implemented a bilateral agreement relating to environmental assessment. This agreement allows the Commonwealth Minister for the Environment and DAWE to rely on specified environmental impact assessment processes of Queensland in assessing actions under the EPBC Act. The bilateral agreement specifically aims to achieve the following objectives: ▪ Protect the environment in accordance with the requirements of the EPBC Act ▪ Promote the conservation and sustainable use of natural resources ▪ Ensure an efficient, timely and effective process for environmental assessment and approval of actions.	ARTC submitted an EPBC Act referral to the Department of Environment and Energy (DotEE, now DAWE) in May 2017 (EPBC 2017/7944) The Minister for the Environment determined that the Project is a 'controlled action' on 21 June 2017 to be assessed under the bilateral agreement with the Queensland Government. The controlling provisions for the controlled action are: ▪ Listed threatened species and communities. As required by the ToR, this EIS addresses the relevant sections of Schedule 4 of the Environment Protection and Biodiversity Conservation Regulations 2000.
EPBC Act Environmental Offsets Policy (2012) (EPBC Act Offsets Policy)	Areas subject to the EPBC Act	Developed to support the management and protection of MNES under the EPBC Act and outlines the Australian Government's approach to the use of environmental offsets for impacts to MNES. Eight principles for the use of environmental offset under the EPBC Act have been developed by now DAWE. These principles are used to assess any proposed environmental offset for MNES to ensure consistency, transparency and equity under the Act. The Australian Government's position is that environmental offsets must: ▪ *Deliver an overall conservation outcome that improves or maintains the viability of the aspect of the environment that is protected by national environment law and affected by the proposed action* ▪ *Be built around direct offsets but may include other compensatory measures* ▪ *Be in proportion to the level of statutory protection that applies to the protected matter*	The Project will implement avoidance and mitigation measures to minimise the significant adverse residual impacts on the MNES. implementing mitigation measures including offsets will be consistent across Inland Rail. Offsets provided for under the policy include direct offsets, and other compensatory methods (or indirect offsets). It is likely that a combination of methods will be applicable to the Project, based on the extent of the significant adverse residual impacts on MNES. The Project will comply with the EPBC Act Offsets Policy for any significant adverse residual impacts to MNES. It is proposed a Detailed Environmental Offset Delivery Plan and Offset Area Management Plans will be developed and implemented by ARTC prior to construction commencement subject to the approval under the EPBC Act.

Legislation/ policy/plans	Legislative jurisdiction	Intent	Applicability
		▪ *Be of a size and scale proportionate to the residual impacts on the protected matter* ▪ *Effectively account for and manage the risks of the offset not succeeding* ▪ *Be additional to what is already required, determined by law or planning regulations or agreed to under other schemes or programs (this does not preclude the recognition of State or territory offsets that may be suitable as offsets under the Act for the same action)* ▪ *Be efficient, effective, timely, transparent, scientifically robust and reasonable* ▪ *Have transparent governance arrangements including being able to be readily measured, monitored, audited and enforced* (DSEWPaC 2012a). The Australian Government defines offsets as measures that compensate for the significant residual impacts of an action on the environment (DSEWPaC 2012a).	
Significant impact guidelines 1.1 – Matters of National Environmental Significance: *Environment Protection and Biodiversity Conservation Act 1999*	MNES	The purpose of the MNES Guidelines are to assist any person who proposes to take an action to decide whether or not they should submit a referral to the DAWE for a decision by the Australian Government Environment Minister on whether assessment and approval is required under the EPBC Act. The MNES Guidelines outlines a 'self-assessment' process, including detailed criteria, to assist persons in deciding whether or not referral may be required. Important terms and phrases are explained.	Assessment of MNES against the MNES Guidelines will facilitate the determination of a significant residual impact to MNES. This has been undertaken in Sections 5.3.3, 5.3.4 and 5.3.5.
EPBC Act Referral Guidelines for the vulnerable koala (combined populations of Queensland, New South Wales and the Australian Capital Territory), (DotE 2014)	MNES	The purpose of the guideline is to assist any person who proposes to take an action to decide whether or not they should submit a referral to the DAWE for a decision by the Australian Government Environment Minister on whether assessment and approval is required under the EPBC Act in relation to the Koala. These guidelines outline a 'self-assessment' process, including detailed criteria, to assist persons in deciding whether or not referral may be required.	Assessment of MNES against the guidelines will facilitate the determination of a significant residual impact to Koala. This has been undertaken in Section 5.3.5.

Legislation/ policy/plans	Legislative jurisdiction	Intent	Applicability
Draft *Guide to nationally protected species significantly impacted by paddock tree removal* (DoEE 2020)	MNES	National environmental law applies to the removal of paddock trees when a 'significant impact' on a nationally protected ecosystem or species is likely to occur. Nationally protected ecosystems include Ramsar wetlands and ecological communities listed in the critically endangered, endangered or vulnerable categories under the EPBC Act. In very rare circumstances, these ecosystems may be significantly impacted by paddock tree removal. Only a very small subset of nationally protected species may be significantly impacted by removing paddock trees. In some cases, undertaking mitigation activities may mean that the removal of paddock trees is lawful and does not require referral under national environmental law. The purpose of the guideline is to assist any person who proposes to clear paddock trees to decide whether or not the action may impact threatened species listed under the EPBC Act and if submission of a referral to the DAWE for a decision by the Australian Government Environment Minister on whether assessment and approval is required under the EPBC Act. These guidelines outline species-specific actions, to assist persons in deciding whether or not referral may be required.	Assessment of MNES against the guide will facilitate the determination of a significant residual impact to applicable threatened species (such as Koala). This has been undertaken where necessary in Section 5.3. The following species are relevant to the Project and included within the draft guide. The species-specific approval requirements noted in the draft Guideline are identified here with their relevance to the Project. ▪ Regent Honeyeater (*Anthochaera phrygia*): *Removing Ironbark paddock trees within known breeding areas or frequented visitation sites.* The nearest breeding site is over 100 km south-west of the Project. The species occurs sporadically in the greater Brisbane region (at best) and does not 'frequent' the Project area or surrounds. The approval requirements within the Guideline are not relevant to this species regarding the Project. ▪ Painted Honeyeater (*Grantiella picta*): *Removing old growth eucalyptus paddock trees containing mistletoe within known breeding areas.* The species is not known to breed to the east of the Great Dividing Range and only sporadically occurs in the greater Brisbane region. The approval requirements within the Guideline are not relevant to this species regarding the Project. ▪ Coxens fig parrot (*Cyclopsittadiophthalma coxeni*): *Any removal of old growth fig paddock trees in areas of known visitation by this species*. There are no records of the species within 20 km of the Project. There are no records in the region from the year 2000 onwards. As such there are no areas of known visitation associated with the Project. The approval requirements within the Guideline are not relevant to this species regarding the Project. ▪ Swift Parrot (*Lathamus discolor*) – *Removing Tasmanian Blue Gum and Black Gum paddock trees in known breeding areas. These parrots only breed in Tasmania.* The Project is located in south-east Queensland. The approval requirements within the Guideline are not relevant to this species regarding the Project.

Legislation/ policy/plans	Legislative jurisdiction	Intent	Applicability
			▪ Koala (*Phascolarctos cinereus*): *Removing paddock trees where they are habitat critical to the species survival or provide the only movement opportunity / refuge to or between areas of habitat critical to the species survival.* There is *potential habitat* within the Project disturbance footprint and surrounds which is analogous to this description. Addressed further in Section 5.3.5.3 under the significant residual impact assessment for the species.
Species recovery plans	MNES	Recovery plans for listed threatened species and ecological communities have been made or adopted under the EPBC Act. These plans remain in force until and unless the species is removed from the threatened list. A recovery plan is a document stating the research and management actions necessary to stop the decline, support the recovery and enhance the chance of long-term survival in the wild, of a protected community, animal or plant species.	Species recovery plans for the following MNES relevant to this Project have been adopted by DAWE and have been considered as part of this assessment: ▪ Macadamia nut (*Macadamia integrifolia*) ▪ Rough-shelled bush nut (*Macadamia tetraphylla*) ▪ Brush-tailed Rock-wallaby (*Petrogale penicillate*) ▪ Spotted-tail quoll (*Dasyurus maculatus maculatus*) ▪ Large-eared pied bat (*Chalinolobus dwyeri*) ▪ Black-breasted button-quail (*Turnix melanogaster*) ▪ Red goshawk (*Erythrotriorchis radiatus*) ▪ Regent honeyeater (*Anthochaera phrygia*) ▪ Swift parrot (*Lathamus discolor*) ▪ Mary river cod (*Maccullochella mariensis*) Draft recovery plans awaiting adoption under the EPBC Act and utilised for this report include the following species: ▪ Australian lungfish (*Neoceratodus forsteri*) ▪ Australian painted snipe (*Rostratula australis*) ▪ Australasian bittern (*Botaurus poiciloptilus*) ▪ Grey-headed flying-fox (*Pteropus poliocephalus*) Species recovery plans adopted by DAWE are accessible at the at the following internet location: http://www.environment.gov.au/cgi-bin/sprat/public/publicshowallrps.pl

Legislation/ policy/plans	Legislative jurisdiction	Intent	Applicability
Threat abatement plans	MNES	Threat abatement plans provide for the research, management, and any other actions necessary to reduce the impact of a listed key threatening process on native species and ecological communities. Implementing the plan should assist the long-term survival in the wild of affected native species or ecological communities	Threat abatement plans relevant to MNES associated with the Project include: ▪ Threat abatement plan for disease in natural ecosystems caused by *Phytophthora cinnamomi* ▪ Threat abatement plan for the biological effects, including lethal toxic ingestion, caused by cane toads (*Rhinella marina*) ▪ Threat abatement plan for predation, habitat degradation, competition and disease transmission by feral pigs (*Sus scrofa*) ▪ Threats identified in the Threat abatement plan for competition and land degradation by rabbits ▪ Threat abatement plan for predation by feral cats ▪ Threat abatement plan for predation by the European red fox ▪ Threat abatement plan for competition and land degradation by unmanaged goats Threat abatement plans approved by DAWE are accessible at the at the following internet location: **https://www.environment.gov.au/biodiversity/threatened/threat-abatement-plans/approved**

3 Methodology of assessment

3.1 Overview

An overview of the stages involved in the assessment of the MNES controlling provision of the project is provided in Figure 3.1. Further information regarding the development predictive habitat mapping to support the assessment process provided in Appendix A.

The initial step of the assessment was to identify the MNES (e.g. EPBC Act listed species and threatened ecological communities (TECs)) relevant to the Project. This was undertaken using a combination of desktop-based datasets and validation of predictive, species specific mapping, which was supplemented by targeted field surveys at defined locations (refer Section 3.3.1). Ecological site investigations associated with pre-clearance work for geotechnical investigations (EPBC Referral 2018/8263) were also incorporated into the findings (refer Section 3.2.2).

Predictive habitat modelling for each of the MNES (refer Section 3.2.4, as well as Appendix A) was developed based on the desktop and field survey results. It is noted the survey guidelines for EPBC Act threatened fauna species state:

"… *Alternatives to a dedicated survey may also be appropriate. For example, a desktop analysis of historic data may indicate that a significant impact is not likely. Similarly, a regional habitat analysis may be used to determine the importance of a site to the listed birds. Proponents should also consider the proposals impact in the context of the species' national, regional, district and site importance to establish the most effective survey technique(s)…"* (e.g. Department of the Environment, Water, Heritage and the Arts (DEWHA) 2010a; 2010b):

It should be noted from the outset that detailed onsite surveys for threatened species have not necessarily been undertaken as per the relevant Commonwealth survey guidelines. Where there are no Commonwealth guidelines (e.g. for threatened flora), surveys have been carried out following State guidelines (e.g. Department of Environment and Heritage Protection (DEHP) 2014b and 2016a). Nevertheless, a range of survey methods carried out over a number of years and seasons. This historic survey effort is considered applicable to detecting the potential presence of MNES fauna/flora that may occur in the area.
Section 3.3.2.2 outlines the methods used during Project-associated surveys as they apply to MNES fauna species.

The threatened species habitat modelling has been based on a conservative approach to mapping habitat. In the absence of sufficient and robust scientific information to support a species being excluded from the area, the species has been assumed to be present if habitat for the species is present, or there are local records to this species. This is a conservative approach to mapping.

The approach is even more conservative as the quality of habitat or the carrying capacity of the habitat has been excluded from the assessment (though this information may be used to determine whether a significant impact is likely when assessed against the MNES Guidelines – refer Sections 5.3.3, 5.3.4 and 5.3.5).

The predictive habitat modelling along with relevant scientific information was used to inform the significant impact assessment (direct and indirect) and where applicable the measures to avoid, minimise and mitigate impacts. This assessment has determined the maximum potential area of disturbance for each MNES using the predictive habitat modelling to provide the total maximum extent of habitat to be cleared irrespective of habitat category (e.g. *Potential habitat, Important habitat* or *Habitat critical to the survival of the species*; refer Section 3.2.4) or quality.

A key outcome of the significant impact assessment is the determination as to whether the Project will have a significant residual impact on each of the MNES under the MNES Guidelines (refer Sections 5.3.3, 5.3.4 and 5.3.5).

The interaction of each stage of the assessment process is represented schematically in Figure 3.1.

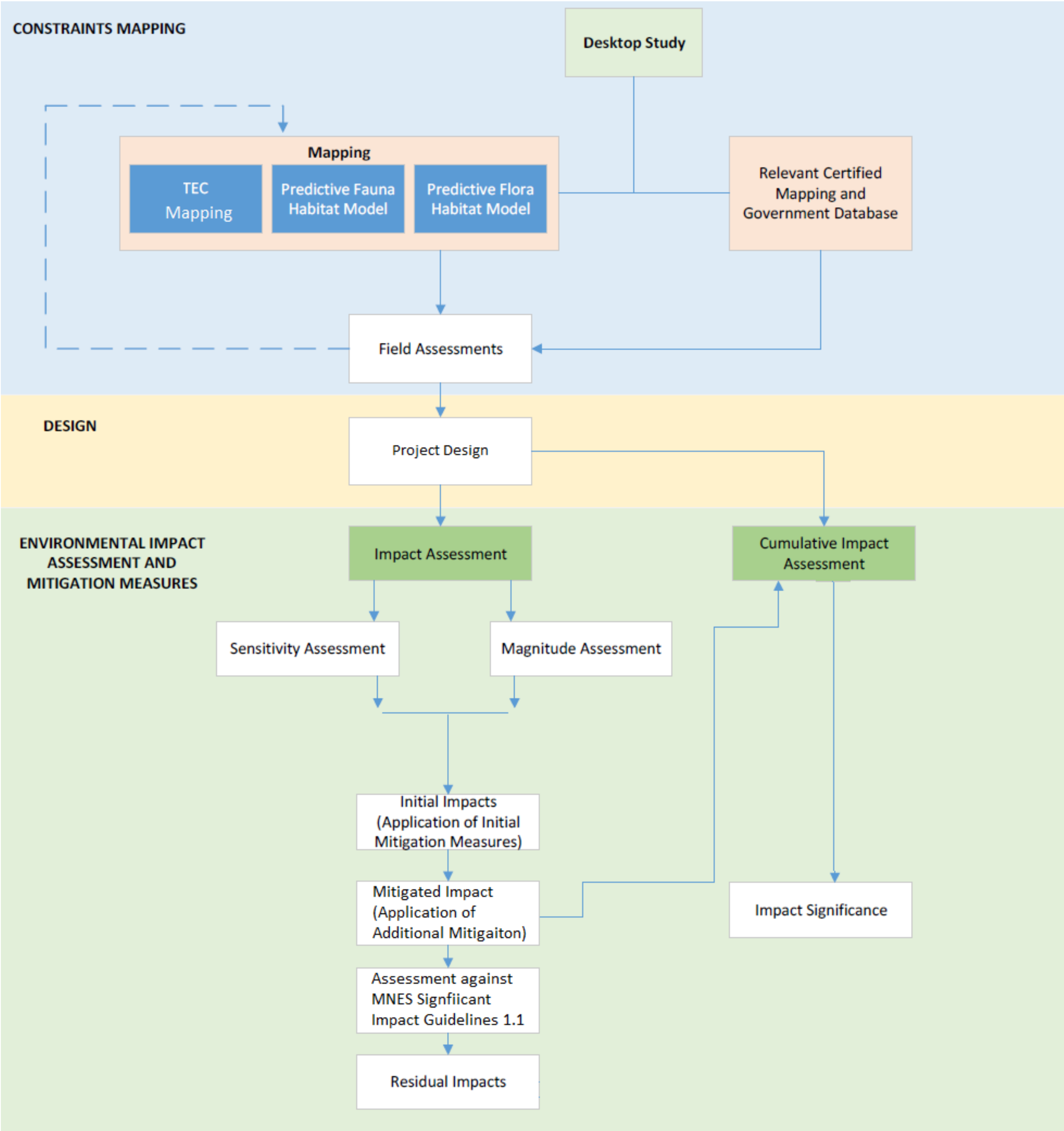


Figure 3.1 Assessment methodology

The approach outlined in Figure 3.1 and documented in this report, is the initial step in the determination of the extent of impacts associated with the Project upon MNES, and represents the maximum extent of clearing. During detailed design, the design and construction methodology will be refined (in particular the disturbance footprint) with due consideration to the Project's impacts and mitigation measures, imposed conditions and additional information on the ecological values of the Project (e.g. additional ecological surveys in accordance with Commonwealth threatened species survey guidelines). It is expected through this process that the extent of clearing, and therefore the impacts on the MNES controlling provisions, will be reduced compared to this assessment.

3.2 Desktop study

This section details the desktop analysis undertaken to identify MNES located within the MNES study area, and existing gaps in datasets. This analysis included a review of existing field data collected prior to the commencement of the Project EIS and field data collected during the field component of the Project EIS. In addition, this section provides details related to the creation of predictive Geographic Information System (GIS) models which specifically identify areas of habitat capable of supporting species and TECs listed under the EPBC Act and within the MNES study area.

3.2.1 Database review

A database review was initially undertaken prior to field investigations to identify MNES that were known or likely to be present within the MNES study area. However, to ensure that the most recent data was obtained, searches were re-run to ensure that any relevant updates, or additional species observations were incorporated into the assessment. Details of the relevant database sources, the most recent search dates, search area parameters and type of information considered for the desktop study are summarised in Table 3.1.

Table 3.1 Database review summary

Database/data source name	Database search date	Database search areas	Data type
Atlas of Living Australia (AoLA 2020)	29/03/2020	Disturbance footprint with 50 km buffer applied	Ongoing inspection of records of flora and fauna, including threatened species listed under the EPBC Act. The Atlas database includes confirmed records from all Australian museums including the Queensland Museum.
Flying-fox monitoring program datasets (DES 2020a)	24/03/2020	Disturbance footprint with 15 km buffer applied	Show the general location of flying-fox roosts in Queensland recorded by the DES and includes camp survey data for continuously and periodically (seasonally or irregularly) used roosts. The exact location of roosts may vary within a small localised area.
Flying-fox roost monitoring and locations(DES 2020b)	06/02/2020	Disturbance footprint with 15 km buffer applied	show the general location of flying-fox roosts in Queensland recorded by the department and include continuously and periodically (seasonally or irregularly) used roosts. The exact location of roosts may vary within a small localised area.
BirdLife Australia (BirdLife Australia 2019)	29/03/2019	MNES study area	Records of avian fauna, including threatened species listed under the EPBC Act.
EPBC Act Protected Matters Search Tool (Australian Government) (DAWE 2020a)	06/02/2020	MNES study area	Provides a "predictive" account of MNES identified within a specific area. Includes: ▪ Threatened species as listed under the EPBC Act ▪ Migratory species listed under the EPBC Act ▪ TECs listed under the EPBC Act ▪ Critical habitats ▪ World Heritage Properties ▪ National Heritage Places ▪ Wetlands of International Importance (i.e. Ramsar) ▪ Great Barrier Reef Marine Park ▪ Commonwealth Marine Area ▪ Nuclear Areas.
Regulated Vegetation Management Map Version 11.1 (Department of Natural Resources, Mines and Energy 2020)	06/02/2020	MNES study area	Mapping of REs and High Value Regrowth that provide habitat for TECs and threatened species under the EPBC Act.

Database/data source name	Database search date	Database search areas	Data type
Wetland Info database (DES 2020c)	06/02/2020	Impact assessment area	Provides interactive maps, species records, case studies and legislation associated with Queensland wetlands.
Wildlife Habitat Map, Version 11.1 (Queensland Government, 2020)	06/02/2020	MNES study area	Modelled habitat for threatened species listed under the EPBC Act.
Wildlife Online database (Queensland Government) incorporating Wildlife Online and Herbrecs datasets	06/02/2020	MNES study area	Records of flora and vertebrate fauna including threatened species listed under the EPBC Act.
Queensland Springs Database (DES 2018)	06/02/2020	Regional extent	The dataset provides a comprehensive catalogue of permanently saturated springs that have fixed locations and any associated surface expression Groundwater Dependant Ecosystems.

3.2.2 Review of existing literature and previous studies

Ecological assessments have been undertaken by various parties to inform the preferred corridor and approval process. The assessments describe the ecological values contained within the MNES study area, including habitat, species diversity, abundance and seasonal distribution (refer Table 3.2). The assessments involved a range of survey techniques including methodologies that aligned with the Commonwealth's threatened species survey guidelines.

In addition, seasonal variation was also captured in the modelling approach (refer Section 3.2.4) which utilised government datasets and historic records that were developed across multiple seasons/years. The results of the modelling and subsequent mapping output provide a measure of the amount of suitable habitat that is present regardless of season as it collates essential "habitat components" required by a species (e.g. vegetation structure, geological features (i.e. surface rocks, cliff faces or boulder piles), presence of specific hydrology regimes). In addition to the material identified in Table 3.2, site specific database queries as identified in Table 3.1, have been accessed to produce the predictive habitat mapping related to MNES flora and fauna to align with that prescribed by relevant recovery plans and conservation advices (refer Section 3.2.4 and Appendix A). Whilst it is acknowledged that each of the previous investigations were undertaken over a single season, the analysis of existing database records, additional survey work (refer Section 3.3) and the formulation of the predictive habitat models which are considered to adequately account for seasonal variation and detectability related to threatened species.

The findings of each of the studies were used to supplement gaps identified from database searches, particularly in relation to the MNES matters. Documents reviewed included those listed in Table 3.2. Methods and survey effort used in the studies is described in Section 3.3.1 and 3.3.2. Information contained within these documents was incorporated into the predictive habitat mapping and relevant results sections of this report. This information was used to assess Project related impacts in relation to MNES.

Table 3.2 Assessments and reports providing ecological information for areas associated with the Project

Document title	Reference	Summary of significant findings related to MNES
Southern Freight Rail Corridor Study (March 2010)	AECOM (2010)	■ Confirmation of the presence of the Swamp Tea-tree (*Melaleuca irbyana*) Forest of South-east Queensland threatened ecological community (TEC) ■ Observations of Koala (*Phascolarctos cinereus*) – anecdotally known to occur throughout the study area from community consultation feedback. Also identified at Paynes Road in September 2009. ■ Observation of Brush-tailed Rock Wallaby (*Petrogale penicillata*) - Observed opportunistically on Mount Flinders ■ Identification of patch of Brigalow (*Acacia harpophylla*) TEC within current MNES study area though outside disturbance footprint (i.e. identified on Lot 118 Plan CH312530, Calvert)
Calvert to Kagaru Flora and Fauna Technical Report	Jacobs-GHD (2016a)	■ Confirmation of the presence of the Swamp Tea-tree (*Melaleuca irbyana*) Forest of South-east Queensland TEC which extends into the periphery of the proposed rail corridor ■ Confirmed the presence of Brigalow (*Acacia harpophylla*) TEC within current MNES study area though outside disturbance footprint (i.e. identified on Lot 118 Plan CH312530, Calvert) ■ Observations of Koala (*Phascolarctos cinereus*) – direct observations and Koala scats in both intact and fragmented landscapes
Woolooman Tunnel Geotechnical Access – Ecological Assessment Report	GHD (2017a)	■ Evidence of Koala (*Phascolarctos cinereus*) presence (scats) recorded
Australian Rail Track Corporation/Transport - Land/southwest of Ipswich/Queensland/Inland Rail Calvert to Kagaru Project (EPBC Referral number 2017/7944)	ARTC (2017)	■ Provides initial details on how the project is likely to impact upon MNES. This includes, identification of potential impacts to nine threatened species, one TEC and three migratory species.
Initial Advice Statement: Inland Rail – Calvert to Kagaru – 10 May 2017.	Jacobs-GHD (2017)	■ Confirmation of the presence of the Swamp Tea-tree (*Melaleuca irbyana*) Forest of South-east Queensland TEC particularly around the Purga nature reserve ■ Observations of Koala (*Phascolarctos cinereus*) – nine distinct locations along the alignment
Inland Rail – Gowrie to Kagaru Geotechnical investigations. MNES assessment report – 23 July 2018	EMM (2018a)	■ Confirmation of the presence of the Swamp Tea-tree (*Melaleuca irbyana*) Forest of South-east Queensland TEC particularly around Ebeneezer ■ Evidence of Koala (*Phascolarctos cinereus*) presence (scats and scratches) throughout locations along alignment ■ Observation of Swift parrot (*Lathamus discolor*) along alignment south of Rosewood
Inland Rail – Gowrie to Kagaru Geotechnical investigations. Protected plant survey reports (2018 and 2019) Preclearance survey reports (2018 and 2019)	EMM (2018b-e; 2019a-c)	■ No MNES observed
Inland Rail – Calvert to Kagaru Geotechnical investigations. Protected plants flora survey reports (8 May 2019, 20 June 2019) Preclearance survey report (11 June 2019)	ELA (2019a-c)	■ Confirmation of the presence of the Swamp Tea-tree (*Melaleuca irbyana*) Forest of South-east Queensland TEC east of Paynes Road (June 2019) ■ Evidence of Koala (*Phascolarctos cinereus*) presence (scats and scratches) throughout locations along alignment

3.2.3 Assessment of the likelihood of occurrence of threatened species

The likelihood of threatened species listed under the EPBC Act to occur within the MNES study area was determined based on the results of the desktop study and review of existing literature (refer Appendix B), which was later supplemented with data derived from field assessments (refer Section 4.4, Appendix F, Appendix G, Appendix I and Appendix J) and used to refine the predictive habitat mapping (refer Figure 3.1 and Appendix A). The likelihood of occurrence assessment is central to determining which MNES features are relevant to the Project and were subject to predictive habitat modelling (refer Section 3.2.4 and Appendix A).

Threatened species considered **possible** or **likely** to occur, or which were identified in the MNES study area during Project-associated field assessments (grouped under **likely**), were assessed as **MNES applicable to the Project**. Threatened species, which were considered **unlikely** to occur within the MNES study area, were not considered further as part of this MNES assessment.

This process allowed for the identification of species that are most likely to be at risk from the Project impacts.

The likelihood of occurrence assessment was based on records collected during the Project EIS field assessments, historic datasets and consideration of a species current (known) distribution range and the presence and condition of suitable habitat in the MNES study area.

Species considered **unlikely** to occur include species that fit one or more of the following criteria:

- The MNES study area is beyond the current distributional limits
- Use specific habitat types or resources that are known not to be present in the MNES study area (e.g. altitudinal limits for species such as the Eastern bristlebird (*Dasyornis brachypterus*) and intertidal saltmarshes and estuarine wetlands for the Eastern curlew (*Numenius madagascariensis*))
- Are considered locally extinct (e.g. Southern Black-throated finch (*Poephila cincta cincta*), and Northern quoll (*Dasyurus hallucatus*)).

Species considered as **possible** include species that fit one or more of the following criteria:

- Have infrequently been recorded previously in, or within 1 km of the MNES study area (i.e. sporadic records with no recent sightings within the past 10 years within 20 km of the MNES study area)
- Use habitat types or resources that are present in the MNES study area, although generally in a poor or modified condition
- Are unlikely to maintain sedentary populations, however, may seasonally utilise resources within the MNES study area opportunistically during variable seasons or migration (e.g. Swift parrot (*Lathamus discolor*)). Note that species that can be identified as sporadically utilising areas of the MNES study area (e.g. Grey-headed flying-fox (*Pteropus poliocephalus*)) are assigned to the "likely" category.

Species considered **likely** to occur include species that fit one or more of the following criteria:

- Have been recently recorded in, or within 1 km of the MNES study area (i.e. sightings within the past 10 years within 20 km of the MNES study area) including during targeted ecological surveys in support of the Project
- Use habitat types or resources that are present in the MNES study area, which are in good condition (with condition based on based desktop works, literature review and, where available and possible, supplementary field assessments)
- Are likely to maintain sedentary populations within the MNES study area.

Information related to ecology, habitat requirements and distribution for each of the threatened species and communities identified from the desktop component is provided in Sections 5.3.4 and 5.3.5 and Appendix B.

3.2.4 Predictive habitat modelling for threatened flora and fauna species

Predictive habitat modelling was undertaken to identify and map areas that were determined as having the potential to provide habitat for threatened species listed under the EPBC Act in accordance with the ToR.

Whist this technical report addresses MNES, State-based GIS layer datasets used as habitat delineators were incorporated into the predictive habitat model where applicable for each species. For example, regional ecosystems (RE) associated with remnant and high value regrowth vegetation, geological datasets, drainage feature mapping and cadastral boundaries were used to identify road reserves (where grazing pressures would be excluded) that may provide *important habitat* for species such as Austral toadflax (*Thesium australe*).

In addition, to adequately capture known records of threatened species (e.g. historic records and those identified during field assessment), all areas (regardless of existing vegetation communities) within a 1 km radius of the record were "automatically" assigned as providing habitat for the specific species to which the record belonged. This distance adequately accounts for the potential movement and dispersal for the relevant species and would also mitigate potential issues associated with record precision. If the record occurred on the outside edge of the MNES study area, the 1 km buffer area for the record would still be integrated into the predictive habitat mapping where it intersected the MNES study area.

In some instances, the mapped *'potential habitat'* contained areas of agricultural land, grassland and open forest/woodland habitat, as well as scattered trees. With reference to Koala (*Phascolarctos cinereus*) this may provide habitat connectivity to larger forest patches or refuge opportunities between habitat patches considered critical to the survival of the species.

The model was designed to recognise specific requirements of each threatened species, which were identified through the broader desktop analysis. Where available this information was derived from species/community recovery plans, DAWE Approved conservation advice for a species/community, and relevant scientific studies. This approach to habitat mapping represents a highly conservative methodology and applies the precautionary principle (i.e. where doubt exists, habitat is included rather than excluded in addition to the inclusion of some areas of habitat that are not considered essential to the survival of the species) so as not to underestimate *potential habitat* for threatened species.

Databases and other information that were used to feed into the predictive GIS based model are identified in Table 3.1. Because of the general paucity of information on the distribution of biota over much of the MNES study area much of the predictive habitat modelling has been undertaken utilising the State-based vegetation mapping (REs) database to delineate potential habitats. Regional ecosystems are an integrated entity derived from landscape pattern, geology and landform, and vegetation. As such, they provide a robust classification for biodiversity planning that incorporates ecological processes at the landscape scale. Regional ecosystems have also been used to define threatened ecological communities within Queensland (refer Section 3.2.5). Aerial imagery was also used to delineate areas of potential habitat located outside of mapped REs which are not captured under the State-based mapping (e.g. vegetated drainage lines).

In addition to database information (e.g. previous ecological survey data and historic records), fauna and flora species data collected during Project-associated field-based assessments (such as species records) (refer Section 3.3) was used to verify and "fine-tune" model outputs (refer Figure 3.1).

The habitat in the predictive threatened species habitat model was categorised as *Habitat critical to the survival of the species*, *Important habitat* and *Potential habitat* using current scientific knowledge and pre-existing data derived from historic surveys, state based mapping and scientific publications and industry recognised experts. The specific habitat assumptions for each species are provided in Appendix A.

The predictive habitat modelling provides greater certainty in predicting the likelihood of a listed threatened species (EPBC Act controlling provisions) occurring within the MNES study area, when compared to limited and or sporadic field investigations.

The species-specific assumptions allowed the following areas to be identified for each threatened species:

- Unlikely habitat
- *Potential habitat*
- *Important habitat* (where applicable – refer Section 3.2.4.3)
- *Habitat critical to the survival of the species* (where applicable).

The use of these habitat categories with DAWE's habitat definitions (with particular reference to *Habitat critical to the survival of the species*) and population definitions (with particular reference to *Important habitat*) for species protected under the EPBC Act (as used within the MNES Guidelines) and where these habitats are defined under relevant recovery plans and/or referral guidelines.

An overview of each of these categories is provided in the sections below.

3.2.4.1 Unlikely habitat

Unlikely habitat consists of areas that do not contain specimen backed records of the particular species (i.e. no point data derived from the positive identification/confirmation of a species in the field) and contain no evidence of habitat values to support the presence or existence of resident individuals or populations of the species. However, it is acknowledged that these areas may provide temporary habitat for species during exceptional circumstances. It is considered that occurrences of the subject species within these areas is an anomaly as these areas are not likely to support the species in the long-term.

3.2.4.2 Potential habitat

Potential habitat consists of areas or locations used by transient individuals or where species may have been recorded but where there is insufficient information to assess the area as *Important habitat* or *Habitat critical to the survival of the species* (i.e. records of the species are considered anomalies as general microhabitat features are not considered to be present). *Potential habitat* also includes habitat that is considered to potentially support a species according to expert knowledge of habitat relationships, despite the absence of specimen backed records and where this does not completely address the relevant criteria to be mapped as *Important habitat* or *Habitat critical to the survival of the species*. *Potential habitat* may include areas of suboptimal habitat for a species. Species specific assumptions that define the *Potential habitat* category are identified in Appendix A. Impacts to *Potential habitat* are not considered to contribute to significant impact to an MNES as the loss of these areas is not deemed to be significant in accordance with the Commonwealth significant impact criteria. However, impact to *Potential habitat* have been considered in relation to movement of species and the potential to contribute towards fragmentation and barrier effects, rather than the loss of habitat *per se*.

3.2.4.3 Important habitat

In line with DAWE's guidelines, areas of *Important habitat* are regarded as a surrogate for important populations of Brigalow belt reptiles. Relevant to the current investigations, the following species are classified as Brigalow Belt reptiles and where relevant, *Important habitat* for these species has been mapped as defined in Section 5 of the *Draft Referral guidelines for the nationally listed Brigalow Belt reptiles* (Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) 2011a):

- Dunmall's snake (*Furina dunmalli*)
- Collared delma (*Delma torquata*)
- Five-clawed worm-skink (*Anomalopus mackayi*).

In addition to the species identified above, the *Important habitat* has been used to capture "Priority habitat areas" for the Swift parrot (*Lathamus discolor*) as identified in the *National Recovery Plan for the Swift Parrot (Lathamus discolor)* (Saunders and Tzaros 2011). Species specific assumptions that define the *Important habitat* category for the abovementioned species are provided in Appendix A.

Impacts to *Important habitat* are considered to contribute towards significant residual impacts to an MNES.

3.2.4.4 *Habitat critical to the survival of the species*

Habitat critical to the survival of the species represents habitat with the greatest value for the relevant MNES and aligns with habitat identified in the conservation listing advice for a relevant MNES. This habitat category identifies areas that align with "*Habitat critical to the survival*" of a listed threatened species identified in an approved Recovery Plan for the relevant MNES. However, in instances where there are no Recovery Plans for a specific species, and in line with a precautionary principle approach, the presence of a specimen backed record (i.e. derived from field investigations or previous database records with low location error information and from within the last 30 years) is considered to align with this category where breeding and foraging habitat is potentially present. For these species, elevation of habitat to this level adequately accounts for the significance of such areas regardless of the absence of a Recovery Plan. Species specific assumptions associated with the mapping of *Habitat critical to the survival of the species* are detailed in Appendix A.

Impacts to *Habitat critical to the survival of the species* are considered to contribute towards significant residual impacts to an MNES.

3.2.5 Mapping of threatened ecological communities

TECs were identified by extrapolation using the relevant DAWE conservation listing advice available on the Species Profile and Threats Database (SPRAT), including analogous regional ecosystems (REs) for each TEC identified during the desktop review phase. Analogous vegetation communities (i.e. remnant and regrowth regional ecosystems) as regulated by the Queensland *Vegetation Management Act 1999* (VM Act) were identified which were then used to spatially map out the extent of each of the identified TEC. Identified TECs and the analogous regional ecosystems (both remnant and high value regrowth) were used to map each of the TECs as stipulated by information provided by the DAWE's SPRAT database and Approved conservation advice and is presented in Table 3.3.

Where considered applicable, aerial imagery was also used to delineate potential TECs (particularly for identifying patches of Swamp tea-tree (*Melaleuca irbyana*)). The use of aerial imagery also allowed for the identification of potential TEC vegetation located outside of mapped REs which are not captured under the State-based mapping (i.e. remnant and high value regrowth).

The Queensland Government mapping extent of Swamp Tea-tree (*Melaleuca irbyana)* was also used to inform the potential extent of Swamp Tea-tree (*Melaleuca irbyana*) Forest of South-east Queensland TEC. This model is based on the likely extent of *Melaleuca irbyana* (1:25,000) and was used to identify potential areas where a TEC may occur outside of the remnant and regrowth mapping.

Interrogation of the State modelling has indicated that many areas that have been mapped are dependent on the "pre-clearing vegetation mapping" and in many instances, these areas are now largely devoid of vegetation communities that would be considered analogous to the Swamp Tea-tree (*Melaleuca irbyana*) Forest of South-east Queensland TEC. Additionally, this modelling recognises three REs which contain *Melaleuca irbyana* 12.3.19, 12.9-10.27 and 12.5.2x1 which are not recognised as the TEC within the conservation listing advice. The use of high value regrowth has been incorporated into the mapping assumptions which represent a cautionary approach to mapping this community at the desktop level. As such the mapping for this TEC provides an overestimation of the actual extent of the TEC within the MNES study area (refer Table 3.3).

It is acknowledged that the State-based RE mapping may not accurately delineate the extent of a TEC within the MNES study area, as the threshold size for some TECs are less than 0.5 ha (refer Table 3.3), while remnant patches from the State-based RE mapping (i.e. 1:50,000 mapping) is 2 ha and/or 75 m width limit for linear features. Therefore, the use of RE mapping may not identify the true extent of potential TECs within the Project disturbance footprint (e.g. smaller patches of potential TEC vegetation may not be mapped as remnant or high-value regrowth communities under State-based mapping). In addition, not all patches of analogous RE (remnant or regrowth) or potential may meet the relevant condition thresholds resulting in an overestimation of area until the patches are verified and delineated in the field. As noted above aerial imagery was used to supplement this mapping, along with targeted field investigations (refer Section 3.3.1 for survey locations). This information was incorporated into the final TEC mapping for the disturbance footprint (refer Section 4.4.1.3) and as such the extent of TEC within the disturbance footprint has a confidence level of 90 per cent.

Impacts to any areas containing a TEC has the potential to contribute toward a significant residual impact to an MNES.

Table 3.3 EPBC Act listed threatened ecological community assumptions used to map areas of occurrence within the MNES study area

TEC name	EPBC Act status	Habitat requirements or analogous REs[1]
Brigalow (*Acacia harpophylla* dominant and co dominant) ecological community	Endangered	The following REs (remnant vegetation and high value regrowth vegetation) are analogous to this TEC in SEQ Bioregion: 12.8.23, 12.9-10.6 and 12.12.26. Patches in poor condition can be excluded from the listed Brigalow ecological community. Poor condition of patches can be recognised by one or more of the following attributes: vegetation that has been comprehensively cleared (not just thinned) within the last 15 years; vegetation in which exotic perennial plants have more than 50% cover, assessed in a minimum area of 0.5 ha (100 m by 50 m); and individual patches of Brigalow that are smaller than 0.5 ha.
Coastal Swamp Oak (*Casuarina glauca*) Forest of New South Wales and South-east Queensland ecological community	Endangered	The following REs (remnant vegetation and high value regrowth vegetation) are analogous to this TEC: 12.1.1 and 12.3.20 The minimum threshold for this community (i.e. meets key diagnostics characteristics) is 0.5 ha.
Swamp Tea-tree (*Melaleuca irbyana*) Forest of SE Queensland	Critically Endangered	The following REs (remnant vegetation and high value regrowth vegetation) are considered to be analogous to this TEC: 12.9-10.11 and 12.9-10.11a, 12.9-10.27, 12.5.2x1, 12.3.18 (formally 12.3.3.c) and 12.3.19. There are no key diagnostic characteristics and condition thresholds for this community. It is acknowledged that the QLD government has prepared habitat modelling for the species *Melaleuca irbyana* (listed as Endangered under the Queensland *Nature Conservation Act 1992*). Interrogation of the State modelling has indicated that many areas that have been mapped are dependent on the “pre-clearing vegetation mapping” and in many instances, these areas are now largely devoid of vegetation communities that would be considered analogous to the Swamp Tea-tree (*Melaleuca irbyana*) Forest of SEQ TEC. However, this modelling recognises three REs which contain *Melaleuca irbyana* 12.3.19, 12.9-10.27 and 12.5.2x1. In addition, the use of high value regrowth and unmapped patches of *M. irbyana* regrowth have been incorporated into the mapping assumptions which represent a cautionary approach to mapping this community at the desktop level. Ground-truthing used to verify mapping (refer Section 4.4.1.3)
Lowland Rainforest of Subtropical Australia	Critically Endangered	The following REs (remnant vegetation and high value regrowth vegetation) are analogous to this TEC: 12.3.1, 12.3.1a, 12.5.13, 12.5.13a, 12.5.13b, 12.5.13c, 12.8.3, 12.8.4, 12.11.1, 12.11.10, 12.12.1 and 12.12.16 where they meet the following criteria: ▪ Is located at or below 300 m above sea level ▪ Is located at least 2 km from the coastline. Note that for remnant patches (which meet the key diagnostic characteristics) the threshold is 0.1 ha or 1 ha for where some residual trees are present, while for non-remnant areas the threshold is 2 ha.

TEC name	EPBC Act status	Habitat requirements or analogous REs[1]
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland (also known as Box-Gum Grassy Woodland and Derived Grassland)	Critically Endangered	The following REs (remnant vegetation and high value regrowth vegetation) are analogous to this TEC: 12.8.16 (western extent of SEQ Bioregion) For this community a patch (which meets the key diagnostic characteristics) must be an area that contains five or more trees in which no tree is greater than 75 m from another tree, or the area over which the understorey is predominantly native. Patches must be assessed at a scale of 0.1 ha (1,000 m^2) or greater.

Table note:

1 As regulated under the Queensland VM Act. Obtained from conservation listing advice contained within SPRAT unless otherwise stipulated. Detailed RE descriptions are provided in EIS Appendix J: Terrestrial and Aquatic Ecology Technical Report

3.3 Field assessments

This section outlines the field assessment methodologies adopted in recognition of relevant departmental guidelines or policies (i.e. survey guidelines, guidelines for EPBC Act listed species or communities, species recovery plans and the MNES Guidelines). Surveys were undertaken with due consideration to the following:

- Commonwealth recognised guidelines for threatened species where applicable (refer: http://www.environment.gov.au/epbc/policy-statements). For example:
  - Nationally threatened ecological community information sheet: Swamp Tea-tree (*Melaleuca irbyana*) Forest of South-east Queensland (Department of the Environment and Heritage 2005)
  - Survey guidelines for Australia's threatened fish (DSEWPaC 2011a)
- Methodology for survey and mapping of regional ecosystems and vegetation communities in Queensland (Neldner et al 2012; Neldner et al 2017)
- Terrestrial vertebrate fauna guidelines for Queensland (V2.0) (Eyre et al 2018)
- Flora survey guidelines - protected plants, *Nature Conservation Act 1992* (DEHP 2016a).

There are no Commonwealth guidelines regarding surveys for MNES flora with the DEHP 2016a guidelines considered suitable for surveying flora species. While for the TECs, there are also no specific Commonwealth survey guidelines with Neldner et al 2012 (and subsequent revisions) suitable to verify and delineate the extent of a TEC based on the relevant diagnostic criteria and condition thresholds (where available) in the relevant Approved conservation advice for the TEC.

As noted previously onsite surveys for relevant threatened fauna have not been carried out for all species as per the relevant Commonwealth survey guidelines. A comparison of the Project survey effort with the required survey effort for each fauna species as per the relevant survey guidelines is not presented within this report. The information within this document is based on desktop information and targeted field-based information from several surveys over a number of years (refer Section 3.3.1). The approach to assessing threatened species presence and habitat modelling for threatened species has adopted a conservative approach in order to avoid underestimating the available habitat potentially present within the disturbance footprint. For some fauna species the presence of suitable habitat features may be sufficient to consider the species as present (e.g. boulder piles/cliff faces for Brush-tailed rock-wallaby (*Petrogale penicillata*)). As such, it is considered this maintains the intent of the various guidelines.

The extent of fieldwork and predictive flora and fauna modelling undertaken for the Project, when used in conjunction with existing information (refer Section 3.4), are considered sufficient to provide confidence in predictions of potential impacts to MNES. Specific methodologies utilised in assessing MNES attributes are specified below.

The location of terrestrial and aquatic survey sites was dictated by land access agreements with landholders which was provided on a voluntary basis. However, where access agreements existed, these locations were survey in addition to publicly accessible areas. ARTC is committed to undertaking additional surveys in accordance with relevant guidelines to verify the assumptions used to inform the mapping and address any constraints/limitations.

Whist not specifically detailed within this document, results of previous field work conducted by Jacobs - GHD (2016a) and findings associated with ecological investigations to support approval processes for the Calvert to Kagaru geotechnical program (i.e. undertaken by EMM and ELA) which occurred concurrently with the EIS investigations reported in this document, have been incorporated within this technical report (refer Figure 3.2 for the locations of areas undertaken as part of these surveys). Surveys undertaken to support the geotechnical program were undertaken in accordance with the Flora survey guidelines - protected plants, *Nature Conservation Act 1992* (DEHP 2016a) and in addition, habitat assessments (including breeding and foraging habitat for threatened species), focussing on threatened species (e.g. Koala). This data has been used to assist in the predictive habitat mapping and refinement of TECs located within the MNES study area. Where data from these surveys is considered relevant it has been incorporated throughout this document but specifically in the significant impact assessments associated with TECs (refer Section 5.3.3), threatened flora (refer Section 5.3.4), and threatened fauna (refer Section 5.3.5). In relation to the Teviot Range, limited accessibility hindered site based EIS investigations in this area. However, to account for this, the results of Jacobs - GHD's, along with EMM and ELA investigations, have been incorporated to describe the existing ecological values of the area and assess potential impacts (refer Section 3.3.1).

3.3.1 Field assessment locations and timing

A representative sampling approach was employed as part of the field sampling methodology. Seasonal sampling (i.e. Spring (mid-September to mid-December) and Autumn (late February to April)) are recommended for the SEQ Bioregion (Eyre et al. 2014). The use of publicly available datasets, surveys undertaken by GHD (2016a) (Autumn 2016), GHD (2017a, 2017b) (Summer 2017), various surveys undertaken by ELA and EMM as part of geotechnical works, surveys undertaken by Future Freight Joint Venture (FFJV) (i.e. Spring 2017) and surveys undertaken by AECOM for the SFRC (early Autumn 2008) fulfil this seasonal requirement (refer Table 3.4). These timings are considered adequate to measure taxa diversity and their repetition throughout the MNES study area. In addition, when combined with the predictive habitat modelling (refer Section 3.2.4) which has been supplemented with field-based datasets, a highly conservative approach has been adopted to the assessment of threatened species.

3.3.1.1 Previous and concurrent ecological surveys for Project

Table 3.4 presents the survey timing and survey activities associated with previous Project associated ecological investigations, including the Jacobs-GHD works in 2016 and 2017, and geotechnical field investigations undertaken by ELA and EMM (2018 and 2019). It is noted the disturbance footprint has changed somewhat since the surveys carried out by GHD, particularly in the Teviot Range area. Figure 3.2a-e presentshows the survey location points. Note, there is substantial overlap in the location of surveys undertaken during programs presented in Figure 3.2a-e with those undertaken as part of targeted surveys associated with the EIS in 2017 (refer Figure 3.3a-b), allowing for seasonal assessments of the same areas. The targeted surveys for the EIS have also captured areas within the alignment not subject to assessment elsewhere such that the majority of the disturbance footprint has been subject to ecological assessment.

Table 3.4 Timing of field investigations undertaken associated with the Project used to supplement the results of the current study

Study/investigation	Consultant/ year	Timing of investigations	Season	Methodologies and notes
Southern Freight Rail Corridor Study (March 2010)	AECOM (2010)	March-April (2008)	Autumn (2008)	Verification of vegetation communities within corridor Targeted surveys for threatened flora and fauna species Incidental aquatic surveys 26 sites targeted within C2K MNES study area

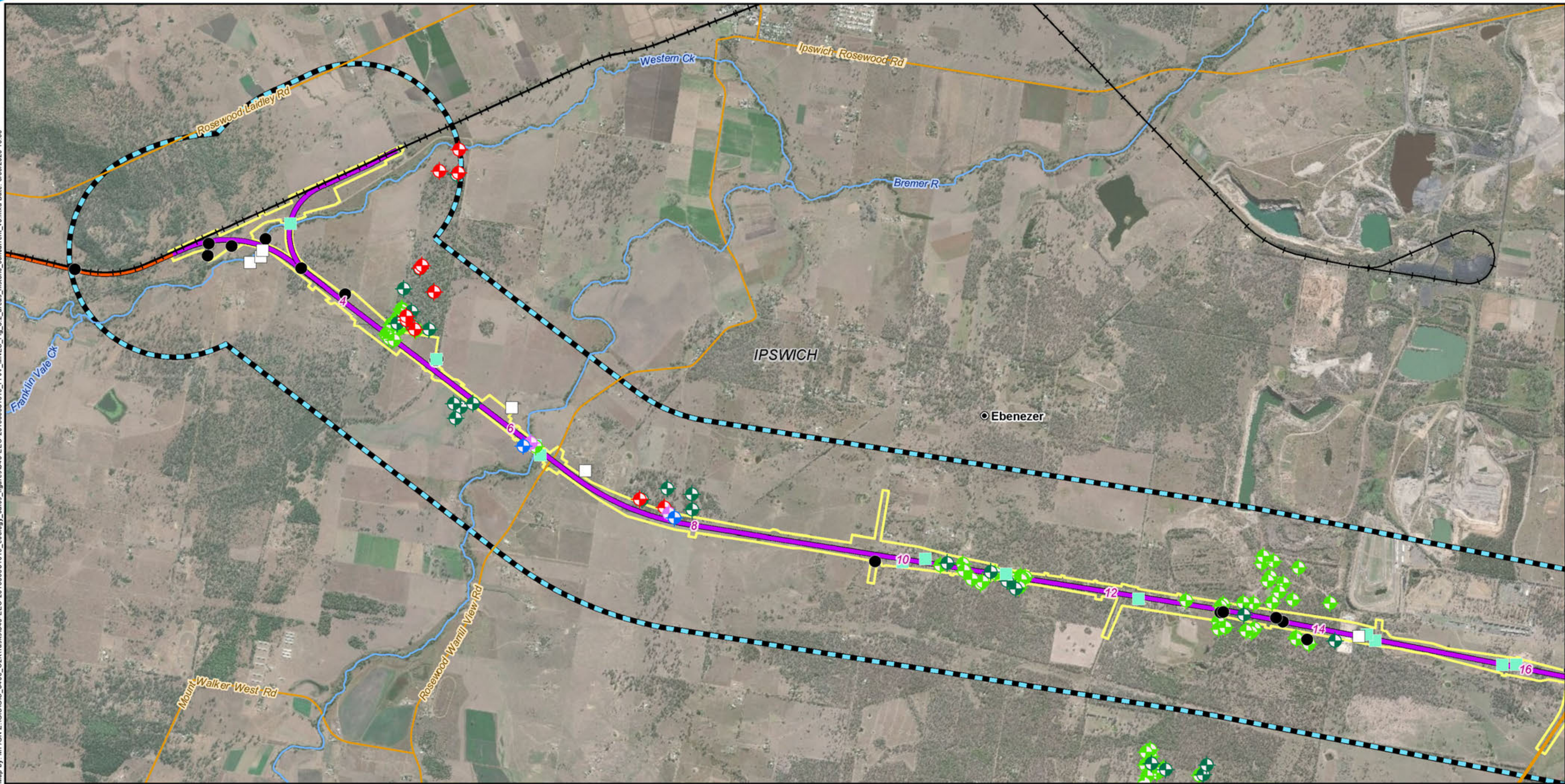
Study/investigation	Consultant/ year	Timing of investigations	Season	Methodologies and notes
Calvert to Kagaru Flora and Fauna Technical Report	Jacobs-GHD (2016a)	9-16 May (2016)	Autumn (2016)	Survey carried out within MNES study area Verification of vegetation communities – 60 flora sites Targeted surveys for threatened flora and fauna species Rapid habitat assessments Nocturnal searches/spotlighting Active searches for Koala Confirmation of TECs Electrofishing for Australian Lungfish and Mary River cod*
Woolooman Tunnel Geotechnical Access – Ecological Assessment Report and Protected Plants Assessment Report	GHD (2017a, 2017b)	13-17 February (2017)	Summer (2017)	Survey of alternative tunnel options in Teviot Range for Project (including areas outside MNES study area) Protected plant surveys (systematic transect searches and plot-based population surveys) Searches for fauna breeding places Threatened fauna habitat surveys Targeted surveys for threatened fauna species Active searches for Koala Nocturnal searches/spotlighting
Protected plant surveys associated with geotechnical investigations to support EPBC Referral 2018-8263 and inform the Gowrie to Kagaru Geotechnical Investigations Environmental Management Plan	EMM (2018b, 2018c)	16 May 2018 - 28 June 2018	Autumn, Winter (2018)	Protected plant surveys within/adjacent to alignment (meander surveys – minimum 30 minutes) at 70 sites throughout C2K alignment
Pre-clearing surveys associated with geotechnical investigations to support EPBC Referral 2018-8263 and inform the Gowrie to Kagaru Geotechnical Investigations Environmental Management Plan	EMM (2018d, 2018e)	4-14 September 2018 26-28 November 2018	Spring (2018)	Threatened fauna habitat assessments within/adjacent to alignment Searches for fauna breeding places TEC confirmation Fauna observations Carried out at 25 sites throughout C2K alignment
Protected Plant surveys associated with geotechnical investigations or C2K alignment (also identified as opportunistic surveys throughout this technical report)	FFJV (2017-2018)	March 2017 - September 2018	Autumn, Winter, Spring (2017-2018)	Protected plant surveys within/adjacent to alignment (meander surveys – minimum 30 minutes) and habitat surveys carried out at 69 sites throughout alignment
Protected plant surveys associated with geotechnical investigations for C2K alignment	ELA (2019a, 2019b)	December 2018 – April 2019	Summer/Autumn (2018/2019)	Protected plant surveys within/adjacent to alignment (meander surveys – minimum 30 minutes) at 42 sites throughout alignment

Study/investigation	Consultant/ year	Timing of investigations	Season	Methodologies and notes
Pre-clearing surveys associated with geotechnical investigations for C2K alignment	ELA (2019c)	December 2018 – April 2019	Summer/Autumn (2018/2019)	Threatened fauna habitat surveys within/adjacent to alignment Koala habitat assessment Searches for fauna breeding places Fauna observations TEC confirmation Carried out at 296 sites throughout alignment
Protected plant surveys associated with geotechnical investigations for Gowrie to Kagaru alignment	EMM (2019a, 2019b)	13-24 May 2019 3 June – 16 July 2019	Autumn/Winter (2019)	Threatened fauna habitat assessments within/adjacent to alignment Searches for fauna breeding places TEC confirmation Fauna observations Carried out at 15 sites within C2K alignment
Pre-clearing surveys associated with geotechnical investigations for Gowrie to Kagaru alignment	EMM (2019c)	14-29 May 2019	Autumn (2019)	Threatened fauna habitat assessments within/adjacent to alignment Searches for fauna breeding places TEC confirmation Fauna observations Carried out at 14 sites within C2K alignment

Tables note:

* Electrofishing is the recommended methodology for these two species under the Commonwealth of Australia 2011 Survey guidelines for Australia's threatened fish

Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



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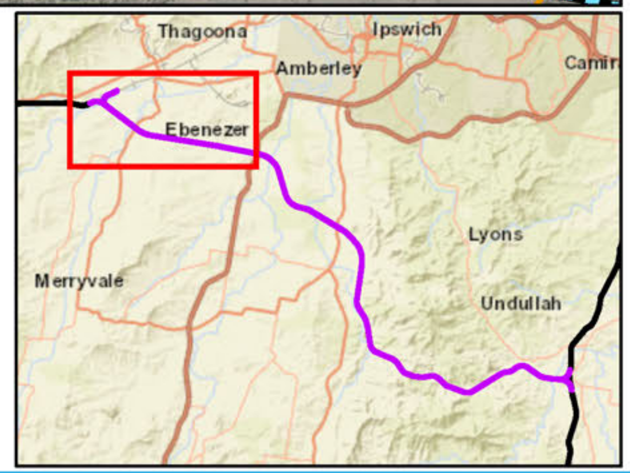

Legend

- 5 Chainage (km)
- Localities
- Existing rail
- H2C project alignment
- C2K project alignment
- Watercourses
- Major roads
- Minor roads
- EIS disturbance footprint (surface disturbance only)
- MNES study area
- Local Government Areas

GHD/Jacobs

- Fauna ecology survey (GHD/Jacobs)
- Quaternary flora survey (GHD/Jacobs)
- Aquatic ecology survey (GHD/Jacobs)
- Supplementary flora survey point (GHD/Jacobs)
- Supplementary habitat survey point (GHD/Jacobs)

- Supplementary fauna survey point (ELA)
- Supplementary habitat survey point (ELA)
- Supplementary flora survey point (EMM)

A3 scale: 1:40,000

0 0.5 1 1.5 2 2.5 km

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Calvert to Kagaru

Figure 3.2a: Location of areas sampled as part of historic and concurrent works

Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

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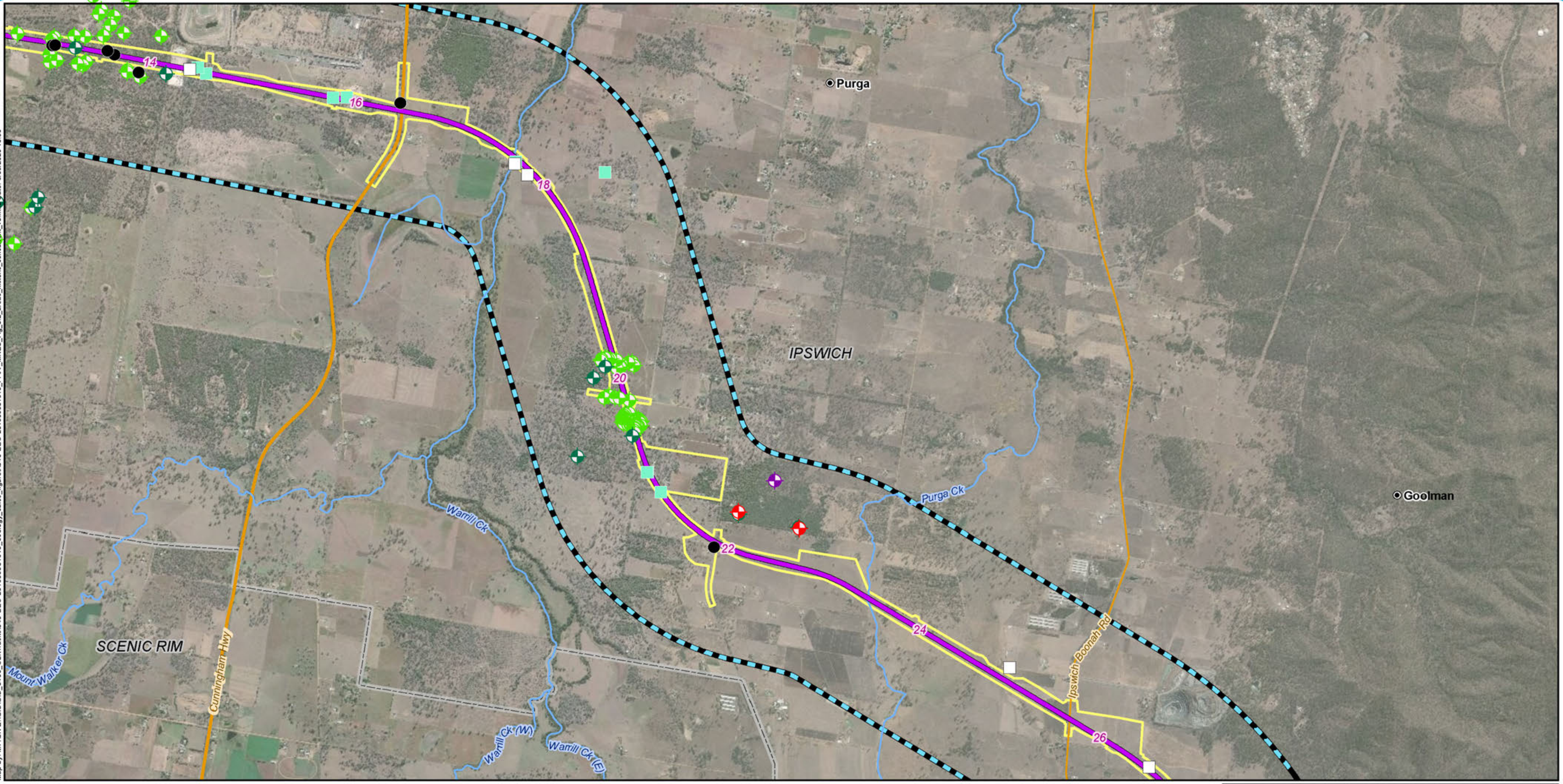

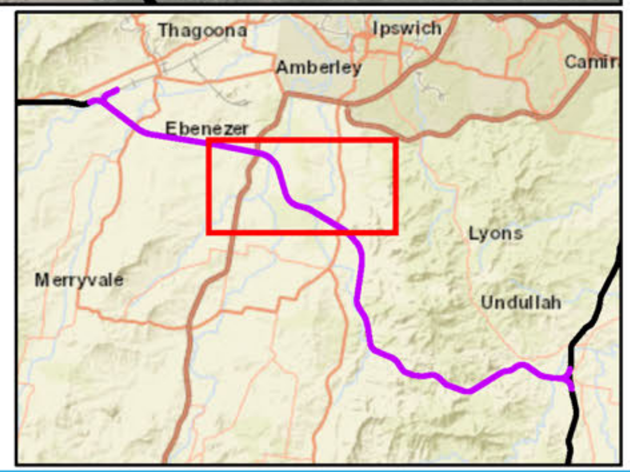

Legend

- 5 Chainage (km)
- Localities
- C2K project alignment
- Watercourses
- Major roads
- Minor roads
- EIS disturbance footprint (surface disturbance only)
- MNES study area
- Local Government Areas

GHD/Jacobs

- Anabat site (GHD/Jacobs)
- Fauna ecology survey (GHD/Jacobs)
- Quaternary flora survey (GHD/Jacobs)
- Supplementary flora survey point (GHD/Jacobs)

- Supplementary fauna survey point (ELA)
- Supplementary habitat survey point (ELA)
- Supplementary flora survey point (EMM)

A3 scale: 1:40,000

0 0.5 1 1.5 2 2.5 km

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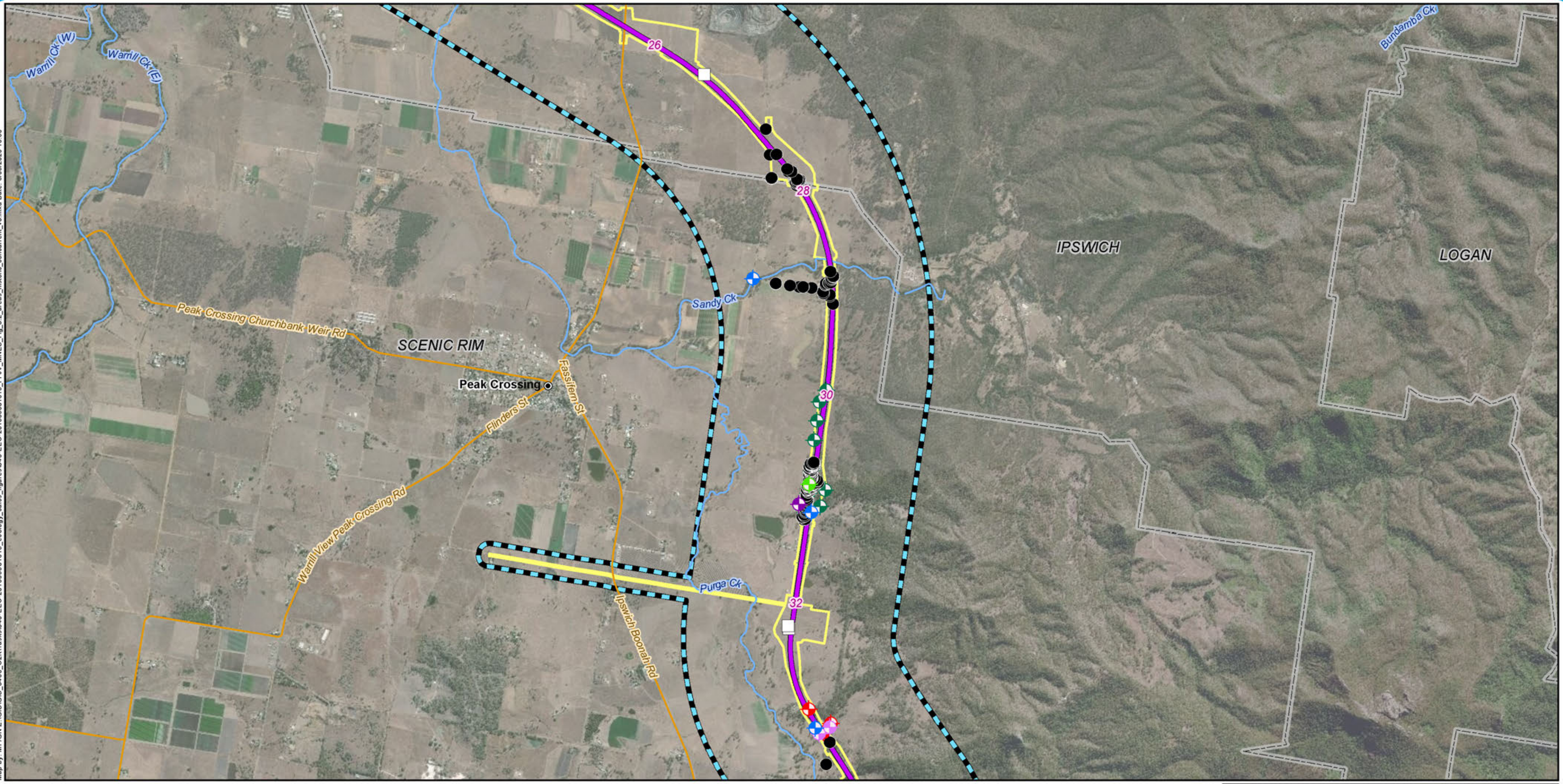
Coordinate System: GDA 1994 MGA Zone 56

Calvert to Kagaru

Figure 3.2b: Location of areas sampled as part of historic and concurrent works

Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



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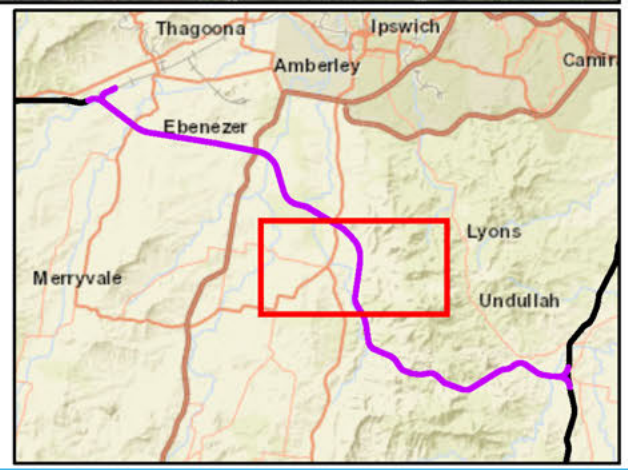
Legend

- 5 Chainage (km)
- Localities
- C2K project alignment
- Watercourses
- Minor roads
- EIS disturbance footprint (surface disturbance only)
- MNES study area
- Local Government Areas

GHD/Jacobs

- Anabat site (GHD/Jacobs)
- Fauna ecology survey (GHD/Jacobs)
- Quaternary flora survey (GHD/Jacobs)
- Aquatic ecology survey (GHD/Jacobs)
- Supplementary flora survey point (GHD/Jacobs)
- Supplementary habitat survey point (GHD/Jacobs)

- Supplementary fauna survey point (ELA)
- Supplementary flora survey point (EMM)



A3 scale: 1:40,000

0 0.5 1 1.5 2 2.5km

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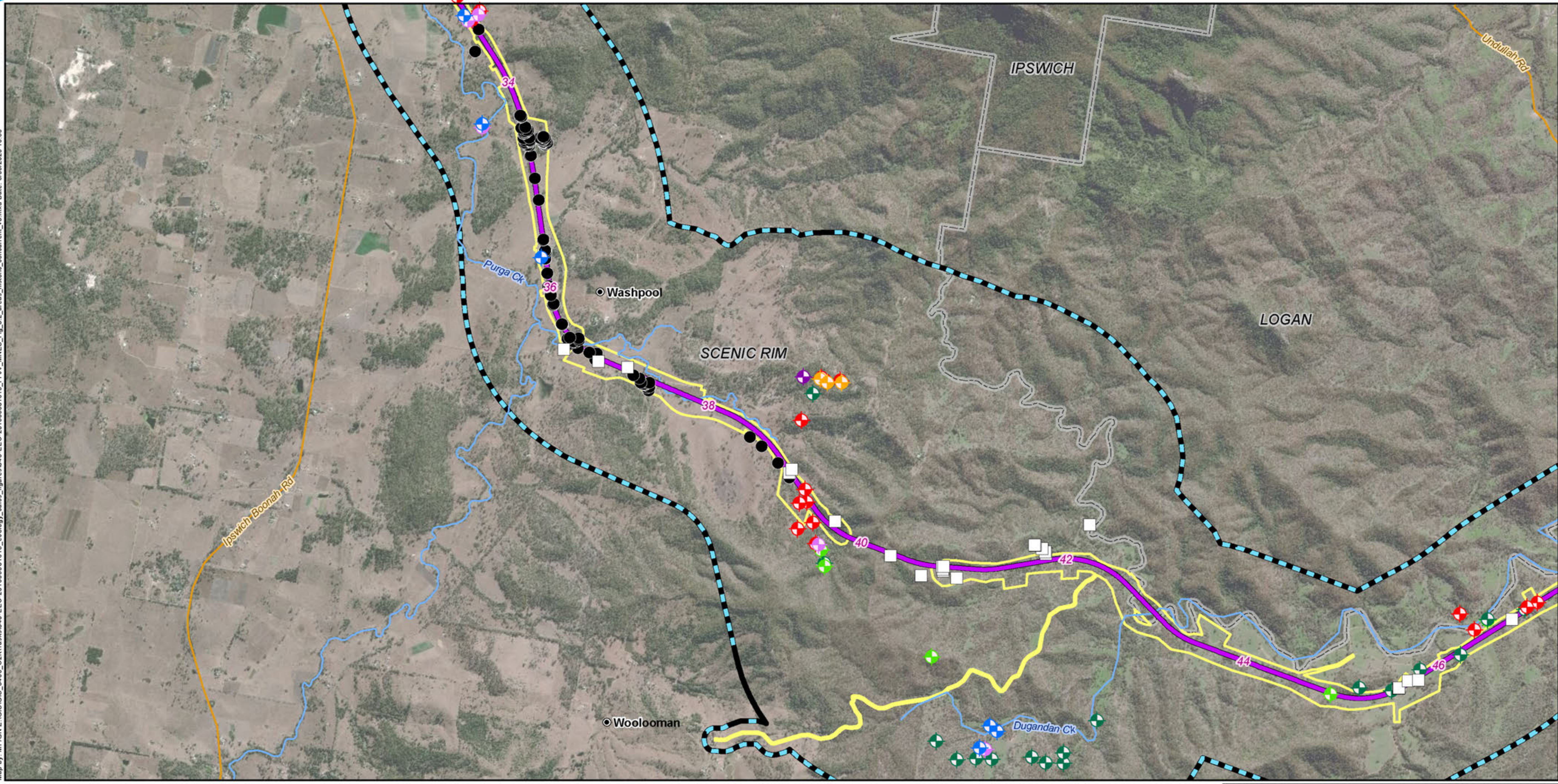
Coordinate System: GDA 1994 MGA Zone 56

Calvert to Kagaru

Figure 3.2c: Location of areas sampled as part of historic and concurrent works

Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



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Legend

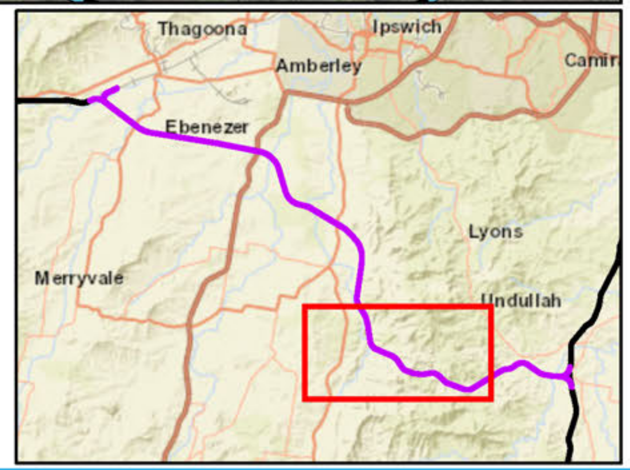
- 5 Chainage (km)
- Localities
- C2K project alignment
- Watercourses
- Minor roads
- EIS disturbance footprint (surface disturbance only)
- MNES study area
- Local Government Areas

GHD/Jacobs

- Anabat site (GHD/Jacobs)
- Fauna ecology survey (GHD/Jacobs)
- Remote cameras (GHD/Jacobs)
- Quaternary flora survey (GHD/Jacobs)
- Aquatic ecology survey (GHD/Jacobs)
- Supplementary flora survey point (GHD/Jacobs)
- Supplementary habitat survey point (GHD/Jacobs)

- Supplementary fauna survey point (ELA)
- Supplementary flora survey point (EMM)

Note that due to topography constraints and the realigment of Wild Pig Creek Road and to minimise impacts on Dugandan Creek, there is a small area not within the disturbance footprint between Chainage 42 and 44.



A3 scale: 1:40,000

0 0.5 1 1.5 2 2.5 km

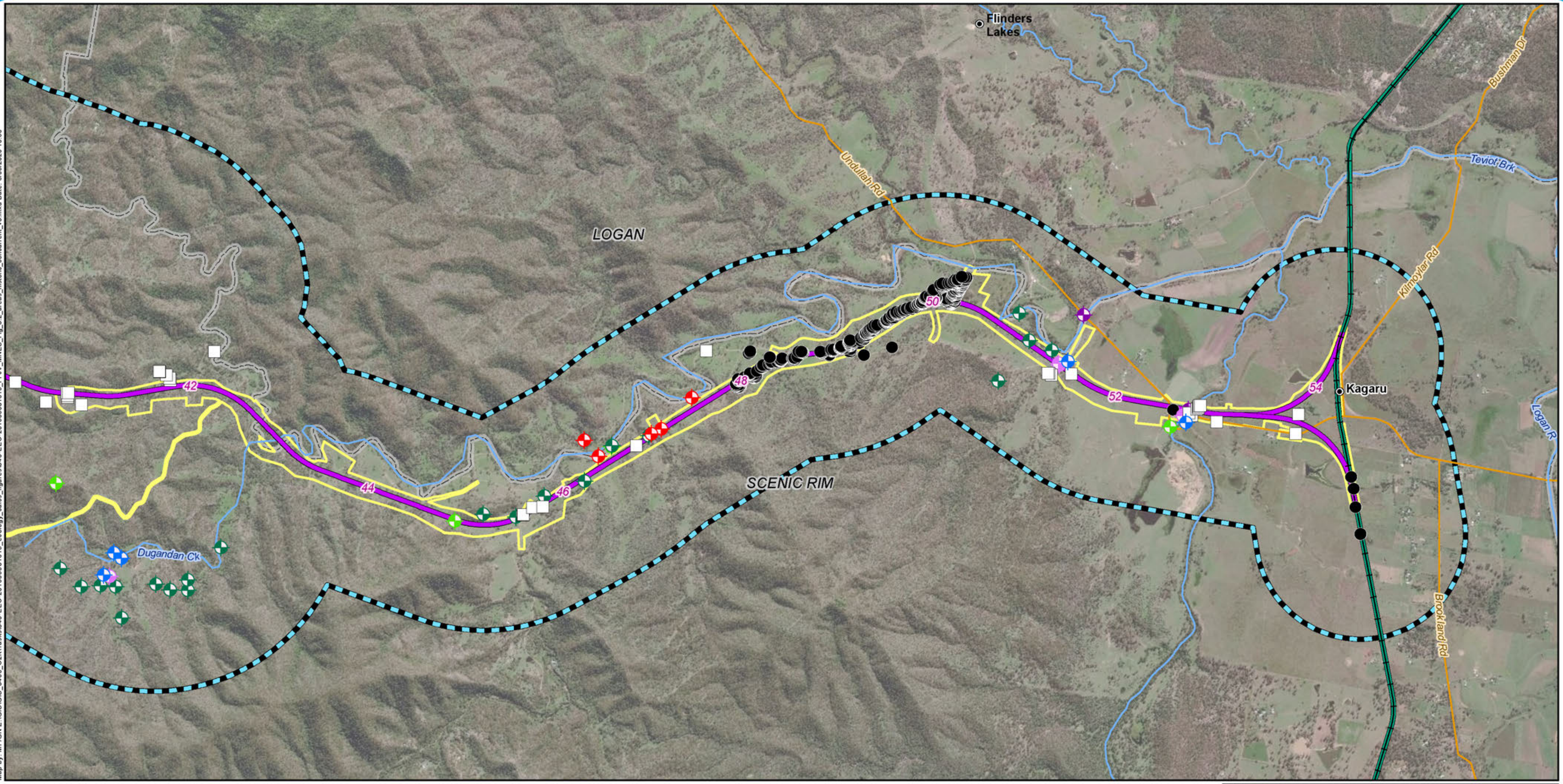
Future Freight
Integrating Community, Environment and Engineering

Issue date: 06/05/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

Calvert to Kagaru

Figure 3.2d: Location of areas sampled as part of historic and concurrent works

Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



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Legend

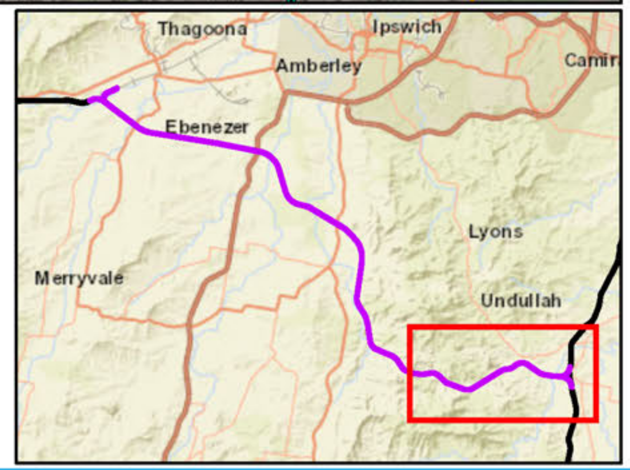
- 5 Chainage (km)
- Localities
- Existing rail
- C2K project alignment
- K2ARB project alignment
- Watercourses
- Minor roads
- EIS disturbance footprint (surface disturbance only)
- MNES study area
- Local Government Areas

GHD/Jacobs

- Anabat site (GHD/Jacobs)
- Fauna ecology survey (GHD/Jacobs)
- Quaternary flora survey (GHD/Jacobs)
- Aquatic ecology survey (GHD/Jacobs)
- Supplementary flora survey point (GHD/Jacobs)
- Supplementary habitat survey point (GHD/Jacobs)

- Supplementary fauna survey point (ELA)
- Supplementary flora survey point (EMM)

Note that due to topography constraints and the realignment of Wild Pig Creek Road and to minimise impacts on Dugandan Creek, there is a small area not within the disturbance footprint between Chainage 42 and 44.



A3 scale: 1:40,000

0 0.5 1 1.5 2 2.5km

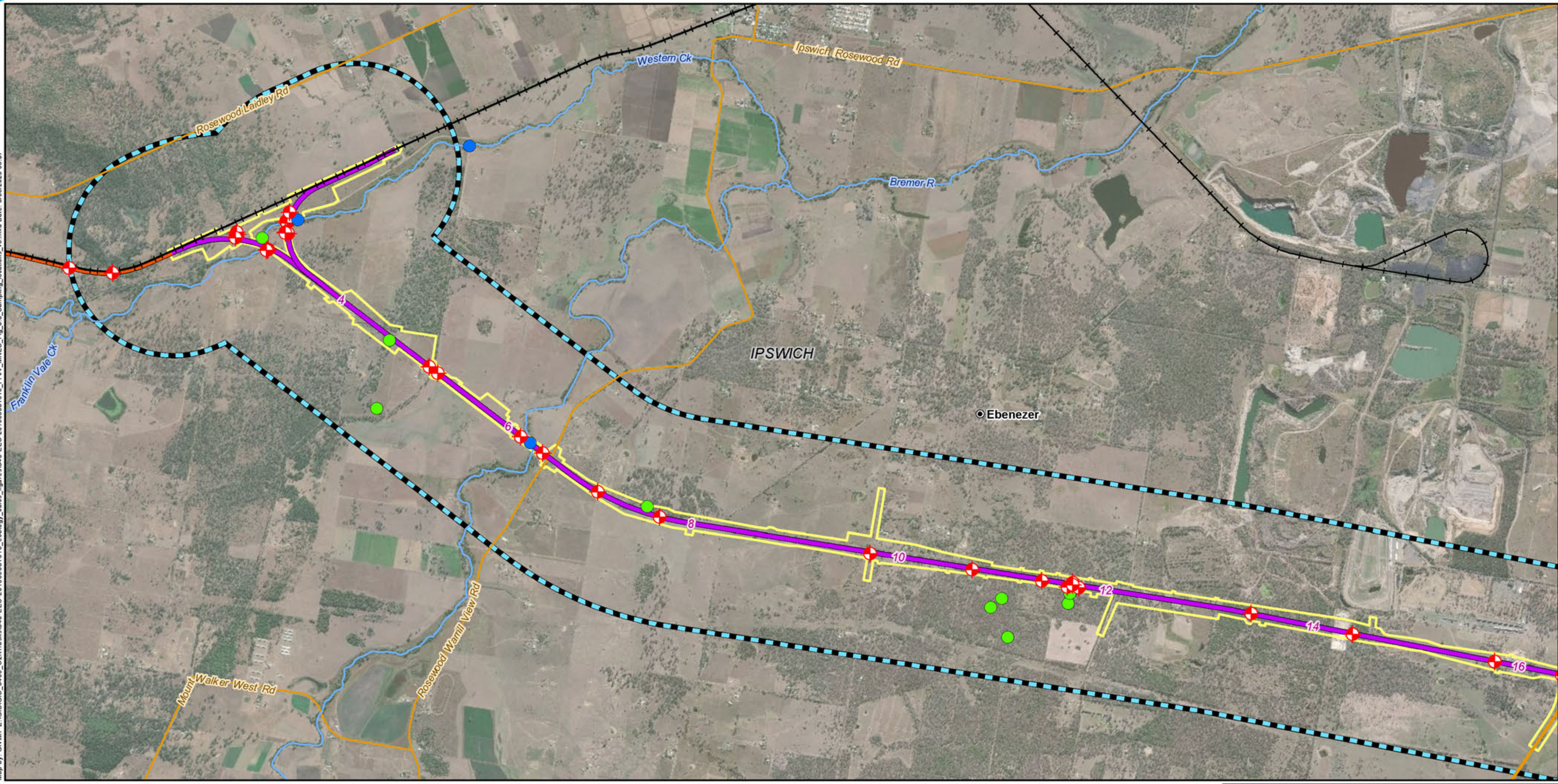
Future Freight
Integrating Community, Environment and Engineering

Issue date: 06/05/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

Calvert to Kagaru

Figure 3.2e: Location of areas sampled as part of historic and concurrent works

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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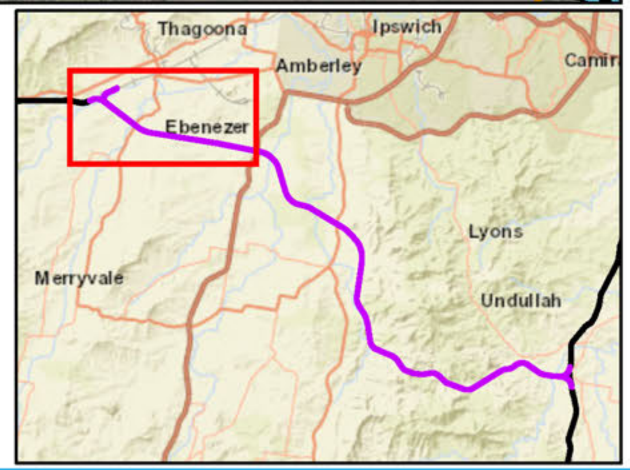
Legend

- 5 Chainage (km)
- Localities
- Aquatic sampling sites
- Anabat/remote camera
- Opportunistic surveys
- Terrestrial sampling sites
- H2C project alignment
- C2K project alignment
- Existing rail
- Watercourses
- Major roads
- Minor roads
- EIS disturbance footprint (surface disturbance only)
- Local Government Areas
- MNES study area



A3 scale: 1:40,000

0 0.5 1 1.5 2 2.5km

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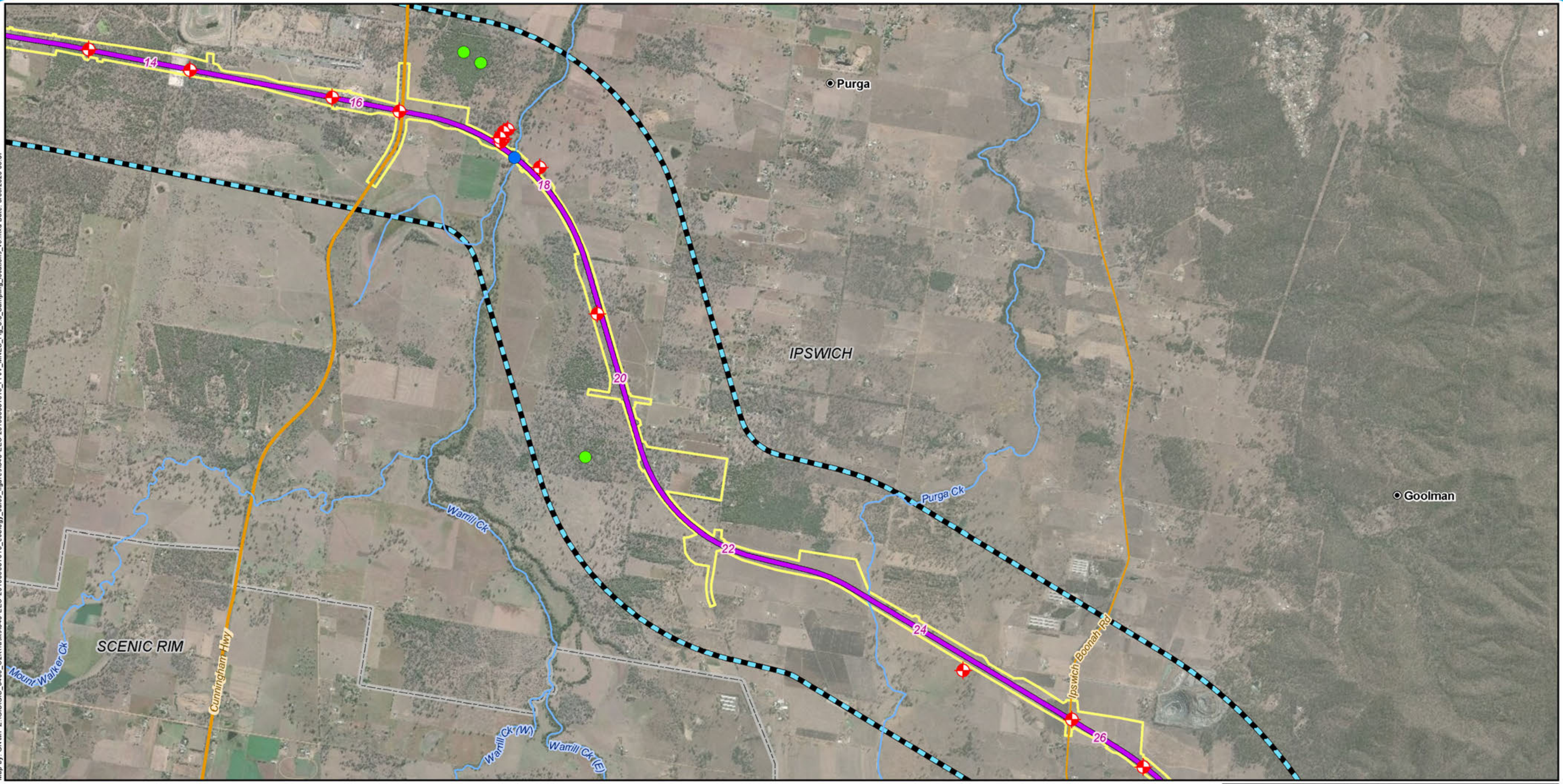
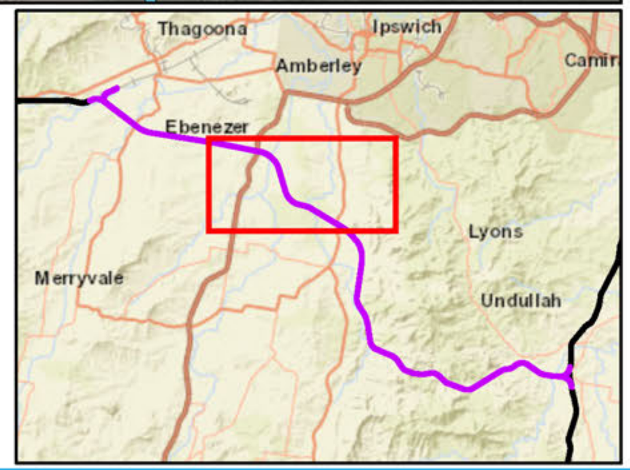
Figure 3.3a: Location of sampling locations within the MNES study area

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



Map by: GNMF Z:\GIS\GIS_3400_C2K\Tasks\340-EEC-201905081615_ecology_calcs_figures\340-EEC-201905081615_FFJV_MNES_Fig_3_3_Sampling_locations_v5.mxd Date: 3/09/2020 09:37



Legend

- 5 Chainage (km)
- Localities
- Aquatic sampling sites
- Anabat/remote camera
- Opportunistic surveys
- Terrestrial sampling sites
- C2K project alignment
- Watercourses
- Major roads
- Minor roads
- EIS disturbance footprint (surface disturbance only)
- Local Government Areas
- MNES study area

A3 scale: 1:40,000

0 0.5 1 1.5 2 2.5km

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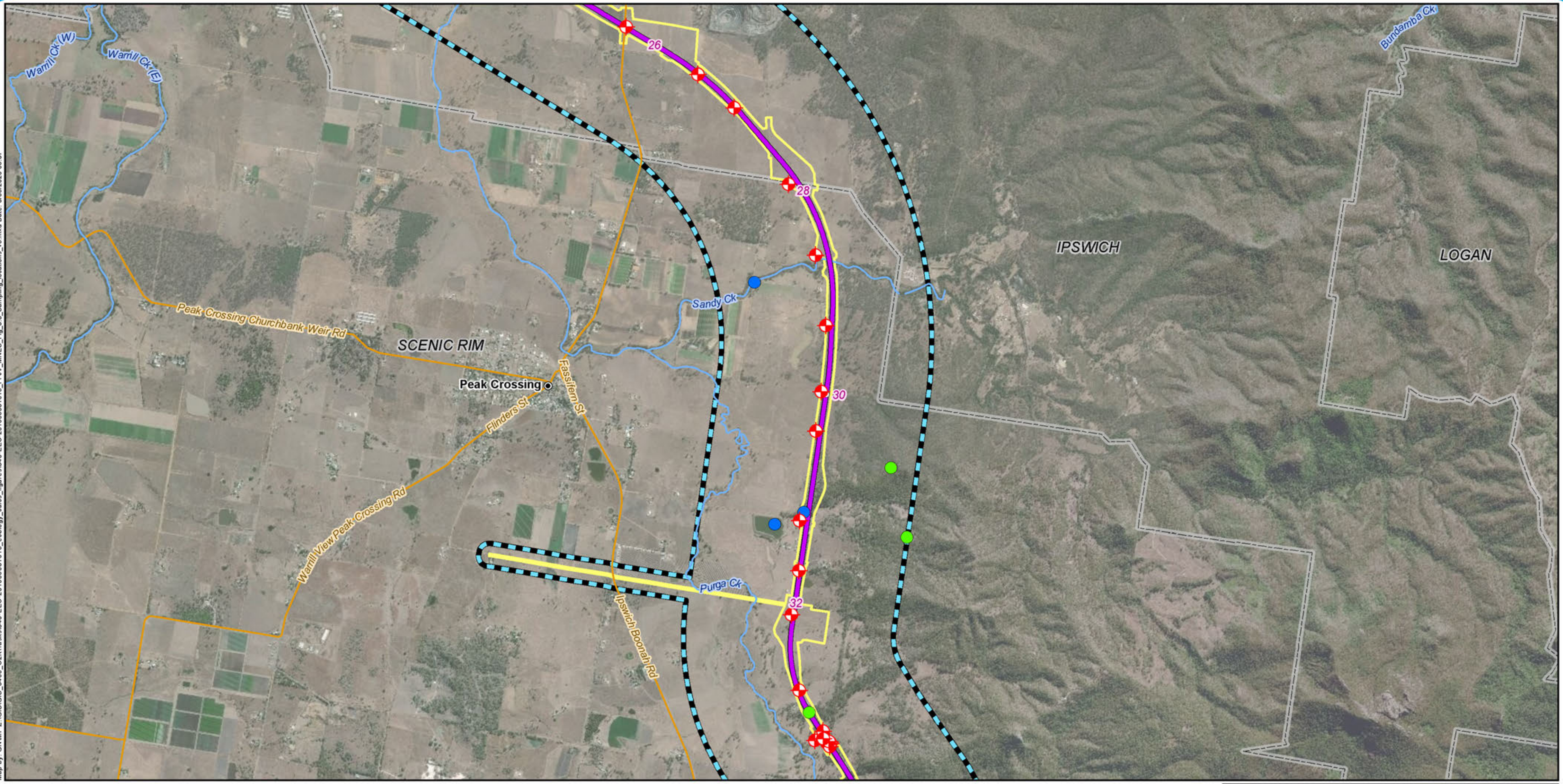
Figure 3.3b: Location of sampling locations within the MNES study area

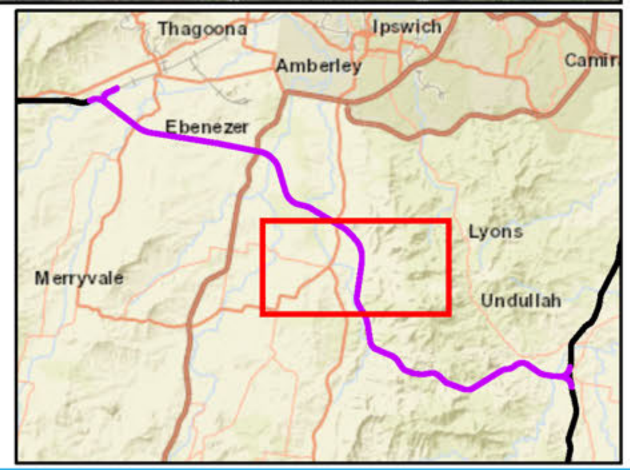
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



Map by: GNMF Z:\GIS\GIS_3400_C2K\Tasks\340-EEC-201905081615_ecology_calcs_figures\340-EEC-201905081615_FFJV_MNES_Fig_3.3_Sampling_locations_v5.mxd Date: 3/09/2020 09:37

Legend

- 5 Chainage (km)
- Localities
- Aquatic sampling sites
- Anabat/remote camera
- Opportunistic surveys
- Terrestrial sampling sites
- C2K project alignment
- Watercourses
- Minor roads
- EIS disturbance footprint (surface disturbance only)
- Local Government Areas
- MNES study area



A3 scale: 1:40,000

0 0.5 1 1.5 2 2.5km

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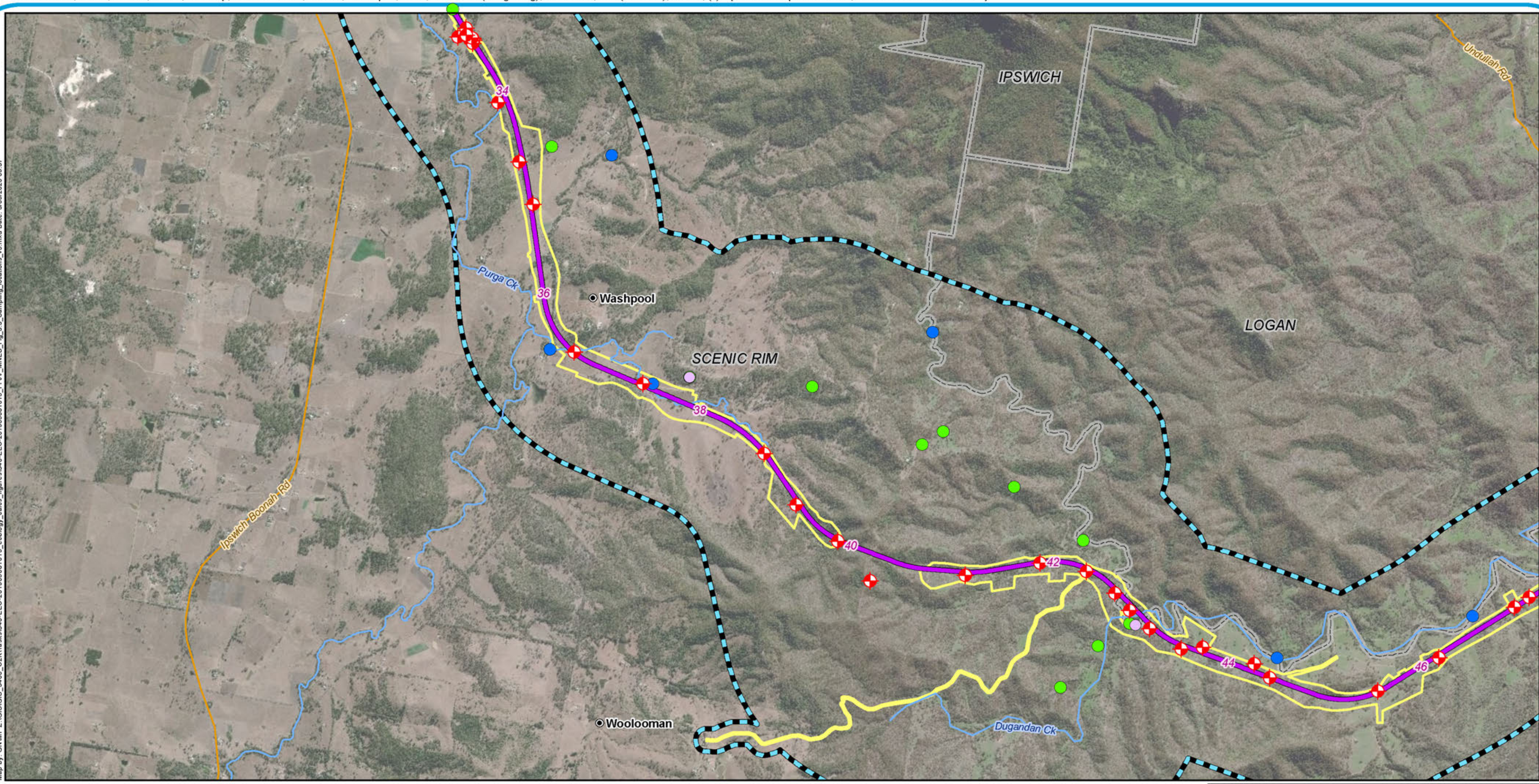
Calvert to Kagaru

Figure 3.3c: Location of sampling locations within the MNES study area

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

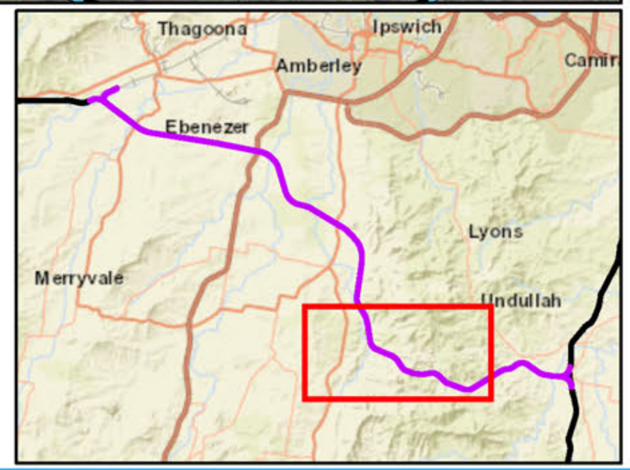


Map by: GNMF Z:\GIS\GIS_3400_C2K\Tasks\340-EEC-201905081615_ecology_calcs_figures\340-EEC-201905081615_FFJV_MNES_Fig_3.3_Sampling_locations_v5.mxd Date: 3/09/2020 09:37

Legend

- 5 Chainage (km)
- Localities
- Aquatic sampling sites
- Anabat/remote camera
- Opportunistic surveys
- Terrestrial sampling sites
- C2K project alignment
- Watercourses
- Minor roads
- EIS disturbance footprint (surface disturbance only)
- Local Government Areas
- MNES study area

Note that due to topography constraints and the realigment of Wild Pig Creek Road and to minimise impacts on Dugandan Creek, there is a small area not within the disturbance footprint between Chainage 42 and 44.



A3 scale: 1:40,000

0 0.5 1 1.5 2 2.5km

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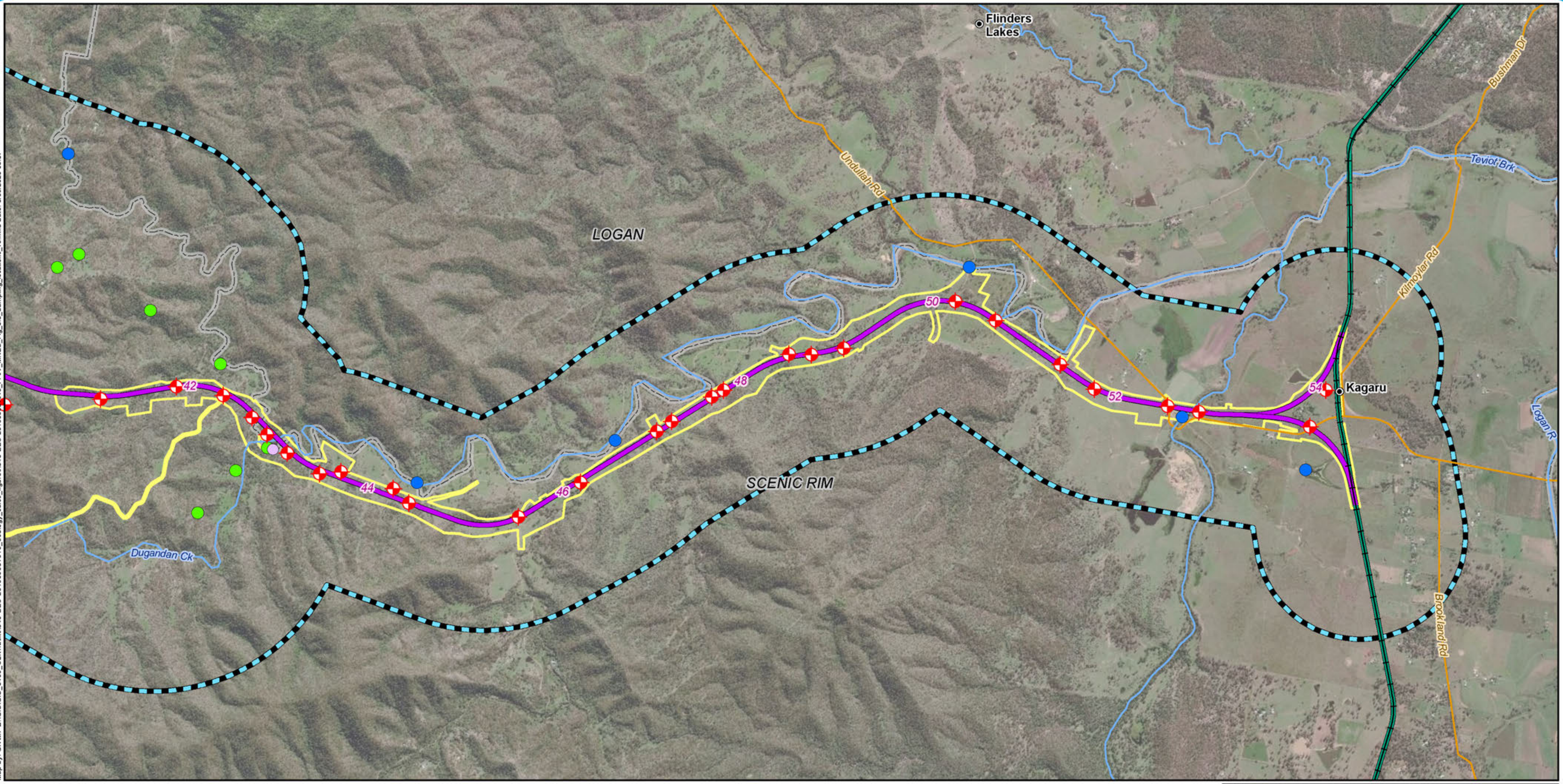
Coordinate System: GDA 1994 MGA Zone 56

Calvert to Kagaru

Figure 3.3d: Location of sampling locations within the MNES study area

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

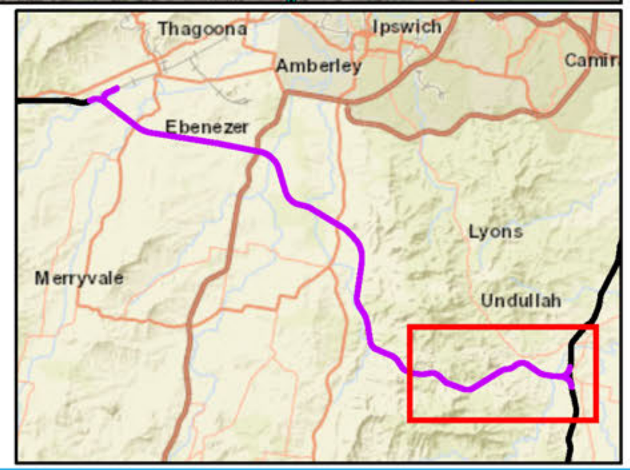


Map by: GNMF Z:\GIS\GIS_3400_C2K\Tasks\340-EEC-201905081615_ecology_calcs_figures\340-EEC-201905081615_FFJV_MNES_Fig_3_3_Sampling_locations_v5.mxd Date: 3/09/2020 09:37

Legend

- 5 Chainage (km)
- Localities
- Aquatic sampling sites
- Anabat/remote camera
- Terrestrial sampling sites
- C2K project alignment
- K2ARB project alignment
- Existing rail
- Watercourses
- Minor roads
- EIS disturbance footprint (surface disturbance only)
- Local Government Areas
- MNES study area

Note that due to topography constraints and the realigment of Wild Pig Creek Road and to minimise impacts on Dugandan Creek, there is a small area not within the disturbance footprint between Chainage 42 and 44.



A3 scale: 1:40,000

0 0.5 1 1.5 2 2.5km

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Integrating Community, Environment and Engineering

Issue date: 03/09/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

Calvert to Kagaru

Figure 3.3e: Location of sampling locations within the MNES study area

3.3.1.2 Project ecological studies

Following the desktop study, field survey sites were selected which were specifically identified as containing features of interest. Terrestrial ecology surveys were carried out at 26 sites and aquatic ecology surveys were carried out at 16 sites. Specifically, the following features were used to target areas:

- Areas containing a representative example of a distinct vegetation community (i.e. areas contained within mapped remnant vegetation, regrowth vegetation, and non-remnant vegetation areas)
- Areas containing landscape features that were considered likely to support threatened species when viewed from aerial photography (i.e. Gilgai areas, wetlands and escarpments)
- Areas known or predicted to support threatened species
- Areas identified as containing or potentially containing EPBC Act listed TECs
- Areas that have not been subject to previous ecological investigations.

At each terrestrial ecology survey location, a vegetation survey, a fauna habitat assessment, active searches for cryptic fauna and opportunistic observations were undertaken as a minimum (refer datasheets in Appendix H and Appendix I). Wetland assessments were carried out in instances where wetland indicators were present (e.g. macrophytes, topography consistent with wetlands or areas mapped as a wetland). The location of terrestrial and aquatic assessment survey sites within the MNES study area, and the date of assessment, are presented in Table 3.5 and shown in Figure 3.3a-e.

Following the initial sampling associated with the EIS studies (in 2017), the Project's alignment through the Teviot Range was revised, and moved north. Additional ecological surveys to support geotechnical investigations (i.e. March 2017 - September 2018) were undertaken by FFJV along the amended alignment (including areas in the Teviot Range associated with the tunnel) (included within 'opportunistic surveys' in Figure 3.3a-e. However, given no surface disturbance is proposed for areas associated with the Tunnel, survey within this section of the alignment has not been as intense as in other areas identified for direct disturbance.

Table 3.5 Field survey sites and date of assessment (excluding opportunistic survey locations)

Site ID	Site location (GDA94)					Assessment date
	Zone	Easting	Northing	Latitude	Longitude	
Terrestrial ecology survey sites						
T1	56J	0482332	6917658	-27.661 166°	152.549 453°	11 September 2017
T2	56J	0481931	6917458	-27.654 854°	152.566 075°	11 September 2017
T3	56J	0481246	6918943	-27.680 447°	152.571 835°	12 September 2017
T4	56J	0481831	6918471	-27.704 678°	152.682 532°	12 September 2017
T5	56J	0481613	6917056	-27.795 896°	152.750 496°	12 September 2017
T6	56J	480482	6919520	-27.794 863°	152.753 320°	12 September 2017
T7	56J	480277	6919395	-27.841 688°	152.763 248°	12 September 2017
T8	56J	479217	6919953	-27.868 612°	152.834 440°	12 September 2017
T9	56J	478035	6920045	-27.840 257°	152.800 746°	13 September 2017
T10	56J	476703	6922268	-27.865 005°	152.853 613°	13 September 2017
T11	56J	475750	6923592	-27.850 105°	152.887 912°	13 September 2017
T12	56J	462328	6936278	-27.863 030°	152.908 488°	14 September 2017
T13	56J	462164	6936560	-27.867 587°	152.920 441°	14 September 2017
T14	56J	462269	6936647	-27.824 790°	152.769 347°	14 September 2017
T16	56J	462903	6936597	-27.844 720°	152.773 337°	14 September 2017
T17	56J	462918	6936694	-27.775 084°	152.748 564°	14 September 2017
T18	56J	469377	6932614	-27.661 166°	152.549 453°	14 September 2017

Site ID	Site location (GDA94)					Assessment date
	Zone	Easting	Northing	Latitude	Longitude	
T19	56J	455225	6940075	-27.654 854°	152.566 075°	15 September 2017
T20	56J	468379	6936376	-27.680 447°	152.571 835°	15 September 2017
T21	56J	468218	6936476	-27.704 678°	152.682 532°	15 September 2017
T22	56J	456438	6939101	-27.795 896°	152.750 496°	15 September 2017
T23	56J	456438	6939101	-27.794 863°	152.753 320°	16 September 2017
T24	56J	456314	6938452	-27.841 688°	152.763 248°	16 September 2017
T25	56J	458893	6937518	-27.868 612°	152.834 440°	16 September 2017
T26	56J	476681	6925260	-27.840 257°	152.800 746°	16 September 2017
T27	56J	476530	6925918	-27.865 005°	152.853 613°	16 September 2017
Aquatic ecology survey sites						
C2K 1A	56J	455563	6940250	-27.863 030°	152.908 488°	29 September 2017
C2K 1A (alt)	56J	457200	6940955	-27.867 587°	152.920 441°	29 September 2017
C2K 2A	56J	457778	6938122	-27.824 790°	152.769 347°	29 September 2017
C2K 3A	56J	468701	6935471	-27.844 720°	152.773 337°	28 September 2017
C2K 5A	56J	475422	6925382	-27.775 084°	152.748 564°	26 September 2017
C2K 5A (1)	56J	475700	6925497	-27.661 166°	152.549 453°	26 September 2017
C2K 6A	56J	476688	6920312	-27.654 854°	152.566 075°	28 September 2017
C2K 7A	56J	483702	6917341	-27.680 447°	152.571 835°	27 September 2017
C2K 7A (alt)	56J	480380	6920477	-27.704 678°	152.682 532°	27 September 2017
C2K 8A	56J	485589	6917743	-27.795 896°	152.750 496°	27 September 2017
C2K 9A	56J	488964	6919397	-27.794 863°	152.753 320°	25 September 2017
C2K 10A	56J	490991	6917967	-27.841 688°	152.763 248°	25 September 2017
C2K 11A	56J	492168	6917463	-27.868 612°	152.834 440°	25 September 2017
C2K 12A	56J	477285	6922185	-27.840 257°	152.800 746°	25 September 2017
C2K 13A	56J	477682	6919978	-27.865 005°	152.853 613°	26 September 2017
C2K 14A	56J	475227	6927687	-27.850 105°	152.887 912°	26 September 2017

3.3.2 Matters of national environmental significance

3.3.2.1 Flora, vegetation community and wetland field assessment

At each survey site targeted for the FFJV EIS studies, a list of all flora species and TECs encountered were recorded and documented. In addition, any wetlands or other notable features relevant to MNES were identified and documented. In addition to specific target areas, opportunistic observations across the MNES study area were used to supplement site specific datasets. Significant flora species that were not previously encountered, or species that were unidentifiable in the field (when sampling occurred), were collected and lodged at the Queensland Herbarium for formal identification (refer Appendix C). As per current Scientific Purposes Permit requirements, no more than two samples per species were taken at each survey location when sampling was required for identification purposes.

Verification via ecological assessment of a representation of distinctly different vegetation communities (including remnant, regrowth and non-remnant communities) and, wetlands or any other features relevant to MNES identified during the desktop component, was undertaken in the field (refer Section 4.4). The following approach to sampling was applied:

- Within a representative of each different type of vegetation or feature identified from aerial imagery, an intensive survey occurred, which included an assessment of the relative species density and diversity within the emergent (E), canopy (T1, T2, T3), shrub (S1, S2, S3) and ground (G) strata layers when they were present. Methodologies used were consistent with the Tertiary level as described by Neldner et al. (2012; 2017). Survey transects approximated 100 m in length and 20 m in width. Where applicable (e.g. wetland or spring features were present) spring and wetland verification was undertaken by assessing the presence of wetland features related to floristic communities, wetland indicators, signs of flooding and topography (refer Appendix H for vegetation assessment sheets).
- Once a full vegetation survey was complete for each representative of the specific vegetation community, verification of the remaining map units of the same type was undertaken at the Quaternary level as described by Neldner et al. (2012; 2017).

A representation of the predictive flora habitat modelling for EPBC Act listed species (i.e. flora) (refer Section 3.2.4) was verified where applicable during site field investigations throughout the MNES study area. In addition, where present wetlands and springs were verified, this information fed back into the GIS system and was used to refine the predictive habitat modelling, wetlands and springs mapping as appropriate (refer Figure 3.1). Noting that wetlands and water courses were dry during the surveys.

Field verification of TEC habitat mapping was undertaken by comparing field observations against the diagnostic community attributes for the TEC where these are available (refer Appendix B). Where site-based field observations of TECs significantly deviated from the desktop derived habitat assumptions, the mapping for these areas was modified to reflect results from ground-truthing. In addition, where a threatened species was observed, these areas were elevated in status to either *potential habitat* (for areas that were not currently mapped as *potential habitat* for the species), or *Habitat critical to the survival of the species* (for locations that were already included within the *potential habitat* mapping layer) (refer Section 3.2.4 for further detailed information).

Protected plant surveys

In addition to the methodologies presented above, a random meander survey was undertaken at each target site and each opportunistic site (regardless of their inclusion/exclusion from “High Risk” areas identified in the Queensland Government Protected Plants flora survey trigger map) to specifically target threatened species. At each site, the random meander survey was undertaken (as per the QLD Protected plants survey guidelines (e.g. DEHP 2016a)) until no new flora species were identified for 30 minutes following the recording of the last identified flora species. As such, surveys were carried out for a minimum of 30 minutes at each site but may have extended well beyond this search timeframe where new species were encountered. Samples of all EPBC Act listed flora species encountered were submitted with the Queensland Herbarium for incorporation into the HERBRECS database, and all flora survey records were submitted to DES as part of FFJV’s scientific purposes licencing commitments.

The random meander survey method was also employed at sites within and adjacent to the Project disturbance footprint associated with vegetation clearing for geotechnical works (largely boreholes and access tracks) (EMM 2018b, 2018c; 2019a, 2019b; ELA 2019a, 2019b). As per the QLD protected plant survey guidelines (DEHP 2016a), surveys were carried out within the targeted clearing area with an additional 100 m buffer area applied (providing a substantial survey area at each site).

Survey effort

In addition to the targeted EIS study survey locations identified in Table 3.5 (26 sites within the MNES study area) and initial flora studies carried out by Jacobs-GHD in 2016a (60 sites within the MNES study area), 69 opportunistic surveys associated with geotechnical investigations were undertaken by FFJV personnel, specifically targeting areas within the disturbance footprint. The location of opportunistic surveys is shown in Figure 3.3a-e. With regard to survey effort, a total area of approximately 299 ha was assessed (i.e. 82 ha associated with targeted surveys and 217 ha associated with opportunistic investigations). This represents approximately 2.4 per cent of the MNES study area and approximately 30.6 per cent of the Disturbance footprint.

Protected plant surveys carried out throughout 2018 and 2019 (refer Table 3.2) by EMM (2018b, 2018c; 2019a, 2019b) and ELA (2019a, 2019b) include surveys at 196 sites within and adjacent to the Project disturbance footprint. This is estimated to have encompassed approximately 149 linear kilometres of protected plant meander surveys within the MNES study area. The methods employed are considered to provide an acceptable level of survey effort to sufficiently inform an assessment against the MNES Guidelines for MNES flora species.

The surveys targeted a range of habitats including cleared agricultural land, remnant and regrowth mapping.

3.3.2.2 Fauna field assessments

Assessments for EPBC Act listed species were conducted for the EIS studies (FFJV) with the following objectives:

- Validation of the predictive habitat mapping where applicable
- Use of specific techniques to identify EPBC Act listed species and their habitat where present.

In addition to the techniques identified above, the use of existing datasets, historic records and the formulation of the predictive habitat models for EPBC Act listed species provided a comprehensive assessment of the MNES fauna habitat contained within the MNES study area, that is considered to incorporate seasonal (i.e. temporal) variation and takes a precautionary approach to EPBC Act listed species contained within the MNES study area.

Field based methodologies are further described in the sections below. A list of species encountered at each site was recorded.

Fauna habitat assessments

At each vegetation assessment location (refer ‘terrestrial sampling sites’ in Figure 3.3), an assessment of fauna habitat features, and a record of all fauna species encountered was undertaken (a total of 26 sites). Fauna habitat assessments were also undertaken within the MNES study area by Jacobs-GHD (2016a) (a total of 34 sites). Fauna habitat features recorded included, but was not limited to:

- Level of disturbance (scale of 0 – nil and 3 – severe) relating to the following:
  - Fire
  - Grazing
  - Clearing
  - Erosion
- List of threatened fauna species that are likely to utilise the area based on available habitat types (based on database search results and predictive habitat mapping)
- Abundance of tree hollows present in the following categories:
  - > 30 cm diameter
  - > 15 cm but < 30 cm diameter

  - > 10 cm but < 15 cm diameter
  - > 5 cm but < 10 cm diameter
  - < 5 cm diameter
- Abundance of fallen logs (>10 cm diameter)
- Abundance of coarse woody debris (<10 cm diameter)
- Abundance of trees with decorticating bark
- Percentage of groundcover containing the following:
  - Leaf litter
  - Bare ground
  - Grasses
  - Soil cracks
  - Surface rocks
  - Non-native flora species (e.g. weeds)
- Presence of:
  - Soil banks (e.g. river beds, road cuttings)
  - Bounders
  - Wetlands/drainage features
- Abundance of the following:
  - Flowers
  - Fruit.

All species of fauna observed at each site were identified to the species level where possible (refer Appendix I for habitat assessments sheets).

Targeted fauna survey methods

When areas were identified as containing habitat considered likely to support threatened species (i.e. both within vegetation assessment areas and at opportunistic locations), specific techniques were employed to increase the likelihood of detecting these species. Specific techniques adopted as part of the ecological assessments (including survey effort where applicable) and their relevance to MNES fauna include the following:

- Anabat devices (Microchiropteran bats) were undertaken by FFJV (EIS studies) at Sites T1 and T9 (overnight) and by Jacobs-GHD (2016a) at four other sites along the alignment for a minimum of four nights (refer Figure 3.2a-e and Figure 3.3a-e for locations). Two additional sites noted in Teviot Range for surveys for alternative tunnel options for Project (GHD 2017a). The total survey effort (20 detector nights) aligns with the recommended total effort (16 detector nights) required for the Large-eared pied bat (*Chalinolobus dwyeri*) as outlined in the *Survey guidelines for Australia's threatened bats* (DEWHA 2010a).
- Area searches for nests including for Red goshawk (*Erythrotriorchis radiatus*) in suitable riparian areas during the EIS studies, and by ELA and EMM during targeted pre-clearance surveys (2018d; 2018e; 2019c)
- Active searches for feeding platelets of the Black-breasted button quail (*Turnix melanogaster*) within suitable habitat for the EIS studies and by Jacobs-GHD (2016a, 2017a).

- Standardised surveys for all birds which is suitable for all MNES species including the Swift parrot (*Lathamus discolor*), Painted honeyeater (*Grantiella picta*) and Australian painted snipe (*Rostratula australis*) at all 'terrestrial sampling sites' (refer Figure 3.3a-e for locations) comprising recording birds by observation or calls for 20 minutes over a 2 ha survey area. These used the Birds Australia census technique described by Loyn (1986) for the EIS studies. Bird surveys also carried out by Jacobs-GHD (2016a) (refer 'fauna ecology survey site in Figure 3.2a-e for locations).
- Active searches for koala (*Phascolarctos cinereus*) at all 'terrestrial sampling sites' (refer Figure 3.3a-e for locations), their pellets and scratches were undertaken for the EIS studies and across several Project-associated studies (Jacobs-GHD 2016a, 2017a; ELA 2019c) (refer 'fauna ecology survey site' in Figure 3.2a-e for locations)
- Active search for latrine sites and dens for the Spotted-tail quoll (*Dasyurus maculatus*) within suitable rocky habitat for the EIS studies, Jacobs-GHD (2016a, 2017a) and ELA (2019c)
- Active searches for Brush-tailed rock wallaby (*Petrogale penicillata*) and their pellets which were validated by experts at Queensland Museum for confirmation. Searches for signs and habitat resources are considered an adequate form of survey method for detecting this species, as long as all suitable rocky habitat including mid-level ledges and holes are inspected for signs of activity (DSEWPaC 2011b. Carried out for the EIS studies, Jacobs-GHD (2016a, 2017a) and ELA (2019c).
- Active searches for reptiles at all 'terrestrial sampling sites' (refer Figure 3.3a-e for locations), including the collared delma (*Delma torquata*). This involved 20 minutes of searching by two people over 1 ha within suitable microhabitats, particularly beneath rocks and fallen logs and amongst leaf litter and woody debris. Carried out for the EIS studies, as well as by Jacobs-GHD (2016a, 2017a) and ELA (2019c) (refer 'fauna ecology survey site' in Figure 3.2a-e for locations).
- Spotlighting and night driving for Dunmall's snake (*Furina dunmalli),* along with other amphibians, reptiles, birds and mammals – outside of formalised survey locations. Carried out for the EIS studies and Jacobs-GHD (2016a, 2017a)
- Call playback (nocturnal birds) - outside of formalised survey locations where suitable habitat for target species was identified (Jacobs-GHD 2016a, 2017a). Playback included calls broadcast for two minutes followed by a 5 minute listening period.

Other species encountered during these works were recorded, along with opportunistic observations (all fauna species) (refer Appendix F for species list and EIS Appendix J: Terrestrial and Aquatic Ecology Technical Report for more details). Remote sensing techniques were used to ensure maximum chances of detecting threatened species, without increasing the species risk of harm or placing stress upon the animal (i.e. animals sampled ethically and humanely). This included:

- Infra-red remote motion-sensing cameras (overnight) at watering points and/or at baited feeding stations (mammals and birds) – Sites T1 and T9 and three in the Teviot Range for the EIS studies. Cameras were also deployed by Jacobs-GHD (2016a; 2017a) (refer Figure 3.2a-e and Figure 3.3a-e for locations).

Whilst the use of non-invasive techniques such as remote sensing data and habitat assessments in lieu of trapping deviates from the techniques recommended by DAWE, the use of such techniques, when combined with the predictive habitat mapping assists in providing information to suitably inform the impact assessment process in instances of site inaccessibility or deficiencies of existing information. The methodology employed is scientifically robust, defendable and repeatable.

Preclearance habitat surveys

In addition to the fauna survey methods employed for the EIS studies identified above (i.e. FFJV and Jacobs-GHD (2016a)) a large number of 'preclearance surveys' associated with vegetation clearing for geotechnical works (largely boreholes and access tracks) (EMM 2018d, 2018e; 2019c, 2019d; ELA 2019c) have been carried out during 2018 and 2019. Surveys were carried out at 39 locations (EMM) and 296 locations (ELA) throughout the Project disturbance footprint.

The surveys included the following methods:

- Searches for potential breeding habitat for threatened species such as:
  - Recording of all burrows/dens, logs, rocks, caves and suitable leaf litter that may contain breeding habitat for threatened species
  - Recording of hollow bearing trees noting hollow attributes such as size, angle, height in the tree and orientation it was facing
  - Recording of bird nests and potential for active nesting
- Habitat suitability assessments for threatened species with key habitat types recorded
- Assessment of Koala microhabitat incorporating evidence of koalas in the area (e.g. sightings, scratches and scats), food tree abundance, tree species and habitat context (ELA survey locations only)
- Incidental fauna observations recorded.

3.3.2.3 Aquatic surveys

Aquatic habitat assessments

A total of 16 sites were selected for aquatic habitat assessments based on wetland and watercourse mapping and land access (refer Table 3.5). The aquatic habitat assessments described the environmental values of targeted watercourses (to assess existing environmental condition proximal to, and where the Project alignment intersects watercourses) within the MNES study area. The Australian River Assessment System (AUSRIVAS) Physical Assessment Protocol (Parsons et al. 2002) was used in the field assessment of the drainage systems.

The key geomorphological, physical habitat and riparian data which was collected at each assessment site included:

- Valley characteristics, including valley shape and channel slope
- Land use, including catchment land use and local land use
- Physical morphology and bedform of the watercourse, including channel shape and extent and type of bars
- Cross sectional dimensions of the watercourse, including bank full channel width and depth, bank width and height and baseflow stream width and depth
- Substrate characteristics, including bed compaction, sediment angularity, bed stability rating, sediment matrix and substrate composition
- Floodplain characteristics, including floodplain width and features
- Bank characteristics, including bank shape and slope, bank material, bedrock outcrops, factors affecting bank stability and artificial bank protection measures
- Instream vegetation and organic matter, including extent of large woody debris, macrophyte cover and species composition
- Physical condition indicators and habitat assessment
- Riparian vegetation characteristics, including shading of channel, extent of trailing bank vegetation, species compositions, riparian zone width and extent of disturbance.

In addition, surface water quality sampling was conducted at aquatic habitat assessment sites. Three discrete water sampling events were carried out: one spring (September 2017); one late summer (February 2018) and one autumn assessments (March 2019). Watercourse flow was limited; however, this was consistent with the highly seasonal, and sporadic flow regimes throughout the MNES study area. Noting the seasonal flow regimes of the watercourses, timing of the assessments was chosen in order to capture dry or wet condition water quality samples.

In-situ water quality field data was collected during each monitoring round in addition to samples collected for laboratory analysis. Aquatic habitat assessment sites (refer Table 3.5) were also used for the water quality assessment. Sampling could not be undertaken at all assessment sites due to a lack of adequate water (i.e. dry conditions) at the time of the water quality sampling event. As such, 12 of the original 16 aquatic habitat sites were used for the water quality assessment. Detailed methodology (including water quality parameters) and results of the water quality sampling assessments are provided in detail in EIS Chapter 13: Surface Water and Hydrology.

Aquatic fauna surveys

Recordings of incidental fauna species observed during the aquatic field survey were taken at each aquatic ecology assessment site. A sample of aquatic fauna species present at the time of the aquatic sampling was undertaken using two baited traps and dip netting, specifically targeting vertebrate species such as fish and turtles where adequate water was present. Capture and release trapping and netting works associated with fish and turtle assessments was conducted to collect incidental species occurrence data and supplement existing data sets. These works did not exceed two hours at any site to reduce risk of harm to species and minimise field survey effort, whilst dip netting was completed on an incidental basis to address size-specific constraints associated with baited traps.

This approach supplemented the targeted surveys, fyke netting and electrofishing, undertaken by Jacobs-GHD (2016a) on the major watercourses intersected by the Project, including Teviot Brook and the Bremer River. These techniques are recommended in the Commonwealth's *Survey guidelines of Australia's threatened fish* (DSEWPaC 2011c) for the Australian lungfish (*Neoceratodus forsteri*) and Mary River cod (*Maccullochella mariensis*), along with common species.

A representation of predictive fauna habitat mapping for EPBC Act listed species was undertaken by comparing the species-specific habitat assumptions derived from the desktop phase, to characteristics observed in the field. Where site-based field observations significantly deviate from the desktop derived habitat assumptions, these areas were updated within the mapping to reflect the existing condition (refer Section 3.2.4 and Appendix A for further details).

3.3.3 Permits to conduct works

The ecological field surveys (undertaken by FFJV) reported in this document were conducted under the provisions of Aurecon's Scientific Purposes Permit (WISP14453114), General fisheries permit (182654) and Animal ethics approval for General Fish Surveys (CA 2015/01/833) and General Terrestrial Surveys (CA 2015/03/846) and AECOM's Scientific Purposes Permit (WISP16615015) and Animal ethics approval for fauna surveys in Queensland (CA 2015/01/834).

3.3.4 Quality assurance/quality control

Quality assurance/quality control in relation to field results occurred through the following processes:

- At least one suitably qualified person in accordance with Section 4.2.1 of the Flora survey guidelines (DEHP 2016a) was present within each survey team
- A portion of any potential MNES flora species encountered, or species that could not be confidently identified during field reconnaissance, was submitted to the Queensland Herbarium for verification/identification
- All flora samples submitted to the Queensland Herbarium were stored in a field press to ensure their integrity. Samples were stored in a cool/dry environment and were submitted to the Queensland Herbarium within nine days of collection
- Scats that were collected in the field were taken to the Queensland Museum for species confirmation
- Any threatened fauna species had to be sighted/confirmed by both member of the field team to produce a confirmed record. Where applicable/possible, proof (e.g. photograph, scat or other evidence) was collected

- Surface water quality sampling was conducted in accordance with industry-accepted standards and quality assured procedures. Field quality control included rigorous sample collection, decontamination procedures (where appropriate), and sample documentation. As each sample was collected it was labelled with a unique sample identifier, the initials of the sampler, the date and the project number. All sample jars were filled leaving no headspace and placed immediately into ice-filled cooler boxes. All samples were transported in ice-filled coolers to prevent degradation of organic compounds. Chain of Custody (CoC) documentation was completed, with data including sample identification, date sampled, matrix type, preservation method, analyses required and name of sampler. Field data monitoring equipment was fully serviced and calibrated prior to use.

3.3.5 Nomenclature

3.3.5.1 Flora

The source of nomenclature for the flora sections of this report is the Census of the Queensland Flora (Department of Environment and Science 2019). The botanical names comply with the rules of the current International Code of Botanical Nomenclature (McNeill et al. 2006) and the International Code of Nomenclature for Cultivated Plants (Brickell et al. 2016). Author abbreviations follow Brummitt and Powell (1992).

3.3.5.2 Fauna

The sources of nomenclature for the fauna sections of this report are as follows:

- Ingram, McDonald and Nattrass (2002) for frogs
- Wilson and Swan (2017) for reptiles
- Pizzey and Knight (2012) for birds
- Menkhorst and Knight (2010) for mammals
- Duncan et al's Action Plan for Australian Bats (1999) for microbats
- Pusey, Kennard and Arthington (2004) for freshwater fish.

3.4 Impact assessment methodology

The MNES assessment of the Project uses a significance-based impact assessment framework to identify and assess potential Project related impacts in relation to MNES. Initial impact assessment was undertaken to identify MNES where they may be subject to significant impacts (refer Section 3.4.3). Where impacts were identified as potentially significant, these were subject to assessment against the MNES significant impact assessment guidelines 1.1 (refer Sections 5.3.3, 5.3.4 and 5.3.5).

For the purpose of assessment, the MNES assessment was undertaken both quantitatively (e.g. measurable assessment of vegetation community (RE) attributes) and qualitatively (e.g. visual evaluation of fauna habitat values). For the purpose of assessment, a significant impact depends upon the sensitivity of the MNES, the quality of the environment, which is impacted, and upon the magnitude of the potential impact. Determination of the sensitivity or vulnerability of the MNES and the magnitude of the potential impacts facilitate the assessment of the significance of total potential project impacts.

The sections below discuss and define impact magnitudes, MNES sensitivity and impact significance.

3.4.1 Magnitude of impacts

The magnitude of a potential impact is essential to the determination of its level of significance on sensitive values/MNES. For the purposes of this assessment, impact magnitude is the nature and extent of the potential impacts, including direct and indirect impacts. The impact magnitude is divided into five categories (refer Table 3.6). The magnitude of impacts is determined using techniques and tools that facilitate an estimation of the **extent**, **duration** (refer Table 3.7) and **frequency** of the impacts.

Table 3.6 Criteria for magnitude

Magnitude	Description
Major	An impact that is widespread, permanent and results in substantial irreversible change to the MNES. Avoidance through appropriate design responses or the implementation of environmental management controls are required to address the impact. (e.g. greater than 50% of the habitat within the greater area disturbed).
High	An impact that is widespread, long lasting and results in substantial and possibly irreversible change to the MNES. Avoidance through appropriate design responses or the implementation of site-specific environmental management controls are required to address the impact. (e.g. between 13-50% of the habitat within the greater area disturbed).
Moderate	An impact that extends beyond the area of disturbance to the surrounding area but is contained within the region where the Project is being developed. The impacts are short-term and result in changes that can be ameliorated with specific environmental management controls. (e.g. between 2-13% of the habitat within the greater area disturbed).
Low	A localised impact that is temporary or short-term and either unlikely to be detectable or could be effectively mitigated through standard environmental management controls. (e.g. between 1-2% of the habitat within the greater area disturbed).
Negligible	An extremely localised impact that is barely discernible and is effectively mitigated through standard environmental management controls. (e.g. less than 1% of the habitat within the greater area disturbed).

The timeframes used to predict the duration of potential impacts on MNES (refer Table 3.7) has been derived using the approach described in the Environmental Assessment and Management (EAM) Risk Management Framework as employed by the Great Barrier Reef Marine Park Authority (GBRMPA 2009). The Framework is designed to manage risk and help inform decisions regarding the construction and operational risks associated with Project activities on environmental values (in this case MNES).

Table 3.7 Timeframes for predicted Project activity impact duration

Duration term	Timeframe – to be defined for each activity type (refer Table 5.1)
Temporary	Days to months (e.g. 1 to 2 seasons; 3 to 6 months)
Short-term	Up to 2 years (i.e. 6 to 24 months)
Medium-term	From 2 to 10 years[1]
Long-term/long lasting	From 11 to 20 years[2]
Permanent or irreversible	More than 21 years[3]

Table notes:

1 Derived from the term 'moderate' EAM Risk Management Framework 2009 (Great Barrier Reef Marine Park Authority 2009)
2 Derived from the term 'major' EAM Risk Management Framework 2009 (Great Barrier Reef Marine Park Authority 2009)
3 Derived from the term 'catastrophic' EAM Risk Management Framework 2009 (Great Barrier Reef Marine Park Authority 2009)

3.4.2 Sensitivity

To assess the significance of potential impacts on sensitive MNES, sensitivity categories are applied to each of the features. The sensitivity categories are split into three discrete groups as described in Table 3.8. These groupings are based on qualitative assessments utilising information related to the sensitivity of the MNES, in addition to the potential of a sensitive MNES's occurrence within the receiving environment.

Through the determination of sensitivity categories for each of the MNES, the features are then able to be assessed through a matrix against the magnitude of the potential Project impact type to indicate the level of significance for each of the impact types on the MNES.

Each particular environmental value assessed (MNES in this case) is treated individually (i.e. MNES are not treated collectively). In the case where there are conflicting classes, the "worst-case" is taken.

Table 3.8 Sensitivity criteria for matters of national environmental significance within the study area

Sensitivity	Description
Major	▪ The environmental value is listed on a recognised or statutory state, national or international register as being of conservation significance ▪ The environmental value is **entirely** intact and **wholly** retains its intrinsic value ▪ The environmental value is unique to the environment in which it occurs. It is isolated to the affected system/area, which is poorly represented in the region, state, country or the world ▪ It has not been exposed to threatening processes, or they have not had a noticeable impact on the integrity of the environmental value ▪ Project activities would have an adverse effect on the environmental value.
High	▪ The environmental value is listed on a recognised or statutory state, national or international register as being of conservation significance ▪ The environmental value is **relatively** intact and **largely** retains its intrinsic value ▪ The environmental value is unique to the environment in which it occurs. It is isolated to the affected system/area, which is poorly represented in the region ▪ The environmental value has not been exposed to threatening processes, or they have not had a noticeable impact on the integrity of the sensitive value ▪ Project activities would have an adverse effect on the environmental value.
Moderate	▪ The environmental value is recorded as being important at a regional level, and may have been nominated for listing on recognised or statutory registers ▪ The environmental value is in a moderate to good condition despite it being exposed to threatening processes. It retains many of its intrinsic characteristics and structural elements ▪ The environmental value is relatively well represented in the systems/areas in which it occurs, but its abundance and distribution are exposed to threatening processes ▪ Threatening processes have reduced the environmental value's resilience to change. Consequently, changes resulting from Project activities may lead to degradation of the prescribed value ▪ Replacement of unavoidable losses is possible due to its abundance and distribution.

Table note:

Low and negligible sensitivity criteria shown in Table 3.9: Significance assessment matrix are not included in this table as they are not considered applicable to MNES.

3.4.3 Initial assessment of the significance of total impact

The significance of a potential impact is a function of an impacted MNES's **sensitivity** and the **magnitude** of the potential impact. Although the sensitivity of the MNES will not change (i.e. is generally determined qualitatively by the interaction of the MNES's condition, adaptive capacity and resilience), the **magnitude** of the potential impact is variable and may be categorised quantitatively to facilitate the prediction of the significance of the potential impact.

Once the sensitive value/MNES has been identified, and the **sensitivity** of the MNES and the **magnitude** of the potential impact have been determined, this will facilitate the assessment of the significance of the potential impact through use of a five by five matrix (refer Table 3.9).

Table 3.9 Significance assessment matrix

Magnitude of impact	Sensitivity				
	Major	High	Moderate	Low	Negligible
Major	Major	Major	High	Moderate	Low
High	Major	Major	High	Moderate	Low
Moderate	High	High	Moderate	Low	Low
Low	Moderate	Moderate	Low	Negligible	Negligible
Negligible	Moderate	Low	Low	Negligible	Negligible

Table 3.10 Significance classifications

Significance rating	Description
Major	Arises when an impact will potentially cause irreversible or widespread harm to an environmental value that is irreplaceable because of its uniqueness or rarity. Avoidance through appropriate design responses is the only effective mitigation.
High	Occurs when the proposed activities are likely to exacerbate threatening processes affecting the intrinsic characteristics and structural elements of the MNES. While replacement of unavoidable losses is possible, avoidance through appropriate design responses is preferred to preserve its intactness or conservation status.
Moderate	Results in degradation of the environmental value due to the scale of the impact or its susceptibility to further change even though it may be reasonably resilient to change. The abundance of the MNES ensures it is adequately represented in the region, and that replacement, if required, is achievable.
Low	Occurs where an environmental value is of local importance and temporary or transient changes will not adversely affect its viability provided standard environmental management controls are implemented.
Negligible	Does not result in any noticeable change and hence the proposed activities will have negligible effect on environmental values. This typically occurs where the activities are located in already disturbed areas.

Significance ratings of Low, Moderate, High and Major constitute a potential significant residual impact to an MNES and are assessed against the *MNES Significant impact guidelines 1.1* (DotE 2013a) Guidelines to confirm the initial impact assessment results (refer Sections 5.3.3, 5.3.4 and 5.3.5).

Following the identification of the level of significance using initial impact mitigation measures, Project mitigation measures were then applied to the potential impacts to identify the residual (mitigated) impacts in a tabular form.

Initial assessment of the significance of impacts was undertaken for the following project phases:

- Construction
- Commissioning and reinstatement
- Operation.

Given the uncertainty associated with timeframe for decommissioning, this phase was not considered in the initial impact assessment.

3.4.4 Assessment of the significance of impact against the matters of national environmental significance significant impact guidelines

Following the initial assessment of significance (refer Section 3.4.3), assessment of impacts to MNES that returned a mitigated initial significance rating of Major, High, Moderate or Low was undertaken. MNES that returned a rating of Negligible, or those MNES for which habitat had not been identified within the MNES study area, were omitted from assessment against the MNES Guidelines. Relevant MNES were assessed against the following guidelines as applicable:

- Significant impact guidelines 1.1 – Matters of National Environmental Significance: *Environment Protection and Biodiversity Conservation Act 1999* (DotE 2013a)
- EPBC Act Referral Guidelines for the vulnerable koala (combined populations of QLD, New South Wales and the Australian Capital Territory) (DotE 2014)

Assessment of MNES against the relevant criteria in the MNES Guidelines is presented in the following sections:

- TECs – Section 5.3.3
- Threatened flora species – Section 5.3.4
- Threatened fauna species – Section 5.3.5.

3.5 Cumulative impact assessment methodology

When numerous projects occur in a region they result in cumulative impacts, which differ from those of an individual project when considered in isolation. Cumulative impacts may be positive or negative, and their severity and duration will depend on the project size and timing overlap.

The sections below outline the selected projects to be used in the cumulative impact assessment and the methodology to be applied in order to undertake the assessment.

3.5.1 Project selection

Projects for inclusion in the cumulative impact assessment (CIA) are all those within the Project region, as shown in Figure 3.4, including the projects that:

- Have been declared a 'coordinated project' by the Coordinator-General under the SDPWO Act and an EIS is currently being prepared or is complete, or an Initial Advice Statement is available on the Queensland Department of State Development, Tourism and Innovation website
- Are currently being assessed under Part 1 of the Chapter 3 of the QLD *Environmental Protection Act 1994* as per DES website
- May use resources located within the region (including materials, groundwater, road networks or workforces) that are the same as those to be used by the Project
- Could potentially compound residual impacts that the Project may have on environmental or social values.

Table 3.11 indicates the projects that have been included in the cumulative impact assessment, and their associated selection criteria. The approximate location of these projects in relation to the Project is shown in Figure 3.4. The projects listed in Table 3.11 include infrastructure development projects located in proximity to the Project. It is noted that the Remondis Waste to Energy Facility located in the Swanbank Industrial Estate has not been included as part of the cumulative impact assessment as the project is located in a highly disturbed environment. Initial investigations indicate this project will not contribute towards impacts to MNES as identified within this document.

It is important to note that projects that fall into the following categories have been excluded from the cumulative impact assessment:

- Existing or historic projects within the Project cumulative impact assessment area that are considered to constitute part of the baseline environment
- Projects that have not been developed to the point that their environmental assessment process has been made public.

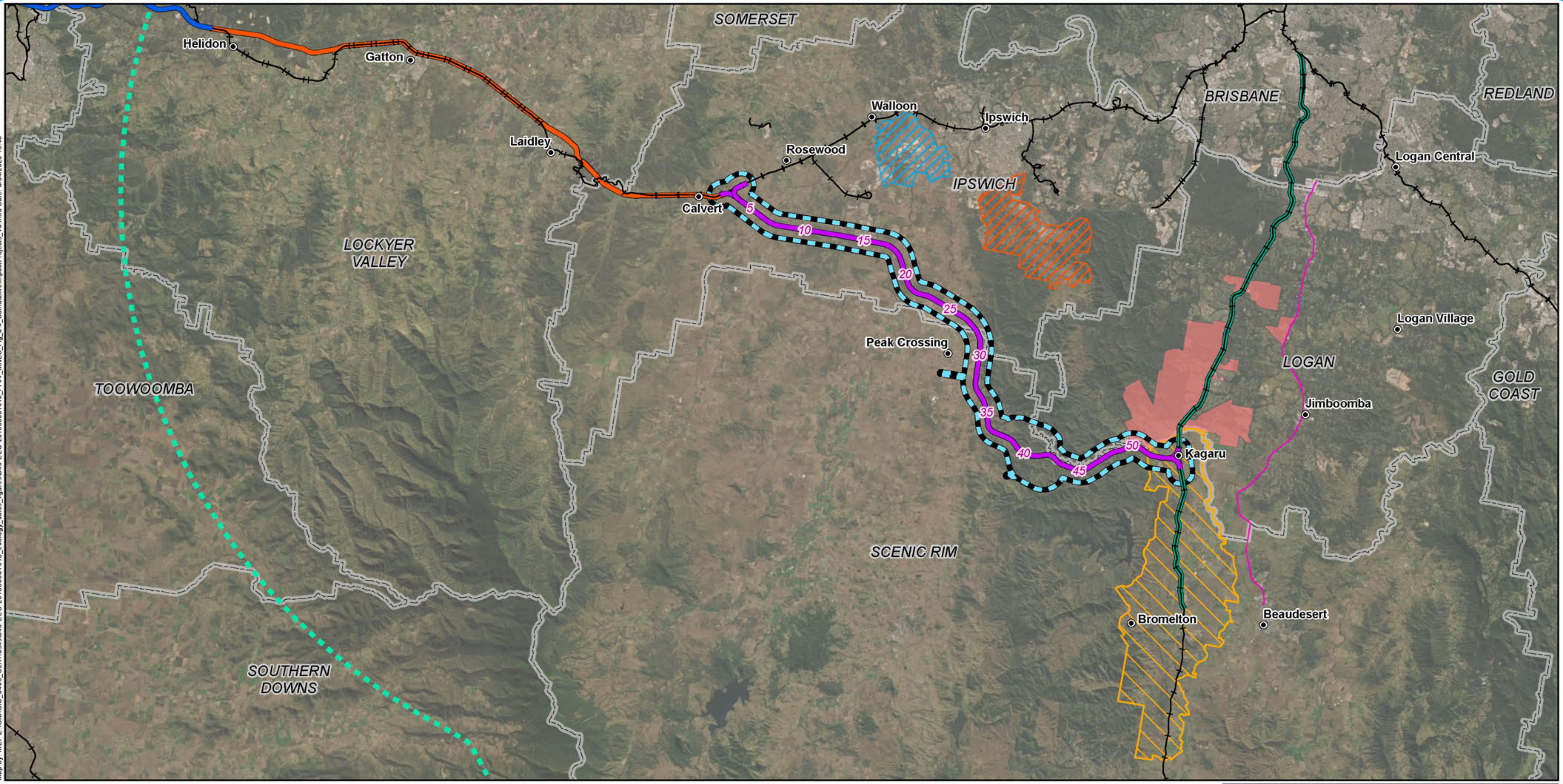
Table 3.11 Projects to be included in cumulative assessment

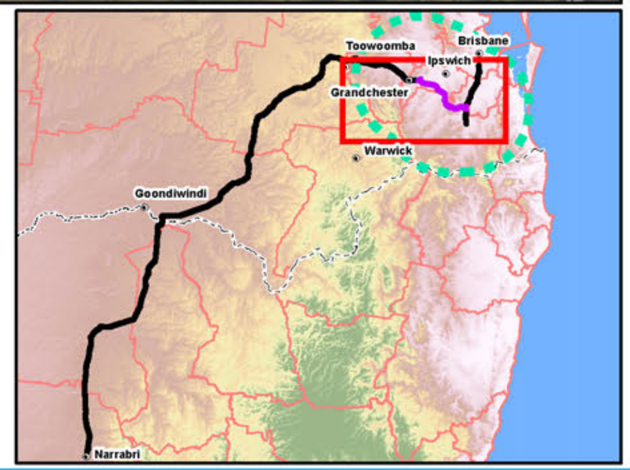
Project and proponent	Location	Description	Source	Project status	Construction dates and jobs	Operation years and jobs	Selection criteria[1]	Relationship to the Project
Kagaru to Acacia Ridge and Bromelton (K2ARB) (ARTC)	Rail corridor from Kagaru to Acacia Ridge and Bromelton	Enhancing and connecting the existing rail corridor (approximately 49 km) from North-east of Kagaru to Acacia Ridge and from south of Kagaru to Bromelton	Application for coordinated project status currently under consideration by the Coordinator-General	ARTC awaiting coordinated project decision by the Coordinator-General	2023 to 2025 Jobs TBA	> 50 years Jobs TBA	c)	Potential overlap of construction for C2K and commencement for K2ARB
Helidon to Calvert (ARTC)	Rail alignment from Helidon to Calvert	The H2C project will include the following: ▪ 47 km single-track dual-gauge freight rail line to accommodate double stack freight trains up to 1,800 m long ▪ Tunnel through the Little Liverpool Range ▪ Construction of rail infrastructure, culverts, bridges, viaducts and crossing loops ▪ Connection to the existing West Moreton Railway Line ▪ Ancillary works including road and public utility crossings and realignments	http://eisdocs.dsdip.qld.gov.au/Inland%20Rail%20Helidon%20to%20Calvert/IAS/h2c-initial-advice-statement.pdf	ARTC currently preparing EIS Declared a 'controlled action by DotEE – 17/03/2017	2021 to 2026 Average 193 full-time construction jobs	> 50 years Jobs 20 full-time equivalent	b) and c)	Potential overlap of construction for H2C and commencement for C2K
Greater Flagstone Priority Development Area (PDA) (Queensland Government)	Located within Logan City, west of Jimboomba and the Mount Lindesay Highway, along the Brisbane-Sydney rail line	When fully developed, it is anticipated that the Greater Flagstone PDA will provide approximately 50,000 dwellings to house a population of up to 120,000 people	https://dsdmip.qld.gov.au/edq/greater-flagstone.html	PDA declared by the Queensland Government on 8 October 2011	2011 to 2041 Jobs TBA	TBA	c) and d)	Potential overlap of construction times, demand for resources and traffic volumes in the Kagaru area

Project and proponent	Location	Description	Source	Project status	Construction dates and jobs	Operation years and jobs	Selection criteria[1]	Relationship to the Project
Bromelton State Development Area (SDA) (Queensland Government)	South of Kagaru in Bromelton	Delivery of critical infrastructure within the Bromelton SDA will support future development and economic growth. This includes a trunk water main and the Beaudesert Town Centre Bypass. This infrastructure provides opportunities to build on the momentum of current development activities by major landowners in the SDA.	https://www.statedevelopment.qld.gov.au/resources/project/bromelton/bromelton-sda-development-scheme-dec-2017.pdf	The current version of the Bromelton SDA Development Scheme was approved by Governor in Council, December 2017 The Development Scheme is managed by the Coordinator-General	2016 to 2031 Jobs TBA	TBA	c) and d)	Ongoing development north of Kagaru in the Bromelton SDA could result in a conflict for construction resources and see an increase of traffic volumes in the Kagaru area.
Ripley Valley PDA (Queensland Government)	Approximately 5 km south-west of the Ipswich central business district and south of the Cunningham Highway	The Ripley Valley PDA covers a total area of 4,680 ha and is an opportunity to provide approximately 50,000 dwellings to house a population of approximately 120,000 people. It is located in one of the largest industry growth areas in Australia and offers opportunities for further residential growth to meet the region's affordable housing needs.	https://dsdmip.qld.gov.au/edq/ripley-valley.html	PDA declared by State Government on 8 October 2011	2009 to 2031 Jobs TBA	TBA	c) and d)	Development could result in potential conflict for construction resources and see an increase in vehicle traffic
South West Pipeline: Bulk Water Connection to Beaudesert (Seqwater)	East of Kagaru, running north from Beaudesert	The proposal is investigating a bulk water pipeline connection from the Southern Regional Water Pipeline to Beaudesert, connecting Beaudesert to the SEQ Water Grid. The pipeline will pass through the site of the future Wyaralong Water Treatment Plant.	http://buildingqueensland.qld.gov.au/projects/south-west-pipeline-bulk-water-connection-to-beaudesert/	Currently completing Detailed Business Case	2021 Jobs TBA	TBA	c)	Potential conflict with demand for construction resources

Project and proponent	Location	Description	Source	Project status	Construction dates and jobs	Operation years and jobs	Selection criteria[1]	Relationship to the Project
RAAF Base Amberley future works (Department of Defence)	RAAF Base Amberley	White paper dedicated future upgrades to RAAF Base Amberley at a cost of $1 billion.	http://www.defence.gov.au/id/_Master/docs/Economic/KPMGRAAFAmberleyReport.pdf	N/A	2016 to 2022 7,000 jobs	TBA	c)	Ongoing development at RAAF Base Amberley may see an increase in road traffic with heavy vehicles and further increase as C2K construction occurs.
Cross River Rail (Queensland Government)	Brisbane City	A new north-south rail line connecting Dutton Park to Bowen Hills under the Brisbane River and CBD.	http://www.statedevelopment.qld.gov.au/assessments-and-approvals/cross-river-rail-project.html	Declared as 'not a controlled action' – 28/0/2010 EIS Complete New lapse date for the Coordinator-General's EIA evaluation report on 31 December 2025 at the time of writing.	2019 to 2025 1,547 jobs	> 50 years 576 jobs	c) and d)	Cross River Rail is located approximately 43 km from C2K at Kagaru. Cross River Rail is unlikely to result in material cumulative environmental impacts; however, depending on timing there may be competition for construction workers.

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community





Legend

5	Chainage (km)
●	Localities
—+—	Existing rail
	G2H project alignment
	C2K project alignment
	Cumulative impact study area
	MNES study area
	Local Government Areas

Projects

- Ripley Valley Priority Development Area
- RAAF Base Amberley
- State Development Area Boundary - Bromelton
- Priority Development Area Boundary - Greater Flagstone
- South West Pipeline
- Inland Rail H2C
- Inland Rail K2ARB

A3 scale: 1:350,000

0 2.5 5 7.5 10 12.5 km

Future Freight
Integrating Community, Environment and Engineering

Issue date: 08/04/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

Calvert to Kagaru

Figure 3.4: Location of projects that have been included in the cumulative impacts assessment

3.5.2 Approach

The approach used to identify and assess potential cumulative impacts of this Project in this technical report is summarised below.

- A review of the potential impacts identified within the EIS assessments:
  - The environment at the time of the EIS ToR is the baseline, prior impacts from past land use has not be considered
- A register of assessable projects has been collated with timelines to demonstrate the temporal relationship between projects. This has included:
  - Identification of projects outside of Inland Rail
  - Only State projects that are in the public domain as being planned, constructed or operated at the time of the EIS ToR have been considered
  - Where additional projects worthy of consideration have arisen after the finalisation of the EIS ToR, the Coordinator-General has been consulted to determine if assessment is required.
  - The Inland Rail projects immediately adjacent to the project within the assessment area. For this Project, the Helidon to Calvert and Kagaru to Acacia Ridge and Bromelton Inland Rail Projects have been considered
- Identification and mapping of the assessable projects and the areas of influence of the aspect being considered:
  - Current operational projects and commercial or agricultural operations that are in the areas of influence around the Project are accounted for in the corresponding technical baseline studies (e.g. air, noise, social, economic, etc.).
- Where there is a potential overlap in impacts (either spatially or temporally), a cumulative impact assessment has been undertaken to determine the nature of the cumulative impact. This includes:
  - Where possible the assessment method has been quantitative in nature (e.g. calculation of impact areas which inform magnitudes) but qualitative assessment has also been undertaken
  - Where quantitative assessment is possible, the significance of impact should be assessed in comparison to the same criteria or guidelines as adopted by the relevant technical impact assessments
  - Where the impacts are expressed qualitatively, the probability, duration, and magnitude/intensity of the impacts should be considered as well as the sensitivity and value of the receiving environmental conditions
- An assessment matrix method (further detailed within Section 3.5.3) has been used to determine the significance of cumulative impacts with respect to detrimental effects
- Where cumulative impacts are deemed to be of ‘medium’ or ‘high’ significance, additional mitigation measures are proposed, beyond those already proposed by the relevant technical impact assessments.

3.5.3 Assessment matrix

Following the identification of each potential cumulative impact, a relevance factor score of Low, Medium or High has been determined in consideration of the impacts, in accordance with the assessment matrix given in Table 3.12.

The significance of the impact has been determined by using professional judgement to select the most appropriate relevance factor for each aspect in Table 3.12 and summing the relevance factors. The sum of the relevance factors determines the impact significance and consequence which are summarised in Table 3.13. For example, if an environmental value such as groundwater was considered to have a probability of impact of 2, duration of impact of 3, magnitude /intensity of impact of 1 and a sensitivity of receiving environment of 1 the significance of impact would be (2+3+1+1 = 7) = Medium.

Table 3.12 Assessment matrix

Aspect	Relevance factor		
	Low	Medium	High
Probability of impact	1	2	3
Duration of impact	1	2	3
Magnitude/Intensity of impact	1	2	3
Sensitivity of receiving environment	1	2	3

Table 3.13 Impact significance

Impact significance	Sum of relevant factors	Consequence
Low	1 to 6	Negative impacts need to be managed by standard environmental management practices. Special imposed conditions unlikely to be necessary. Monitoring to be part of general project monitoring program.
Medium	7 to 9	Mitigation measures likely to be necessary and specific management practices to be applied. Specific imposed conditions are likely. Targeted monitoring program required, where appropriate.
High	10 to 12	Alternative actions should be considered and/or mitigation measures applied to demonstrate improvement. Specific imposed conditions required. Targeted monitoring program necessary, where appropriate.

4 Description of environmental values

4.1 Content of this section

This section describes the ecological values of the MNES study area including the results of the desktop analysis, field surveys results and predictive habitat mapping. This section then defines the ecological values and MNES of the MNES study area which will be the scope of the impact assessment presented in Section 5.

The following sections present the environmental values associated with the regional setting in which the Project occurs in order to provide a broader context for the observed values within the MNES study area.

4.2 Regional and local context

Landscapes within the Calvert area (western MNES study area) are characterised by very high levels of anthropogenic disturbance and present a highly fragmented environment dominated primarily by pasture grasses, isolated trees and areas of woody regrowth. Whilst much of the area is subject to grazing and other agricultural practices, waterways (e.g. Western Creek and the Bremer River) typically retain some degree of floristic structural complexity and have the potential to act as local fauna movement conduits and refuge habitats for a diversity for species (refer Section 4.4.4.7 and habitat types depicted in Figure 4.6a-e).

Areas around Ebenezer (east of Calvert) are typically characterised as a highly fragmented and anthropogenically impacted (i.e. subject to land clearing for agricultural purposes) landscape. However, areas of woody regrowth vegetation are more present when compared to the western portion of the alignment, particularly to the south of the disturbance footprint. As in the west, non-native pasture improvement species (e.g. grasses) dominate much of the landscape. Areas containing remnant vegetation are present within this area, however these vegetation communities largely exist as isolated islands within a fragmented landscape. Despite this fragmented landscape, the areas associated with Ebenezer have been identified as an ecological corridor of regional significance. The area is also modelled by DES as core habitat for *Melaleuca irbyana*, with patches of vegetation around Ebenezer and Purga analogous to the Swamp Tea-tree (*Melaleuca irbyana*) Forest of South-east Queensland TEC (refer Figure 4.6a-e).

The areas south of Purga towards Peak Crossing and Washpool are largely rural landscapes dominated by pasture species. However, within these areas woody regrowth and remnant vegetation in the form of intact ecosystems are increasingly common to the east of the disturbance footprint, particularly around Peak Crossing and Washpool. These areas coincide with the Project's parallel alignment with the Teviot Range. Most of this remnant vegetation is located outside of the disturbance footprint and situated in areas of sloping topography (refer Figure 4.6a-e).

Throughout the Woolooman area (in the east of the MNES study area) and the Teviot Range, the terrain is rugged and there is minimal development although historic land clearing practices have resulted in large areas of woody regrowth vegetation that has not yet reached remnant status (in relation to canopy height and cover). Whilst there is some remnant vegetation contained within the MNES study area, most remnant communities are located to the north and south of the disturbance footprint. The existing nature of the topography and vegetation facilitates the Teviot Range functioning as a fauna movement conduit in a north-south direction with the area identified as a terrestrial ecological corridor of State significance (refer Figure 11.12 in EIS Chapter 11: Flora and Fauna). In addition, this area functions as flora and fauna refuge habitat and is known to support threatened species such as Lloyd's olive (*Notelaea lloydii*) and Koala (*Phascolarctos cinereus*).

The area of Teviot Range to the north and east of the Project alignment (Flinders Peak area) is centred on a cluster of intrusive volcanic plugs of Tertiary age (Mounts Blaine, Catherine, Goolman, Perry, Welcome, Flinders Peak and Ivorys Rock) and is recognised by DES as an area of special biodiversity (DEHP 2016b). This is due to the presence of several SEQ endemic taxa and wildlife refugia.

The eastern portion of the alignment (areas around Kagaru), is characterised by largely non-remnant vegetation communities and agricultural land. The landscape is highly fragmented with remnant vegetation communities generally restricted to steep topography or waterways (e.g. Teviot Brook). Refer EIS Appendix J: Terrestrial and Aquatic Ecology Technical Report for further detail.

4.2.1 Geology

The geology west of the Teviot Range is underlain by interbedded sandstone, mudstone and siltstone of the Walloon Coal Measures. The central portion of the MNES study area is dominated by medium to coarse grained sandstone of the Gatton Sandstone that forms the topographic high of the Teviot Range. The eastern portion of the MNES study area is underlain by the interbedded siltstone, claystone and sandstone of the Koukandowie Formation and Walloon Coal Measures (Figure 9.4 in EIS Chapter 9: Land Resources).

Relatively thin deposits of alluvial sediments overlay the sedimentary rocks in places and are associated with the primary surface water features within the MNES study area. The alluvial sediments are limited in extent, both laterally and vertically, away from the watercourses. The key groundwater units are the unconfined alluvial sediment aquifers associated with the key watercourses, and the low permeability aquifers of the Walloon Coal Measures, Koukandowie Formation and Gatton Sandstone. Refer EIS Chapter 14: Groundwater and EIS Appendix O: Groundwater Technical Report for further details on geology associated with the MNES study area.

4.2.2 Catchment values

The Project is located in the lower reaches of the Bremer River catchment intersecting the Western Creek, the Bremer River, Warrill Creek and Purga Creek and their associated floodplains west of the Teviot Range (refer Figure 13.2 in EIS Chapter 13: Surface Water and Hydrology). Lake Moogerah, along with number of weirs are located upstream of the Project on Warrill Creek which are likely to impact environmental flows. The catchment health is considered to be in poor condition (Healthy Land and Water 2019a), with freshwater health continuing to decline due to a decrease across most indicators, particularly water quality and fish community health (Healthy Land and Water 2019a). Sites located on the local watercourses relative to the Project are considered to be in very poor condition. There are also a number of palustrine wetlands associated with the Bremer River catchment and in particular with the Warrill Creek catchment within close proximity to the Project, including Ten Mile Swamp.

The Project is also located in the mid-reaches of the Logan River catchment intersecting Woollaman Creek through the Teviot Range and Teviot Brook at the eastern extent. Wyaralong Dam is located, approximately 9 km upstream of the Project on Teviot Brook and influences environmental flows within the catchment. The catchment health is considered to be in slightly improved condition, although freshwater health has declined and remains in poor condition predominantly due to a decrease in fish community health across most of the assessment sites. One of the Healthy Waterway sites is located on Teviot Brook adjacent to the Project disturbance footprint (upstream) and is considered to be in very poor condition (Healthy Waterways 2019). Refer EIS Chapter 13: Surface Water and Hydrology and EIS Appendix M: Surface Water Quality Technical Report for further details on catchments and surface water quality relevant to the Project.

4.2.3 Groundwater values

The water table is typically a subdued version of topography, with the depth to groundwater increasing beneath topographic highs (for example the Teviot Range), and shallower groundwater in lower lying reaches (such as close to surface water drainage lines). Depths to groundwater in the alluvial sediments are anticipated to be between 5 m and 15 m but have been measured at less than 5 m in several locations across the MNES study area. In the main outcrop areas of Walloon Coal Measures, the water table is expected to be at least 5 m, and greater than 10 m beneath higher relief. Within the Gatton Sandstone of the Teviot Range the water table will be in the order of 60 m or more below ground surface at its deepest.

Potential aquatic and terrestrial groundwater dependent ecosystems (GDEs) were identified as being present within the MNES study area (refer Figure 4.8 in EIS Appendix J: Terrestrial and Aquatic Ecology Technical Report). Numerous watercourses traversing the MNES study area are designated as moderate potential aquatic GDEs from regional studies (as defined in the GDE Atlas (BoM2020)) including Western Creek, Bremer River, Warrill Creek, Purga Creek and Teviot Brook. The potential GDEs are described as wetlands 'supplied by alluvial aquifers with near-permanent flow'.

Low and moderate potential terrestrial GDEs (from regional studies) have been identified within the Teviot Range portion of the MNES study area. These are generally described as wetland vegetation supplied by low porosity sedimentary rock with intermittent flow. Wetland supplied by alluvial aquifers with near permanent flow (eastern flank) and riparian vegetation supplied by sedimentary rocks with saline flow (western flank) are also indicated.

Groundwater quality is variable across the key groundwater units. The MNES study area is located within the Clarence–Moreton bioregion assessment area where strong evidence of interaction between groundwater and surface water has been reported (Raiber et al. 2016). This supposition is based on several lines of evidence inclusive of assessment of groundwater and surface water quality, streamflow time-series data, groundwater hydrographs and streambed elevation.

It is anticipated that there will be interaction between watercourses and shallow groundwater in the associated alluvial sediments at some locations, particularly where drainage channels are more deeply incised and groundwater levels are shallow. The degree of interconnection will vary laterally due to local variations in alluvial sediment lithology, underlying bedrock geology and drainage channel morphology, as well as seasonally due to changes in groundwater elevations due to rainfall/drought events. At times watercourses may change from gaining systems (receiving baseflow from shallow groundwater) to losing systems (with surface water locally recharging the alluvial sediments).

An assessment of surface water–groundwater interaction in the Bremer River Basin found that hydraulic connection between the aquifer and river was relatively poor and of limited lateral extent (Raiber et al. 2016). This was thought to be linked to the broad valley of the Bremer River and limited depth of incision into the underlying alluvial sediments, with upper sections typically fine-grained clay rich floodplain sediments. Refer EIS Chapter 14: Groundwater and EIS Appendix O: Groundwater Technical Report for further details on groundwater values relevant to the Project.

There are no World heritage areas, National heritage areas, Commonwealth marine areas or Great Barrier Reef Marine Park areas located within or in close proximity to the MNES study area. The Project is located 30 km to 40 km upstream of Moreton Bay, a wetland of international importance (Ramsar) and is considered sufficiently displaced such that potential downstream impacts will be negligible.

4.3 Results of desktop study

The following subsections provide a comprehensive description of ecological values, based on the desktop study results, within the MNES study area and broader landscape.

The results of the database searches are presented in full in Appendix D. Results associated with previous surveys and surveys conducted concurrently with the EIS field investigations (i.e. additional ecological surveys associated with siting of geotechnical assessment locations) have been incorporated into the predictive habitat mapping and the relevant sections of this technical report, and has informed the impact assessment section of this document where appropriate.

4.3.1 Flora

4.3.1.1 Threatened flora species

A total of 20 threatened flora species identified under the provisions of the EPBC Act are predicted to occur within the MNES study area based on database searches (refer Table 4.1) (refer Appendix B for species profiles). Of these, 18 species have been identified exclusively from the EPBC Act protected matters search tool (PMST) report (DAWE 2020a) which is a predictive search tool that does not rely on specimen-backed records. The location of specimen-backed records for threatened flora species, derived from database sources (e.g. Wildlife Online and Atlas of Living Australia) is provided in Figure 4.1.

A total of two species listed under the provisions of the EPBC Act are considered likely to occur within the MNES study area based on specimen-backed records in Wildlife online and the Atlas of Living Australia databases and the presence of suitable habitat (refer Table 4.1).

A total of 14 species listed under the provisions of the EPBC Act are considered as a ‘possible occurrence’ within the MNES study area based on the presence of suitable habitat (refer Table 4.1).

A total of four species listed under the provisions of the EPBC Act are considered unlikely to occur within the MNES study area based on their distributional limits (refer Table 4.1).

Information related to the ecology, biology and distribution for species listed in Table 4.1 is provided in Appendix C.

Table 4.1 Threatened flora species identified from database searches

Family	Species name	Common name	EPBC Act	Data source			Likelihood of occurrence
				Wildlife online	PMST	Atlas	
Poaceae	*Arthraxon hispidus*	Hairy-joint grass	V		✓		Possible
Euphorbiaceae	*Bertya ernestiana*	A shrub	V		✓		Possible
Rutaceae	*Bosistoa transversa*	Three-leaved bosistoa	V		✓		Possible
Orchidaceae	*Bulbophyllum globuliforme**	Miniature moss-orchid	V				Possible
Cycadaceae	*Cycas ophiolitica*	-	E		✓		Unlikely, the MNES study area is outside of the species natural range (i.e. Rockhampton region of Queensland)
Sapindaceae	*Cupaniopsis tomentella*	Boonah tuckeroo	V	✓	✓		Possible
Poaceae	*Dichanthium setosum*	Bluegrass	V		✓		Possible
Brassicaceae	*Lepidium peregrinum*	Wandering pepper-cress	E		✓		Possible
Characeae	*Lychnothamnus barbatus^*	A green algae	E				Possible
Proteceae	*Macadamia integrifolia*	Macadamia nut	V		✓		Possible
Proteceae	*Macadamia tetraphylla*	Rough-shelled bush nut	V		✓		Unlikely, there are no occurrences of this species within 40 km of the MNES study area. Outside of the known range.

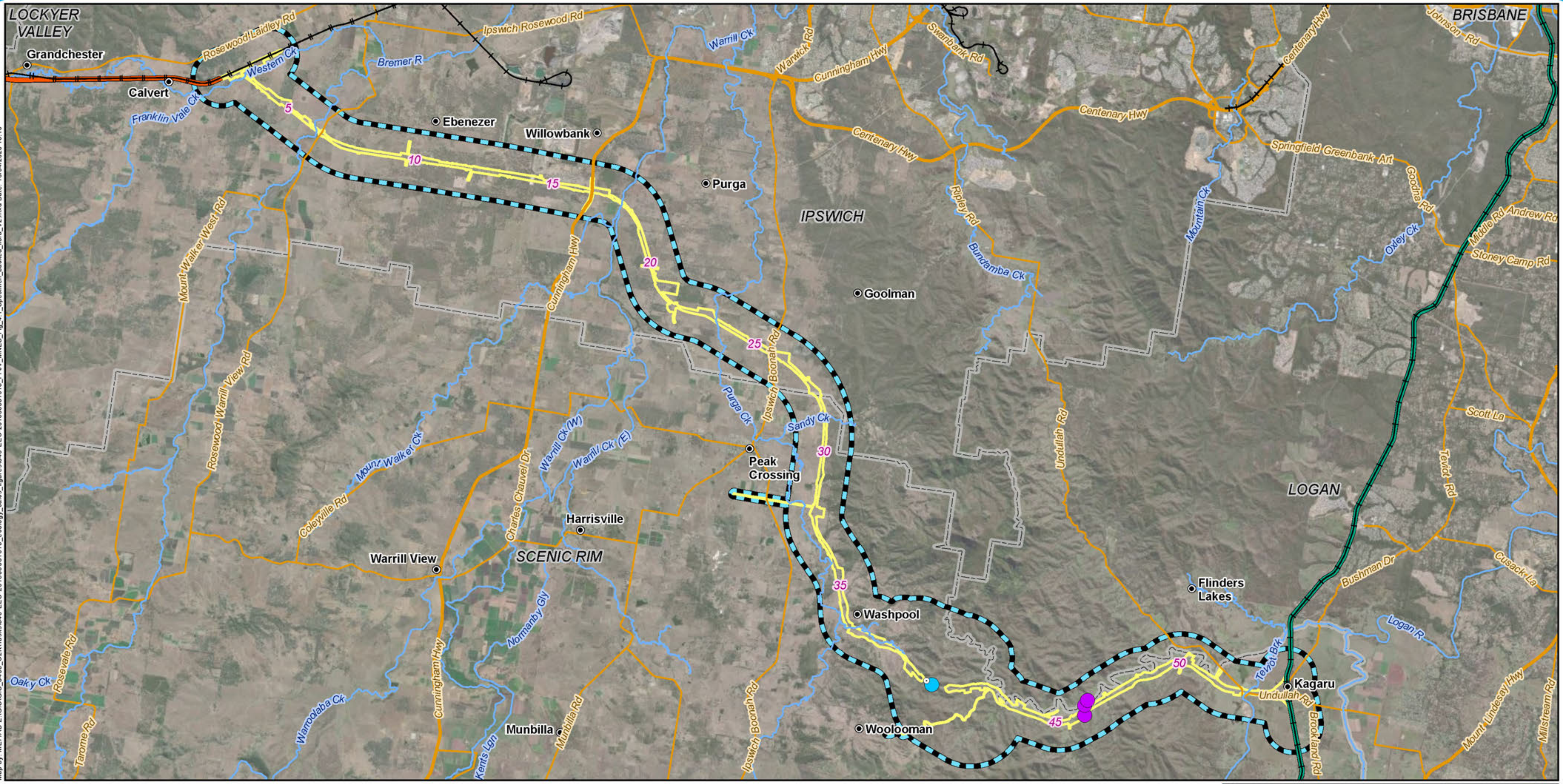
Family	Species name	Common name	EPBC Act	Data source			Likelihood of occurrence
				Wildlife online	PMST	Atlas	
Oleaceae	*Notelaea ipsviciensis*	Cooneana olive	CE		✓		Unlikely, this species is very localised occurring in the Ipswich area. MNES study area is outside of the known range.
Oleaceae	*Notelaea lloydii*	Lloyd's olive	V	✓	✓		Likely
Orchidaceae	*Phaius australis*	Lesser swamp-orchid	E		✓		Possible
Rutaceae	*Phebalium distans*	Mt Berryman phebalium	CE		✓		Possible
Sapotaceae	*Planchonella eerwah*	Shiny-leaved condoo	E	✓	✓	✓	Likely
Asteraceae	*Rhaponticum australe**	Austral cornflower	V				Unlikely, the MNES study area is outside of the species natural range
Simaroubaceae	*Samadera bidwillii*	Quassia	V		✓		Possible
Fabaceae	*Sophora fraseri*	Brush sophora	V		✓		Possible
Santalaceae	*Thesium australe*	Austral toadflax	V		✓		Possible

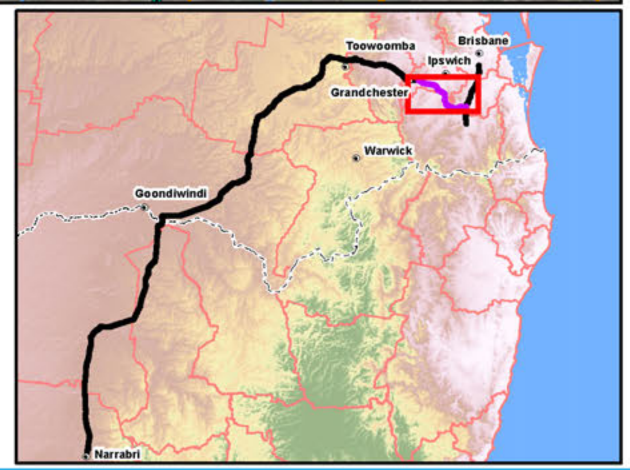
Table notes:

CE = Critically endangered E = Endangered PMST = Protected Matters Search Tool
V = Vulnerable ✓ = species present within database record within the MNES study area
* = Species identified in the ToR but not returned from database searches
^ = species not returned in database searches but has been included as it has been previously identified from Warrill Creek that is in proximity to the MNES study area.

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Map by: MEF/AD Z:\GIS\GIS_3400_C2K\Tasks\340-EEC-201905081615_ecology_calcs_figures\340-EEC-201905081615_FFJV_MNES_Fig_4.1_Specimen_backed_flora_V2.mxd Date: 16/04/2020 15:16





Legend

- 5 Chainage (km)
- Localities
- Notelaea lloydii
- Planchonella eerwah
- Existing rail
- H2C project alignment
- K2ARB project alignment
- Watercourses
- Major roads
- Minor roads
- EIS disturbance footprint (surface disturbance only)
- MNES study area
- Local Government Areas

A3 scale: 1:150,000

0 1 2 3 4 5km

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Coordinate System: GDA 1994 MGA Zone 56

Calvert to Kagaru

Figure 4.1: Location of specimen backed records of MNES significant flora species derived from desktop assessments

4.3.1.2 Threatened ecological communities

The EPBC Act PMST report identified the following TECs as having potential to occur within the MNES study area:

- Brigalow (*Acacia harpophylla* dominant and co-dominant) – Endangered. There are known occurrences of this community south west of Washpool (i.e. remnant areas of RE 12.9-10.6 (*Acacia harpophylla* open forest on sedimentary rocks)), approximately 2.5 km southwest of the Project alignment (outside of the MNES study area). This community was also identified on Lot 118 on CH312530 (occupying approximately 1 ha), approximately 400 m east of the proposed spur line onto the West Moreton Rail Line (AECOM 2010) near the western extent of the Project disturbance footprint. Jacobs-GHD (2016a) confirmed the TEC as present in this area.

  However, a subsequent review has found this area lies adjacent to Western Creek on an alluvial plain. This community is mapped as RE 12.3.10a under the State-based vegetation mapping (land zone 3 denoting alluvial soils) and is described as *Acacia harpophylla* open forest to woodland (Queensland Herbarium 2019). The Approved conservation advice for the TEC (DotE 2013b) designates 16 REs as a 'key diagnostic characteristic' in identifying the TEC in Queensland. The advice does not list RE 12.3.10a, or any other REs on land zone 3 occurring within the SEQ Bioregion as meeting the description of the TEC. As such, it is assumed the TEC is not present within the MNES study area as described in the Approved conservation advice for the TEC (DotE 2013b).

- Coastal Swamp Oak (*Casuarina glauca*) Forest of New South Wales and South-east Queensland ecological community – Endangered. The MNES study area intersects an area where the community may occur (i.e. Bremer River, Warrill Creek, Purga Creek and Teviot Brook), however these waterways are not tidal (which the community requires) and none of the REs are analogous with this community (refer Table 3.3) occur within or near the MNES study area. Known patches of this TEC are significantly displaced from the Project.
- Lowland Rainforest of Subtropical Australia – Critically Endangered. The MNES study area intersects an area where the community may occur, however none of the REs (remnant and regrowth) that are analogous with this community (refer Table 3.3) occur within MNES study area. Based on the mapping by SEQ Catchments (2013) and the Approved conservation advice (DSEWPaC 2011d) known patches of this TEC are significantly displaced from the Project, however the area around Flinders Peak Conservation Park may support this community.
- Swamp Tea-tree (*Melaleuca irbyana*) Forest of South-east Queensland - Critically Endangered. This community is likely to occur within the MNES study area (refer below).
- White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland - Critically Endangered. The MNES study area intersects an area where the community may occur, however this community is predominantly known from west of the Great Dividing Range or from the western extent of the SEQ Bioregion and no REs (remnant or regrowth) analogous with this TEC were identified within the MNES study area. However, the national recovery plan (Department of Environment, Climate Change and Water NSW. 2010) indicates that this community is likely to occur to the south of the eastern extent of the Project (~1.5 km), in association with Teviot Brook. Based on the RE mapping the vegetation is mapped as RE12.8.16 (*Eucalyptus crebra* +/- *E. melliodora*, *E. tereticornis* woodland on Cainozoic igneous rocks) which is analogous with this community.

Profiles related to each of the TECs identified above, mapping produced by DAWE, relevant threat abatement/recovery plans and threatening processes are provided in Appendix B.

Swamp Tea-tree (*Melaleuca irbyana*) Forest of South-east Queensland

Based on review of the RE mapping (i.e. current and pre-clearance), aerial imagery and previous surveys, the only TEC likely to occur within the MNES study area is Swamp Tea-tree (*Melaleuca irbyana*) Forest of South-east Queensland. Similar observations were noted as part of the SFRC works, which initially investigated the alignment in 2005 (refer Table 3.2) and noted the presence of approximately 78 ha of *M. irbyana* communities within the relevant Corridor of Interest (AECOM 2010).

The current RE mapping and Queensland Government modelling of *Melaleuca irbyana* extent indicates the presence of this community within the following areas relevant to the Project:

- The disturbance footprint between Hayes Road and Coveney Road is mapped as non-remnant. However, modelling predicts the community may or is likely to occur.
- The disturbance footprint along Paynes Road traverses remnant and regrowth vegetation analogous with this TEC (i.e. RE 12.3.18) and other vegetation communities of which Swamp tea-tree is a component (i.e. RE 12.3.19 and RE 12.9-10.27) (refer Table 4.3). This is further reflected in the Queensland Government modelling which maps these regrowth areas as areas where the community may or is likely to occur.
- The disturbance footprint between the Cunningham Highway and Middle Road is primarily mapped as non-remnant, however regrowth analogous with the TEC is present. This is further reflected in the modelling which maps these regrowth areas as areas where the community may or is likely to occur.

The extent of vegetation communities incorporating Swamp tea-tree that occur within the MNES study area and the disturbance footprint based on vegetation community mapping at a desktop level is detailed in Table 4.2. As noted in Table 3.3 the Queensland Government modelling of *Melaleuca irbyana* extent is based on a number of assumptions (including pre-clearance vegetation mapping, high value regrowth communities and Commonwealth mapping/modelling). Given the conservative approach of the desktop mapping, incorporation of this data likely over-estimates the actual extent of the TEC on the ground within the MNES study area.

The desktop assessment identified 5.75 ha of remnant and 13.09 ha of high-value regrowth REs analogous to the Swamp tea-tree TEC within the Project disturbance footprint. This community is also known to provide habitat for a number of threatened flora and fauna species, including some of the species listed in Table 4.1 and Table 4.3.

Table 4.2 Vegetation communities (REs) comprising Swamp tea-tree (*Melaleuca irbyana*) and associated TEC identified within the MNES study area based on desktop mapping

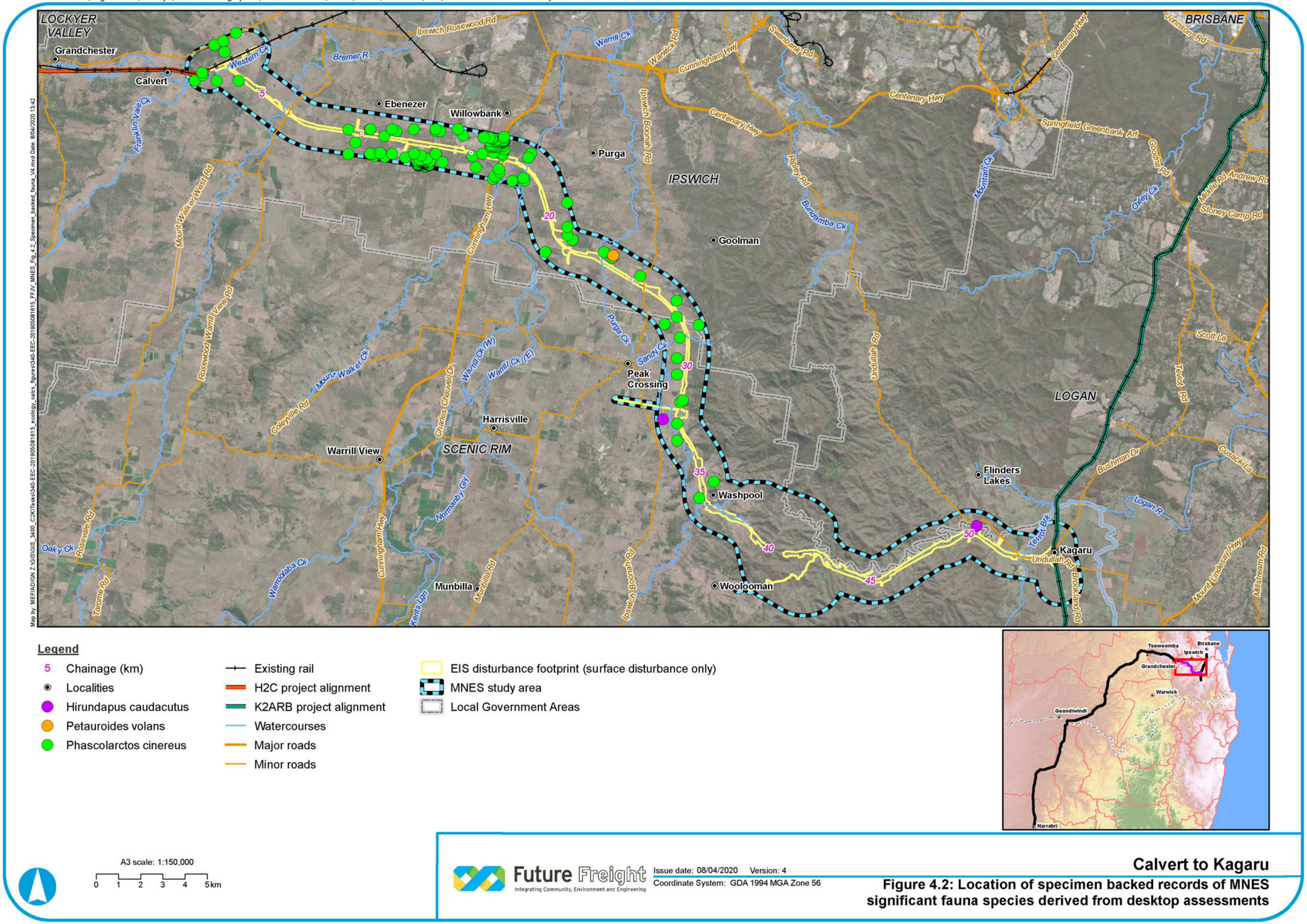
RE	Swamp tea-tree forest of south-east Queensland (DEWHA 2008a)	EPBC Act status	Extent (ha)			
			MNES study area		Disturbance footprint	
			Remnant	Regrowth	Remnant	Regrowth
12.3.18 (*Melaleuca irbyana* low open forest on alluvial plains)	Analogous to TEC	CE	42.89	68.34	5.75	1.79
12.3.19 (*Eucalyptus moluccana* and/or *Eucalyptus tereticornis* and *E. crebra* open forest to woodland, with a sparse to mid-dense understorey of *Melaleuca irbyana* on alluvial plains)	-	-	17.21	65.81	0.92	9.75
12.9-10.11 (*Melaleuca irbyana* low open forest on sedimentary rocks)	Analogous to TEC	CE	41.62	109.10	0.00	11.30
12.9-10.27 (*Corymbia citriodora* subsp. *variegata* and/or *E. moluccana, E. tereticornis, E. crebra* open forest with *Melaleuca irbyana* understorey on sedimentary rocks)	-	-	63.38	233.22	1.87	29.42
Total area			165.1	476.47	8.54	52.26
			641.57		**60.8**	

4.3.2 Fauna

4.3.2.1 Threatened fauna species

A total of 32 threatened fauna species are predicted to occur within the MNES study area (refer Table 4.3). Of these, 26 species have been identified exclusively from the EPBC Act PMST report (DAWE 2020b) which is a predictive search tool that does not rely on specimen backed records. The location of specimen backed records for threatened fauna species, derived from database sources (e.g. Birds Australia, Wildlife Online and Atlas of Living Australia) is provided in Figure 4.2.

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



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Calvert to Kagaru

Figure 4.2: Location of specimen backed records of MNES significant fauna species derived from desktop assessments

Of the threatened species identified above, five are considered likely or known to occur within the MNES study area based on previous studies, specimen-backed records in the Wildlife online and the Atlas of Living Australia (AoLA) databases and the presence of suitable habitat (refer Table 4.3).

Of the threatened species identified, 17 are considered possible to occur within the MNES study area based on the presence of suitable habitat (refer Table 4.3).

Of the threatened species identified, 10 are considered unlikely to occur within the MNES study area based on their distributional limits and/or ecological requirements (refer Table 4.3).

Information related to the ecology, biology and distribution for all species listed in Table 4.3 is provided in Appendix B.

Table 4.3 Threatened fauna species identified from database searches

Family	Species name	Common name	EPBC Act	Data source			Likelihood of occurrence
				Wildlife Online	PMST	Atlas	
Birds							
Accipitridae	*Erythrotriorchis radiatus*	Red goshawk	V		✓		Possible
Ardeidae	*Botaurus poiciloptilus*	Australasian bittern	E		✓		Possible
Columbidae	*Geophaps scripta scripta*	Squatter pigeon	V		✓		Unlikely. The species is typically associated with the western slopes of the Great Dividing Range. While there are some records of this species within the broader project context, there are no recent records within 20 km of the MNES study area (AoLA 2020)
Dasyornithidae	*Dasyornis brachypterus*	Eastern bristlebird	E		✓		Unlikely, species occurs in montane areas in eucalypt forests with a dense tussock grass layer (DAWE 2020). Habitat does not occur and the species has never occurred in or near the MNES study area.
Estrildidae	*Poephila cincta cincta*	Southern Black-throated Finch	E		✓		Unlikely. Expert advice indicated that this species is locally extinct within SEQ (DAWE 2020a)
Meliphagidae	*Anthochaera phrygia*	Regent honeyeater	CE		✓		Possible
Meliphagidae	*Grantiella picta*	Painted honeyeater	V		✓		Possible
Psittacidae	*Cyclopsitta diophthalma coxeni*	Coxen's fig-parrot	E		✓		Unlikely. No records close to MNES study area and no reliable records of the species from the year 2000 onwards. Preferred habitats featuring fig trees (lowland rainforest, warm and cold subtropical as well as cool temperate rainforests) (Birdlife International 2018) do not occur within or near the MNES study area.
Psittacidae	*Lathamus discolor*	Swift parrot	CE		✓		Known. Recorded within MNES study area during protected plant surveys (EMM 2018a)

Family	Species name	Common name	EPBC Act	Data source			Likelihood of occurrence
				Wildlife Online	PMST	Atlas	
Rostratulidae	*Rostratula australis*	Australian painted snipe	E		✓		Possible
Scolopacidae	*Calidris ferruginea*	Curlew sandpiper	CE, M		✓		Possible
Scolopacidae	*Numenius madagascariensis*	Eastern curlew	CE, M		✓		Unlikely. Species is essentially a coastal specialist.
Turnicidae	*Turnix melanogaster*	Black-breasted button-quail	V		✓		Possible
Apodidae	*Hirundapus caudacutus*	White-throated needletail	V, M		✓		Likely
Mammals							
Dasyuridae	*Dasyurus hallucatus*	Northern quoll	E		✓		Unlikely, the species has never been recorded in the greater Brisbane region. Nearest records in the Toowoomba Range are older (<1986) (AoLA 2020) and the species likely no longer occurs in the area.
Dasyuridae	*Dasyurus maculatus maculatus*	Spotted-tail quoll	E		✓		Possible
Macropodidae	*Petrogale penicillata*	Brush-tailed rock-wallaby	V		✓		Possible
Muridae	*Pseudomys novaehollandiae*	New Holland mouse	V		✓		Possible
Petauridae	*Petauroides volans volans*	Southern greater glider	V	✓	✓	✓	Likely
Phascolarctidae	*Phascolarctos cinereus*	Koala	V	✓	✓		Known. Recorded during surveys by Jacobs-GHD (2016a)
Potoroidae	*Potorous tridactylus tridactylus*	Long-nosed potoroo	V		✓		Possible
Pteropodidae	*Pteropus poliocephalus*	Grey-headed flying-fox	V		✓		Likely
Vespertilionidae	Chalinolobus dwyeri	Large-eared pied bat	V		✓		Possible
Reptiles							
Elapidae	*Furina dunmalli*	Dunmall's snake	V		✓		Unlikely. No database records of this species ever occurring to the east of the Great Dividing Range (AoLA 2020).
Pygopodidae	*Delma torquata*[#]	Collared delma	V				Possible
Scincidae	*Anomalopus mackayi*[#]	Five-clawed worm-skink	V				Possible

Family	Species name	Common name	EPBC Act	Data source			Likelihood of occurrence
				Wildlife Online	PMST	Atlas	
Scincidae	*Coeranoscincus reticulatus*# (formerly *Saiphos reticulatus*)	Three-toed snake-tooth skink	V				Unlikely. Largely occurs in wet rainforest and wet sclerophyll forest habitats (DAWE 2020a) which does not occur within or near the footprint. Nearest record is from Mount Tamborine (AoLA 2020).
Invertebrates							
Noctuidae	*Phyllodes imperialis smithersi*	Pink underwing moth	E		✓		Unlikely, no suitable habitat (wet old growth rainforest) (OEH 2017d) likely present and no evidence the species may occur. The nearest moth record is 58 km away from the MNES study area and nearest record of the larval food plant (native rainforest vine, *Carronia multisepalea*) is 31 km away from the MNES study area (AoLA).
Nymphalidae	*Argynnis hyperbius inconstans*	Australian fritillary	CE		✓		Unlikely, no suitable habitat likely present and no evidence the species may occur. Additionally, there are no known records of the larval host plant *Viola betonicifolia* within the MNES study area, with the nearest record from 1987 located 16 km from the disturbance footprint (AoLA 2020)
Fish							
Pericichthyidae	*Maccullochella mariensis*	Mary River cod	E		✓		Unlikely. Whilst it is acknowledged the Mary River cod may have potential to occur within the broader region, these individuals are likely to have resulted from fish stocking activities and are considered to be outside of areas within their natural distribution. There are no database records of the species in the Brisbane/Logan River catchments. Habitat critical to the survival of this species is restricted to the Mary River drainage system and therefore this species has been excluded from the impact assessment
Pericichthyidae	*Maccullochella peelii*	Murray cod	V		✓		Unlikely, the MNES study area is beyond the known range of this species (i.e. Murray-Darling Basin)
Protopteridae	*Neoceratodus forsteri*	Australian lungfish	V		✓		Possible

Table notes:

CE = Critically endangered E = Endangered M= Migratory V = Vulnerable

✓ = species present within database record within the MNES study area

^ = Species not returned in database searches but have been included as it has been previously identified in proximity to the MNES study area

= Species not returned in database searches but specified in the ToR

PMST = Protected Matters Search Tool

* = Fish species have been actively stocked in a number of the project catchments

4.4 Existing environment

The following subsections provide a description of the existing ecological values of the Project MNES area based on the results of the field assessments. The results presented in this section detail the existing flora and fauna species (including weeds and pests), habitats, vegetation communities, and MNES.

4.4.1 Flora

4.4.1.1 Species richness

A total of 252 plant species were identified within the MNES study area during Project EIS field assessments. This included a total of 183 (72.5 per cent) native species, and 69 (27.5 per cent) non-native species (refer Appendix E and Appendix I).

Non-native species were typically more abundant and diverse in areas of high anthropogenic disturbance when compared to those characterised by an intact canopy of native species such as identified as remnant vegetation/intact bushland. However, encroachment of non-native species, particularly those spread by birds (e.g. *Lantana camara* and *Lantana montevidensis*) was evident in relatively undisturbed areas. These species in particular have the potential to outcompete, replace and exclude native flora species within such environments. Aquatic macrophytes were poorly represented throughout the MNES study area.

4.4.1.2 Threatened flora species

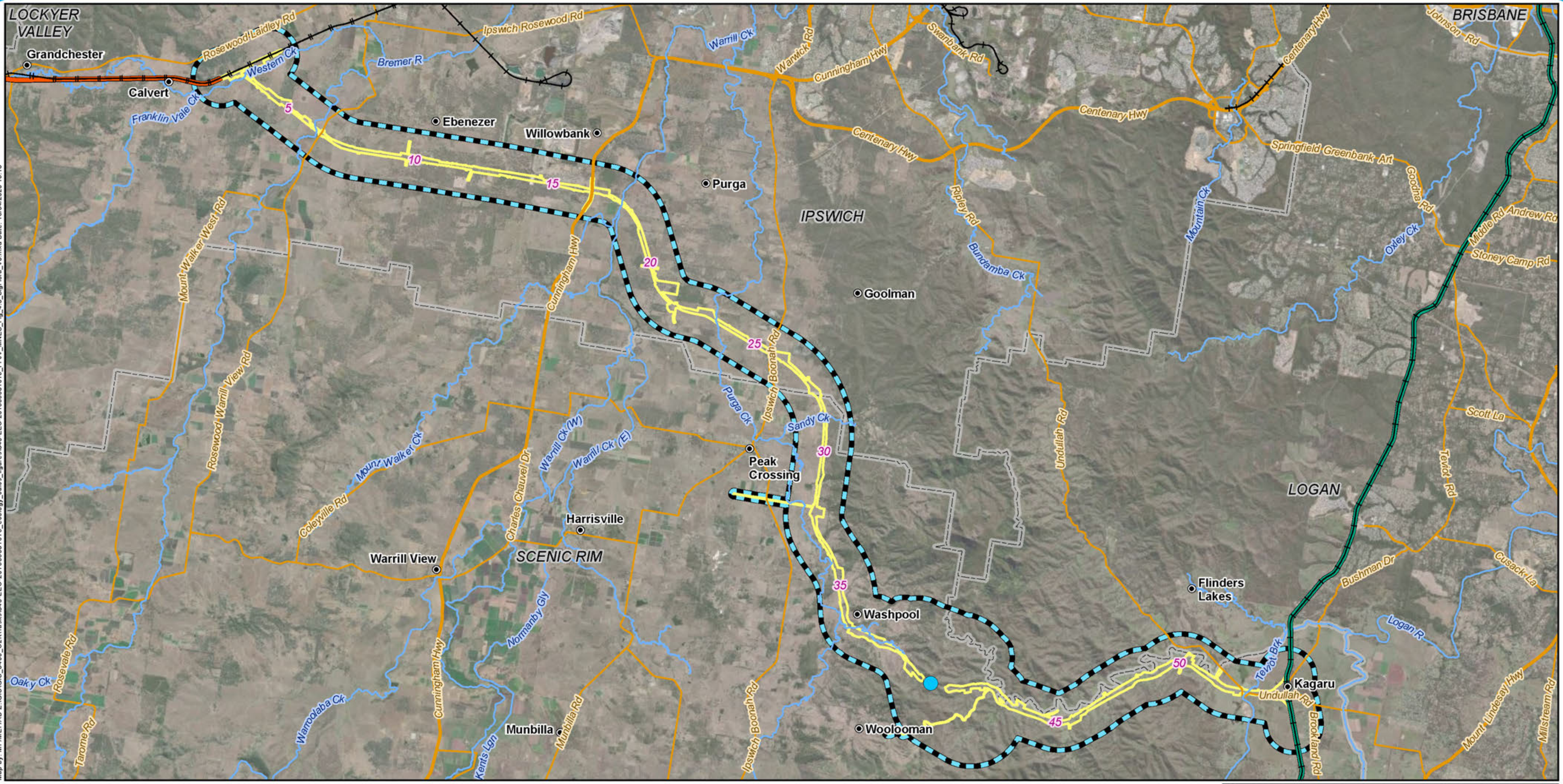
As noted in Section 4.3.1.1, there is the potential for a number of threatened flora species to occur throughout the MNES study area.

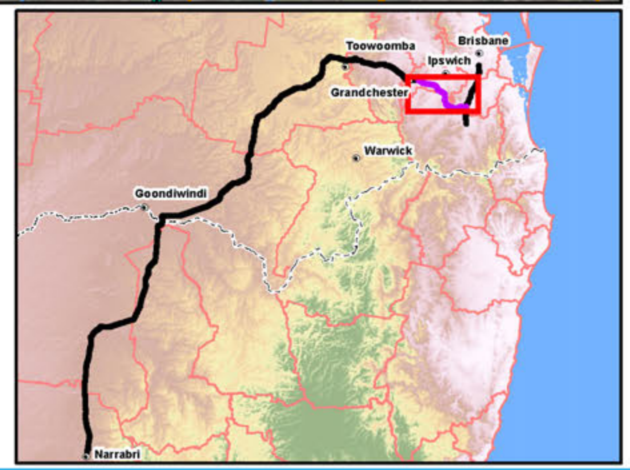
During the field investigations, including targeted protected plants surveys of the disturbance footprint undertaken historically and concurrently with the investigations associated with this EIS (refer Table 3.2), eight specimens of Lloyd's olive (*Notelaea lloydii*), were recorded above the proposed tunnel where the Project alignment intersects the western edge of the Teviot Range (south-east of the Washpool area) (refer Figure 4.3). These individuals were recorded in regrowth woodland on sedimentary soils (refer Photograph 4.1). Dense thickets of *Lantana camara* were present within this area. Weed invasion, particularly by this species, is listed as a threatening process for this species (DEWHA 2008b).

As noted in Section 4.3.1.1, there have been a number of other records of this species within the habitat of Teviot Range (refer Figure 4.1 and Section 5.3.4.2). Targeted searches (GHD 2017b) of suitable habitat associated with the previous tunnel options (north and south of the current alignment) failed to detect this species.

Photograph 4.1 Lloyd's olive (centre) and habitat location – Teviot Range (2017)

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community





Legend

- 5 Chainage (km)
- Localities
- Notelaea lloydii
- Existing rail
- H2C project alignment
- K2ARB project alignment
- Watercourses
- Major roads
- Minor roads
- EIS disturbance footprint (surface disturbance only)
- MNES study area
- Local Government Areas

A3 scale: 1:150,000

0 1 2 3 4 5km

Map by: MFMEF/AD Z:\GIS\GIS_3400_C2K\Tasks\340-EEC-201905081615_ecology_calcs_figures\340-EEC-201905081615_FFJV_MNES_Fig_4.3_SigFlora_V3.mxd Date: 16/04/2020 15:18

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Calvert to Kagaru

Figure 4.3: Locations of observed MNES significant flora species within the MNES study area

The field investigations also confirmed habitat for a number of other flora species within the MNES study area comprising the following:

- Hairy-joint grass (*Arthraxon hispidus*) (in shaded or potential wetter areas throughout)
- Miniature moss-orchid (*Bulbophyllum globuliforme*) (dry rainforest habitat in Teviot Range)
- Boonah tuckeroo (*Cupaniopsis tomentella*) (dry rainforest habitat in Teviot Range)
- *Lychnothamnus barbatus* (an algae) (Warrill Creek crossing area)
- Shiny-leaved condoo (*Planchonella eerwah*) (dry rainforest habitat in Teviot Range).

This information was used to inform the predictive habitat modelling for each of the MNES flora species. Predictive habitat mapping within the MNES study area for those species considered to have habitat potentially impacted by the Project are presented in Appendix H. *Potential habitat* for threatened flora species is largely associated with drainage line vegetation in isolated areas and habitat within the Teviot Range.

The Austral toadflax (*Thesium australe*) is not currently known to occur within or in close proximity to the MNES study area. Nearby database records associated with this species exceed 27 years in age (and are largely much older) and the environment associated with these areas has undergone significant change as a result of anthropogenic processes and is no longer considered to be suitable for the persistence of this species. Therefore, the species has been excluded from further analysis.

It is noted that although all areas within the MNES study area were not surveyed, information derived from historic and concurrent surveys (refer Section 3.4) was used to inform the predictive mapping for MNES flora species where applicable.

4.4.1.3 Threatened ecological communities

A single Critically endangered TEC, ‘Swamp Tea-tree (*Melaleuca irbyana*) Forest of South-east Queensland’, exists and was confirmed to occur within the central and western portions of the MNES study area (refer Figure 4.4) based on State RE mapping and ground-truthing surveys carried out as part of the EIS studies, by Jacobs-GHD (2016a) and surveys by EMM and ELA (2017 to 2019). Vegetation community survey methods for the EIS studies are described in Section 3.3.2.1. Survey locations illustrating survey effort across the MNES study area are depicted in Figure 3.2a-e and Figure 3.3a-e (EIS studies).

The Approved conservation advice from DAWE (DEWHA 2008a) does not detail any ‘key diagnostic criteria’ or ‘threshold conditions’ for this TEC, as generally used to identify occurrences of other TECs (particularly where disturbance may be an issue to the integrity of the community). The Approved conservation advice only describes this TEC as a community of low open forest dominated by dense thickets of Swamp Tea Tree, usually 8 to 12 m high. It may also have an emergent layer that includes Narrow-leaved Ironbark (*Eucalyptus crebra*), Silver-leaved Ironbark (*E. melanophloia*), Grey box (*E. moluccana*) or Forest red gum (*E. tereticornis*). Regional Ecosystem mapping analogous with the TEC include:

- **12.9-10.11** *Melaleuca irbyana* low open forest or thicket. Emergent *Eucalyptus moluccana*, *E. crebra*, *E. tereticornis* or *Corymbia citriodora* subsp. *variegata* may be present.
- **12.3.18** (previously classified as 12.3.3c) *Melaleuca irbyana* low open forest or thicket. Emergent *Eucalyptus moluccana*, *E. crebra*, *E. tereticornis* or *Corymbia citriodora* subsp. *variegata* may be present.

In addition, Ryan (2008; in DAWE 2020a) observes: ‘where *Eucalyptus* woodland with a clear *Melaleuca irbyana* understorey occurs as an extinction/buffer zone adjacent to Swamp Tea-tree forest, it has very close affinities with the latter. It is thus best considered part of the Swamp Tea-tree Forest ecological community’. The definition of what extent of occurrence of *Melaleuca irbyana* constitutes a ‘clear understorey’ is not provided.

Site surveys identified occurrences of the Swamp tea-tree based on the description provided in the Approved Conservation Advice. REs 12.3.19 and 12.9-10.27, which have *M. irbyana* as a sparse to mid-dense understorey, are not currently identified as a TEC by the Commonwealth Government conservation listing and also occur within the disturbance footprint. Surveys carried out for the EIS studies in vegetation patches mapped as comprising these REs confirmed the presence of *M. irbyana* as scattered individuals or not present at all and therefore not analogous to the TEC structure described above (refer Sites 12, 13, 14, 16, 17 and 18 in Appendix H).

Within the MNES study area, the communities are mostly discrete patches interspersed amongst eucalypt woodlands on alluvial plains, lands cleared for grazing and resource extraction activity. This generally aligns with the present distribution mapping for the community as outlined in Figure 7.3 in Appendix B.

As noted in Section 4.3.1.2, the area around Paynes Road/Seppanen Road (in the Willowbank area) has been mapped as an area where the community may or is likely to occur and this was confirmed during field surveys. In this area the TEC occurs as several patches close together. A large section of vegetation adjacent to the south side of Paynes Road featured a mosaic of extremely dense regrowth *M. irbyana* up to 7 m high and more open areas of mature trees with a canopy height of 8 m -11 m. Some patches also featured emergent (sparse) canopy species including *E. tereticornis*, *E. crebra*, and *E. melanophloia* (EMM 2018a). Vegetation patches located adjacent to the east of Paynes Road were described as 'dense, to mid-dense low open forest community comprising of monospecific stands of *M. irbyana'* (ELA 2019b).

The adjacent woodland between the various mapped patches also comprise *M. irbyana* in the understorey and may be considered as 'intergrade/buffer areas' under the definition provided by Ryan (2008, in DAWE 2020a). As such, for this assessment the entire vegetated area within these patches has been considered as representing Swamp tea-tree TEC (refer Figure 4.4). In general the patches of the TEC identified above were considered to be in good condition as all components of the vegetation structure (*Melaleuca irbyana* mid canopy, emergent eucalypts and an understorey of herbaceous species and vines) were well represented as per the description for this TEC (refer Photograph 4.2).

The community was also confirmed as occurring between Glencairn Road and Lubes Road including a small patch within, and a larger patch adjacent to the disturbance footprint. Oher larger patches of the TEC (mapped as remnant and regrowth RE 12.3.18) were also identified in the Purga Nature Reserve and between the Cunningham Highway and Champions Way (both areas outside of the Project disturbance footprint) during EIS study surveys (refer Site 20 and 21 in Appendix H). Other areas where the community may or is likely to occur within the disturbance footprint, include around Hayes and Coveney roads and between the Cunningham Highway and the Middle Road. Interrogation of aerial imagery also confirmed the likelihood of the community occurring in some of these areas, including as patchy regrowth, with these areas included in the mapping.

In other areas where the modelling indicated the potential presence of the community, *M. irbyana* was recorded as scattered (i.e. sparsely distributed) individuals through the understory of eucalypt woodland (refer Photograph 4.3) or as low-growing scattered regrowth individuals in cleared areas and as such were not considered to be a TEC.

Ground-truthing site surveys were not able to be carried out in all areas of mapped vegetation communities analogous to the TEC, including areas mapped as regrowth RE 12.9-10.11. These areas have been considered as 'regrowth Swamp tea-tree TEC' until field confirmation can be carried out, noting that there are no key diagnostic characteristics or thresholds for this community (refer Figure 4.4).

Targeted surveys of the disturbance footprint confirmed the presence of nine polygons of this community within and adjacent to the disturbance footprint. A further five areas of regrowth TEC may also be present. These communities generally align with RE mapping for the area (i.e. RE 12.3.18) though the following was noted:

- There were errors in the boundaries of the State-based RE mapping polygons analogous to the TEC
- Areas adjacent to and east of Paynes Road originally mapped as RE 12.3.19 (regrowth and remnant) were found to be incorrectly mapped and were considered analogous to the TEC (i.e. as RE 12.3.18) expanding the extent of TEC mapped as occurring in this area

- Small areas of TEC regrowth were identified throughout the western portion of the Project disturbance footprint including areas where no previous mapping (remnant or high-value regrowth) was identified during the desktop assessment
- Not all of the RE polygons identified under the State's vegetation mapping were considered analogous with the TEC. That is, the RE polygons comprising woodlands dominated by *Eucalyptus tereticornis* with only scattered *M. irbyana* in the understorey. The latter areas are not analogous with the TEC.

As noted above this assessment has taken a conservative approach. There are several areas within the Project disturbance footprint currently mapped as regrowth TEC which may not represent the Swamp tea-tree TEC as based on the description provided by DAWE (DEWHA 2008a). This also includes areas mapped as 'intergrade/buffer areas' between TEC patches in the Paynes Road area which may not include areas featuring *M. irbyana.* Prior to any on-ground works the current TEC mapping (as provided in Figure 4.4) aerial imagery will be revised and all areas within the disturbance footprint identified as potentially comprising the TEC will be surveyed to confirm to what extent the TEC is actually present within the Project disturbance footprint.

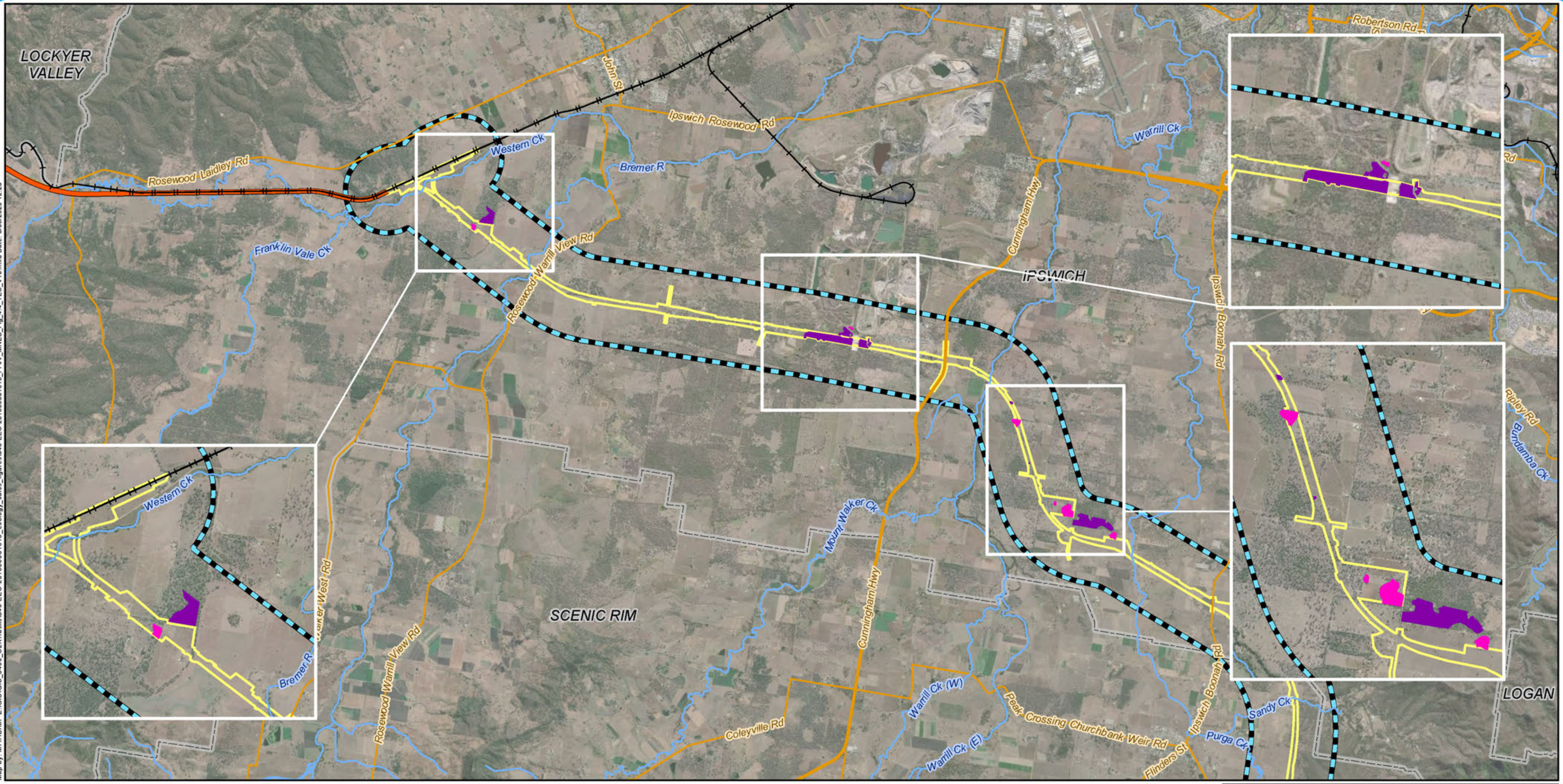
Photograph 4.2 Swamp tea-tree TEC within matters of national environmental significance study area (Jacobs-GHD 2016a)

Photograph 4.3 Swamp tea-tree as scattered understorey species in woodland (EMM 2018a)

The extent and distribution of Swamp Tea-tree (*Melaleuca irbyana*) Forest of South-east Queensland TEC within the disturbance footprint is provided in Table 4.4 and depicted in Figure 4.4. This includes areas of TEC 'confirmed' as present from Project survey data and regrowth areas which have not been subject to onsite surveys.

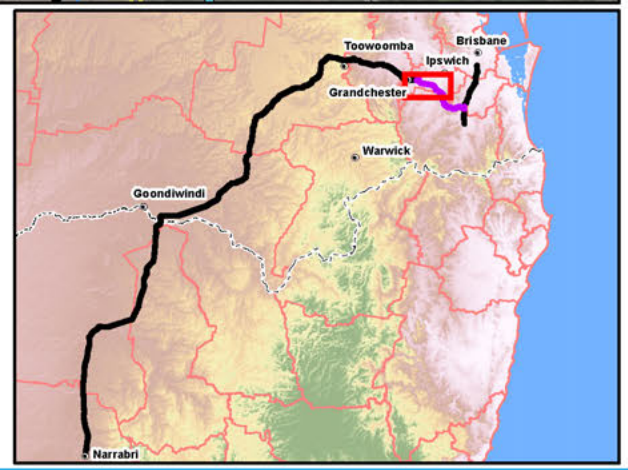
Table 4.4 Threatened ecological communities identified within the matters of national environmental significance study area

TEC Name	EPBC Act status*	Extent (ha)	
		MNES study area	Disturbance footprint
Swamp Tea-tree (*Melaleuca irbyana*) Forest of South-east Queensland (RE 12.3.18 and 12.9-10.11)	Critically Endangered	261.95 (unconfirmed)	20.8 (confirmed TEC) 9.65 (regrowth TEC)



Legend

- Existing rail
- H2C project alignment
- Watercourses
- Major roads
- Minor roads
- Swamp tea tree TEC
- Regrowth Swamp tea tree TEC
- Local Government Areas
- EIS disturbance footprint (surface disturbance only)
- MNES study area



A3 scale: 1:99,770

0 0.8 1.6 2.4 3.2 4km

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Calvert to Kagaru

Figure 4.4: Extent and distribution of TEC Swamp Tea-tree (*Melaleuca irbyana*) Forest of SEQ within the MNES study area

4.4.2 Fauna

This section outlines the fauna species richness observed within the MNES study area. This section also provides the threatened species listed under the provisions of the EPBC that were recorded within the MNES study area.

4.4.2.1 Species richness

Project EIS field investigations have identified a total of 172 fauna species (refer Appendix F and Appendix I), including 164 (95.3 per cent) native species and eight (4.65 per cent) non-native species. Recorded species consisted of 122 (70.93 per cent) birds, 24 (13.95 per cent) mammals, 16 (9.30 per cent) reptiles, five (2.91 per cent) amphibians and five (2.91 per cent) fish.

Given the fragmented nature of bushland areas within the MNES study area, their vagile nature and ability to persist in fragmented landscapes it is to be expected that birds would constitute the largest percentage of observed species. However, their dominance of the recorded species is also likely to be an artefact of their detectability when compared to more cryptic species such as amphibians and reptiles.

4.4.2.2 Threatened fauna species

As noted in Section 4.3.2.1, there is the potential for a number of threatened fauna species to occur throughout the MNES study area.

During the EIS field investigations, a single threatened fauna species, Koala (*Phascolarctos cinereus*), was identified within the MNES study area during the Project EIS field investigations. Two individuals were identified in alluvial Spotted gum (*Corymbia citriodora*)/Queensland blue gum (*Eucalyptus tereticornis*) woodlands in the eastern portion of the alignment (Ebenezer area). Koala scats were also recorded in this area (refer Figure 4.5). Records from previous investigations include one Koala in the Peak Crossing area, as well as scats throughout the alignment (Jacobs-GHD 2016a). The Swift parrot was also recorded in alluvial Queensland blue gum (*Eucalyptus tereticornis*) woodlands in the Ebenezer area during protected plant surveys (EMM 2018a). The location of observed Koalas and the Swift parrot is provided in Figure 4.5.

Brush-tailed rock-wallaby (*Petrogale penicillata*) was also identified incidentally on Flinders Peak (approximately 4 km north of the Project alignment) during investigations for the SFRC (AECOM 2010). However, essential habitat components (e.g. rocky outcrops, cliffs caves etc) were not encountered during the field investigations for the EIS.

Field investigations also confirmed the presence of habitat (foraging and breeding), including:

- The Teviot Range is an extensive tract of habitat with varying levels of disturbance (with regard to the MNES study area) with features known to support a variety of MNES fauna species
- Confirmed habitat (primarily in areas containing eucalypt open forest/woodland communities) for the following species:
  - Collared delma (*Delma torquata*) – Teviot Range where microhabitats such as coarse woody debris and loose rocky outcrops occur
  - Regent honeyeater (*Anthochaera phrygia*) - box-ironbark woodlands
  - Australasian bittern (*Botaurus poiciloptilus*) - wetlands
  - Spotted-tail quoll (*Dasyurus maculatus maculatus*) – rocky habitat within the Teviot Range
  - Red goshawk (*Erythrotriorchis radiatus*) – extensive intact habitat within Teviot Range
  - Painted honeyeater (*Grantiella picta*) - eucalypt/acacia woodlands
  - Swift parrot (*Lathamus discolour*) – eucalypt woodlands
  - Greater glider (*Petauroides volans volans*) – eucalypt woodlands with large hollows present

– Koala (*Phascolarctos cinereus*) - eucalypt woodlands
– Grey-headed flying-fox (*Pteropus poliocephalus*) – foraging habitat throughout.

The availability of habitat types and their relevance to MNES fauna and flora are discussed further in Section 4.4.4.

This information was used, in addition to that contained within relevant recovery plans and conservation listing advices, to inform the predictive habitat modelling and mapping for each of the MNES fauna species (refer Appendix H for species habitat maps). *Potential habitat* for MNES fauna species is spread throughout the Project alignment but is focused on the Teviot Range for many species. It is noted that whilst some areas of the MNES study area were not accessible for the detailed Project surveys these areas largely comprised cleared grazing lands. Vegetated areas (such as the Teviot Range and Payne's Road) which are more likely to support threatened species and communities were the focus of site surveys. Information derived from historic and concurrent surveys (refer Section 3.4) was used to inform the predictive mapping for MNES fauna species where applicable.

4.4.2.3 Aquatic species

As noted in Table 4.3, one threatened aquatic species (Australian lungfish) has potential to inhabit the watercourses associated with the MNES study area.

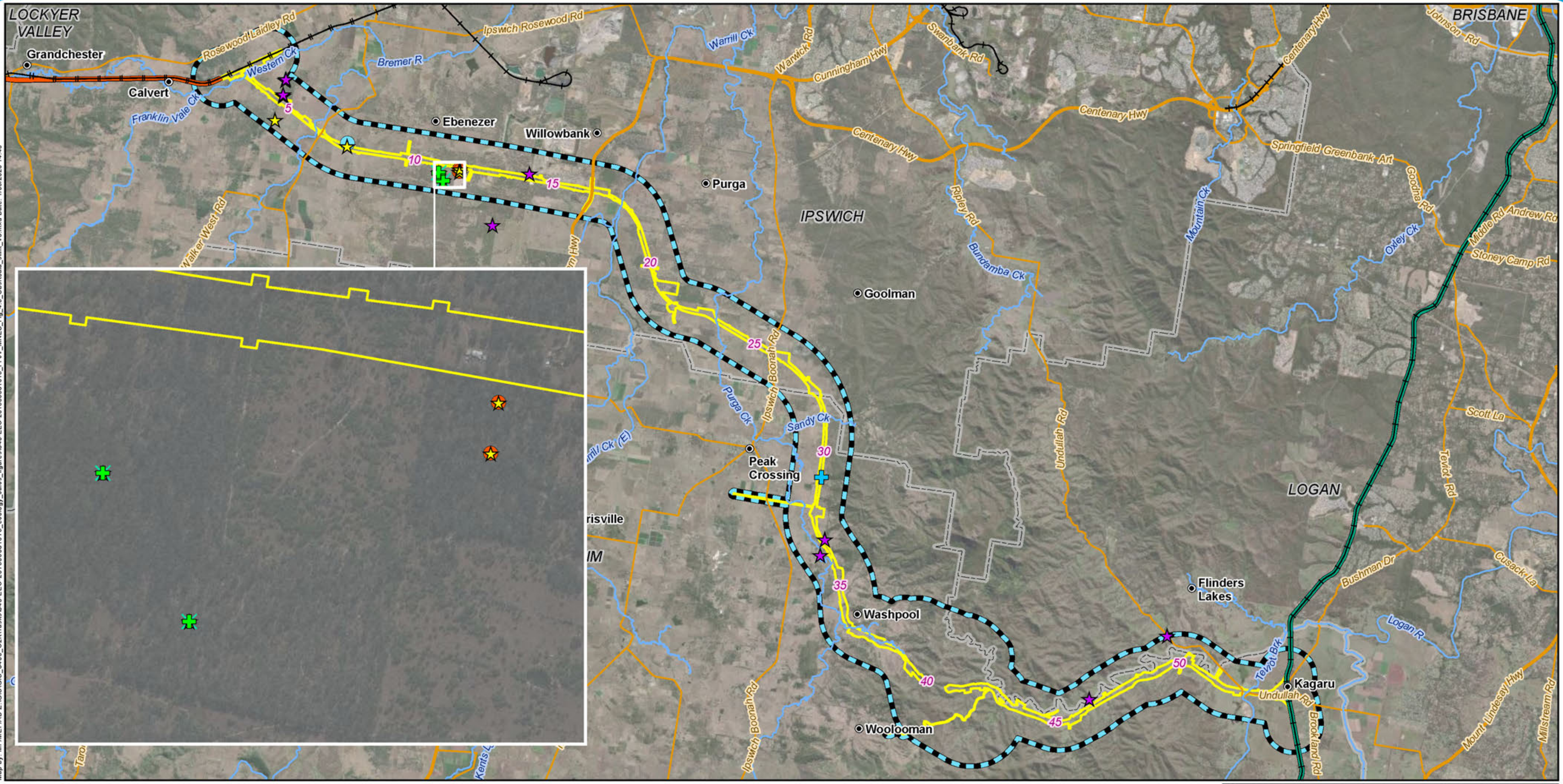
As noted in the *draft Recovery Plan for the Australian Lungfish (Neoceratodus forsteri)* (DotEE 2019a), known habitat for this species relevant to the Project is associated with the Bremer River. Furthermore, under the plan, Habitat critical for the survival of the species is defined as:

- Any breeding or foraging habitat in areas where the species occurs as defined by the Plan's distribution map for the Brisbane River catchment which includes the Bremer River intersected by the Project
- Any newly discovered breeding or foraging locations.

This species was not encountered during targeted fish surveys (Jacobs-GHD 2016a), though suitable habitat in the form of large permanent pools were noted on Teviot Brook and Purga Creek, both of which are outside the known distribution of the species. Where the Project intersects the Bremer River, habitat would not be considered breeding or foraging habitat given the limited presence of aquatic macrophytes or large, deep pools (refer Section 4.4.4.7 and species assessment in Section 5.3.5.3) and the ephemeral nature of the reach at this section of the river. As such this area should not be considered *Habitat critical to the survival of the species* but has been included within the predictive habitat mapping to ensure that a conservative approach to impact assessment occurs.

The Mary River cod is also known from the Logan River catchment, including Teviot Brook. Suitable habitat is present in the MNES study area although the species was not detected during targeted fish surveys in Teviot Brook (Jacobs-GHD 2016a). However, this species has been translocated into a number of impoundments including Wyaralong Dam and Moogerah Dam for recreational fishing purposes (upstream of the MNES study area waterways). The *Mary River cod research and recovery plan* (Simpson and Jackson 1996) notes the species distribution as currently restricted to the Mary River and the species is not considered as present for the purposes of this assessment.

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



Map by: MF/MEF/AD Z:\GIS\GIS_3400_C2K\Tasks\340-EEC-201905081615_ecology_calcs_figures\340-EEC-201905081615_FFJV_MNES_Fig_4_5_ObsKoala_swift_V3.mxd Date: 1/05/2020 14:40

Legend

- 5 Chainage (km)
- Localities
- Swift parrot record

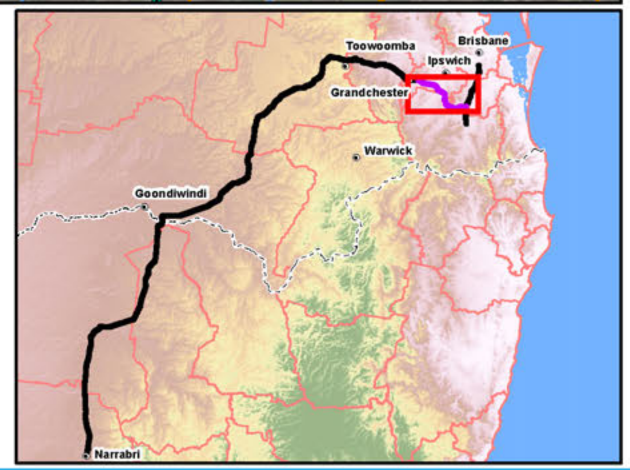
Koala Observation Type (GHD/Jacobs)

- Live
- Scat

Koala Observation Type

- Live
- Scat
- Scratches
- Dead

- Existing rail
- H2C project alignment
- K2ARB project alignment
- Watercourses
- Major roads
- Minor roads
- EIS disturbance footprint (surface disturbance only)
- MNES study area
- Local Government Areas



A3 scale: 1:150,000

0 1 2 3 4 5km

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Calvert to Kagaru

Figure 4.5: Locations of observed Koalas (Phascolarctos cinereus) and Swift parrot (EMM 2018) within the MNES study area

4.4.3 Predicted habitat for threatened flora and fauna species

Predictive habitat mapping for threatened flora and fauna species (refer Sections 3.2.4, and Appendix A) indicates that *potential habitat* for 25 threatened species (six flora and 19 fauna) occurs within the MNES study area. Areas of habitat for these species is presented in Table 4.5 and mapped areas of habitat are provided in Appendix G.

The predictive habitat mapping also indicates that there is no habitat within the Project disturbance footprint for Miniature moss-orchid (*Bulbophyllum globuliforme*), Boonah tuckeroo (*Cupaniopsis tomentella*), and Shiny-leaved condoo (*Planchonella eerwah*).

The predictive habitat mapping is based on a range of considerations including desktop and ground-truthed vegetation/habitat mapping, database search results for species records and the results of field surveys for the Project. The disturbance footprint encompasses a total area of 972.49 ha. Under current Queensland Government (DNRME 2020) vegetation mapping this includes 33.55 ha of remnant vegetation and 118.0 ha of high-value regrowth vegetation (refer EIS Appendix J: Terrestrial and Aquatic Ecology Technical Report). The remaining 820.94 ha (84.4 per cent of the disturbance footprint) has been heavily modified (e.g. clearing for agriculture/cattle grazing) and is very unlikely to provide habitat for most MNES fauna apart from scattered ephemeral flooded areas (for wetland birds) and small areas that are less impacted such as those areas associated with road reserves.

The predictive estimation of habitat provided in Table 4.5 represents a highly conservative approach, accounting for MNES movement patterns, and where doubt existed regarding the potential of an area to provided habitat for a specific MNES, these areas were incorporated into the predicted estimation. The values provided in Table 4.5 are considered to represent the upper limit of available habitat within the MNES study area for each MNES.

It is noted the predictive estimate of *Potential habitat* for Koala encompasses 474.17 ha within the project disturbance footprint (in addition to 124.31 ha of *Habitat critical to the survival of the species*).

The *EPBC Act referral guidelines for the vulnerable Koala* (DotE 2014) defines koala habitat as:

"any forest or woodland containing species that are known koala food trees, or shrubland with emergent food trees. This can include remnant and non-remnant vegetation in natural, agricultural, urban and peri-urban environments. Koala habitat is defined by the vegetation community present and the vegetation structure; the koala does not necessarily have to be present."

For the purposes of this assessment *Habitat critical to the survival of the species* (i.e. koala habitat) includes all mapped remnant and regrowth vegetation communities containing eucalypt species and includes drainage lines which may provide suitable riparian habitat trees located outside of known vegetation mapping (e.g. Bremer River). As noted in Figure 4.2 and Figure 4.5 the most records for koala were from eucalypt woodlands (remnant and regrowth) near Western Creek, around Ebenezer, Warrill Creek, Purga Creek and the associated floodplain and the ecotone between the floodplains of Purga and lower slopes of Teviot Range. These areas were considered to be *Habitat critical for the survival of the species* (refer Appendix G).

Potential habitat for the species is based on a 1 km buffer placed on recent species records (refer Figure 4.2) located outside of mapped vegetation communities (remnant or regrowth) and aims to consider potential movement patterns on a local scale outside of *Habitat critical for the survival of the species* (refer Appendix A for methodology). *Potential habitat* encompasses habitat comprising scattered trees in grazing paddocks (in which the species has been known to use but do not provide the only movement opportunity / refuge to or between areas of habitat critical to the species survival) and grazing and cropped areas which do not feature trees at all (e.g. Warrill Creek and Purga Creek floodplain). The area also includes remnant and regrowth communities and wetlands where koala trees are not a major component of the vegetation community. For example Swamp Tea-tree (*Melaleuca irbyana*) Forest of South-east Queensland in which the species has been recorded, has been mapped as *potential habitat* (i.e. generally monotypic communities, though some areas koala tree (eucalypt species) may be present as emergents).

As such, *Potential habitat* is likely a significantly over-estimate with the main risk to the species in these areas the barrier effect/fragmentation (i.e. generally north south movement, as there is strong connectivity east west in Ebenezer where the majority of the records are from). A study by Barth et al (2020) noted that koalas use paddock trees and roadside vegetation during both breeding and non-breeding seasons, with these areas utilised significantly more than expected based on their availability within the landscape.

Habitat determination will be subject to further refinement through additional studies during the final design stage of the Project.

It should also be noted while there is large habitat area values associated with White-throated needletail (*Hirundapus caudacutus*) (constituting the entire MNES study area) this is an aerial foraging species which may forage over any habitat including heavily disturbed areas. As such, all 'air-space' above the Project may be considered habitat. Given this habitat (i.e. above the Project) will not be impacted by the Project construction/operation activities the species is not subject to further impact assessment.

Table 4.5 Predicted habitat for threatened (EPBC Act) flora and fauna species within the MNES study area

Species name	Common name	EPBC Act status*	Predicted habitat within the MNES study area (ha)* (12,442.24 ha)				Predicted habitat within the disturbance footprint (ha)* (972.49 ha)			
			Total habitat	Potential habitat	Important habitat	Habitat critical to the survival of the species	Total habitat	Potential habitat	Important habitat	Habitat critical to the survival of the species
Flora (threatened)										
Arthraxon hispidus	Hairy-joint grass	V	67.47	67.47	0.00	0.00	4.15	4.15	0.00	0.00
Bulbophyllum globuliforme	Miniature moss-orchid	V	6.29	6.29	0.00	0.00	0.00	0.00	0.00	0.00
Cupaniopsis tomentella	Boonah tuckeroo	V	6.29	6.29	0.00	0.00	0.00	0.00	0.00	0.00
Lychnothamnus barbatus	An algae	E	113.45	113.45	0.00	0.00	6.90	6.90	0.00	0.00
Notelaea lloydii	Lloyd's olive	V	1,089.16	0.00	0.00	1,089.16	26.77	0.00	0.00	26.77
Planchonella eerwah	Shiny-leaved condoo	E	6.29	6.29	0.00	0.00	0.00	0.00	0.00	0.00
Fauna (threatened)										
Anthochaera phrygia	Regent honeyeater	CE	924.90	924.90	0.00	0.00	11.43	11.43	0.00	0.00
Botaurus poiciloptilus	Australasian bittern	E	592.72	592.72	0.00	0.00	42.43	42.43	0.00	0.00
Calidris ferruginea	Curlew sandpiper	CE, M	600.53	600.53	0.00	0.00	38.15	38.15	0.00	0.00
Chalinolobus dwyeri	Large-eared pied bat	V	89.30	89.30	0.00	0.00	2.89	2.89	0.00	0.00
Dasyurus maculatus maculatus	Spotted-tail quoll (South-eastern mainland population)	E	1,927.68	1,571.09	0.00	356.59	76.36	69.44	0.00	6.92
Delma torquata	Collared delma	V	898.27	0.00	898.27	0.00	9.56	0.00	9.56	0.00
Erythrotriorchis radiatus	Red goshawk	V	1,968.90	305.75	0.00	1,663.15	79.05	1.80	0.00	77.25
Grantiella picta	Painted honeyeater	V	311.23	311.23	0.00	0.00	30.10	30.10	0.00	0.00
Lathamus discolor	Swift parrot	CE	2,966.22	2,764.98	0.00	201.24	141.18	129.44	0.00	11.74
Neoceratodus forsteri	Australian lungfish	V	249.15	249.15	0.00	0.00	27.62	27.62	0.00	0.00
Petauroides volans	Greater glider	V	1,007.67	1,007.67	0.00	0.00	16.60	16.60	0.00	0.00
Petrogale penicillata	Brush-tailed rock-wallaby	V	0.024	0.024	0.00	0.00	0.00	0.00	0.00	0.00

Species name	Common name	EPBC Act status*	Predicted habitat within the MNES study area (ha)* (12,442.24 ha)				Predicted habitat within the disturbance footprint (ha)* (972.49 ha)			
			Total habitat	Potential habitat	Important habitat	Habitat critical to the survival of the species	Total habitat	Potential habitat	Important habitat	Habitat critical to the survival of the species
Phascolarctos cinereus	Koala combined populations of QLD, NSW and the ACT)	V	7,613.98	4,878.50	0.00	2,735.48	598.48	474.17	0.00	124.31
Potorous tridactylus tridactylus	Long-nosed potoroo (SE mainland)	V	865.37	865.37	0.00	0.00	9.56	9.56	0.00	0.00
Pseudomys novaehollandiae	New Holland mouse	V	880.47	880.47	0.00	0.00	9.56	9.56	0.00	0.00
Pteropus poliocephalus	Grey-headed flying-fox	V	3,084.70	1,873.48	0.00	1,211.22	143.89	72.45	0.00	71.44
Rostratula australis	Australian painted snipe	E	600.53	52.36	0.00	548.17	38.15	3.60	0.00	34.55
Turnix melanogaster	Black-breasted button-quail	V	4.19	0.00	0.00	4.19	0.00	0.00	0.00	0.00
Hirundapus caudacutus^	White-throated needletail	V, M	12,445.93	9,361.23	3,084.70	0.00	972.49	828.59	143.90	0.00

Table notes:

CE = Critically endangered E = Endangered V = Vulnerable M = Migratory
^ = Aerial species, all "air-space" above the Project is considered habitat. However, these areas will remain unimpacted by the Project. This species has not been subject to impact assessment.
* = No value (i.e. 0) represent areas where habitat modelling has indicated that no predicted habitat has been identified within a particular area. For species where no habitat is present within the MNES study area, impact assessment has not occurred although their habitat requirements and ecology has been considered through the modelling process (refer Appendix A).

4.4.4 Flora and fauna habitat within the matters of national environmental significance study area

A total of nine broad flora and fauna habitat types have been identified within the MNES study area. The broad habitat types were delineated by grouping vegetation communities according to their vegetative structure, composition, and geomorphological characteristics. The condition of the various habitat types was derived from aerial photograph interpretation, RE mapping, relevant database searches, field reconnaissance and previous experience within the MNES study area.

Discrete areas of remnant vegetation are scattered across the MNES study area, however, most of the area is characterised by non-remnant vegetation, particularly cleared agricultural areas, which provide grassland habitat to fauna species. Non-remnant linear vegetation along roadsides and drainage lines, regrowth vegetation and isolated paddock trees form a variegated landscape mosaic in an otherwise fragmented environment.

Mature eucalypt open forest and woodland is the dominant forest/woodland habitat type in the MNES study area. Areas of habitat ranged in size from small fragments less than 1 ha in size, which are often degraded as a result of cattle grazing and selective logging or thinning of trees leading to weed invasion and structural simplification. Larger tracts of forest/woodland was typically associated with steep topography (e.g. Teviot Range).

Each broad habitat type is discussed in further detail below and shown in Figure 4.6a-e. The following sections denote the State-based vegetation communities (REs) associated with the broad habitat types discussed. For detailed descriptions of the REs please refer to Appendix A within Appendix A of this report: Predictive habitat modelling methodology. An analysis of the quantity of fauna habitat contained within the MNES study area and within the disturbance footprint is presented in Table 4.6.

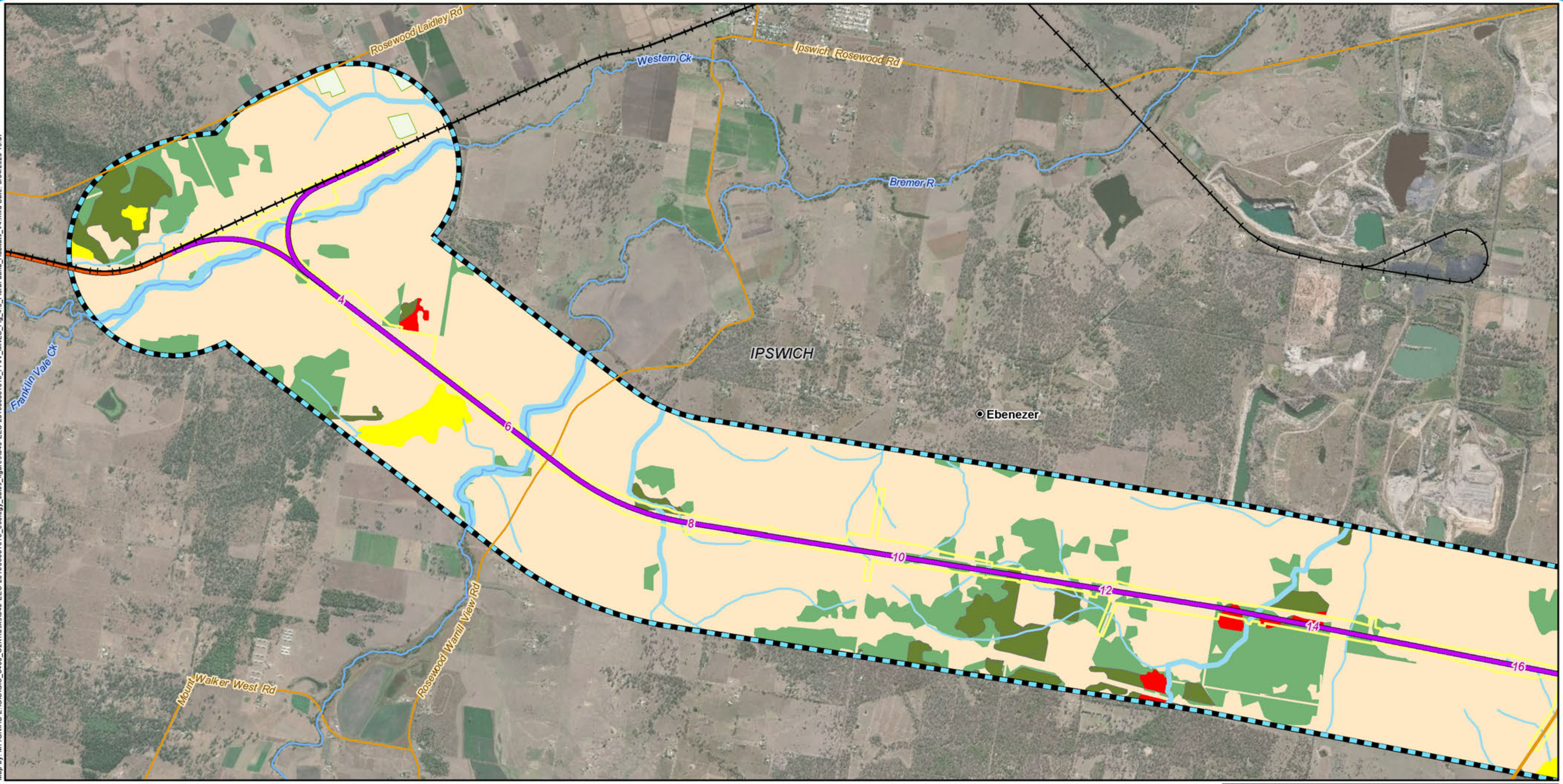
Table 4.6 Extent of flora and fauna habitat located within the MNES study area

Fauna habitat type (refer Figure 4.6)	Extent (ha)	
	MNES study area	Disturbance footprint
Mature eucalypt open forest and woodland (on sedimentary and igneous rocks and on alluvial plains)	1,025.45	11.17
Mature eucalypt riparian open forest and woodland	18.09	1.39
Araucarian notophyll/microphyll and microphyll vine forest	4.34	0.00
Melaleuca low open woodland*	80.27	30.31
Wetlands	69.00	0.75
Grassland (modified non-remnant habitats)	8,144.91	729.10
Riparian zones/waterways	1,050.08	73.44
Cultivated land (modified non-remnant habitats)	332.09	32.36
Regrowth communities	1,690.39	93.87
No Habitat present	27.60	0.00

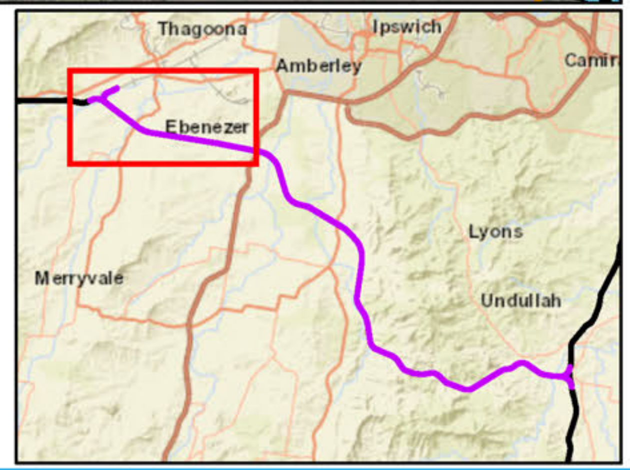
Table note:

* Includes communities currently mapped as regrowth communities under State-based vegetation mapping

Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



Map by: MFIGN/AD Z:\GIS\GIS_3400_C2K\Tasks\340-EEC-201905081615_ecology_calcs_figures\340-EEC-201905081615_FFJV_MNES_Fig_4_6_FloraFauna_Habitats_V4.mxd Date: 8/04/2020 16:37



Legend

- 5 Chainage (km)
- Localities
- Existing rail
- H2C project alignment
- C2K project alignment
- Watercourses
- Major roads
- Minor roads
- EIS disturbance footprint (surface disturbance only)
- MNES study area
- Local Government Areas
- Cultivated land
- Grassland
- Regrowth communities
- Mature eucalypt open forest and woodland (on sedimentary and igneous rocks and on alluvial plains)
- Melaleuca low open woodland
- Riparian zones / waterways
- Wetlands

A3 scale: 1:40,000

0 0.5 1 1.5 2 2.5km

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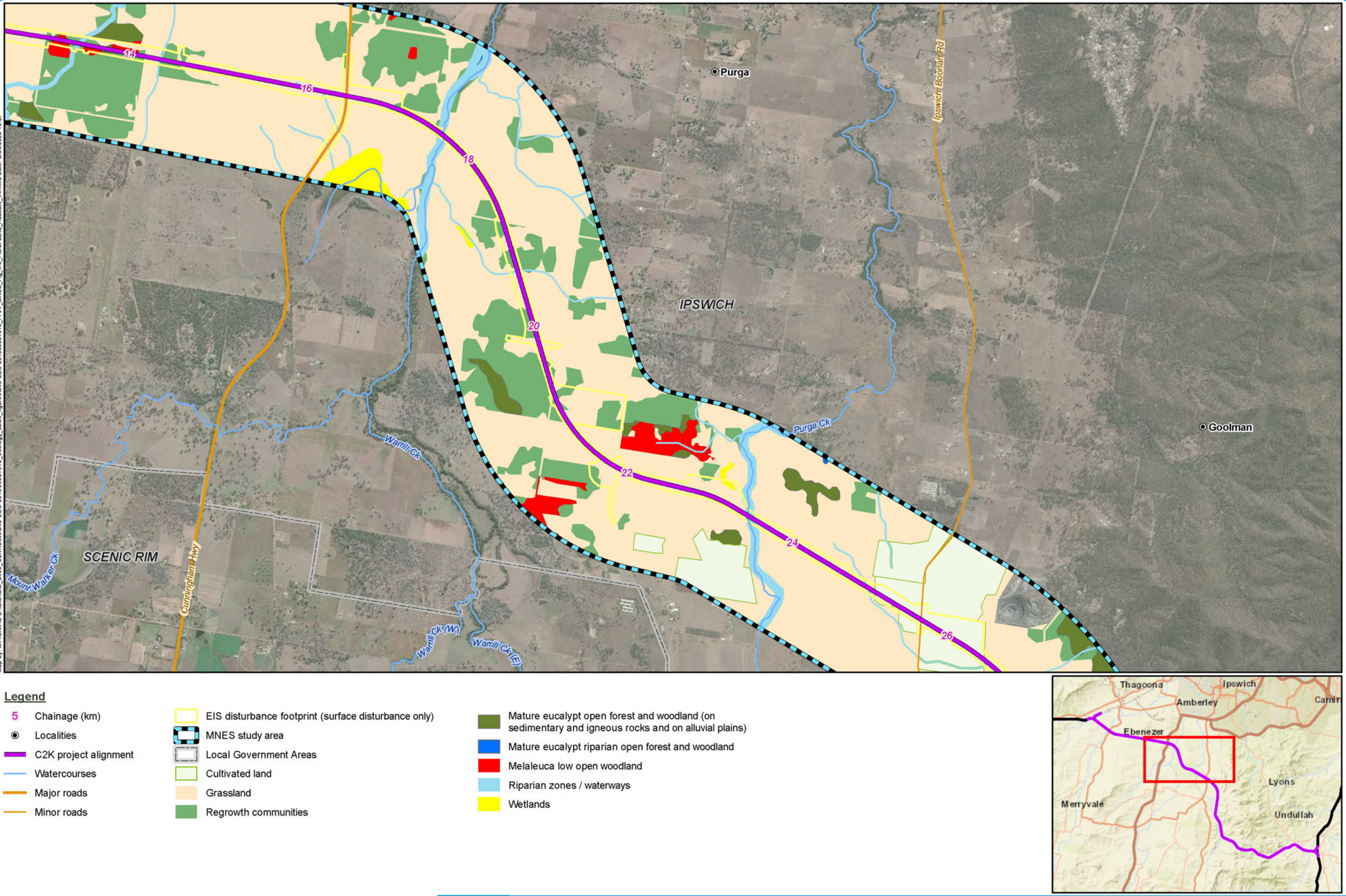
Calvert to Kagaru

Figure 4.6a: Location of fauna and flora habitat types contained within the MNES study area

Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



Map by: MF/GN/AD Z:\GIS\GIS_3400_C2K\Tasks\340-EEC-201905081615_ecology_calcs_figures\340-EEC-201905081615_FFJV_MNES_Fig_4.6_FloraFauna_Habitats_V4.mxd Date: 8/04/2020 16:37

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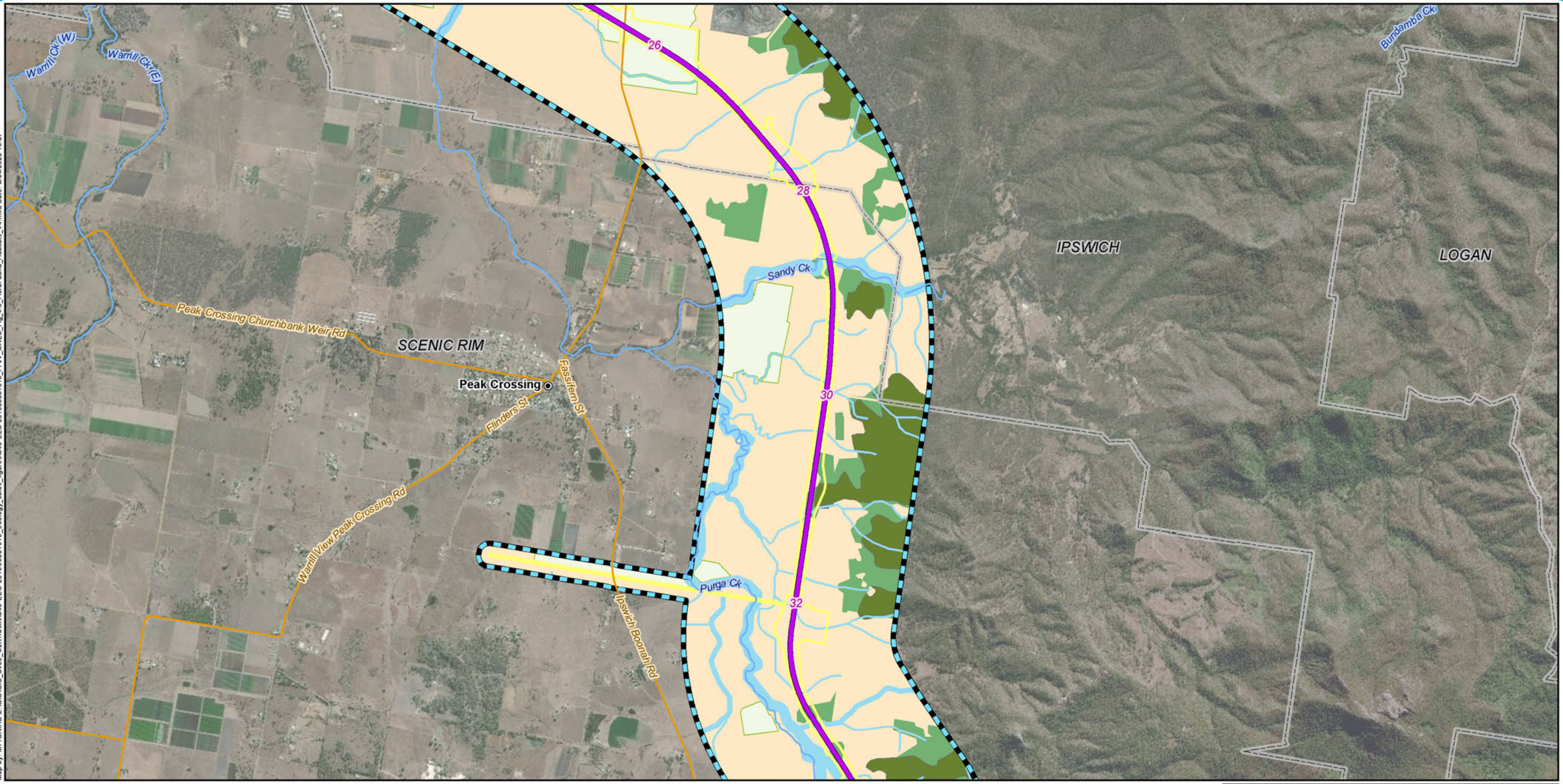
Figure 4.6b: Location of fauna and flora habitat types contained within the MNES study area

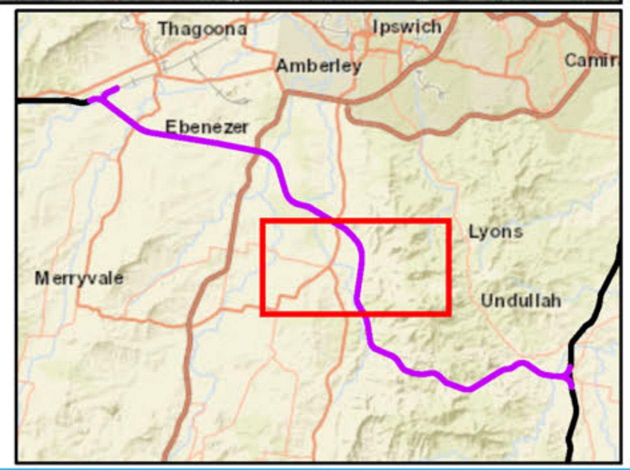
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Map by: MF/GN/AD Z:\GIS\GIS_3400_C2K\Tasks\340-EEC-201905081615_ecology_calcs_figures\340-EEC-201905081615_FFJV_MNES_Fig_4_6_FloraFauna_Habitats_V4.mxd Date: 8/04/2020 16:37



Legend

- 5 Chainage (km)
- Localities
- C2K project alignment
- Watercourses
- Major roads
- Minor roads
- EIS disturbance footprint (surface disturbance only)
- MNES study area
- Local Government Areas
- Cultivated land
- Grassland
- Regrowth communities
- Mature eucalypt open forest and woodland (on sedimentary and igneous rocks and on alluvial plains)
- Riparian zones / waterways



A3 scale: 1:40,000

0 0.5 1 1.5 2 2.5 km

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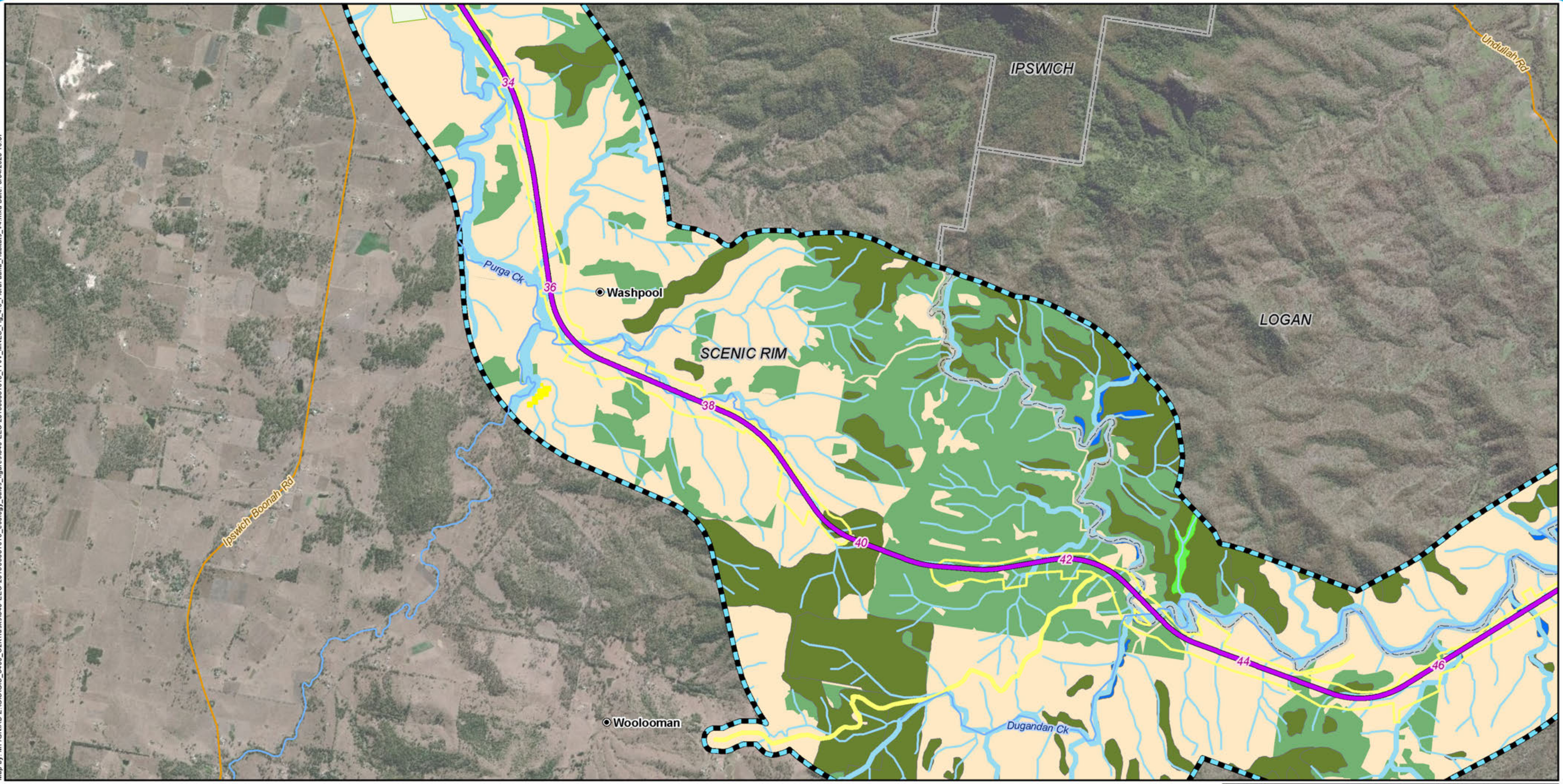
Calvert to Kagaru

Figure 4.6c: Location of fauna and flora habitat types contained within the MNES study area

Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

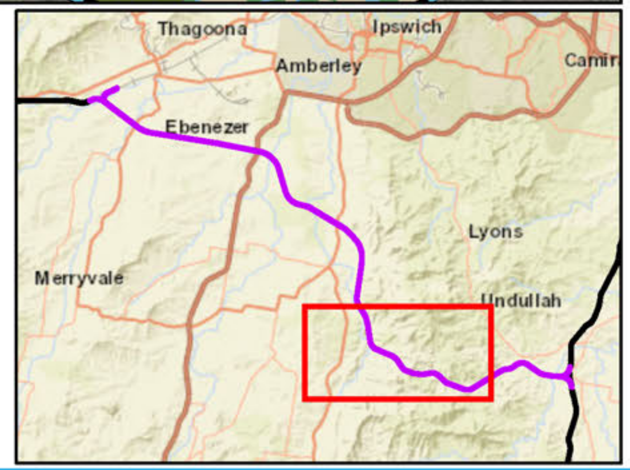


Map by: MF/GN/AD Z:\GIS\GIS_3400_C2K\Tasks\340-EEC-201905081615_ecology_calcs_figures\340-EEC-201905081615_FFJV_MNES_Fig_4_6_FloraFauna_Habitats_V4.mxd Date: 8/04/2020 16:37

Legend

- 5 Chainage (km)
- Localities
- C2K project alignment
- Watercourses
- Major roads
- Minor roads
- EIS disturbance footprint (surface disturbance only)
- MNES study area
- Local Government Areas
- Araucarian notophyll/microphyll and microphyll vine forest
- Cultivated land
- Grassland
- Regrowth communities
- Mature eucalypt open forest and woodland (on sedimentary and igneous rocks and on alluvial plains)
- Mature eucalypt riparian open forest and woodland
- Riparian zones / waterways

Note that due to topography constraints and the realigment of Wild Pig Creek Road and to minimise impacts on Dugandan Creek, there is a small area not within the disturbance footprint between Chainage 42 and 44.



A3 scale: 1:40,000

0 0.5 1 1.5 2 2.5 km

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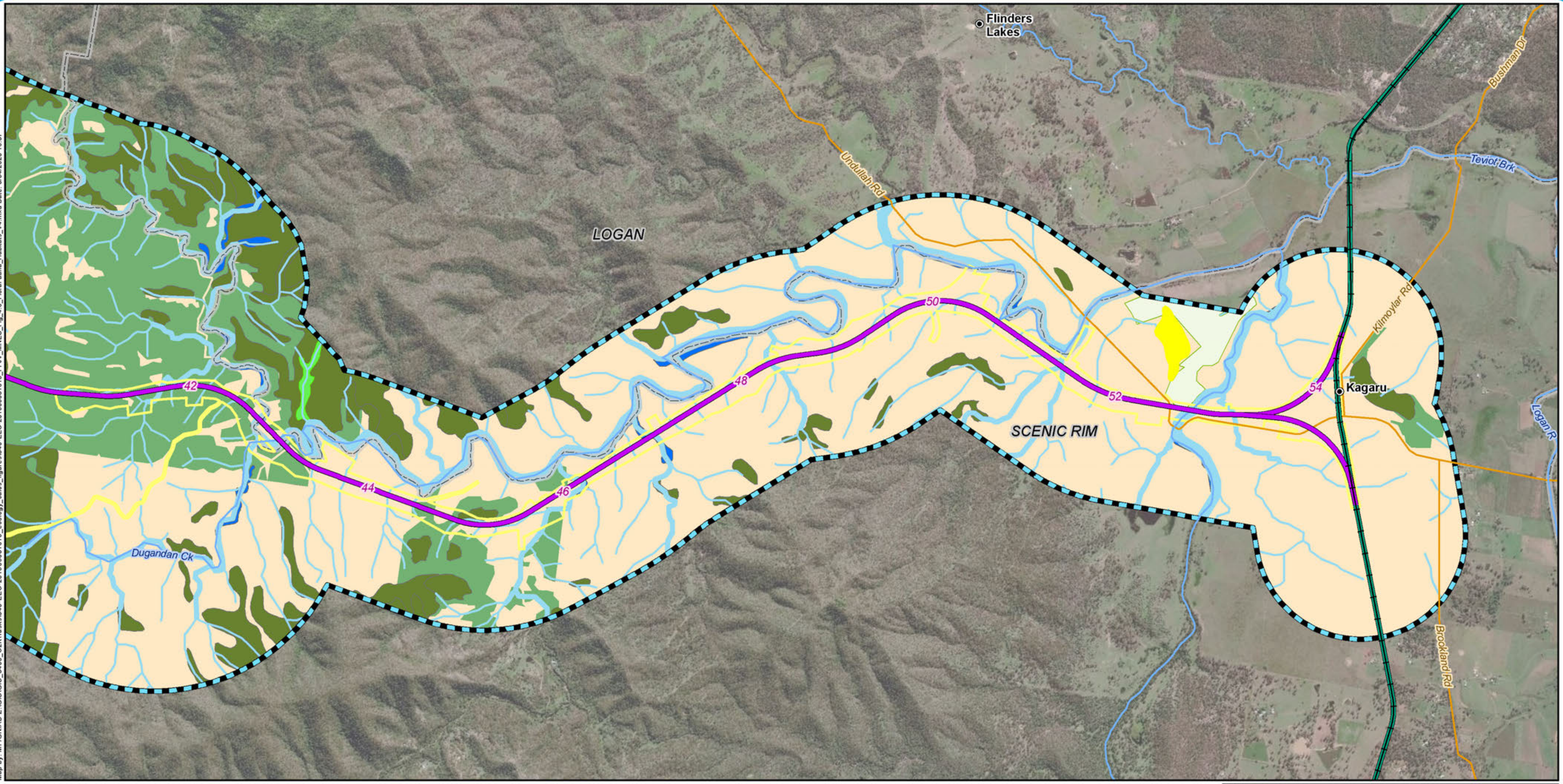
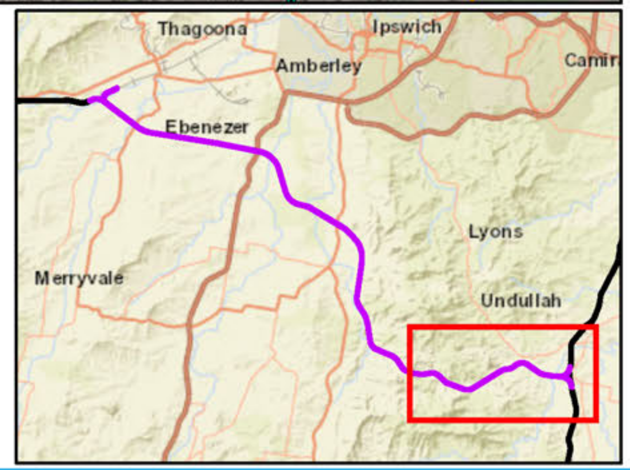
Calvert to Kagaru

Figure 4.6d: Location of fauna and flora habitat types contained within the MNES study area

Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



Map by: MFIGN/AD Z:\GIS\GIS_3400_C2K\Tasks\340-EEC-201905081615_ecology_calcs_figures\340-EEC-201905081615_FFJV_MNES_Fig_4.6_FloraFauna_Habitats_V4.mxd Date: 8/04/2020 16:37



Legend

- 5 Chainage (km)
- Localities
- Existing rail
- C2K project alignment
- K2ARB project alignment
- Watercourses
- Major roads
- Minor roads
- EIS disturbance footprint (surface disturbance only)
- MNES study area
- Local Government Areas
- Araucarian notophyll/microphyll and microphyll vine forest
- Cultivated land
- Grassland
- Regrowth communities
- Mature eucalypt open forest and woodland (on sedimentary and igneous rocks and on alluvial plains)
- Mature eucalypt riparian open forest and woodland
- Riparian zones / waterways
- Wetlands

Note that due to topography constraints and the realigment of Wild Pig Creek Road and to minimise impacts on Dugandan Creek, there is a small area not within the disturbance footprint between Chainage 42 and 44.

A3 scale: 1:40,000

0 0.5 1 1.5 2 2.5km

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Coordinate System: GDA 1994 MGA Zone 56

Calvert to Kagaru

Figure 4.6e: Location of fauna and flora habitat types contained within the MNES study area

4.4.4.1 Mature Eucalypt open forest and woodland

On sedimentary and igneous rocks

This habitat is dominant in the elevated areas associated with the Teviot Range in the eastern portion of the MNES study area (refer Figure 4.6a-b). These communities are dominated by Narrow-leaved ironbark (*Eucalyptus crebra*), Grey gum (*Eucalyptus major*), White mahogany (*Eucalyptus acmenoides*), Grey ironbark (*Eucalyptus siderophloia*), Spotted gum (*Corymbia citriodora*), Brush box (*Lophostemon confertus*), and Swamp box (*Lophostemon suaveolens*). Areas of remnant, mature eucalypt open forest and woodland within the MNES study area are represented by the following REs: 12.9-10.2, 12.9-10.3, 12.9-10.7, 12.9-10.17 and 12.9-10.27.

The condition and structure of these habitats varies greatly across the MNES study area, ranging from a simplified structure with sparse shrub and/or ground strata reflective of past land use and current management practices (i.e. logging, cattle grazing and vegetation thinning), to a complex vegetation structure with all strata (i.e. canopy, mid-storey and understorey) essentially intact. Invasive weeds including Lantana (*Lantana camara* and *montevidensis*), and Prickly pear (*Opuntia)* species were observed as commonly occurring in this habitat with dense infestations noted in some areas.

Important microhabitat refugia provided by this habitat type includes rocky escarpments and outcrops, boulder piles, hollow logs, and termite nests (i.e. arboreal and terrestrial).

Canopy species present in this habitat type provide a range of trunk and limb hollows (of a variety of size classes) which potentially provide suitable habitat for Microchiropterian bats, gliders, possums, birds (including parrots, cockatoos and owls), arboreal snakes and monitors. Eucalypt flowering events may provide seasonal foraging resources for a number of dispersive MNES bird species including the Swift parrot (*Lathamus* discolour) and the Regent honeyeater (*Anthochaera phrygia*). Standing dead trees (stags) also provide roosting sites, nesting dens and breeding locations for a similar range of species. Where mature eucalypt open forest and woodlands (on sedimentary and igneous rock) occur as fragmented/isolated patches in largely cleared agricultural landscapes, they are somewhat restricted in their capacity to support woodland and forest species and are more likely to offer habitat value to transitional species and support mammal and bird species typical of disturbed areas.

Photograph 4.4 Brush box/Swamp box dominated open forest in Teviot Range (Jacobs-GHD 2016a)

Photograph 4.5 Spotted gum dominated woodland with *Lantana camara* understorey (2017)

Areas of mature eucalypt open forest and woodland (on sedimentary and igneous rock) within the MNES study area may provide suitable habitat for a range of MNES fauna species where appropriate habitat values are present for the species. The required habitat elements to support MNES species (e.g. large tree hollows, large fallen timber) are not present throughout. Suitable habitat for MNES fauna may include Collared delma (*Delma torquata*), Long-nosed potoroo (*Potorous tridactylus*), Greater glider (*Petauroides volans volans*), Koala (*Phascolarctos cinereus*) and Grey-headed flying fox (*Pteropus poliocephalus*). The presence of large rocks/cliffs may support habitat for Large-eared pied bat (*Chalinolobus dwyeri*), Spotted-tail quoll (*Dasyurus maculatus maculatus*) and Brush-tailed rock wallaby (*Petrogale penicillata*) although no such habitat areas were observed within or near the Project disturbance footprint. Lloyd's olive (*Notelaea lloydii*) is also known to occur in this habitat within the Project disturbance footprint.

On alluvial plains

Areas of mature eucalypt open forest and woodland on alluvial plains largely occur within the MNES study area to the west of the Teviot Range (refer Figure 4.6a-b and Photograph 4.6) and include areas dominated by Queensland blue gum (*Eucalyptus tereticornis*). Areas of remnant eucalypt open forest and woodland (on alluvial plains) within the MNES study area are represented by RE 12.3.3 and 12.3.19.

This habitat type exists on floodplains and creek flats within the MNES study area and generally exhibits low structural complexity, particularly at lower strata levels. Ground cover is typically low due to livestock use, and the understorey very sparse with an open canopy of large Queensland blue gum (*Eucalyptus tereticornis*). However, mature eucalypt trees on alluvial plains are known to retain large hollows and provide important habitat, such as food and shelter, for a range of fauna species, including birds, mammals, and reptiles. MNES fauna species that may occur in eucalypt open forest and woodland on alluvial plains within the MNES study area include Regent honeyeater (*Anthochaera phrygia*), Swift parrot (*Lathamus discolor*), Large-eared pied bat (*Chalinolobus dwyeri)*, Koala (*Phascolarctos cinereus*), and Grey-headed flying fox (*Pteropus poliocephalus*). In particular, Queensland blue gum (*Eucalyptus tereticornis*) is a favoured forage species for Koala.

Furthermore, during the wet season this habitat type may flood temporarily, effectively becoming a temporary wetland habitat (floodplain wetland). When flooded this habitat type is suitable for a range of wetland bird species, including ducks, geese, grebes, snipe, crakes, rails, egrets, and herons. Threatened fauna species that may utilise flooded eucalypt open forest and woodland on alluvial plains include Australian painted snipe (*Rostratula australis*).

It is important to note that the definition of open forest and woodland habitats applied here excludes riparian vegetation along watercourses which has been classified as the habitat type; mature eucalypt riparian open forest and woodlands.

Photograph 4.6 Alluvial woodland dominated by Queensland blue gum and Grey gum in western alignment (Jacobs-GHD 2016a)

4.4.4.2 Mature eucalypt riparian open forest and woodland

Eucalypt riparian open forest and woodlands within the MNES study area include open forests and woodlands dominated by Queensland blue gum (*Eucalyptus tereticornis*) fringing drainage lines with associated species including *Melaleuca* spp., Moreton Bay ash (*Corymbia tessellaris*), *Angophora* spp., and River she-oak (*Casuarina cunninghamiana*) (refer Photograph 4.7). Areas of remnant and regrowth eucalypt riparian open forest and woodland mapped within the MNES study area are represented by RE 12.3.7. It is noted not all vegetated waterways may be mapped under the State-based mapping. Waterways intersected by the Project disturbance footprint providing relatively consistent riparian vegetation (and therefore landscape connection) include Bremer River, Warrill Creek, Sandy Creek and Woollaman Creek. Riparian forests along other creeks (such as Western Creek and Purga Creek) have been heavily disturbed in the past and do not currently maintain a consistent riparian vegetation connection across the landscape.

This habitat type occurs exclusively along the edge of rivers, creeks and vegetated drainage lines within the MNES study area. Mature eucalypt riparian open forest and woodlands within the MNES study area is often structurally complex at all strata levels and potentially supports the greatest fauna diversity per hectare. Nevertheless, these areas have been subject to high levels of disturbance in the past and currently from cattle grazing activity including tree clearing (often to the edge of this habitat) (refer Photograph 4.8) and stock access to water. Weed infestation is often prominent and dense infestations of *Lantana camara* are common.

Riparian zones within the MNES study area, often contain well structural components which provides important habitat for smaller species such as insectivorous birds, reptiles and mammals. Riparian forests dominated by Queensland blue gum (*Eucalyptus tereticornis*) provide abundant seasonal nectar resources for birds and mammals and generally have large tree hollows suitable as shelter nesting sites for arboreal mammals (such as Greater glider (*Petauroides volans volans*)) and some bird species (particularly parrots). In addition, proximity to permanent water sources also increases the importance of these areas as habitat. Riparian vegetation also contributes to in-stream habitat (e.g. large woody debris) considered important for MNES fish species. Within these zones, threatened aquatic fauna are considered to have potential to occur where large permanent waterholes occur, specifically Australian lungfish (*Neoceratodus forsteri*).

A range of fauna, including birds, mammals, and reptiles, utilise this habitat type for foraging, breeding, and dispersal. The movement corridors provided by this habitat type are important for structural connectivity, in otherwise fragmented landscapes. MNES fauna species that may occur in mature eucalypt riparian open forests and woodland include Regent honeyeater (*Anthochaera phrygia*), Swift parrot (*Lathamus discolor*), Greater glider (*Petauroides volans volans*), Koala (*Phascolarctos cinereus*) and Grey-headed flying fox (*Pteropus poliocephalus*). As noted above Queensland blue gum (*Eucalyptus tereticornis*) is favoured as a forage species for Koala. The Red goshawk (*Erythrotriorchis radiatus*), Large-eared pied bat (*Chalinolobus dwyeri*), and Spotted-tail quoll (*Dasyurus maculatus maculatus*) may utilise this habitat where it occurs within or adjacent to the extensive habitat in the Teviot Range.

Photograph 4.7 Tall riparian forest on Woolaman Creek (upstream of alignment) in the Teviot Range (2017)

Photograph 4.8 Degraded riparian forest at alignment crossing of Purga Creek (Jacobs-GHD 2016a)

4.4.4.3 Araucarian notophyll/microphyll and microphyll vine forest

Araucarian notophyll/microphyll and microphyll vine forest within the MNES study area includes Araucarian notophyll/microphyll vine forest and microphyll vine forest and is represented by RE 12.9-10.16. Within the MNES study area this habitat occurs as a single patch in the Teviot Range. It does not occur within the disturbance footprint (refer Figure 4.6b). Dominant species include Hoop pine (*Araucaria cunninghamiana*), Booyong (*Argyrodendron* sp.), Carrol (*Backhousia myrtifolia*), and Tuckeroo (*Cupaniopsis parvifolia*).

This habitat type typically occurs on the steep slopes of south-facing gullies with Cainozoic and Mesozoic sediments. Structural complexity is generally very high, with a closed shrub layer, sub-canopy and canopy, with or without emergent *Araucaria cunninghamiana*. A broad range of microhabitat refugia are often present, including tree hollows, hollow logs, rock crevices, and dense vine thickets. Araucarian notophyll/microphyll and microphyll vine forest within the MNES study area provides habitat to forest-dependent fauna, which prefer dense, undisturbed habitat. Fruiting trees are often abundant, providing important foraging habitat for frugivorous birds and bats. Threatened species that may utilise Araucarian notophyll and microphyll vine forest within the MNES study area includes Shiny-leaved condoo (*Planchonella eerwah*), Black-breasted button-quail (*Turnix melanogaster*), Spotted-tail quoll (*Dasyurus maculatus maculatus*), Long-nosed potoroo (*Potorous tridactylus tridactylus*), and the Grey-headed flying fox (*Pteropus poliocephalus*).

4.4.4.4 Melaleuca low open woodland

Melaleuca low open woodland within the MNES study area includes low open woodland and tall shrubland dominated by Swamp tea-tree (*Melaleuca irbyana*). This community occurs on floodplains in the western section of the alignment (refer Figure 4.6a-b) and in some cases is analogous to a Swamp Tea-tree (*Melaleuca irbyana*) Forest of South-east Queensland TEC (refer Section 4.4.1.3). Within this habitat type *Melaleuca irbyana* forms a closed shrub layer or sub-canopy with a sparse understorey. An open canopy of emergent eucalypts (e.g. *Eucalyptus tereticornis*) is sometimes present. This habitat type provides foraging and nesting habitat for a range of bird species. Melaleuca low open woodland occurs on Mesozoic sediments where drainage is impeded, such as lower slopes and elevated flats. Ephemeral pools commonly occur, provided suitable breeding habitat for a range of frog species. During the wet season this habitat type commonly forms a palustrine wetland when flooded. There is some evidence to suggest that Swamp tea-tree communities may require at least intermittent access to groundwater (such as during drought conditions) (Soonthornvipat 2018) and therefore may be considered as a GDE.

This habitat provides limited value for MNES fauna species but may include Australian painted snipe (*Rostratula australis*) (although only where suitable ground cover may occur during inundation) and foraging habitat Grey-headed flying fox (*Pteropus poliocephalus*) during flowering events.

4.4.4.5 Wetlands

Wetland habitat within the MNES study area is generally limited in extent with some larger areas mapped in the western floodplain between Willowbank and Calvert and a riverine wetland area located near Kagaru (refer Figure 4.6a-b). Wetland habitat located within the Project disturbance footprint is very limited. Wetland habitats within the MNES study area include dams and reservoirs (lacustrine), wetlands associated with the floodplains of major watercourses (riverine), and vegetated swamps (palustrine). Artificial wetlands include typically small farm dams and much larger turkey-nest dams (refer Photograph 4.9) associated with irrigated cropping, as well as drinking water supply reservoirs. Riverine wetlands associated with floodplains are ephemeral and typically vegetated by a mixture of native and non-native grasses and grass-like plants (refer Photograph 4.10), and Queensland bluegum (*Eucalyptus tereticornis*).

Palustrine wetlands within the MNES study area typically occur on alluvial floodplains and are dominated by Poaceae (grasses), Restionaceae (rushes) and Cyperaceae (sedges). Naturally occurring wetland swamps in the MNES study area may be represented by a variety or remnant and non-remnant habitats but include RE 12.3.8 (specifically described as a swamp community) as well as RE 12.3.7 (riverine wetlands).

Wetland habitats within the MNES study area are considered to provide suitable habitat for a variety of fish, amphibian, reptile (incl. turtles) and bird species. Larger palustrine-wetlands such as Ten Mile Swamp potentially provide important refuge habitat for many bird species, including dispersive species. MNES fauna species that may utilise wetland habitats within the MNES study area include the Australasian bittern (*Botaurus poiciloptilus)* and Australian painted snipe (*Rostratula australis*) although both of these species are reliant on the presence of dense vegetation either aquatic (in the case of the bittern) or as nearby cover (for snipe). It is noted farm dams are less likely to provide these habitat elements and the floodplain wetlands in the area are highly ephemeral. At the time of the EIS field surveys the study region had undergone an extended dry period with no water available on floodplain wetlands. The Curlew sandpiper (*Calidris ferruginea*) may occasionally occur on large farm dams with shallow muddy areas.

Photograph 4.9 Minimally vegetated farm dam located downstream of alignment (2017)

Photograph 4.10 Ephemeral swampland area within matters of national environmental significance study area (2017)

In Queensland 'high ecological significance' (HES) wetlands are defined by modelling using the Aquatic Biodiversity Assessment and Mapping Methodology (AquaBAMM) to identify important wetland areas as 'matters of state environmental significance' under State legislation. These wetlands are typically of a 'high' or 'very high' conservation value under the criteria used for AquaBAMM mapping. There are 66 ha of State mapped wetlands (as mapped by DES) considered as HES wetlands that occur within the MNES study area, of which none lies within the current disturbance footprint and will not be directly impacted from activities associated with the Project. The HES wetland areas are located at the following watercourses and chainage (Ch):

- Two HES wetlands proximal to Western Creek (Ch 2.40 km)
- HES wetland at tributary of the Bremer River (Ch 5.20 to Ch 5.60 km)
- HES wetland at tributary of Warrill Creek (Ch 17.00 to Ch 17.60 km)
- HES wetland at Purga Creek (Ch 36.00 km)
- HES wetland at Teviot Brook (Ch 52.40 to Ch 52.80 km) (refer Figure 4.7 in EIS Appendix J: Terrestrial and Aquatic Ecology Technical Report for locations).

Refer to the EIS Appendix J: Terrestrial and Aquatic Ecology Technical Report for a detailed description on these areas and their locations.

Other wetland values within the MNES study area are represented through aquatic conservation assessment modelling. The catchment aquatic conservation assessment indicates a skew towards higher value riverine wetlands (against the criteria indicated above) throughout the Bremer River and Logan River catchments, indicating the presence of sensitive wetlands throughout both catchments. Noting this, aquatic assessment within the MNES study area indicated areas of very low value (i.e. portions of Purga Creek), low value (i.e. Dugandan Creek and Woollaman Creek) and medium value (i.e. Western Creek, Bremer River, Warrill Creek, portions of Purga Creek and Teviot Brook). No springs mapped on the Queensland wetland mapping layer were identified within the MNES study area. Further information regarding wetland values are provided in EIS Appendix J: Terrestrial and Aquatic Ecology Technical Report.

4.4.4.6 Grassland

Grassland habitats within the MNES study area include non-native grasslands and derived native grasslands. Non-native grasslands are dominated by exotic pasture grasses and are represented by areas of non-remnant vegetation (excluding cultivated land) (refer Photograph 4.11), previously cleared of native-vegetation for agriculture. Dominant pasture grasses include Rhodes grass (*Chloris gayana*), Pigeon grass (*Setaria sphacelata*), Green panic (*Megathyrsus maximus*), and Sabi grass (*Urochloa mosambicensis*). However, native grass species also occur including Native rats-tail grass (*Sporobolus creber*), Forest bluegrass (*Bothriochloa bladhii*), Bluegrass (*Dichanthium sericeum*), and Blady grass (*Imperata cylindrica*).

Derived native grasslands are dominated by native grass species and are represented by areas of non-remnant vegetation (excluding cultivated land), previously cleared of woody species (i.e. trees and shrubs) for agriculture. Dominant grass species include Queensland panic (*Panicum queenslandicum*), Bluegrass (*Dichanthium sericeum*), Digitaria (*Digitaria divaricatissima*) and Pitted bluegrass (*Bothriochloa decipiens*). However, exotic pasture grasses sometimes occur, such as Rhodes grass (*Chloris gayana*).

Non-native and native derived grasslands are considered as a single habitat type due to similarities in structure and floristics. Grassland is the most extensive fauna habitat within the MNES study area and is typically located on alluvial floodplains and creek flats. These grassland habitats are commonly utilised for agricultural purposes including livestock grazing and fodder harvesting.

Grasslands within the MNES study area provide foraging habitat for granivorous bird species such as finches, parrots and pigeons. Grassland habitats also provide important microhabitat refugia (i.e. soil cracks) for small ground fauna such as native rodents, skinks, and snakes. Scattered paddock trees occur across many grassland habitats, providing fauna habitat and connectivity in otherwise cleared and fragmented landscapes. In general, the grasslands that dominate the Project disturbance footprint provide poor habitat value for MNES fauna species potentially occurring in the area, although grasslands may provide temporary habitat for wetland bird species when flooded (refer Photograph 4.12).

Photograph 4.11 Typical non-native grassland occurring in matters of national environmental significance study area (2017)

Photograph 4.12 Rock wall and pool on Teviot Brook at Project alignment crossing (2017)

4.4.4.7 Riparian zones/waterways

Riparian zones are an interface between terrestrial and aquatic ecosystems and also play a vital role in supporting biodiversity. Healthy, native riparian vegetation reduces the water temperature of aquatic habitats by shading (as a buffer to thermal radiation). When water temperature increases, poikilothermic aquatic organisms will experience physiological stress (Guschina and Harwood, 2006), with expected reduced resilience to additional stressors (such as further degraded water quality parameters). More sunlight in the riparian zone also increases the growth of soft leaved vigorous weeds and algae that can choke the stream channel, reducing fish passage at lower hydrological flow.

In addition, riparian zones within the MNES study area are highly variable in condition due to the impacts of surrounding land use, weed invasion (particularly *Lantana camara*), cattle access and erection of man-made infrastructure (refer Photograph 4.12 and Photograph 4.13). Healthy examples of this community typically contain well developed vegetation communities and complex structural components (i.e. well-developed canopy, sub-canopy, shrub and ground layers) which provides important habitat for smaller species such as insectivorous birds, reptiles and mammals. Riparian forests dominated by Queensland blue gum (*Eucalyptus tereticornis*) provide abundant seasonal nectar resources for birds and mammals and generally have large tree hollows suitable as shelter nesting sites for arboreal mammals (such as Greater glider (*Petauroides volans volans*)) and some bird species (particularly parrots). In addition, proximity to permanent water sources also increases the importance of these areas as habitat. Within these zones, threatened aquatic fauna are considered to have potential to occur where large permanent waterholes occur, specifically Australian lungfish (*Neoceratodus forsteri*).

Within the MNES study area, habitats with permanent water are likely to support the most diverse and abundant aquatic communities, however areas with seasonal water provide periodically available habitat and act as pathways for fauna. Riverine waters and habitats associated with the Project were found to range from low value to medium value during aquatic assessments (refer Section 4.4.4.5). These crossings (and associated works within the riparian vegetation communities) coincide with medium aquatic conservation assessment scores indicating the value of riverine wetlands and associated habitat importance to MNES within the MNES study area. Further information regarding riverine habitat values is provided in EIS Appendix J: Terrestrial and Aquatic Ecology Technical Report.

Vegetation associated with riparian zones provides an important role in facilitating fauna movement in otherwise fragmented environments and as such are pivotal in the movement of genetic material within populations and ecosystems and ensure correct ecosystem function and processes are maintained.

Photograph 4.13 Riparian community with limited structure at large pool at Warrill Creek on alignment crossing (2017)

Photograph 4.14 Regrowth eucalypt community in Teviot Range with dense understorey of *Lantana camara* (2017)

4.4.4.8 Cultivated land

Cultivated land within the MNES study area includes irrigated and dryland crops, stubble fields and fallow fields. Common crops include winter cereals, vegetables and legumes. The availability of soil cracks and other microhabitat refugia is greatly reduced by soil cultivation. Cultivated land typically occurs in low-lying areas on fertile clays and provides habitat for generalist bird species such as Torresian crow (*Corvus orru*), Australian magpie (*Gymnorhina tibicen*), and Little corella (*Cacatua sanguinea*). Non-native fauna species are typically abundant in cultivated land habitats, including restricted matters (Category 3 invasive animals) such as European red fox (*Vulpes vulpes*), Domestic dog (*Canis familiaris*), and Feral pig (*Sus scrofa*).

4.4.4.9 Regrowth communities

Areas of regrowth vegetation are present throughout the MNES study area but with concentrations in the western section of the Teviot Range and lands in the Ebenezer to Purga areas (refer Figure 4.6). Extant patches of regrowth vegetation within the MNES study area are typically in poor ecological condition, suffering from extensive weed invasion and disturbance from cattle grazing practices (refer Photograph 4.14). However, in instances where patches contain mature larger trees with hollows, the ecological value of these areas significantly increases. Areas of regrowth habitat may provide foraging and perching habitat value for terrestrial fauna species and suitable microhabitats, including cracking clay soils for reptile species. Where large, isolated hollow bearing trees are present, these features may provide nesting and denning sites for arboreal mammals and birds. Koala (*Phascolarctos cinereus*) will utilise immature forage trees in non-remnant lands. Regrowth communities extend movement corridors for a range of fauna where they 'fill in' connections between remnant patches. They may also serve as 'stepping stones' across the landscape for more mobile fauna potentially acting as refuge habitat between larger patches of remnant vegetation (e.g. such as the larger areas of extant vegetation in the Little Liverpool Range and Teviot Range).

4.5 Matters of national environmental significance values and matters of national environmental significance

4.5.1 Ecological values

Consistent with the relevant legislation as stated in Section 2 of this report, the overarching ecological values adopted for the MNES study area, include:

- Australia's natural environmental and native flora and fauna
- Finite natural resources, including conservations parks, and wetlands
- Land conducive to the maintenance of existing landforms, ecological health, biodiversity, riverine and wetland areas
- Biodiversity.

4.5.2 Matters of national environmental significance

For the identified MNES, predictive habitat mapping has been used to assess the species potential to occur within the MNES study area (refer Appendix A). Mapping associated with this process is presented in Appendix G and the area of predicted habitat contained within the MNES study area and within the disturbance footprint is provided in Table 4.5. In instances where species/communities did not have *potential habitat* contained within the MNES study area, these species were not subject to impact assessment and were no longer considered to constitute MNES as the risk of impacts to any of these species are considered low. The MNES identified within the MNES study area are listed in Table 4.7 along with their assigned sensitivity value as determined by Table 3.8.

Table 4.7 **Identified matters of national environmental significance matters of national environmental significance within the matters of national environmental significance study area**

Associated ecological value	Identified MNES	Assigned sensitivity (refer Table 3.8)	Justification
▪ Australia's natural environment and native flora and fauna ▪ Biodiversity	EPBC Act listed TECs: ▪ Swamp Tea-tree (*Melaleuca irbyana*) Forest of South-east Queensland	High	▪ Protected by Commonwealth legislation ▪ Important for biodiversity ▪ Rare ▪ High sensitivity, high exposure to impacts
	Threatened terrestrial flora and fauna species listed under the provisions of the EPBC Act (including habitat): **Flora** ▪ Hairy-joint grass (*Arthraxon hispidus*) ▪ Miniature moss-orchid (*Bulbophyllum globuliforme*) ▪ Boonah tuckeroo (*Cupaniopsis tomentella*) ▪ *Lychnothamnus barbatus* (an algae) ▪ Lloyd's olive (*Notelaea lloydii*) ▪ Shiny-leaved condoo (*Planchonella eerwah*) **Fauna** ▪ Regent honeyeater (*Anthochaera phrygia* (Regent honeyeater) ▪ Australasian bittern (*Botaurus poiciloptilus*) ▪ Curlew sandpiper (*Calidris ferruginea*) ▪ Large-eared pied bat (*Chalinolobus dwyeri*) ▪ Spotted-tail quoll (*Dasyurus maculatus maculatus*) ▪ Collared delma (*Delma torquata*) ▪ Red goshawk (*Erythrotriorchis radiatus*) ▪ Painted honeyeater (*Grantiella picta*) ▪ Swift parrot (*Lathamus discolor*) ▪ Australian lungfish (*Neoceratodus forsteri*) ▪ Greater glider (*Petauroides volans volans*) ▪ Brush-tailed rock-wallaby (*Petrogale penicillata*) ▪ Koala (*Phascolarctos cinereus*) ▪ Long-nosed potoroo (*Potorous tridactylus tridactylus*) ▪ New Holland mouse (*Pseudomys novaehollandiae*) ▪ Grey-headed flying-fox (*Pteropus poliocephalus*) ▪ Australian painted snipe (*Rostratula australis*) ▪ Black-breasted button-quail (*Turnix melanogaster*)	High	▪ Protected by Commonwealth legislation ▪ Rare ▪ High sensitivity, high vulnerability

5 Potential impacts and impact mitigation

Potential Project related impacts are described in the sections below. These impacts are then assessed against the identified MNES, with initial mitigation considered as part of 'initial impact mitigation' impact assessment. Project mitigation measures are then used to re-assess the significance of impact to determine any residual risk of impact with all mitigation measures in place.

Through information gathered during the Project EIS process, MNES within the receiving environment which have the potential to be subject to significant impacts, have been identified. Mitigation measures have been developed to reduce the potential magnitude of impacts. Impact assessment methods to be adopted, depending on the nature of the environmental value being assessed, are described in Section 5.1.3.

5.1 Description of potential impacts

5.1.1 Project activities

Infrastructure activities proposed as part of the Project have been categorised into four phases; construction, commissioning and reinstatement, operation and decommissioning. A description of Project related activities and the duration of their disturbance is provided in Table 5.1.

Table 5.1 Description of Project related activities associated with construction, commissioning and reinstatement, operation, and decommissioning phase

Phase	Infrastructure activity	Description of activities	Duration of disturbance (refer Table 3.7)
Construction	Site preparation	Vegetation clearing	Permanent
		Topsoil stripping	Medium term/permanent
		Construction of temporary site compounds	Medium term
		Construction of rail access roads	Permanent
		Installation of boreholes and construction water storage	Medium term
		Installation of offices, hardstands	Medium term
		Stockpiling	Medium term
		Artificial impoundment dewatering	Permanent
	Utility diversions	Excavation	Temporary
		Trenching	Short term
		Modification, diversion and realignment of utilities and associated infrastructure	Short term/medium term
	Drainage	Culvert installation	Medium term
	Structures	Construction of bridges over main waterways	Medium term
		Road/rail bridge construction	Medium term
	Civil works	Cutting construction	Medium term
		Embankment construction using cut to fill from rail alignment and borrow to fill from external borrow sources, where required	Medium term
		Construction of temporary haul roads	Medium term
		Drainage controls	Medium term
	Road works	Road realignment	Permanent
		Construction of permanent rail maintenance access roads	Permanent

Phase	Infrastructure activity	Description of activities	Duration of disturbance (refer Table 3.7)
	Rail logistics	Sleeper stockpiling	Medium term
		Rail stockpiling	Medium term
	Rail construction	Drilling	Temporary
		Ballast installation	Short term
		Sleeper placement	Short term
		Rail placement	Short term
		Installation of train signals and communications infrastructure	Short term
		Demobilising site compounds	Short term
	Tunnel construction	Removal of construction material and waste	Temporary
		Roadheader excavation	Short term
		Blasting	Temporary
		Removal of redundant structures	Temporary
		Decommissioning work site signs	Temporary
		Decommissioning access roads	Short term
		Forming and stabilising of spoil mounds	Short term
	Signals and communications installation	Removal of temporary fencing	Temporary
Commissioning and reinstatement	Demobilisation/ Decommissioning	Establish permanent fencing	Permanent
		Restoration of disturbed areas, including revegetation where required	Short term
	Spoil mounds	Conversion of haul roads and construction access roads into permanent roads	Medium term
	Fencing	Train services	Permanent
	Restoration	Minor maintenance works	Temporary
	Road works	Bridge and culvert inspections	Temporary
		Sleeper replacement	Temporary
		Rail welding	Temporary
		Rail grinding	Temporary
		Ballast dropping	Temporary
		Track tamping	Temporary
		Major periodic maintenance	Temporary
Operation	Train operations	Train movement along rail	Permanent
	Operational maintenance	Ongoing vehicle movement within rail corridor	Permanent

5.1.2 Potential impacts to matters of national environmental significance

5.1.2.1 Habitat loss and degradation from vegetation clearing/removal

The disturbance footprint encompasses a total of 972.49 ha. Under current Queensland Government (DNRME) vegetation mapping this includes 32.55 ha of remnant vegetation and 118.0 ha of regrowth vegetation (high value regrowth). The remaining 820.94 ha (84.4 per cent of the disturbance footprint) has been heavily modified (clearing for agriculture/cattle grazing).

The removal of vegetation and construction of linear infrastructure resulting in habitat loss is likely to pose the largest risk of adverse impacts for biodiversity arising from the Project. The impact may be direct in the form of vegetation and habitat removal, or indirect, as fauna and flora diversity may become reduced due to shortages in available habitat resources. Habitat loss and degradation can also occur due to the increased risk of fire during construction and maintenance activities. Small-scale clearing within largely intact patches of vegetation can cause localised depletion of some species (Kutt et al. 2012) and is particularly relevant to species with small home ranges, or reduced ability to disperse (e.g. Collared delma (*Delma torquata*)). Vegetation clearing, and habitat loss are likely to occur during the construction phase activities. Habitat loss and degradation has the potential to impact upon all MNES (including their associated habitats) identified in this assessment (refer Table 5.4). Of the MNES identified, the greatest amount of predicted habitat to be removed within the disturbance footprint (refer Table 4.5) is to the following:

- Lloyd's olive (*Notelaea lloydii*) – 26.77 ha of *Habitat critical to the survival of the species*
- Koala (*Phascolarctos cinereus*) – 124.31 ha of *Habitat critical to the survival of the species*

The Project will also directly impact a maximum of 30.45 ha (potentially occurring within the disturbance footprint) of vegetation communities equivalent to the Swamp Tea-tree (*Melaleuca irbyana*) Forest of South-east Queensland TEC.

Whilst it is acknowledged that the SEQ Bioregion exists in a highly modified state and potential vegetation removal associated with the Project is considered to be relatively small when compared to historical broad scale vegetation clearing that has occurred in the region for agricultural purposes, this does not diminish the significance of such loss. Vegetation clearing and habitat loss that cannot be avoided, particularly in high constraint areas (e.g. within the Swamp Tea-tree (*Melaleuca irbyana*) Forest of South-east Queensland. TEC), is likely to result in permanent impacts to threatened biodiversity values.

5.1.2.2 Matters of national environmental significance fauna species injury or mortality

Physical trauma to fauna is a direct impact that has the potential to reduce local population size and has the potential to create "source/sink" dynamic, but this may not necessarily alter population size (Furrer and Pasinelli, 2016). However, changes in the mortality rate can affect population viability and may be a critical factor in a fragmented landscape where population sizes are fairly small and/or poorly connected. The impact of mortality on population viability is particularly pronounced for longer-lived, slow breeding species, such as the Koala (i.e. K-selected species) and is less pronounced in those that are R-selected (e.g. those species with high fecundity and shorter lifespans) (Oli 2004).

Physical trauma to fauna is a direct impact that reduces local population numbers. Physical trauma to MNES fauna has the potential to occur during all phases of the Project with the highest potential likelihood during construction activities that involve vegetation clearing, earthworks, trenching and increased labour force in the fields (through the movement of vehicles). Species most at risk of injuries and mortality are those that are cryptic, difficult to detect and with poorly developed dispersal mechanisms (e.g. Collared delma (*Delma torquata*)). However, larger species with defined territories and movement patterns (e.g. Greater glider (*Petauroides volans volans*), and Koala (*Phascolarctos cinereus*)) are less likely to be at risk to direct mortality where appropriate mitigation measures are applied (i.e. pre-clearance surveys and the use of fauna spotters during clearing).

This potential impact will be proportionate to the extent of vegetation and habitat potential for species that is removed and has the potential to impact MNES, including threatened fauna species listed under the provisions of the EPBC Act.

Some listed diurnal (active during the day) and mobile species, such as listed birds, may move away from areas being disturbed (i.e. vegetation removal) and may not be adversely impacted in terms of direct physical trauma unless fauna are nesting. However, other listed species that are less mobile (i.e. ground-dwelling reptile and mammal species, or those that are nocturnal and nest or roost in trees or tree hollows during the day (i.e. arboreal mammals such as listed gliders and Koala), may find it difficult to move away from roosts or active breeding places.

There is the potential for fauna injury or mortality during all phases of the Project through vehicle collision, but particularly when high volumes of vehicle activity occur or during the operational stages of the rail. Vehicle collision is a direct impact that reduces local population numbers and is a common occurrence in Australia (Coffin 2007; Rowden et al. 2008). The construction of construction tracks, as well as the general use of access tracks and roads across the Project disturbance footprint will result in increased vehicle movements that may cause injury or death to fauna by vehicle strike. In addition, once operational, train strike may also occur. Mammals, reptiles, amphibians and birds are all at risk of vehicle strike, particularly common species (e.g. macropods) that are tolerant of disturbance and/or those species that can utilise roads for movement pathways or as foraging habitat.

In addition, entrapment of wildlife in utility diversions (e.g. trenches) or other excavations associated with the Project may also cause physical trauma to fauna. For example, open trenches for underground utilities, or other pits are known to be effective at trapping a wide variety of wildlife and often result in mortality (Ayres and Wallace 1997; Doody et al. 2003; Woinarski et al. 2006). Species most likely to become trapped in pits or other excavations during construction of the Project are ground dwelling species that are capable of moving across modified areas (e.g. Collared delma *Delma torquata*, Long-nosed potoroo *Potorous tridactylus tridactylus* and the New Holland mouse *Pseudomys novaehollandiae*) and arboreal which ascend to the ground to disperse (e.g. Koala *Phascolarctos cinereus*).

Given the nature of the Project, there is potential for some species such as the Greater glider (*Petauroides volans volans*) to be struck by trains during periods of dispersal and movement (e.g. whist gliding over the alignment). This would only be the case where the alignment is at ground level in predicted habitat (i.e. not in locations of high embankments, bridges or cuttings).

The unmitigated potential occurrence of fauna species injuries or mortalities resulting from the Project can be permanent, where mortality to the species occurs, or temporary where the species is rehabilitated and re-released (refer Table 3.7 for definitions associated with timeframes).

5.1.2.3 Reduction in biological viability of soil to support plant growth due to soil compaction

Compaction of soil as a result of the Project activities may result in direct impacts to soil consistence (i.e. the strength and coherence of a soil) and soil structure (i.e. the arrangement of soil particles). Changes to soil consistence and structure can affect the productive capacity of the soil for agricultural practices, the suitability of the soils for various land uses, how the soil and landscape will respond to management practices, and the flow paths by which water moves within the soil and landscape (Fitzpatrick et al. 1999).

Reduction in soil viability may negatively impact the Swamp Tea-tree (*Melaleuca irbyana*) Forest of South-east Queensland as well as threatened flora such as Hairy-joint grass (*Arthraxon hispidus*), Boonah tuckeroo (*Cupaniopsis tomentella*), Lloyd's olive (*Notelaea lloydii*) and Shiny-leaved condoo (*Planchonella eerwah*). Impacts to soil may also have flow on effects to MNES fauna though degradation of their associated habitat.

The most direct effect of soil compaction is an increase in the bulk density of soil which can restrict plant root growth and function. Due to the increase in bulk density, large pores essential for water and air movement in soil are primarily affected. This influence over water and air movement can impact root penetration, seedling emergence and plant growth (Fitzpatrick et al. 1999; Duiker 2005). This will act directly upon recruitment processes and may impact upon a species/communities ability to recolonise following disturbance.

Soil biota may also be affected by compaction, for example earthworm numbers and activity can be reduced in compacted soils and compaction may impact upon the growth of fungi that are a potential food source for threatened species such as the Long-nosed potoroo (*Potorous tridactylus tridactylus*). In addition, water infiltration and percolation are slower in compacted soils, thereby inhibiting root growth, leading to the potential reduced uptake of immobile nutrients such as phosphorus and potassium; and increased nitrogen losses can be expected because of prolonged periods of saturated conditions in compacted soils.

The unmitigated potential impacts of soil compaction resulting from the Project are generally short-term and temporary (refer Table 3.7 for definitions associated with timeframes).

5.1.2.4 Displacement of threatened flora and fauna species by invasion of weed and pest species

Weed and pest species have the potential to impact on terrestrial and aquatic biodiversity as native species can become displaced through predation and competition. In addition, weeds may impact the Swamp Tea-tree (*Melaleuca irbyana*) Forest of South-east Queensland TEC through competitive processes and displacement, altering nutrient cycling and outcompeting for limited resources.

Pest species can also damage native vegetation by grazing and trampling (Adair and Groves 1998; Clarke et al. 2001; Thorp and Lynch 2011) or though direction competition/predation (e.g. *Gambusia holbrooki* within aquatic ecosystems).

Therefore, weed and pest species may reduce the extent or quality of available habitat and hence population size for a specific threatened species. This may have the effect of increasing mortality and reducing the size and viability of population sizes though resource limitation and associated stresses.

Proliferation of weed and pest species is an indirect impact (i.e. not a direct result of the Project activities) that may have cumulative effects as each Project activity, as well as agricultural practices and other resource project activities, may act in conjunction to increase the chances of weed and pest proliferation throughout the Project disturbance footprint and adjoining areas. Proliferation of weed and pest species has the potential to occur during all phases of the Project, especially during the construction phase, however the highest likelihood of weed and pest species occurring is from vegetation clearing and soil disturbance from local agricultural land practices.

The effects of proliferation of weed and pest species may not be noticeable immediately or even in the short-term, as visible signs may take several months or seasons to impact on ecological MNES. These potential impacts are likely to be long-term and affect all ecological MNES in the disturbance footprint, including affecting the quality and integrity of TECs, remnant vegetation, habitat for threatened species, wetlands and waterways.

Non-native species comprised 27.5 per cent of the flora species recorded in the MNES study area (refer Appendix F). Of these, 15 flora species were restricted matters, listed under the provisions of the Queensland *Biosecurity Act 2014* (some of which are also listed as Weeds of National Significance (WoNS)). Weed species such as *Lantana camara* (listed as a WoNS) are noted as a potential threat to a number of MNES species (e.g. *Notelaea lloydii*) and were identified as common throughout the MNES study area. Without appropriate management strategies, the Project activities have the potential to disperse weeds into areas of remnant vegetation where weed species are currently limited, occur in low densities, or have high specific habitat requirements where weed encroachment has been identified as a threatening process (e.g. Collared Delma (*Delma torquata*)). However, pest and weed invasion may benefit some MNES by supplying an abundant food source which would otherwise be unavailable (e.g. non-native plants as a food source for the Brush-tailed rock-wallaby (*Petrogale penicillata*)).

Project activities also have the potential to introduce new weed species into the MNES study area. The most likely causes of weed dispersal and introduction associated with the Project include earthworks, movement and disturbance of soil, and attachment of seed (and other propagules) to vehicles and machinery during all phases. Weed dispersal by vehicles along access tracks and roads is a key source of weed invasion (Birdsall et al. 2012). Weed invasion is an indirect impact that may degrade the quality of habitats, potentially resulting in habitat loss.

Soil disturbance during construction may increase the risk of invasion from weed and/or pest species, which can further reduce habitat quality and compromise the integrity of adjacent areas such as those occupied by the Swamp Tea-tree (*Melaleuca irbyana*) Forest of South-east Queensland TEC (refer Appendix B).

Large areas of the MNES study area have significant weed growth, particularly non-native grasses, which have been introduced as part of historic agricultural land use of the area. Therefore, the potential for habitat modification from weed invasion resulting from the Project is highest where Project activities take place in relatively intact areas, such as those identified as containing intact remnant vegetation that currently has low weed diversity and abundance.

Unmitigated Project activities have the potential to disperse pest (animal) species from the MNES study area into the surrounding landscape, due to habitat removal, noise disturbance, and human presence during the construction and operation phases of the Project. Construction of access tracks and the rail infrastructure through large patches of intact vegetation may result in the establishment of pest species (particularly predators such as foxes and cats) into areas where they are currently absent or in low numbers (Catling and Burt 1995). Nevertheless, Project surveys noted several pest species as being common in the area including Red fox and feral dogs. Therefore, unmitigated potential impacts of the displacement of native species through the invasion of non-native species may be temporary or irreversible (refer Table 3.7 for definitions associated with timeframes).

5.1.2.5 Reduction in the connectivity of biodiversity corridors

Biodiversity corridors (including those associated with waterways) can be defined as systems of linear habitat which enhance the connectivity of wildlife populations and may help to overcome the main consequences of habitat fragmentation (Wilson and Lindenmayer 1995). Corridors can assist ecological functioning at a variety of spatial and temporal scales from daily foraging movements of individuals, to broad-scale genetic gradients across biogeographical regions. Fragmentation of such corridors have been identified as important threatening process to MNES such as the Spotted-tail quoll (*Dasyurus maculatus maculatus*) and the Koala (*Phascolarctos cinereus*) (refer Appendix B).

Queensland corridor mapping for the SEQ Biodiversity Planning Assessments (Version 4.1, 2016) depicts regional and State corridors within the Project disturbance footprint, which portrays vegetation that is significant for the spread and movement of flora and fauna, including MNES. A State corridor is associated with the Teviot Range and a regional corridor is associated with fragmented habitat in the Ebenezer area. Connectivity is present north and south of the MNES study area, and this is particularly evident in areas associated with steep topography and drainage lines.

Most of the disturbance footprint exists in a generally fragmented environment. However, functional connectivity is retained through local linkages of remnant and regrowth vegetation, associated with roadside and riparian corridors linking larger patches of vegetation on private land. These linkages are likely to provide landscape permeability for vagile MNES such as birds and bats.

The potential impacts of linear infrastructure traversing these biodiversity corridors include habitat fragmentation, edge effects and barrier effects resulting in reduced population size and connectivity. These potential impacts are discussed further in the sections below. An additional potential impact upon biodiversity corridors resulting from the Project is the proliferation of weeds and pest species, as mentioned previously. Whilst bioregional corridors are not a MNES per se, MNES such as threatened species may be heavily impacted by fragmentation of bioregional corridors due to the importance of habitat quality and linkages for species at a local scale and the cumulative impacts at a regional landscape scale.

The unmitigated potential impacts to biodiversity corridors resulting from the Project are likely to be long-term or irreversible.

5.1.2.6 Edge effects

Edge effects refer to the changes in environmental conditions (e.g. altered light levels, wind speed, temperature) that occur along the edges of habitats. These new environmental conditions along the habitat edges can promote the growth of different vegetation types (including weed species), promote invasion by pest animals specialising in edge habitats, or change the behaviour of resident native animals (Moenting and Morris 2006). Edge zones can be subject to higher levels of predation by introduced mammalian and native avian predators. The distance of edge effect influences can vary and has been previously recorded from 50 m to greater than 1 km from an edge (Forman et al. 2000; Bali 2005).

Within the MNES study area, many patches of vegetation are small, irregularly shaped, and fragmented, and as such are already subject to considerable edge effects. Therefore, it is unlikely that the Project would increase the overall extent of edge effects in these areas. However, in large habitat patches with low edge to area ratios (e.g. in the Teviot Range), Project activities (vegetation clearing, temporary and permanent) may result in fragmentation and reduction of existing habitat along with associated edge effects.

Edge effects have the potential to impact on the range of flora and fauna species identified as potentially occurring in the MNES study area, especially upon the species with specific micro-habitat requirements that are less tolerant to disturbance (e.g. Collared delma (*Delma torquata*) and New Holland mouse (*Pseudomys novaehollandiae*)). Conversely, some threatened plant species appear to respond positively to edge effects, particularly ground disturbance, and colonise these edge areas reasonably quickly such as Hairy-joint grass (*Arthraxon hispidus*).

It is anticipated that MNES involving threatened species and wetland and waterway habitat (including habitat for Spotted-tail quoll (*Dasyurus maculatus maculatus*), Collared delma (*Delma torquate*), Greater glider (*Petauroides volans volans*), New Holland mouse (*Pseudomys novaehollandiae*), and the Australian lungfish (*Neoceratodus forsteri*)) may be impacted the most from edge effects, where avoidance of vegetated areas is not practicable.

The unmitigated potential impacts of edge effects resulting from the Project are considered to be short-term or irreversible (refer Table 3.7 for definitions associated with timeframes).

5.1.2.7 Habitat fragmentation

Habitat fragmentation relates to the physical dividing up of a continuous habitat into separate smaller fragments (Fahrig 2002). The habitat fragments tend to be smaller and separated from each other by a matrix of less suitable habitat. The new habitat type situated between fragments is often artificial and less suitable to the species remaining within these newly created fragments (Bennett 1990) or is generally only used by adaptive and aggressive generalist species (i.e. Noisy miners) (Loyn et al. 1983) which further decreases population levels of other species remaining in the fragments. Fragmentation reduces patch size, thereby increases edge effects within a patch and reducing the area of undisturbed ‘core’ habitat for the fauna species present in an area.

The landscape in which the Project is situated is highly fragmented with most vegetation occurring as small fragments due to agricultural practices such as pasture, cropping and horticulture. The Project activities will contribute to further fragmentation along with the associated edge effects and reduction in habitat. Habitat fragmentation has been identified as important threatening process to MNES such as the Spotted-tail quoll (*Dasyurus maculatus maculatus*) and the Koala (*Phascolarctos cinereus*) (refer Appendix B). This is due to the importance of connectivity, dispersal opportunities and habitat quality for fauna species at a local scale and the cumulative impacts at a regional scale. In some instances the Project may not result in significant fragmentation of populations identified as relevant to the area (refer to species-specific population information in Section 5.3.4 and Section 5.3.5) given the capacity of the species to disperse widely across the landscape (e.g. Koala (*Phascolarctos cinereus*)).

Linear Project activities may however result in some small scale localised fragmentation which has the potential to be detrimental to the dispersal of relatively sedentary species, such as small mammals, frogs, and reptiles which can lead to crowding effects and increased competition within habitat patches. Mobile species such as larger mammals, birds, and bats may not be affected by this small-scale fragmentation, as the landscape in which they currently exist is fragmented and the predicted level of fragmentation would not be enough to restrict their dispersal between habitat patches providing that mitigation measures are in place to facilitate dispersal in these species. On the other hand, localised fragmentation may have a greater impact on vegetation communities comprising small patches such as the Swamp Tea-tree TEC (refer Appendix B).

The unmitigated potential impacts of habitat fragmentation resulting from the Project are considered to be long-term or irreversible (refer Table 3.7 for definitions associated with timeframes).

5.1.2.8 Barrier effects

Barrier effects (permanent and/or temporary) occur where particular species are either unable or are unwilling to move between suitable areas of habitat due to the imposition of a barrier. This can include a habitat type that has become unsuitable (e.g. cleared areas devoid of vegetation or structure) or a physical barrier such as a fence, alteration to a waterway or a culvert that that does not provide movement opportunities (particularly important to aquatic MNES such as the Australian lungfish *Neoceratodus forsteri*). Terrestrial MNES most vulnerable to barrier effects include the Collared delma (*Delma torquata*), Southern greater glider (*Petauroides volans volans*), Brush-tailed rock-wallaby (*Petrogale penicillata*), Koala (*Phascolarctos cinereus*) Long-nosed potoroo (*Potorous tridactylus tridactylus*) and the New Holland mouse (*Pseudomys novaehollandiae*).

Various Project activities may create temporary and/or permanent barrier effects, particularly those that may create a hard barrier that restricts fauna movement (e.g. operational and construction access tracks, temporary waterway barrier works such as the construction of culverts within watercourses, operational rail corridor, construction laydown areas etc). This impact may affect MNES species such as Collared delma (*Delma torquata*) and the New Holland mouse (*Pseudomys novaehollandiae*). Mobile MNES species such as larger mammals, birds, and bats may not be affected to the same extent. However, in some instances the Project infrastructure/works may not present a barrier to populations identified as relevant to the area (refer to species-specific population information in Sections 5.3.4 and 5.3.5) given the capacity of the species to disperse widely across the landscape (including heavily disturbed areas) and utilise Project infrastructure (such as culverts) (e.g. Koala (*Phascolarctos cinereus*)) (refer Section 5.2.2).

Human activity and infrastructure are likely to create a barrier as many species are known to avoid areas of human activity resulting in indirect habitat loss. Human presence may affect species in different ways. Some species display avoidance behaviour while others may habituate and become attracted to areas of human activity. Predators and prey may respond differentially to human activity, causing a disruption of community interaction and potentially disrupting ecological processes (Caro 2005). Human presence and activity are likely to produce avoidance responses in larger mammalian predators that are sensitive to disturbance (i.e. Quolls), while species such as macropods (i.e. kangaroos and wallabies) and smaller amphibian and reptile species are more likely to habituate to human presence.

Similarly, barrier effects may be experienced by native animals in the form of increased patrolling and predation by pest animals (e.g. foxes and wild dogs) along barriers, such as a cleared corridor, as prey becomes more exposed and easier to detect and catch.

The unmitigated potential impacts of barrier effects resulting from the Project are considered to be, in most cases, short-term or temporary but may in some cases be long-term or irreversible (refer Table 3.7 for definitions associated with timeframes).

5.1.2.9 Aquatic habitat degradation

Activities related to the construction and operation of the Project are likely to impact water quality, thereby degrading habitats for aquatic fauna and flora. Erosion and sedimentation, contamination and an increase in litter (refer Section 5.1.2.11) are all potential mechanisms that will adversely impact aquatic habitat. In addition, direct loss of waterway habitat may occur though activities associated with waterway crossings during construction and operation.

The transport of sediment and eroded material can be washed off areas of exposed soil, stockpile locations, or localised areas in proximity to Project infrastructure (e.g. culverts and bridges) during rainfall events and thus may also affect terrestrial habitats.

Transported sediments from the terrestrial environment may lead to increased sediment loads and turbidity within waterways and potentially increase nutrient loads. In addition to direct impacts to aquatic habitat degradation associated with erosion and sedimentation, flow on effects from increased sedimentation may impair the functioning of culverts, should deposition be too high, exacerbating barrier effects (refer Section 5.1.2.8).

There is potential for contaminants and pollutants associated with construction and operation of the Project to enter aquatic environments, resulting in the alteration or loss of *potential habitat* for terrestrial and aquatic species. Concrete, oil and grease and other chemicals associated with construction and operation may result in localised run-off into adjacent watercourses and waterbodies following rainfall events.

The disturbance and modification of some riparian zones and works within watercourses/wetlands during the construction phase of the Project has the potential to reduce the ecological integrity of watercourses thereby impacting on structural aspects that support breeding and foraging requirements of aquatic species (e.g. removal of stags, loss of heterogenous substrates).

Aquatic habitat degradation is considered a ‘high ranking’ threatening process contributing to Australian lungfish (*Neoceratodus forsteri*) population declines (DotEE 2019a) although this largely occurs at the catchment scale, as a result of land clearing, pesticide use and irrigation abstraction which influence water quality. The Lungfish is restricted to areas of permanent water and is known to complete their lifecycle entirely within freshwater habitats (i.e. potamodromous). The species is known to occur in impounded waters on rivers and has successful populations where it has been introduced to dams. The temporary impoundment of watercourses intersected by the Project in which the species may occur (Bremer River catchment) is not expected to pose a risk to the species. Potential threats are more likely to be realised through impacted water quality (e.g. increased turbidity) in aquatic habitats localised to the site of construction works, although this is only expected to be temporary in nature.

Other aquatic MNES that may be directly impacted by habitat degradation include *Lychnothamnus barbatus* (algae) with this species is susceptible to declining water quality or interrupted hydrological regimes. This species is only known from Warrill Creek catchment upstream of the Project.

5.1.2.10 Noise, dust, and light impacts

Noise, dust, and light are direct impacts that have the potential to occur as a result of Project activities during all phases and may also have cumulative effects. The scientific understanding of the impacts of noise on fauna is limited. There are no current State or Commonwealth government policies or guidelines that recommend noise thresholds or limits associated impacts to fauna. Noise may adversely affect wildlife by interfering with communication, masking the sound of predators and prey, causing stress or avoidance reactions, and in some cases, may lead to changes in reproductive or nesting behaviour. Excessive noise may lead some species to avoid noisy areas, potentially resulting in the fragmentation of species habitat. On the other hand, many animals react to new noise initially as a potential threat, but quickly ‘learn’ that the noise is not associated with a threat (Radle 2007).

The Project may lead to localised increases of airborne dust levels during construction. Increased dust can result in respiratory issues in fauna, adverse impacts on plant photosynthesis and productivity (Chaston and Doley 2006), changes in soil properties ultimately impacting plant species assemblages’ (Farmer 1993), and mortality and/or decreases in aquatic health in aquatic communities from the toxicity of poor water quality. Evidence of potential impacts on entire vegetation communities is scarce. Many studies focus on specific impacts to single species. Recent research on threatened flora in a semi-arid environment in Western Australia found no significant impact on plant health as a result of a range of dust accumulation loads caused by vehicle movements (Matsuki et al. 2016). The deposition of (unpaved) road dust on nearby freshwater wetlands caused by heavy traffic increases due to energy development projects found minimal impact on water quality or soils (Creuzer et al. 2016).

Artificial lighting may have a range of impacts across different groups of taxa and between species within these groups. Rodents may avoid brightly lit areas at night. Frogs and nocturnal reptiles may congregate at artificial lights to feed on insects attracted to light (Perry et al. 2008). Similarly, many microbat species may congregate at artificial lighting (Rich and Longcore, 2006), although other species may avoid well-lit areas (Threlfall et al. 2013).

The likelihood of potential impacts is anticipated to be greatest where Project activities take place near vegetated areas and known habitat, during construction, decommissioning and rehabilitation phases. Operating rail lines will generate noise and vibration, and it is likely that many species will habituate as a result of the regularity of generated noise.

The Project will result in minor light spill (i.e. “warm light” at level crossings and around the tunnel portals) into adjacent receiving environments (e.g. fauna habitat) due to the operation of plant and equipment throughout the construction phase of the Project and installation of lighting on infrastructure required for the operation of the Project. Impacts associated with light spill may include direct impacts (e.g. increased susceptibility to predation) or indirect impacts related to altered foraging and habituation in areas exposed to increased lighting. Light impacts associated from construction will be temporary in nature, however operational lighting impacts may be long-term and very localised (e.g. infrastructure) or transient in nature (i.e. vehicle movement). Whist light spill may impact negatively on many species, it may positively impact upon species such as the Large-eared pied bat (*Chalinolobus dwyeri*) by attracting nocturnally flying insects upon which this species feeds.

It is noted that none of these impacts (noise, light and dust) are listed as threatening processes for the MNES species relevant to the Project as listed on DAWEs SPRAT database (2020). Ecological MNES affected from these potential impacts include all threatened flora (impacts associated with dust) and terrestrial fauna species (impacts associated with noise and vibration) and aquatic species (impacts associated with dust, noise and vibration) listed under the provisions of the EPBC Act. The Swamp Tea-tree (*Melaleuca irbyana*) Forest of South-east Queensland TEC is likely to be impacted to a lesser extent and these impacts are likely to be associated with dust alone (i.e. reducing photosynthetic processes following settlement of dust on the leaves of components of the TEC). These types of impacts are likely to be short-term in duration and localised.

5.1.2.11 Increase in litter (waste)

The act of littering has the potential to impact the surrounding environment (by causing injury to wildlife), poses threats to human health and is aesthetically displeasing. When discarded as litter, human-made materials such as plastic, glass and aluminium have the potential to cause external injury to wildlife, entanglement, and if accidentally ingested, may cause starvation or suffocation and as such negatively impact species such as the Australian lungfish (*Neoceratodus forsteri*). Littered objects may also provide suitable habitat for disease-spreading insects, such as flies and mosquitoes (Healthy Land and Water 2019b).

According to the National Litter Index, across Australia the most littered items are cigarette butts; and plastic objects are the most littered by volume of material. Cigarette butts and small plastic items are often mistaken for food resources and have been found in the stomachs of juvenile birds. In addition, littering of cigarette butts also poses a bushfire risk (Healthy Land and Water 2019b).

Ecological MNES affected from this potential impact include all threatened flora (through alterations in recruitment and nutrient cycles) and fauna species (direct consumption, declines in habitat suitability and entanglement). This type of impact has the potential to be long-term in duration due to the varying times of decomposition; however, it is likely to be localised and manageable.

5.1.2.12 Erosion and sedimentation

Terrestrial impacts associated with erosion and sedimentation include compaction of soil, loss of soil structure, nutrient degradation, and increased soil salinity all of which can lead to reductions in the carrying capacity of the terrestrial environment as a result of decreasing habitat value.

Erosion and subsequent sedimentation can be damaging to the ecological health of waterways and the surrounding terrestrial environment and may be a proximate cause of environmental degradation. Mobilised coarse sandy-sediment tends to accumulate in areas of slow-flow and may smother bottom-dwelling organisms and their habitats. Deep permanent river pools, that are valuable habitats for aquatic fauna and refuges for wildlife during summer and drought, may become filled by coarse sediments, which may render them ineffective in relation to their ability to support aquatic and terrestrial species.

Large sediment accumulations can cause upstream flooding or deflect the flow into the adjacent stream bank or even onto adjacent land, causing further erosion and transported sediments can fill the deep permanent pools of rivers and degrade this critical refuge habitat.

In addition to secondary impact of erosion and sedimentation on aquatic habitats, the primary impact of erosion on terrestrial habitat has the potential to occur in relation to Project activities. As indicated above, these would be expected to occur within areas of exposed soil, stockpile locations, or localised areas in proximity to Project infrastructure (e.g. culverts and bridges) during rainfall events. The changes to overland flow paths from erosion have the potential to have localised direct impact on terrestrial habitat. These impacts are principally associated with a loss of substrate stability around vegetation and may result in a loss of vegetation quality and cover.

5.1.2.13 Tunnelling impacts – Teviot Range

The construction and operation of the proposed tunnel through the Teviot Range may have potential to cause a number of localised impacts to habitats located above the tunnel such as subsidence, groundwater drawdown, and vibrations caused by the tunnel construction. Lloyd's olive (*Notelaea lloydii*) was identified as present above the proposed tunnel area. There are no other MNES flora or TECs identified as present in the tunnel area. The tunnel is proposed to be 1,015 m long with an excavated cross-section of approximately 135 m^2 (internal space dimensions are driven by ventilation requirements). The maximum cover of rock above the tunnel is approximately 90 m.

The tunnel intersects the Gatton Sandstone (part of the Marburg Subgroup), which is a sedimentary rock comprising medium-coarse grained sandstone (refer EIS Chapter 9: Land Resources for further detail). Aboveground subsidence or surface cracking may result from both the tunnelling process itself, or as a result of settlement caused by subsequent groundwater drawdown processes caused by the tunnel. Potential subsidence is unlikely to have any significant impacts upon flora, fauna or local ecological communities.

Geotechnical survey works within the tunnel area have so far been limited (refer Jacobs-GHD 2016b and Golder 2019). Nevertheless, initial interpretation of results indicates the potential for minimal settlement and therefore damage to vegetation communities due to subsidence from the tunnel appears to be low. However, ongoing geotechnical investigations will further assess the potential for settlement/subsidence and will inform the final design of the tunnel.

Groundwater monitoring in the Teviot Range area indicates groundwater levels in the Gatton Sandstone ranges from 20.2 metres below ground level (mbgl) to 72 mbgl in the vicinity of the tunnel itself, to 16.9 mbgl approximately 4 km east of the tunnel (Jacobs-GHD 2016b; Golder 2019). The vegetation in the range at the tunnel area comprises remnant and regrowth eucalypt woodland dominated by species such as Spotted gum (*Corymbia citriodora*), Grey gum (*Eucalyptus major*), and Narrow-leaf ironbark (*E. crebra*). None of these species are known to require access to groundwater.

Lowered groundwater levels due to long-term seepage into the tunnel has the potential to impact groundwater users and vegetation such as deep-rooted trees (GDEs). Mapping of GDEs (from the BoM GDE Atlas 2020) indicates the potential presence of 'low potential' GDEs associated with local gully lines in the range area, the nearest of which lies to the west and south side of the west portal of the tunnel. It is noted the mapped GDEs have not been confirmed as present. Preliminary predictive numerical modelling of the drained tunnel through the Teviot Range was carried out to estimate potential groundwater drawdown impacts (Golder 2019). Drawdown is assumed to be ongoing and long-term. Under the base case scenario (estimated typical groundwater levels and three structural features) drawdown impacts may extend up to 1,000 m laterally either side of the tunnel, with a potential GDE within the predicted 5 m drawdown extent. Ongoing and further investigations are anticipated to confirm that risks posed to potential GDEs are acceptable. Should this not be the case, works will be completed during subsequent phases (i.e. detailed design and early works) to develop mitigation and management strategies that achieve acceptable residual risks (refer EIS Chapter 14: Groundwater for further information).

Potential ground-borne vibration and associated ground-borne noise due to tunnel construction works and during operations (train movements) has been assessed in a conservative fashion relying on technical assumptions for the vibration emitted by the excavation activity and the surrounding geotechnical conditions (refer EIS Chapter 15: Noise and Vibration for further information). The assessment considered the closest sensitive (human) receptors to the tunnel were not expected to experience vibration or ground-borne noise levels that could trigger the assessment criteria. There are no guidelines regarding potential impacts of ground vibration to fauna. A tunnelling Project in New Zealand adopted human vibration limit criteria to identify potential impact zones on wetland bird species and thereby informing fauna relocation activities (NDY 2020). Vibration impacts are very likely to be similar to those described for noise (refer EIS Chapter 15: Noise and Vibration). Following the completion of construction vibration will be restricted to train movements (i.e. regular events of relatively short duration). As such, any potential impact on MNES fauna is considered likely to be minor at worst.

5.1.3 Assessment of potential impacts to matters of national environmental significance associated with air quality, surface water and hydrology, groundwater, and noise and vibration

An assessment of potential Project related impacts associated with air quality, surface water and hydrology, groundwater, and noise and vibration were undertaken for the identified MNES. This assessment is summarised in Table 5.2. Potential impacts identified within Table 5.2 were incorporated into the assessment of initial impact magnitude as shown in Table 5.5.

Specific impacts associated with the relevant MNES are discussed in Section 5.3.2, 5.3.3, 5.3.4 and 5.3.5.

Table 5.2 Assessment of potential impacts related to air quality, surface water and hydrology, groundwater, and noise and vibration upon matters of national environmental significance

MNES category	Discipline	Project phase	Key findings in relation to discipline and the identified MNES	Reference for further information and mitigation measures
Threatened Ecological Communities	Air quality	Construction	Air quality has not been identified as a threatening process to TECs (i.e. Swamp Tea-tree forests) (refer Appendix B) and is not likely to impact upon TECs identified within the MNES study area	▪ EIS Chapter 12: Air quality ▪ Section 5.2 – Impact mitigation ▪ Section 5.3.3 – significant impact assessment ▪ Appendix B – TEC information and threatening processes
		Commissioning and reinstatement		
		Operation		
		Decommissioning		
	Surface water and hydrology	Construction	The identified TEC (i.e. Swamp Tea-tree) is highly susceptible to alterations to hydrology (refer Appendix B). Whilst not listed as a threatening process, significant alterations to hydrology may impact upon this TEC. However, significant deviations in hydrological process are not considered likely to occur as a result of the Project.	▪ EIS Chapter 13: Surface water and hydrology ▪ EIS Appendix N: Hydrology and Flooding Technical Report ▪ Section 5.2 – Impact mitigation ▪ Section 5.3.3 – significant impact assessment ▪ Appendix B – TEC information and threatening processes
		Commissioning and reinstatement	No significant impact expected during this stage	
		Operation	Significant deviations in hydrological process (e.g. time of submergence, area of inundation and peak levels) between the base/existing case and the developed cased are not predicted to occur. This includes the area around Paynes Road, Ebenezer and floodplain areas of Bremer River and Warrill Creek.	
		Decommissioning	No significant impact expected during this stage	
	Groundwater	Construction	The identified TEC (i.e. Swamp Tea-tree) is highly susceptible to alterations to hydrology (refer Appendix B). Some evidence suggests the community may require at least intermittent access to groundwater (i.e. may be a GDE). However, there are no significant impacts from the Project expected to occur to groundwater levels that are likely to impact upon the identified TEC.	▪ EIS Chapter 14: Groundwater ▪ Section 5.2 – Impact mitigation ▪ Section 5.3.3 – significant impact assessment ▪ Appendix B – TEC information and threatening processes
		Commissioning and reinstatement		
		Operation		
		Decommissioning		
	Noise and vibration	Construction	Noise and vibration have not been identified as a threatening process to the identified TEC (i.e. Swamp Tea-tree) (refer Appendix B) and is not likely to impact upon TECs identified within the MNES study area	▪ EIS Chapter 15: Noise and vibration ▪ Section 5.2 – Impact mitigation ▪ Section 5.3.3 – significant impact assessment ▪ Appendix B – TEC information and threatening processes
		Commissioning and reinstatement		
		Operation		
		Decommissioning		

MNES category	Discipline	Project phase	Key findings in relation to discipline and the identified MNES	Reference for further information and mitigation measures
Threatened flora species	Air quality	Construction	Air quality has not been identified as a threatening process to any of the flora MNES identified (refer Appendix B). Whilst it is acknowledged that particulate matter (e.g. dust during the construction period) has the potential to settle on foliage, is not expected that this will significantly impede photosynthetic processes. Impact associated with air quality are not likely to result in an impact to MNES flora species within the MNES study area.	▪ EIS Chapter 12: Air quality ▪ Section 5.2 – Impact mitigation ▪ Section 5.3.4 – significant impact assessment ▪ Appendix B – species information and threatening processes
		Commissioning and reinstatement		
		Operation		
		Decommissioning		
	Surface water and hydrology	Construction	Some of the identified flora MNES (e.g. *Lychnothamnus barbatus*) are highly susceptible to alterations to hydrology (refer Appendix B). Whilst listed as a threatening process, significant alterations to hydrology are not likely to occur as a result of the Project.	▪ EIS Chapter 13: Surface water and hydrology ▪ Section 5.2 – Impact mitigation ▪ Section 5.3.4 – significant impact assessment ▪ Appendix B – species information and threatening processes
		Commissioning and reinstatement	No significant impact expected during this stage	
		Operation	No significant impact expected during this stage	
		Decommissioning	No significant impact expected during this stage	
	Groundwater	Construction	No MNES flora species associated with the Project is considered groundwater dependent. There are no significant impacts expected to occur to groundwater that are likely to impact upon any of the identified flora MNES as a result of Project activities.	▪ EIS Chapter 14: Groundwater ▪ Section 5.2 – Impact mitigation ▪ Section 5.3.4 – significant impact assessment ▪ Appendix B – species information and threatening processes
		Commissioning and reinstatement	No significant impact expected during this stage	
		Operation	No significant impact expected during this stage	
		Decommissioning	No significant impact expected during this stage	
	Noise and vibration	Construction	Noise and vibration have not been identified as a threatening process to any of the identified MNES flora species (refer Appendix B) and are not likely to impact upon flora MNES identified within the MNES study area.	▪ EIS Chapter 15: Noise and vibration ▪ Section 5.2 – Impact mitigation ▪ Section 5.3.4 – significant impact assessment ▪ Appendix B – species information and threatening processes
		Commissioning and reinstatement		
		Operation		
		Decommissioning		

MNES category	Discipline	Project phase	Key findings in relation to discipline and the identified MNES	Reference for further information and mitigation measures
Threatened fauna species	Air quality	Construction	The greatest Impacts associated with air quality (i.e. dust) will be during the construction period. Whilst not identified as a threatening process to MNES fauna species *per se*, particulate matter (e.g. dust) may settle on plants and in waterways. Once in waterways it may result in reduced water quality. However, despite these potential impacts, significant impacts to MNES fauna species are not expected to occur as a result of air quality impacts.	▪ EIS Chapter 12: Air quality ▪ Section 5.2 – Impact mitigation ▪ Section 5.3.5 – significant impact assessment ▪ Appendix B – TEC information and threatening processes
		Commissioning and reinstatement	No significant impact expected during this stage	
		Operation	No significant impact expected during this stage	
		Decommissioning	No significant impact expected during this stage	
	Surface water and hydrology	Construction	One identified MNES fauna species (e.g. Australian lungfish) is aquatic (refer Appendix B). Whilst these species are susceptible to declines in water quality, any impact associated with construction is considered to be short-term and temporary. It is not expected that water quality will decline to the point to which these aquatic species will be adversely impacted.	▪ EIS Chapter 13: Surface water and hydrology ▪ Section 5.2 – Impact mitigation ▪ Section 5.3.5 – significant impact assessment ▪ Appendix B – TEC information and threatening processes
		Commissioning and reinstatement	No significant impact expected during this stage	
		Operation	Significant deviations in hydrological (flooding) processes (e.g. time of submergence, area of inundation and peak levels) between the base/existing case and the developed cased are not predicted to occur. This includes the floodplain areas of Bremer River, Warrill Creek, Purga Creek and Teviot Brook. During operation the tunnel will require the release of groundwater draining into the tunnel. The release of water is not predicted to be of a quantity to impact surface water or MNES values.	
		Decommissioning	No significant impact expected during this stage	
	Groundwater	Construction	One identified MNES fauna species (e.g. Australian lungfish) is aquatic (refer Appendix B). Whilst these species are susceptible to declines in water quality, the Project is not likely to significantly alter the existing quality of groundwater, to the point where it will impact upon these MNES.	▪ EIS Chapter 14: Groundwater ▪ Section 5.2 – Impact mitigation ▪ Section 5.3.5 – significant impact assessment ▪ Appendix B – TEC information and threatening processes
		Commissioning and reinstatement		
		Operation		
		Decommissioning		

MNES category	Discipline	Project phase	Key findings in relation to discipline and the identified MNES	Reference for further information and mitigation measures
	Noise and vibration	Construction Commissioning and reinstatement	Whilst noise and vibration have not been identified as a specific threatening process for MNES fauna species that have potential to occur within the MNES study area, animals typically show avoidance behaviours to foreign stimuli, including noise and vibration. Whilst such stimuli may result in little impact to vagile species such as the Grey-headed flying-fox and the Swift parrot, other less vagile species such as the Koala, Brush-tailed rock-wallaby and Spotted-tail quoll may avoid areas that are subject to acute noise and vibration events. Avoidance of areas subject to such stimuli is likely to occur during the construction phase and may result in a reduction in foraging efficiency.	▪ EIS Chapter 15: Noise and vibration ▪ Section 5.2 – Impact mitigation ▪ Section 5.3.5 – significant impact assessment ▪ Appendix B – TEC information and threatening processes
		Operation	Whilst acute noise and vibration are known to result avoidance behaviours in animals, chronic noise and vibration, particularly when applied at regular intervals, are less likely to illicit a response. It is therefore likely that once operational, impacts associated with noise and vibration will not adversely impact upon MNES fauna species.	
		Decommissioning	As noted for the commissioning stage, acute noise and vibration are likely to result in a short-term impact upon MNES fauna species.	

5.2 Impact mitigation

This section outlines both the flora and fauna impact mitigation measures included as part of the Project design and the mitigation measures that are proposed for the Project to manage predicted environmental impacts. The impacts are initially assessed with consideration of the Project design mitigation measures and then reassessed to determine residual risk after the inclusion of the proposed mitigation measures.

5.2.1 Design considerations

Development of the design has progressed in parallel with the impact assessment process. Design solutions for avoiding, minimising or mitigating impacts have therefore been incorporated into the Project as appropriate and where possible.

Mitigation measures and controls that have been factored into the design for the Project are as follows:

- The Project is generally located within the existing SFRC, which was gazetted as a future rail corridor in 2010. The Project design has been developed to utilise the existing rail corridor protection and minimise land severance and impacts to natural and rural landscapes to the greatest extent possible.
- The Project has avoided direct impacts on nationally or regionally protected areas such as the Flinders-Goolman Conservation Estate
- Clearing of vegetation will be restricted to the minimum required to enable the safe and efficient construction, operation and maintenance of the rail corridor, including minimising the disturbance of sensitive areas such as:
  - Habitat for critically endangered, endangered and vulnerable flora and fauna species
  - Critically endangered and endangered TECs
  - Riparian vegetation
  - Steep slopes and
  - Instream habitats.
- The Project incorporates bridge and culvert structures to maintain existing flow paths and flood flow distributions. Twenty-one bridge structures over watercourses are to be constructed to minimise disturbance of aquatic habitats.
- The Project has been developed to minimise impacts to watercourses, riparian vegetation and instream habitats by adopting a crossing structure hierarchy where bridges are preferred to culverts to maintain connectivity for MNES species such as Australian lungfish and riparian fauna conduits that are important to MNES species
- The nominated rail corridor has been restricted to the land required to accommodate permanent infrastructure components of the railway, including earthworks, cross drainage and rail maintenance access roads. Habitat for MNES species has been avoided wherever possible.
- Fauna crossing opportunities for species such as Koala, have been co-located with waterway crossing structures to maintain habitat connectivity across the rail corridor (refer Figure 5.1). Where possible, these align with regional, State and locally significant fauna movement corridors or areas of important fauna habitat. Six crossing points have been selected for dedicated fauna infrastructure including bridge sites on Western Creek, Bremer River, Warrill Creek, Woollaman Creek and Teviot Brook. A sixth area within the Teviot Range has been selected for a rope bridge crossing point where the alignment is located within a cutting area. The six locations have been assessed as providing movement opportunities for the greatest number of species. Opportunities to incorporate fauna infrastructure and fauna fencing at these and other potential crossing points (such as large culverts) will be considered during the detailed design process.

- Avoidance of natural movement corridors (e.g. Teviot Range associated with the tunnel) will maintain connectivity for species such as the Koala, Spotted-tail quoll and Brush-tailed rock-wallaby which have habitat with the broader region. For example, the rail tunnel (1,015 m long) occurs where the alignment crosses a higher point in the Teviot Range. Fauna will be able to utilise the unimpacted section of the range over the tunnel as a movement corridor.

5.2.2 Proposed mitigation measures

To manage Project risks a number of mitigation measures have been proposed for implementation in future phases of Project delivery, as presented in Table 5.3. Further detail regarding species specific mitigation measures is provided in Table 5.7 and should be considered in conjunction with the measures detailed in this section. Mitigation measures have been recommended to address Project specific issues and opportunities. Legislative requirements and accepted government plans, policies and practices have been met. Information related to government threat abatement plans and recovery plans has been incorporated into the identified mitigation measures wherever applicable. Mitigation measures have been selected based on the best available information including government guidelines (e.g. DTMR's Fauna Sensitive Road Design Manual (DTMR 2010)) and the appropriateness and effectiveness in managing the identified impacts including mitigation measures used on similar projects that have been subject to legislative approval (refer footnotes to Table 5.3). It is acknowledged the effectiveness of these measures may not be subject to rigorous peer-reviewed analysis.

A review has been undertaken of a cross-section of available published literature on effectiveness of mitigation measures used on linear infrastructure. There is significant literature which corroborates ARTC's proposed mitigation measures as being effective:

- Installation and regular maintenance of fauna exclusion fences can help reduce wildlife mortality during construction. Wildlife crossing structures (underpasses and overpasses) have been constructed around the world and are used by many species to safely cross linear infrastructure (Bond and Jones 2008; VicRoads 2012; van der Grift et al. 2015; van der Ree et al. 2015a; Weller 2015)
- Wildlife crossing structures also improve traffic safety and contribute to the conservation of biodiversity by allowing animals to move safely across roads, thereby reducing the risk of collision (Smith et al. 2015)
- Wildlife crossing structures are the most effective approach to mitigate the barrier effect of linear infrastructure on wildlife movement (Taylor and Goldingay 2010; Smith et al. 2015)
- The combination of exclusion fencing with wildlife passes are complementary, with the ability to avoid animal collisions and maintain infrastructure permeability (VicRoads 2012; Carlvalho et al. 2017; Ghent 2018; Barrientos et al. 2019).
- VicRoads (2012) corroborates the use of bridge underpasses for the effective use of koala crossings
- The most effective stream crossings for fish, when long-span bridges are not an option, are culverts or shorter span bridges that simulate the natural channel (Offburg and Blank 2015).
- Use of planting native species to the region was validated by Milton, et al. (2015).

ARTC is committed to implementing ongoing monitoring of the effectiveness of the measures with contingency (under an adaptive management framework) to change/improve management strategies where deleterious impacts to the identified environmental values are observed, or are not minimised, as per the objectives of the proposed mitigation measures.

Literature is in agreement that monitoring is a critical component of quantifying effectiveness of a specific mitigation measure (van der Ree et al. 2008; van der Grift et al. 2015). This is because the success of mitigation measures are heavily reliant on factors such as existing environment, potential habitat, species, climate, design components of the linear infrastructure, and operational frequency of the transport; due to these factors it is not feasible to be able to provide a quantification of effectiveness of the Project's mitigation measures (Ghent 2018).

For example a comprehensive evaluation of the effectiveness of wildlife crossing structures requires a clear definition of success. Effectiveness is defined as the extent to which the goals of mitigation are reached. However, it is difficult to assess effectiveness without a specific and measurable goal. Therefore, ARTC recommends the SMART approach, that is, goals that are Specific, Measurable, Achievable, Realistic and Time framed (van der Ree et al. 2008; van der Ree et al. 2015b and 2015c; van der Grift et al. 2015). Van der Ree et al. (2007) proposed that the overall objective of wildlife crossing structures is to ‘increase the permeability of a road corridor’. Criteria that can be used to measure effectiveness include:

- Rates of vehicle strike
- Habitat connectivity
- Biological requirements are met
- Allowance for dispersal and re-colonisation
- Maintenance of meta-population processes and ecosystem services.

It is also recommended that goals should be set for individual projects that are specific to species, location and the nature of the conflict. For example, a specific goal might be to ensure more than 90 % of individuals that approach a crossing structure successfully cross it, or to maintain the risk of extinction of a population to less than 5 % over the next 100 years.

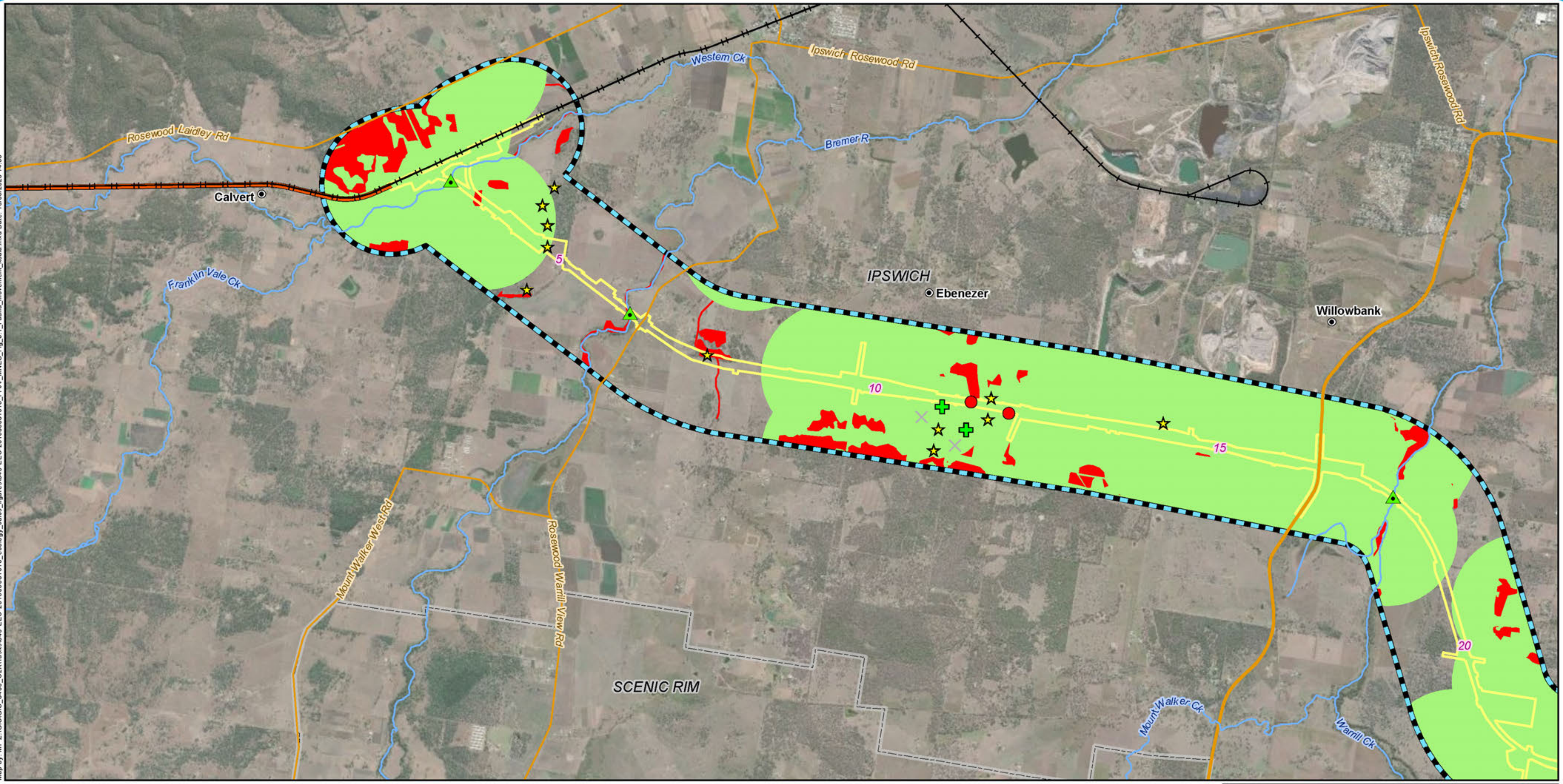
Additional strategies as identified by the relevant threat abatement plan/recovery plans will be incorporated into the Project’s mitigation strategies following the primary approval phase of the Project as part of detailed design. A summary of threat abatement plans and recovery plans applicable to the identified MNES is provided in Appendix B and Sections 5.3.4 and 5.3.5.

Table 5.3 identifies the relevant delivery phase, the aspect to be managed, and the proposed mitigation measure which are directly applicable to MNES or their associated habitat, which is then factored into the initial impact assessment (refer Section 5.3.2).

In addition, it is recognised that targeted surveys for some of the MNES fauna species has not been carried out in accordance with the Commonwealth Guidelines within the disturbance footprint as part of Project surveys detailed in this report. ARTC will undertake additional ecological surveys in accordance with relevant Commonwealth and/or State surveys guidelines to verify and further refine the habitat mapping and extent of local populations (where applicable). These additional works will inform relevant approvals and management plans, along with necessary offset requirements and disturbance limits.

EIS Chapter 23: Draft Outline Environmental Management Plan provides further context and the framework for implementation of these proposed mitigation and management measures.

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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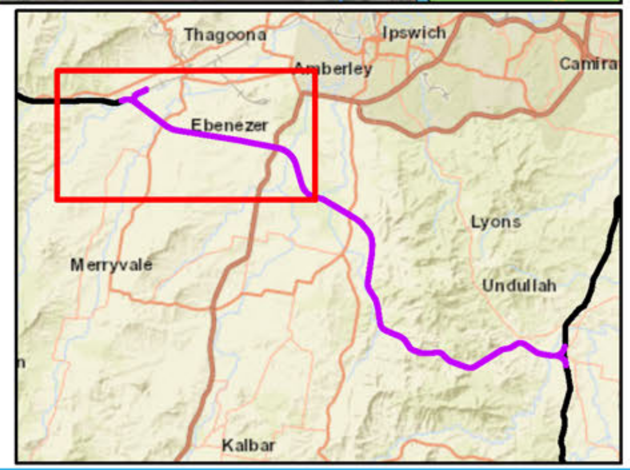

Legend

- 5 Chainage (km)
- Localities
- Fauna crossings
- Major roads
- Minor roads
- H2C project alignment
- Existing rail
- Watercourses
- EIS disturbance footprint (surface disturbance only)
- Local Government Areas
- MNES study area

Koala observations

- Live
- Scat
- Scratches
- Dead

A3 scale: 1:60,000

0 0.5 1 1.5 2 2.5km

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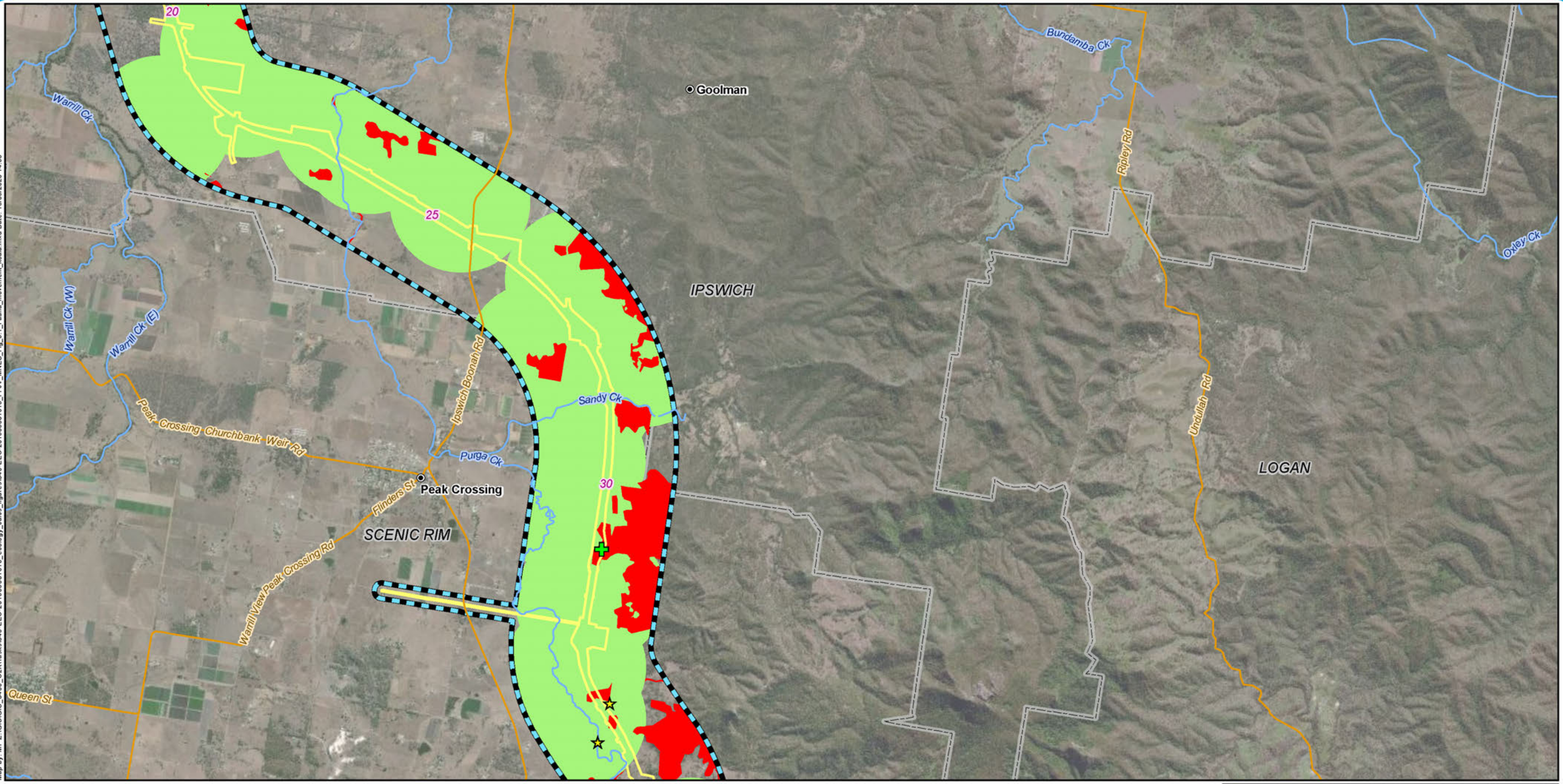
Calvert to Kagaru

Figure 5.1a: Location of preliminary fauna movement opportunities and the presence of Koala records and habitat

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



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Legend

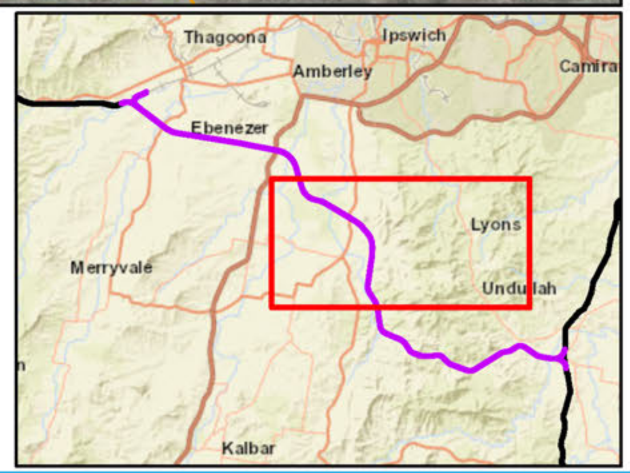
5 Chainage (km)
Localities

Koala observations

Live
Scat
Scratches
Dead

Major roads
Minor roads
Watercourses

EIS disturbance footprint (surface disturbance only)
Local Government Areas
MNES study area



A3 scale: 1:60,000

0 0.5 1 1.5 2 2.5km

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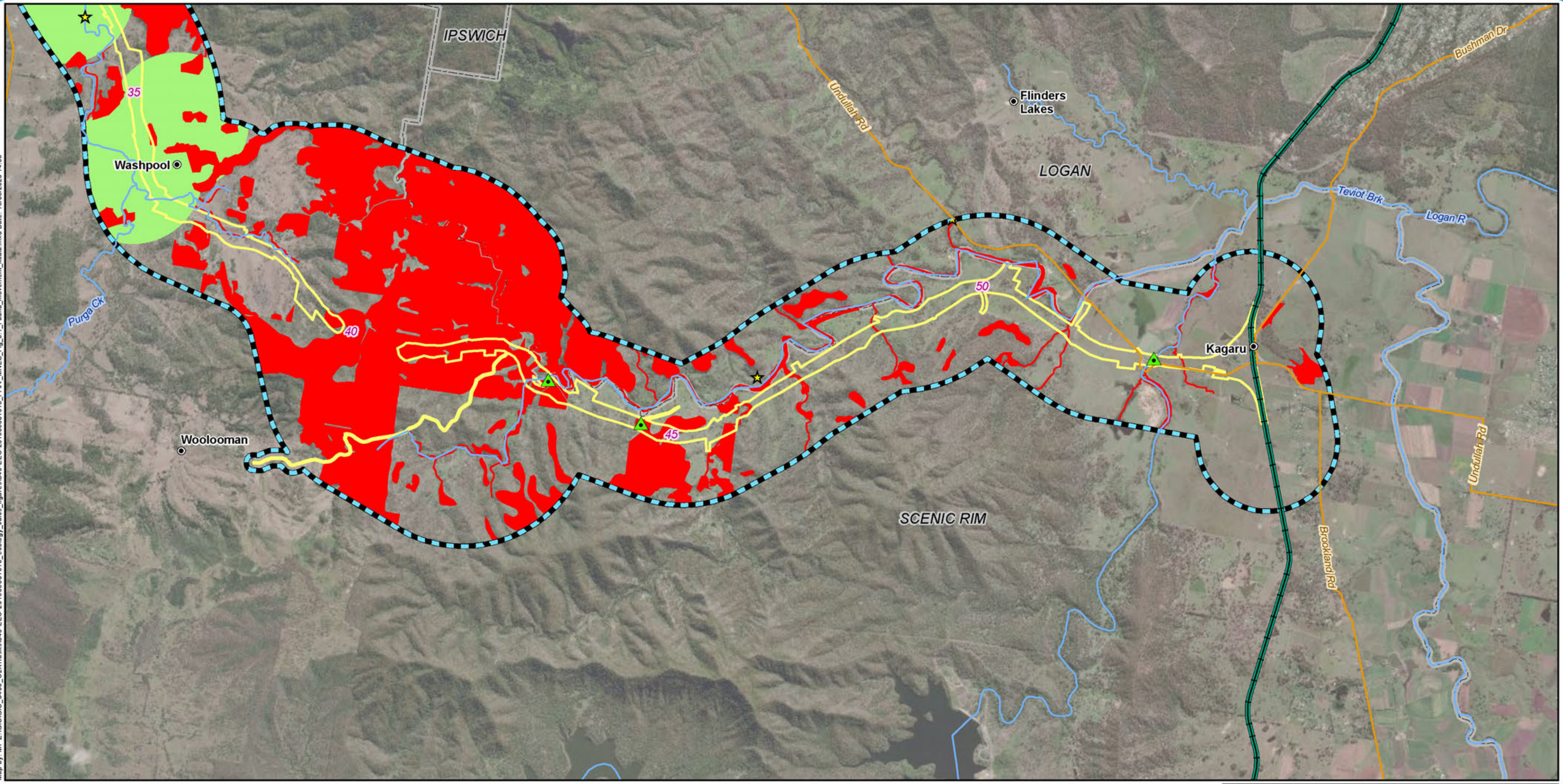
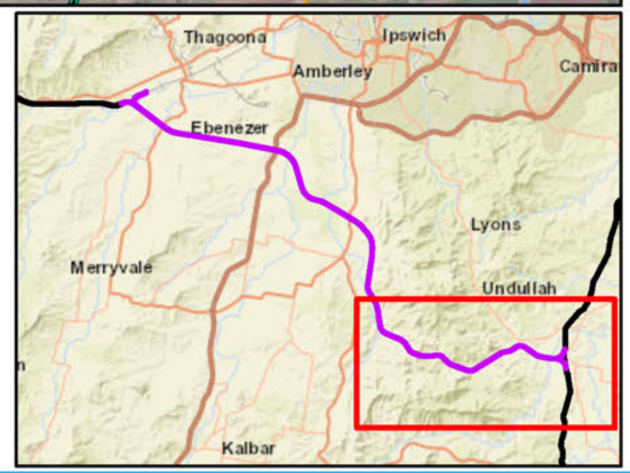
Calvert to Kagaru

Figure 5.1b: Location of preliminary fauna movement opportunities and the presence of Koala records and habitat

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community



Map by: MF Z:\GIS\GIS_3400_C2K\Tasks\340-EEC-201905081615_ecology_calcs_figures\340-EEC-201905081615_FFJV_MNES_Fig_5_1_Fauna_movement_koala.mxd Date: 16/09/2020 14:55



Legend

- 5 Chainage (km)
- Localities
- Fauna crossings

Koala observations

- Live
- Scat
- Scratches
- Dead

- Major roads
- Minor roads
- K2ARB project alignment
- Existing rail
- Watercourses

- EIS disturbance footprint (surface disturbance only)
- Local Government Areas
- MNES study area

Note that due to topography constraints and the realigment of Wild Pig Creek Road and to minimise impacts on Dugandan Creek, there is a small area not within the disturbance footprint between Chainage 42 and 44.

A3 scale: 1:60,000

0 0.5 1 1.5 2 2.5km

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Calvert to Kagaru

Figure 5.1c: Location of preliminary fauna movement opportunities and the presence of Koala records and habitat

Table 5.3 Project impact mitigation and management measures

Delivery phase	Environmental value impacted	Mitigation and management measures
Detailed design	MNES	While the assessment assumes the entire Project disturbance footprint will be cleared, the disturbance footprint will be refined through detailed design as far as practical, to that required to safely and efficiently construct and operate the Project and avoid unnecessary clearing. This will involve inputs from the design team, construction contractor and where applicable, the constructing authority.
		Flora and fauna surveys will be undertaken where they are required to verify prior surveys and assessments, refine potential offsets, inform micro-siting of infrastructure, support secondary approvals and establish baseline conditions against which relevant outcomes of the Reinstatement and Rehabilitation Plan and monitoring activities can be compared. Methods and sequencing of surveys, including seasonal timing, will be in accordance with the relevant published State and Commonwealth survey guidelines and conservation advices for each target species (e.g. *Survey guidelines for Australia's threatened birds* (DEWHA 2010b)) or Queensland guidelines where Commonwealth guidelines do not exist (e.g. *Protected Plants Survey Guidelines* (DES 2020f)) Flora species to be targeted through these surveys include, but are not limited to the following: ▪ Hairy-joint grass (*Arthraxon hispidus*) ▪ Miniature moss-orchid (*Bulbophyllum globuliforme*) ▪ Boonah tuckeroo (*Cupaniopsis tomentella*) ▪ an algae (*Lychnothamnus barbatus*) ▪ Lloyd's olive (*Notelaea lloydii*) ▪ Shiny-leaved condoo (*Planchonella eerwah*). Fauna surveys, including terrestrial, aquatic habitats and breeding habitats (including burrows and hollow bearing trees/logs, wetlands, existing culverts and structures) will target, but are not limited to the following species: ▪ Regent honeyeater (*Anthochaera phrygia*) ▪ Australasian bittern (*Botaurus poiciloptilus*) ▪ Curlew sandpiper (*Calidris ferruginea*) ▪ Large-eared pied bat (*Chalinolobus dwyeri*) ▪ Spotted-tail quoll (*Dasyurus maculatus maculatus*) ▪ Collared delma (*Delma torquata*) ▪ Red goshawk (*Erythrotriorchis radiatus*) ▪ Painted honeyeater (*Grantiella picta*) ▪ Swift parrot (*Lathamus discolor*) ▪ Australian lungfish (*Neoceratodus forsteri*) ▪ Greater glider (*Petauroides volans volans*) ▪ Brush-tailed rock-wallaby (*Petrogale penicillata*) ▪ Koala (*Phascolarctos cinereus*)

Delivery phase	Environmental value impacted	Mitigation and management measures
		▪ Long-nosed potoroo (*Potorous tridactylus tridactylus*) ▪ New Holland mouse (*Pseudomys novaehollandiae*) ▪ Grey-headed flying-fox (*Pteropus poliocephalus*) ▪ Australian painted snipe (*Rostratula australis*) ▪ Black-breasted button-quail (*Turnix melanogaster*) Where a species is detected this will be reported to the relevant agencies along with information on the species habit, habitat in which the species was identified and where possible, population size and local threatening processes. The information will be used to refine the predictive habitat mapping, significant residual impact assessment, disturbance limits, mitigation measures and offsets. Surveys of representative MNES habitat that will be impacted by the Project will be undertaken in accordance with the *Guide to determining terrestrial habitat quality - methods for assessing habitat quality under the Queensland Environmental Offsets Policy. Version 1.3* (DES 2020d) and the *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy* (DSEWPaC, 2012a) to enable a condition assessment of vegetation communities that require offset for the Project.
		Based on the outcome of flora, fauna and MNES habitat surveys: ▪ Work with the design team and construction team to implement measures to avoid and/or further minimise the extent of impacts (i.e. designate no-go zones, reduce the construction or operational footprint within or adjacent to communities or habitat for MNES, define clearing limits) ▪ This information will inform staged and sequential clearing (i.e. clearing of non-habitat trees in area, then a wait period and then the clearing of the remaining habitat) ▪ Identify suitable locations for the release of fauna that may be encountered during pre-clearing or clearing or for the salvaging of microhabitats.
		For any threatened flora species identified through surveys within the disturbance footprint, consult with relevant specialist to determine the feasibility of translocating or propagating specimens in accordance with relevant guidelines (e.g. *Guidelines for the Translocation of Threatened Plants in Australia* (Commander et al. 2018)), including the collection of seed. Feasibility will be assessed noting that not all species can be translocated or propagated and that for the majority of the species identified as potentially occurring with the Project disturbance footprint there is limited evidence of these species being successfully translocated, even though some are used in the horticultural industry.
		The following TEC specific measures for Swamp Tea-tree (*Melaleuca irbyana*) Forest of South-east Queensland TEC will also be implemented: ▪ Undertake a baseline assessment to determine the health and condition of the community to inform offsets and quantify impacts during construction and potentially operations ▪ Work with the design team to minimise the direct impact on Swamp Tea-tree (*Melaleuca irbyana*) Forest of South-east Queensland TEC. This includes ensuring that communities (remnant and regrowth) identified within the construction disturbance footprint are avoided (e.g. Lots 3 and 4 on RP178669 contain approximately 7 ha of TEC, which are identified as a potential laydown area), siting access roads to avoid and minimise impacts in the Warrill Creek area and ensuring that changes to the predicted hydrology outcomes consider this TEC.

Delivery phase	Environmental value impacted	Mitigation and management measures
		▪ Continue to refine the Project design in response to hydraulic modelling outcomes to demonstrate continued compliance with the design objectives of the Project including maintaining inundation regimes within the Swamp Tea-tree (*Melaleuca irbyana*) Forest of South-east Queensland TEC as close to natural conditions as possible.
		The following species-specific measures for Lloyd's olive (*Notelaea lloydii*) will also be implemented: ▪ Avoid works above the tunnel as this area is known to support an important population of Lloyd's olive (*Notelaea lloydii*) ▪ Undertake protected flora surveys as per *Protected Plants Survey Guidelines* (DES 2020f) with a particular focus within the area of Teviot Range identified as habitat for the species (refer species habitat mapping in Appendix G). This includes assessing the condition and health of the population above the tunnel prior to construction to establish the baseline for monitoring during construction to determine if any changes to the population occur as a result of the Project or due to natural attrition. Potential criteria may include recruitment and presence of fertile material, plus signs of water stress. ▪ As part of the MNES monitoring plan continue to monitor this population during construction.
		The following species-specific measures for Australian Lungfish (*Neoceratodus forsteri*) will also be implemented: ▪ Avoid clearing within and along major watercourses, in particular Bremer River and Teviot Brook, through the use of bridge structures and the placement of pylons away from bed and banks ▪ Pre-construction surveys of waterways identified as *potential habitat* of species (e.g. Bremer River) to identify whether Australian lungfish occurs. Surveys will follow the Survey guidelines for Australia's threatened fish (DSEWPaC 2011c) ▪ Where a temporary impoundment or diversion is required for construction purposes and the species is found to be present, the Flora and Fauna Sub-plan will include requirements for an appropriately qualified person to be consulted to make an assessment on the method of recovery, transport and release of fish. The Flora and Fauna Sub-plan will include requirements for the application of follow relevant State (DAF) fish salvage guidelines during construction activities. ▪ The Biosecurity Management Sub-plan will include measures to manage the risk of translocating non-endemic flora and fauna through dewatering and fish salvage activities ▪ The Surface Water Sub-plan will be developed to include measures to maintain low flows during drought conditions and avoid fluctuations to water levels downstream during spawning period (i.e. Bremer River) ▪ The Reinstatement and Rehabilitation Plan will establish requirements for instream and riparian habitats impacted by Project works. This includes restoration of natural riparian vegetation and where possible, reinstatement of instream habitat to pre-construction state (e.g. replacement of large woody debris and ensure no or limited change to instream flows and allow fish passage).
		The following species-specific measures for Spotted-tail quoll (*Dasyurus maculatus maculatus*) and Brush-tailed rock-wallaby (*Petrogale penicillata*) will also be implemented: ▪ Avoid works above the tunnel as this area is a key corridor to maintain movement during construction and operation of the Project ▪ Targeted surveys for identified mammal species will follow the *Survey guidelines for Australia's threatened mammals* (DSEWPaC 2011b) and include the identification of species-specific habitat (refer species habitat mapping in Appendix G) and habitat features considered suitable for species presence (e.g. cliff faces/boulder piles for Brush-tailed rock-wallaby and Spotted-tail quoll) ▪ As part of the MNES monitoring plan, establish camera traps above the tunnel areas to monitor fauna movement across this area during construction

Delivery phase	Environmental value impacted	Mitigation and management measures
		▪ The Flora and Fauna Sub-plan will include restricted works measures for implementation if Spotted-tail quoll and Brush-tailed rock-wallaby are observed within or adjacent to disturbance footprint to allow safe movement away from works area. These measures may include, but are not limited to the following: – Measures to remove carrion from the Project disturbance footprint (and the rail corridor), along with waste management measures – Pest control measures in known or potential habitat for the Spotted-tail quoll consider risks to the species (e.g. use of baiting to control wild dogs) – Salvage hollow logs and rocky outcrops removed from the Project disturbance footprint into adjoining habitat – Establish buffer zones around known key habitat and den sites – Where possible avoid clearing within the known habitat (e.g. Teviot Range) during the breeding season for the Spotted-tail quoll – Measures to manage the clearing of hollow logs and hollow bearing trees (e.g. tapping of tree prior to clearing, removal of hollows prior to clearing and grubbing activities).
		The following species-specific measures for Swift parrot (*Lathamus discolor*) will also be implemented: ▪ Where possible through design, reduce the disturbance footprint in winter foraging habitat, including avoiding clearing for ancillary works ▪ Incorporate winter foraging species into the landscape design and Reinstatement and Rehabilitation Plan.
		The following species-specific measures for Australian painted snipe (*Rostratula australis*) will also be implemented: ▪ Targeted surveys to be undertaken of potential habitat following the *Survey guidelines for Australia's threatened birds* (DEWHA 2010b) ▪ Should the Australian Painted snipe or other target wetland species be found to occur, the CEMP Flora and Fauna sub-plan will include: – Clearing/construction works in potential habitat areas will be timed where possible to avoid wet conditions where habitat is likely to be most suitable – Restricted works/avoidance measures in place should nesting be detected. ▪ The CEMP will include measures to minimise noise as much as feasible and the Air Quality Sub-plan will include measures to minimise dust impacts including dust monitoring and suppression methods ▪ The Biosecurity Management Sub-plan will include site hygiene and waste management measures to ensure pest predator fauna are not attracted to works areas or utilising Project disturbance footprint.
		The following species-specific measures for Collared delma (*Delma torquata*) will also be implemented: ▪ Targeted surveys to be undertaken as per *Survey guidelines for Australia's threatened reptiles* (DSEWPaC 2011e) where suitable habitat is identified (refer species habitat mapping in Appendix G) ▪ The Flora and Fauna Sub-plan will include restricted works measures for implementation if the Collared delma is observed within or adjacent to disturbance footprint to allow safe movement away from works area. Other measures may include, but are not limited to the following: – Measures to ensure retrieval of potential habitat elements (e.g. loose surface rock, large fallen timber) during vegetation clearing and placement in adjacent unimpacted habitat – Erosion and sediment control measures in steep slopes (and known *important habitat* for this species) to avoid/minimise slippages – Measures to allow safe handling of fauna (where required) and repatriation in a suitable habitat away from site.

Delivery phase	Environmental value impacted	Mitigation and management measures
		The following species-specific measures for Red goshawk (*Erythrotriorchis radiatus*) will also be implemented: ■ Pre-clearing surveys of woodlands identified as potential habitat for Red goshawk (refer species habitat mapping in Appendix G) will be undertaken to identify whether individuals occur and potentially nest within the disturbance footprint. Surveys for nest sites within or near the disturbance footprint will be as per MNES guidelines where suitable nesting habitat (i.e. large emergent trees near water) are identified. ■ Where Red goshawk nesting is identified in pre-clearing surveys, the Flora and Fauna Sub-plan will include restricted works measures for construction to allow nesting to continue undisturbed (e.g. micrositing of works to avoid nests or maximise separation distance, 100 m buffer and signage around nests, no disturbance to nests until after breeding season (being until fledglings/offspring no longer use the nest/roost for habitat). Some limited works may occur in the buffer zone during this period (e.g. cultural heritage surveys).
		The following species-specific measures for Koala (*Phascolarctos cinereus*) will also be implemented: ■ Avoid works above the tunnel as this area is a key corridor to maintain movement during construction and operation of the Project ■ Pre-clearing surveys to be undertaken of woodlands (and other relevant habitats) identified as potential habitat of species (refer species habitat mapping in Appendix G) to identify whether individuals occur within disturbance footprint ■ Project design to incorporate fauna crossing structures to allow fauna movement across alignment. The location and frequency of the passages will be based on an understanding of local Koala movements and in consultation with relevant stakeholders (e.g. DTMR and local councils. ■ Fauna and fencing in accordance with ARTC guidelines and DTMR's Fauna Sensitive Road Design Manual (DTMR 2010). Fencing extent will be determined by the availability of suitable habitat adjacent to alignment. ■ Viaducts and the bridge structures will assist in the retention of corridor(s) of at least 100 m width. While the tunnel will ensure a corridor over 1 km wide is maintained through the Teviot Range. ■ The Flora and Fauna Sub-plan will include restricted works measures for implementation within or adjacent koala habitat to allow safe movement away from works area. These measures may include, but are not limited to the following: – Staged and sequential clearing within koala habitat in areas where koala have been identified as being present (e.g. undertake pre-clearing koala searches on the morning prior to clearing commencing) – Measures to allow safe handling of koalas (where required) and repatriation in suitable habitat away from site – Requirements for koalas subject to handling to be examined and if suspected of Chlamydia infection will be taken to a predesignated veterinarian/wildlife care facility for treatment prior to release – A procedure to guide koala interactions, including any translocations – Appropriate construction traffic speed limits will be established and managed to minimise vehicle strike risk – Incorporation of koala trees in landscape design and rehabilitation works, especially along existing corridors which are to be retained (e.g. riparian corridors).

Delivery phase	Environmental value impacted	Mitigation and management measures
		The following species-specific measures for Greater glider (*Petauroides volans volans*) will also be implemented: ▪ Avoid works above the tunnel as this area is a key corridor to maintain movement during construction and operation of the Project ▪ Pre-clearing surveys to be undertaken of woodlands (and other relevant habitats) identified as potential habitat for the species (refer species habitat mapping in Appendix G) to identify whether individuals occur within disturbance footprint, including potential movement pathways, nest sites (i.e. hollow bearing trees) and feeder trees ▪ Project design to incorporate fauna crossing structures to allow fauna movement across alignment. The location and frequency of the passages will be based on an understanding of local Greater glider movements and in consultation with relevant stakeholders (e.g. DTMR and local councils. ▪ Fauna and fencing in accordance with ARTC guidelines and DTMR's Fauna Sensitive Road Design Manual (DTMR 2010). Fencing extent will be determined by the availability of suitable habitat adjacent to alignment. Also, where possible, avoid the use of barb wire particularly on the top strand, to prevent threatened species (particularly Greater glider, flying-foxes and microbats) from becoming entangled. Fauna friendly fencing must be used, whilst being in accordance with landowner and/or structural requirements. ▪ The Flora and Fauna sub-plan will include: – Pre-clearing surveys to identify and map out hollow bearing trees, feeder trees and potential movement pathways – Consultation with the project team and construction team to determine whether key microhabitats can be avoided – Where key microhabitats cannot be avoided developed protocols/procedures to manage these features, including relocating hollow bearing trees into adjacent habitat and the use of nest boxes, tapping of hollows bearing trees or where possible by lowering trees slowly with a claw extension.
		The following species-specific measures for Grey-headed flying-fox (*Pteropus poliocephalus*) will also be implemented: ▪ Pre-clearing surveys to be undertaken of riparian habitat identified as potential roost sites of species to identify whether camps occur within or near the disturbance footprint. It is noted no roost sites have been previously identified within 5 km of the Project. ▪ Where possible, reduce the disturbance footprint in winter foraging species, including avoiding clearing for ancillary works ▪ Incorporate winter foraging species into the landscape design and Reinstatement and Rehabilitation Plan ▪ Work with the design team and property team to incorporate fencing which minimises the risk of entanglement (e.g. avoid the use of barbed wire fencing with a high tensile wire strand as the top wire) ▪ The Flora and Fauna Sub-plan will include measures to be implemented should a roost site be found to occur. These will incorporate the mitigation standards detailed in the *Commonwealth's Referral guideline for management actions in grey-headed and spectacled flying-fox camps* (DotE 2015a).
		For other MNES species included in the initial impact assessments for MNES flora (Table 5.6) and MNES fauna (Table 5.7), review the outcome of additional flora and fauna surveys, and ensure the species-specific measures contained in Table 5.6 and 5.7 are appropriately implemented for survey, landscape design, the Reinstatement and Rehabilitation Plan or the Flora and Fauna Sub-plan.

Delivery phase	Environmental value impacted	Mitigation and management measures
		Develop a post-construction MNES monitoring plan. The MNES monitoring plan will be informed by the survey results and developed in consultation with relevant stakeholders. The MNES monitoring plan will define the TEC or other MNES habitat location, reference condition, assessment framework, infrastructure elements (e.g. erosion and sediment control devices, fauna crossing structures), corrective actions, completion criteria and monitoring timeframes. Criteria and monitoring targets to be considered include (but are not limited to): ▪ For Swamp Tea-tree (*Melaleuca irbyana*): level of dieback and recruitment, dust deposition on leaves, changes to the local hydrology through observations of soil moisture with these criteria to be determined in consultation with relevant specialist ▪ For Lloyd's olive: Weed monitoring within identified Lloyd's olive population, with annual monitoring in accordance with completion criteria ▪ For Painted snipe: Ongoing annual weed monitoring within wetland habitat in accordance with completion criteria ▪ For Lloyd's olive: monitor individuals used in rehabilitation activities in accordance with the Rehabilitation and Reinstatement Plan, if included.
		Project design to incorporate minimum lighting requirements feasible for Project safety.
		The potential for Project works to impact MNES through erosion, soil loss, land degradation, sedimentation or decreased surface water or groundwater quality or availability will be managed through the following: ▪ Soil surveys to further characterise soil conditions across the disturbance footprint at a suitable scale to inform detailed design, including appropriate design responses where reactive or problem soils are present or suspected (e.g. sodosols near Ebenezer, vertosols near Purga and Willowbank, saline hazard areas, and potential for acid sulfate soils near artificial waterbodies or impoundments ▪ Contaminated land surveys to inform detailed design and subsequent contaminated land strategy ▪ A Soil Management Plan will be developed to provide the framework for the stripping, storage, treatment and reuse of topsoil ▪ An Erosion and Sediment Control Plan (ESCP) will be developed as part of the CEMP, in accordance with the International Erosion Control Association's *Best Practice Erosion and Sediment Control* (IECA, 2008). It will include: – Soil/land conservation objectives for the Project – Management of problem soils – Temporary/permanent drainage, erosion and sediment control measures – Stockpiling and management/segregation of topsoil where it contains native plants seedbank or weed material – Vehicle, machinery and imported fill hygiene protocols and documentation – Requirements for training, inspections, corrective actions, notification and classification of environmental incidents, record keeping, monitoring and performance objectives for handover on completion of construction – Where practical and or in accordance with specific flora and fauna management plans, vegetation clearing and ground disturbing works will be staged sequentially across the Project to minimise areas exposed to erosion and sediment risk of receiving waterways and drainage lines in accordance with the general environmental duty of the *Environmental Protection Act 1994* (Qld) – Measures for minimising the exposure time of unprotected materials to prevent sedimentation of receiving waterways and subsequent impacts to ecological receptors

Delivery phase	Environmental value impacted	Mitigation and management measures
		– A process for site- and activity-specific preparation when forecast large or high-intensity wet weather events are predicted. This may include, but not be limited to, removing equipment out of riparian zones, stabilising/covering live work areas, additional application of soil binders/veneers and pre event treatment, and dewatering of sediment basins. – Process for the continuous review of effectiveness of erosion and sediment controls – Water quality monitoring requirements as defined in the Surface Water Sub-plan to assess the effectiveness of erosion and sediment controls and reinstatement and rehabilitation programs – The ESCP will align with the Reinstatement and Rehabilitation Plan and will include progressive stabilisation of earth materials and soil consolidation to prevent erosion and sedimentation in areas within the disturbance footprint that do not form part of the permanent works (e.g. temporary construction compounds, temporary waterway barrier works and laydown areas etc.) ▪ A surface water monitoring framework, which will inform the development of the Surface Water Sub-plan and construction water quality monitoring program. It will identify monitoring locations including upstream, downstream and at the intersection of the Project disturbance footprint and watercourse. It will include the relevant water quality objectives, parameters, criteria and specific monitoring locations, frequency and duration identified in consultation with relevant regulators to reduce impacts to surface water quality. ▪ The Surface Water Sub-plan will establish the construction water quality monitoring program which will include (as a minimum): – Analysis of the representative background monitoring dataset – Identification of Project works and activities during construction and operation, including runoff, emergencies and spill events, that have the potential to impact on surface water quality of potentially affected waterways and riparian land (via discharge points) – A risk management framework for evaluation of the risks to surface water quality and ecosystems in the receiving environment, including definition of impacts that trigger contingency and ameliorative measures. ▪ Potential aquatic and terrestrial Groundwater Dependent Ecosystems will be field-truthed to confirm presence ▪ Further geotechnical investigations will be undertaken at deep cut sections to inform design and location-specific construction management of groundwater. ▪ Risks associated with dewatering (i.e. water table lowering) and environmental management requirements during construction will be identified through appropriate baseline groundwater monitoring, modelling and analysis, and incorporated into the CEMP.
	Riparian vegetation and aquatic habitats	Project design minimises impacts to waterways, riparian vegetation and in-stream flora and habitats by: ▪ Adopting a waterway crossing structure hierarchy: bridges preferred to culverts, to maintain infrastructure permeability for fauna at identified habitat connectivity points, however local conditions and constructability impacts must be considered when determining the preferred environmental solution ▪ Avoiding, then minimising the extent and duration of temporary waterway diversions. Where unavoidable, implement water quality, erosion and sediment control measures to minimise impacts to downstream environments and water users. ▪ Continuing to refine Project design in response to hydraulic modelling outcomes. This includes addressing flood impact objectives which include consideration of peak water levels, flow distribution, velocities, and duration of inundation, and implications for fish passage. This will confirm bridge lengths, culvert sizing and numbers, localised scour and erosion protection measures for both rail, road and other permanent Project infrastructure.

Delivery phase	Environmental value impacted	Mitigation and management measures
		▪ Avoiding, then minimising the extent of permanent waterway diversions. Where unavoidable, waterway diversion design to include simulation of natural features e.g. meanders, pools, riffles, shaded and open sections, deep and shallow sections and different types of sub-strata, depending on the pre-disturbance environmental values, as per requirements of relevant and applicable conditions of approval, legislation, regulations and industry guidelines. Maintenance activity locations, construction compounds and storage areas will be defined as part of Project detailed design and positioned away from waterways. ▪ Stormwater controls, such as scour protection, are to be further developed and incorporated where necessary to achieve compliance with established water quality objectives. Temporary and permanent measures must be appropriate to the site conditions, responding to the erosion risk assessment, environmental receptors, climatic zone and seasonal factors. The ESCP will establish and specify the monitoring and performance objectives for handover to operational management on completion of construction. ▪ Ensuring the disturbance footprint extents allow sufficient space for provision of the required temporary and permanent erosion and sediment control measures/pollution control measures defined during detailed design ▪ Undertaking rehabilitation of temporary waterway crossings in accordance with the Reinstatement and Rehabilitation Plan ▪ Developing ESCPs for implementation during pre-construction, construction and commissioning
	Fauna passage[1,2]	Refine fauna passage locations and associated rehabilitation areas in the design to maintain infrastructure permeability, particularly at the six key locations identified as part of the EIS assessment process to maintain and/or re-establish habitat connectivity, which includes but is not limited to: ▪ Spotted-tail quoll (*Dasyurus maculatus maculatus*) ▪ Greater glider (*Petauroides volans volans*) ▪ Brush-tailed rock-wallaby (*Petrogale penicillata*) ▪ Koala (*Phascolarctos cinereus*) ▪ New Holland mouse (*Pseudomys novaehollandiae*). Design of fauna passage structures and associated rehabilitation areas will respond to local topographical and hydrological context, with consideration of safety requirements for the rail corridor and adjoining properties. Design bridges and culverts to accommodate terrestrial fauna passage where assessed as appropriate, in addition to fish passage design requirements. Fauna passage design will be consistent with the intent of DTMR's Fauna Sensitive Road Design Manual (DTMR 2010) and where applicable species-specific requirements.
	Fauna fencing[1,2]	Fauna fencing opportunities will be further assessed and, where appropriate, developed during detailed design to limit fauna strike and fauna mortality risk and/or maintain habitat connectivity. This will include: ▪ Assessment of the compatibility of each approach for the targeted local species with the general fencing principles at each proposed fencing location ▪ Consideration of safety requirements for the rail corridor and adjoining properties ▪ Consultation with adjoining landholders ▪ Requirements for maintaining an appropriate clearance buffer between adjacent vegetation and fauna fences ▪ Consideration for maintenance constraints and responsibilities that a fauna connectivity or fencing opportunity may introduce to operations.

Delivery phase	Environmental value impacted	Mitigation and management measures
		Fauna fencing will be designed with reference to DTMR's Fauna Sensitive Road Design Manual (DTMR 2010). Additional expert guidance in relation to specific design features will be sought during the detailed design process. The design will aim to maximise infrastructure permeability by connecting fauna fencing with safe crossing opportunities.
	Aquatic fauna	Design watercourse crossing structures (including culverts and bridges) to maintain fish passage where applicable in accordance with *Accepted development requirements for operational work that is constructing or raising waterway barrier works* (DAF 2018) or conditions of development approval for operational work that is constructing or raising waterway barrier works. The design will aim to minimise the need for ongoing maintenance and inspection to maintain fish passage.
		Develop a dewatering strategy in accordance with the *Biosecurity Act 2014* (Qld), providing reasonable measures to avoid the spread of pest species and in accordance with any required aquatic fauna species management plans and water quality objectives defined in the outline CEMP.
	Flora	Where feasible and practicable, locate construction areas including compounds, stockpiles, fuel storage, laydown areas and staff parking outside the tree protection zone as defined in *AS4970-2009 Protection of trees on development sites*. Where practical, existing tracks will be used and the design for new access tracks (permanent and temporary) will be undertaken with the aim of minimising disturbance of substrate and vegetation.
	Landscape, rehabilitation and stabilisation	Landscape design establishes the requirements for rehabilitation of disturbed areas for habitat re-creation, landscaping and stabilisation, including for riparian zones and informs the development of the Reinstatement and Rehabilitation Plan and the Landscape and Rehabilitation Management Plan[1,3]. This will also include criteria for retrieval of potential habitat elements (loose surface rock, large fallen timber) during vegetation clearing for habitat recreation where appropriate. Develop a Reinstatement and Rehabilitation Plan for areas within the disturbance footprint that do not form part of the permanent works (e.g. construction compounds, laydown areas, temporary access tracks etc). The Plan will include and clearly identify: ▪ Location of areas subject to rehabilitation and/or reinstatement/stabilisation, in accordance with the landscape and rehabilitation design developed during detailed design, including operational rail safety considerations ▪ Objectives and timeframes for rehabilitation and/or reinstatement/stabilisation works (including biodiversity, vegetation establishment and erosion and sediment control outcomes to be achieved) ▪ Where appropriate, the plan describes how the objectives align with relevant recovery plans, threat abatement plans, conservation advices or policy guidance for target species in areas identified for rehabilitation ▪ Details of the actions and responsibilities to progressively rehabilitate, regenerate, and/or revegetate areas, consistent with the Reinstatement and Rehabilitation Plan objectives ▪ Native flora species endemic to the Scenic Rim and Ipswich regions or other suitable species appropriate to the landscape context and nursery/seed stock sources. Where possible (i.e. propagated material is available) include MNES species (e.g. Lloyd's olive) in rehabilitation activities. ▪ Incorporate koala trees in landscape design and rehabilitation works, especially along existing corridors which are to be retained (e.g. riparian corridors) ▪ Procedures, timeframes, measurable performance objectives and responsibilities for monitoring the success of rehabilitation and/or reinstatement/stabilisation areas

Delivery phase	Environmental value impacted	Mitigation and management measures
		▪ Corrective actions if the outcomes of rehabilitation and/or reinstatement/stabilisation are not achieved. A Landscape and Rehabilitation Management Plan will be developed to define post construction maintenance requirements, monitoring requirements and completion criteria for areas defined in the landscape design and/or identified in the Reinstatement and Rehabilitation Plan.
	Offsets[1,2]	Restriction of the Project disturbance footprint through detail design as far as practical to that required to safely and efficiently construct and operate the Project[1,2,3]. In doing so, areas of MNES, MSES and their associated habitat will be avoided, thereby minimising significant adverse residual impacts to MNES. Significant adverse residual impact to habitat for MNES and MSES will be re-calculated to confirm the Project's offset obligations under Australian Government and State requirements based on the outcomes of the Flora, fauna and MNES habitat surveys. A Project offset delivery plan and Offsets management plans will be developed to provide for the staged delivery of offsets, where appropriate, ahead of relevant clearing works being undertaken and finalised in consultation with relevant Australian Government and State regulatory agencies (refer Appendix J: Environmental Offset Delivery Strategy QLD).
	Flora and fauna	Develop the Flora and Fauna Sub-plan to include appropriate criteria, directives and procedures in relation to: ▪ Pre-clearing surveys, including terrestrial, aquatic and wetland habitats, protected plants, breeding habitats (including burrows and hollow bearing trees/logs, existing culverts and structures, riparian habitat identified as potential roost sites) for both threatened and non-threatened species by suitably qualified persons ▪ Staged and sequential clearing protocols ▪ Signage requirements for the delineation of no-go areas and clearing extents, including avoiding works above the tunnel as this area is a key corridor to maintain movement during construction and operation of the project ▪ Animal handling protocols, including relocation and emergency care. For example, koalas subject to handling will be examined and if suspected of Chlamydia infection will be taken to a predesignated veterinarian/wildlife care facility for treatment prior to release ▪ Restricted works/avoidance measures should nesting of Australian painted snipe or Australasian bittern be detected ▪ Works protocols should an active Red goshawk nest site be identified, to allow nesting to continue undisturbed ▪ Works protocols should a grey headed flying fox roost site be found, in accordance with the Commonwealth's *Referral guideline for management actions in grey-headed and spectacled flying-fox camps* (DotE 2015a) ▪ Works protocols to allow safe movement away from works area, should other fauna be observed within or adjacent to the works area ▪ Relocation of habitat features (such as hollow bearing logs or rocks for the Collared delma) where applicable ▪ Requirements for inspections and corrective actions during construction and rehabilitation activities ▪ Requirements for fauna and flora management actions to be undertaken by suitably qualified persons ▪ Requirements for training, inspections, corrective actions, notification and classification of environmental incidents, record keeping, monitoring and performance objectives for handover on completion of construction.

Delivery phase	Environmental value impacted	Mitigation and management measures
	Weeds and pests	Develop the Biosecurity Management Sub-plan[1,2,3] to include: ▪ Requirements for pre-clearing surveys to determine the risk of environmental weeds and pests including prohibited and restricted matters prescribed under the *Biosecurity Act 2014* (Qld) and Biosecurity Regulation 2016 being present ▪ Relevant guidelines to control potential deleterious pathogens including *Phytophthora cinnamomi* and Myrtle rust (e.g. DotE 2015b) associated with Project activities both of which may impact Melaleuca and eucalypt species. ▪ Revegetation species to be obtained from source certified free of *Phytophthora cinnamomi* ▪ Mapping of the existing extent and severity of any weed infestation and weed management requirements in the disturbance footprint or on adjacent land, (restricted matters including mother of millions, Opuntioid cactus, Lantana and Giant rats tail grass) ▪ Pest animal management, including Red imported fire ants management within the Biosecurity Zones 1 and 2 as per current DAF advice ▪ Weed surveillance and treatment during construction and rehabilitation activities ▪ Vehicle and plant washdown protocols when traversing properties via temporary access tracks or if any high risk areas are identified during the Project construction ▪ Requirements in relation to pesticide and herbicide use and documentation, recognising ACDC Act requirements including any limitations on use, such as, restrictions on use in sensitive environmental areas, drainage lines that flow to waterways and aquatic habitats, and ensuring that broad scale use does not result in an increased erosion and sediment risk ▪ Vehicle and plant equipment and imported fill hygiene protocols and documentation ▪ Erosion and sediment control risks associated with broad scale weed removal or treatment ▪ Stockpiling and management/segregation of topsoil where it contains native plants seedbank or weed material ▪ Consideration of local government Biosecurity Plans (City of Ipswich Biosecurity Plan 2018-2023 and City of Logan Biosecurity Plan 2017-2022) ▪ Dewatering and fish salvage requirements to manage the risk of translocating non-endemic flora and fauna ▪ Requirements for monitoring the effectiveness of weed hygiene measures.
		Develop the Community Engagement Sub-plan in the CEMP, to enable members of the public to assist with weed surveillance in the vicinity of Project works.
Pre-construction	Flora and fauna	Implement the Flora and Fauna Sub-plan. Undertake pre-clearing surveys in any areas to be cleared to enable pre-construction activities and confirm the species-specific works protocols to be implemented. Document the area and type of vegetation cleared in a post clearance summary, including MNES for offsetting and compliance purposes.
	Landscape, rehabilitation and stabilisation	The Reinstatement and Rehabilitation Plan will guide the approach to rehabilitation and be implemented progressively during pre-construction and construction phase activities.
	Weeds and pests	Implement the Biosecurity Management Sub-plan during pre-construction to reduce the potential for the spread of weeds and pests into the surrounding environments and land uses.

Delivery phase	Environmental value impacted	Mitigation and management measures
	Erosion and sediment control	Implement appropriate site stabilisation treatments, including seeding and planting requirements, in accordance with the ESCPs and Reinstatement and Rehabilitation Plan.
Construction and commissioning (including reinstatement)	Flora and fauna (including MNES)	Project clearing extents are limited to that which is required to safely construct, operate and maintain the Project, in accordance with the approved disturbance footprint. Locate temporary construction facilities compounds, stockpiles, fuel storage, laydown areas, temporary access roads and staff parking to minimise the extent of disturbance on existing habitat and significant vegetation (i.e. undertake micro-siting of these temporary activities and facilities). Appropriate construction traffic speed limits will be established and managed to minimise vehicle strike risk. Clearly define clearing boundaries associated with the construction disturbance footprint with flagging or marking tape, signage or other suitable means to delineate no go areas. Undertake this delineation and marking process in a manner that is consistent with the Project flagging/marking tape process and specifications, to ensure that it is consistent with the wider Project control processes and does not conflict or contradict any other demarcation practices. Staged and sequential clearing where feasible to minimise the extent of exposed areas. Where possible, minimise loss of canopy vegetation and works that will lead to the proliferation of weed species[1]. A qualified Fauna Spotter Catcher will undertake pre-clearance surveys of habitats and vegetation, including where applicable fauna reduction activities. The Fauna Spotter Catcher will supervise the subsequent clearing. The area and type of vegetation cleared will be documented where required for compliance with secondary approvals and offset purposes[1,2,3]. Implement the post-construction MNES Monitoring Plan. Continue monitoring each nominated MNES against initial assessment values, until completion criteria are achieved. Corrective actions to be implemented where Project-associated impacts are identified. Implement Air Quality Sub-plan to minimise dust impacts including dust monitoring and suppression methods.
	Riparian vegetation and aquatic habitats	Locate construction areas including compounds, stockpiles, fuel storage, laydown areas, temporary and permanent access roads within the disturbance footprint. Undertake a flood/drainage assessment to inform the siting and scale of temporary construction areas (including stockpiles, construction compounds, fuel storage and laydown areas etc). Locate these areas on land that is not subject to flooding to the extent possible. Siting of plant and equipment and refuelling facilities to be undertaken in accordance with *AS1940:2017 The storage and handling of flammable and combustible liquids*. Implement the site-specific ESCPs. Works within or adjacent to watercourses will be conducted in accordance with relevant secondary approvals including: ▪ *Riverine protection permit exemption requirements* (WSS/2013/726) or conditions of a riverine protection permit issued for the Project ▪ *Accepted development requirements for operational work that is constructing or raising waterway barrier works* (DAF 2018) or conditions of development approval for operational work that is constructing or raising waterway barrier works. Dewatering/extraction of water from artificial impoundments will be undertaken after consultation with relevant stakeholders. Dewatering strategies will be required to comply with the *Biosecurity Act 2014* (Qld) to take reasonable measures to avoid the spread of pest species (with capacity to affect water quality) and in accordance with any required aquatic fauna species management plans. The salvage and relocation of fish within isolated aquatic environments will be managed in accordance with DAF Guidelines for Fish Salvage.

Delivery phase	Environmental value impacted	Mitigation and management measures
		An appropriately qualified person will be consulted to make an assessment on the method of recovery, transport and release of fish and other aquatic fauna, as required. As a minimum, the following will be implemented: ■ Relocation will be undertaken by a suitably qualified person ■ Dewatering pumps will have an intake screen ■ Records of all fish recovered, and the location of their release will be maintained. In the event of a spill incident during construction, any impacted aquatic environments will be assessed for the presence of fauna. If necessary, salvage and recovery efforts will be undertaken[1].
	Fauna passage	Prioritise bridge structures/culverts construction where practical and feasible, particularly in the six key locations identified as part of the EIS assessment process to maintain and/or re-establish habitat connectivity as soon as possible and minimise the disruption to waterways. Stage the implementation of the Reinstatement and Rehabilitation Plan in locations associated with fauna passage structures.
	Flora	Minimise clearance of remnant vegetation to that necessary for safe and efficient construction and operation[1,2,3]. Where practicable and feasible, locate construction areas including compounds, stockpiles, fuel storage, laydown areas, staff parking outside the tree protection zone as defined in *AS4970-2009 Protection of trees on development sites*. Where possible, minimise loss of canopy vegetation and works that will lead to the proliferation of weed species. Implement a Soil Management Plan as part of the CEMP, guiding the stripping, stockpiling and management of topsoil where it has the potential to contain seedbank or weed material. Topsoil stockpiles will be managed to maintain the viability of soil seed banks for threatened flora species[1] such as Hairy-joint grass, Boonah tuckeroo, Lloyd's olive and Shiny-leaved condoo. Plan and implement revegetation and rehabilitation works so that they do not create safety, maintenance or performance issues e.g. vegetation does not grow and obscure signals or impact longevity of rail infrastructure.
	Aquatic fauna	Construct temporary and permanent watercourse crossing structures in accordance with the detailed design and *Accepted development requirements for operational work that is constructing or raising waterway barrier works* (DAF 2018) or conditions of development approval for operational work that is constructing or raising waterway barrier. This is required to minimise impacts to aquatic fauna (i.e. fish passage) and hydrology during construction and operation.
	Fauna fencing	Install fauna exclusion fencing in accordance with detailed design and fencing hierarchy especially in conjunction with the six identified fauna passages/creek crossing locations for the Project to maintain permeability in the alignment[1,2].
	Weeds and pests	Implement the Biosecurity Management Sub-plan during construction to reduce the potential for the spread of weeds and pests into the surrounding environments and land uses. The effectiveness of weed hygiene measures will be monitored as a component of the environmental monitoring procedure for the Project. Any vegetated material containing, or with the potential to contain, weed seed material will not be used for on-site mulching or erosion protection[1,2] Implement the Community Engagement Sub-plan in the CEMP, to enable members of the public to assist with weed surveillance in the vicinity of Project works.

Delivery phase	Environmental value impacted	Mitigation and management measures
	Landscape, rehabilitation and stabilisation	Construct landscaping treatments in accordance with the landscape design. Implement the Soil Management Plan to protect MNES species (e.g. soil seedbanks and habitat). Undertake progressive rehabilitation and reinstatement of disturbed areas in accordance with the Reinstatement and Rehabilitation Plan and the Landscape and Rehabilitation Management Plan to minimise threatening process to MNES such as weed invasion.
	Erosion and sediment control	Vegetation clearing and ground disturbing activities will be supplemented by the progressive installation of erosion and sediment controls including stabilisation works to minimise areas exposed to erosion and sediment risk. Implement site stabilisation treatments in accordance with: ▪ ESCP ▪ Air Quality Sub-plan ▪ Reinstatement and Rehabilitation Plan. Assess the suitability of cleared vegetation for mulching/erosion protection on a case by case basis. Any vegetated material containing or with the potential to contain weed seed material will not be used for on-site mulching or erosion protection without prior treatment. For any unsuitable material i.e. noxious weeds etc, the cleared and grubbed material shall be removed from the site and disposed of in accordance with relevant statutory requirements and the Biosecurity Management Sub-plan. Re-use suitable mulch generated by construction of the Project within appropriate timeframes and manner as specified in the ESCP and the Reinstatement and Rehabilitation Plan.
Operation	Riparian vegetation and aquatic habitats	▪ Undertake maintenance activities and refuelling facilities in accordance with *AS1940:2017 The storage and handling of flammable and combustible liquids.* ▪ Where maintenance activities within or adjacent to watercourses are required these will be undertaken in accordance with: – *Riverine protection permit exemption requirements* (WSS/2013/726) or conditions of a riverine protection permit issued for the works – *Accepted development requirements for operational work that is constructing or raising waterway barrier works* (DAF 2018) or conditions of development approval for operational work that is constructing or raising waterway barrier works.
	Weeds and pests	▪ Weed management protocols for the operational rail corridor and other ARTC facilities will be in accordance with the requirements of the Qld *Biosecurity Act 2014, ARTC operation and maintenance procedures and policies* and the Operation EMP[1,2,3]. These protocols will include: – Site hygiene and waste management procedures to deter pest animals – Weed surveillance and treatment during operation and maintenance activities – Requirements in relation to pesticide and herbicide use, including any limitations on use. Restrictions may apply in proximity to watercourses, known areas of MNES or MSES habitat or land uses sensitive to spray-drift from the application of pesticides and herbicides. – Vehicle, machinery and imported fill hygiene protocols and documentation – Erosion and sediment control risks associated with broad scale weed removal or treatment Corrective actions should the outcomes not achieve the adopted objectives.

Delivery phase	Environmental value impacted	Mitigation and management measures
		ARTC's Enviroline will be advertised for the Project to enable members of the public to notify ARTC of issues, including concerns regarding weeds and pests.
	Fauna passage	Cross drainage structures will be inspected to assess physical condition and performance, structural integrity and corrective measures in accordance with ARTC's *Structures Inspection Engineering Code of Practice* (ETE-09-01) [1,2]. Fauna passages will be maintained and where applicable monitored during the operational life of the Project (design life of 100-years)
	Fauna fencing	Inspect and maintain fauna fencing in accordance with ARTC *Engineering (Track and Civil) Code of Practice – Section 17 Right of Way: Inspection and Assessment*[1,2]. Fauna fencing will be maintained and where applicable monitored during the operational life of the Project (design life of 100-years). Record vehicle strikes with Koalas and Greater gliders and investigate potential source of the issue Where applicable implement corrective measures (e.g. erect fauna friendly fencing, glider poles etc)

Table notes:

1 Mitigation measure successfully implemented as part of the Toowoomba Second Range Crossing Project.

2 Mitigation measure approved by the Commonwealth as part of the rail component for the Carmichael Coal Mine and Rail Project (EPBC 2013/6885) (refer measures within *Species Management Plans. Carmichael Rail Project* (CRN 2019)).

3 Mitigation measure commonly applied across other projects as approved by the Commonwealth in central and southern Queensland e.g. *Santos Significant Species Management Plan – GFD Project* (Santos 2016), *Anya Significant Species Management Plans* (Shell 2017), *Species Management Plans - Carmichael Rail Project* (CRN 2019).

5.3 Significant Impact assessment

Potential flora and fauna impacts during construction, commissioning/reinstatement and operation have been assessed in accordance with the qualitative impact assessment methodology outlined in EIS Chapter 4: Assessment methodology.

Potential impacts to environmental values due to construction of the Project are summarised in Section 5.3.2 and have been assessed in Sections 5.3.3, 5.3.4 and 5.3.5. For the purposes of impact assessment, the maximum potential direct disturbance to each MNES (i.e. areas identified using the predictive habitat mapping) have been used. This mapping assumes the presence of species if habitat has been identified as being present (i.e. habitat has been used as a proxy for species presence). This represents an application of the precautionary approach and represents a highly conservative estimate of Project impacts. Given the highly conservative approach adopted, impacts identified represent the maximum potential impact and assumes a “worst-case” scenario in relation to the Project’s disturbance. The clearing extents identified during this assessment will be reduced during the subsequent Project stages following the primary approval phase.

The initial significance assessment is undertaken on the assumption that the design measures factored into the Project design (refer Section 5.2.1) have been implemented. The residual significance level of the potential impacts is reassessed taking into consideration the implementation of the proposed mitigation measures listed in Table 5.3. This has been split into consideration of the construction phase, the commissioning and reinstatement phase, and operations. Environmental offsets in response to significant residual impacts are discussed in Section 5.4.

5.3.1 Quantification of potential magnitude of direct impacts

Estimations of the potential magnitude of disturbance (i.e. clearing as a result of the Project) was undertaken for each MNES, using the total quantity of habitat as identified in Table 5.4. (i.e. combines the habitat categories to identify the maximum *potential habitat* loss). Note that the different habitat categories were considered in relation to the MNES significant impact criteria in Section 5.3.

The table also provides an estimate of the total extent of habitat within the MNES study area for each MNES and the percentage of this habitat being disturbed as a result of the Project.

Table 5.4 Estimation of potential magnitude of disturbance for each matter of national environmental significance for the Project

MNES	Total coverage of MNES potential habitat within the MNES study area (ha). Study area size = 12,422.24 ha	Total unmitigated potential impact area associated within the disturbance footprint (ha). Disturbance footprint size = 972.39 ha	Percentage (%) disturbance to MNES values within the MNES study area based on the unmitigated potential disturbance	Magnitude of disturbance
Threatened ecological communities (EPBC Act)				
Swamp Tea-tree (*Melaleuca irbyana*) Forest of Southeast Queensland TEC	641.57	30.45	4.75	Moderate
Threatened flora habitat * (EPBC Act):				
Hairy-joint grass (*Arthraxon hispidus*)	67.47	4.15	6.15	Moderate
Miniature moss-orchid (*Bulbophyllum globuliforme*)	6.29	0.00	0.00	Negligible
Boonah tuckeroo (*Cupaniopsis tomentella*)	6.29	0.00	0.00	Negligible
A green algae (*Lychnothamnus barbatus*)	113.45	6.90	6.09	Moderate

MNES	Total coverage of MNES potential habitat within the MNES study area (ha). Study area size = 12,422.24 ha	Total unmitigated potential impact area associated within the disturbance footprint (ha). Disturbance footprint size = 972.39 ha	Percentage (%) disturbance to MNES values within the MNES study area based on the unmitigated potential disturbance	Magnitude of disturbance
Lloyd's olive (*Notelaea lloydii*)	1,089.16	26.77	2.46	Moderate
Shiny-leaved condoo (*Planchonella eerwah*)	6.29	0.00	0.00	Negligible
Threatened fauna habitat * (EPBC Act):				
Regent honeyeater (*Anthochaera phrygia*)	924.90	11.43	1.24	Low
Australasian bittern (*Botaurus poiciloptilus*)	592.72	42.43	7.16	Moderate
Curlew sandpiper (*Calidris ferruginea*)	600.53	38.15	6.35	Moderate
Large-eared pied bat (*Chalinolobus dwyeri*)	89.30	2.89	3.23	Moderate
Spotted-tail quoll (*Dasyurus maculatus maculatus*)	1,927.68	76.36	3.96	Moderate
Collared delma (*Delma torquata*)	898.27	9.56	1.06	Low
Red goshawk (*Erythrotriorchis radiatus*)	1,968.90	79.05	4.01	Moderate
Painted honeyeater (*Grantiella picta*)	311.23	30.10	9.67	Moderate
Swift parrot (*Lathamus discolor*)	2,966.22	141.18	4.76	Moderate
Australian lungfish (*Neoceratodus forsteri*)	249.15	27.62	11.09	Moderate
Greater glider (*Petauroides volans volans*)	1,007.67	16.60	1.65	Low
Brush-tailed rock-wallaby (*Petrogale penicillata*)	0.024	0.00	0.00	Negligible
Koala (*Phascolarctos cinereus*)	7,613.98	598.48	7.86	Moderate
Long-nosed potoroo (*Potorous tridactylus tridactylus*)	865.37	9.56	1.10	Low
New Holland mouse (*Pseudomys novaehollandiae*)	880.47	9.56	1.09	Low
Grey-headed flying-fox (*Pteropus poliocephalus*)	3,084.70	143.89	4.66	Moderate
Australian painted snipe (*Rostratula australis*)	600.53	38.15	6.35	Moderate
Black-breasted button-quail (*Turnix melanogaster*)	4.19	0.00	0.00	Negligible

Table note:

* There is potential for each of the MNES value impacts to overlap spatially. As a result, addition of disturbance values presented in the above table would not represent a true reflection of the total disturbance footprint

5.3.2 Initial assessment of impacts and mitigation measures

Following the assessment of the sensitivity of MNES values, identification of the potential impacts to these values and the assessment of the magnitude of impact, an initial outline of the assessment of the impact of the Project on each MNES value was undertaken.

The magnitude of impacts presented in Table 5.4, takes into consideration direct impacts associated with the direct removal of habitat and also considers indirect impacts associated with air quality (refer EIS Chapter 12: Air Quality), surface water and hydrology (refer EIS Chapter 13: Surface Water and Hydrology), groundwater (refer EIS Chapter 14: Groundwater) and noise and vibration (refer EIS Chapter 15: Noise and Vibration). The initial assessment of potential impacts from the Project on MNES values is provided in the following section for TECs (refer Table 5.5), threatened flora (refer Table 5.6) and threatened fauna (refer Table 5.7). The assessments present an initial assessment significance of those impacts detailed in Section 5.1.2 considered appropriate to the MNES species or species groups assessed (i.e. application of mitigation measures already incorporated into the design), an outline of the mitigation measures detailed in Table 5.3 which are most appropriate to the species or species groups (further species-specific information is added where required), and an assessment of the reduction of impact following the application of the Project's mitigation measures (refer Table 5.3). The assessment provides a more targeted focus on those Project impacts most likely to affect individual MNES.

The initial assessment of impacts has taken a conservative approach and those MNES that returned an impact rating of Major, High, Moderate or Low are assessed using MNES Guidelines (refer Sections 5.3.3, 5.3.4 and 5.3.5).

Table 5.5 Initial impact assessment of the Project upon identified matters of national environmental significance – Threatened ecological communities

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 5.2.1		Application of proposed mitigation measures presented in Table 5.3 by "Environmental value impacted" and "Delivery phase" and inclusion of species-specific measures	Residual impact significance following the application of Project mitigation measures presented in Table 5.3[3]	
			Magnitude[1]	Significance		Magnitude	Significance
Swamp Tea-tree (*Melaleuca irbyana*) Forest of Southeast Queensland TEC							
High	Pre-construction and construction	Habitat loss from vegetation clearing/removal Reduction in biological viability of soil to support plant growth due to soil compaction Displacement of flora and fauna species from invasion of weed and pest species Edge effects Dust impacts Aquatic habitat degradation Erosion and sedimentation	Moderate	Major	▪ MNES (detailed design), flora and fauna (pre-construction, construction and commissioning) ▪ Flora (detailed design, construction and commissioning) ▪ Weeds and pests (pre-construction, construction and commissioning) ▪ Erosion and sediment control (pre-construction, construction and commissioning) ▪ Landscape, rehabilitation and stabilisation (pre-construction, construction and commissioning) ▪ Riparian vegetation and aquatic habitats (detailed design, construction and commissioning) **TEC-specific:** Undertake a baseline assessment to determine the health and condition of the community to inform offsets and quantify impacts during construction and potentially operations Work with the design team to minimise the direct impact on Swamp Tea-tree (*Melaleuca irbyana*) Forest of South-east Queensland communities. This includes ensuring that communities (remnant and regrowth) identified within the construction disturbance footprint are avoided (e.g. Lots 3 and 4 on RP178669 contain approximately 7 ha of TEC, with these lots identified as a potential laydown area), siting access roads to avoid and minimise impacts in the Warrill Creek area and ensuring that changes to the predicted hydrology outcomes consider this TEC.	Low	High (refer to Section 5.3.3 for assessment against MNES Impact guidelines)

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 5.2.1		Application of proposed mitigation measures presented in Table 5.3 by "Environmental value impacted" and "Delivery phase" and inclusion of species-specific measures	Residual impact significance following the application of Project mitigation measures presented in Table 5.3[3]	
			Magnitude[1]	Significance		Magnitude	Significance
					Continue to refine Project design in response to hydraulic modelling outcomes to demonstrate continued compliance with the design objectives of the Project including maintaining inundation regimes within the Swamp Tea-tree (*Melaleuca irbyana*) Forest of South-east Queensland TEC as close to natural conditions as possible. The CEMP Biosecurity Management Plan will consider relevant guidelines to control potential deleterious pathogens including *Phytophthora cinnamomi* and Myrtle rust (e.g. DotE 2015b) associated with Project activities both of which may impact *Melaleuca* species. Develop Air Quality Management Sub-plan (refer EIS Chapter 12: Air Quality) and will include measures to minimise dust impacts including dust monitoring and suppression methods. Continue to refine Project design in response to hydraulic modelling outcomes to demonstrate continued compliance with the design objectives of the Project including maintaining inundation regimes within the TEC as close to natural conditions as possible.		
	Commissioning and reinstatement	Displacement of flora and fauna species from invasion of weed and pest species Erosion and sedimentation	Low	Moderate	▪ Weeds and pests (pre-construction, construction and commissioning) ▪ Erosion and sediment control (pre-construction, construction and commissioning) ▪ Landscape, rehabilitation and stabilisation (pre-construction, construction and commissioning) ▪ Flora (detailed design, construction and commissioning) In accordance with the MNES Monitoring Plan, regular monitoring and maintenance of erosion and sediment devices/infrastructure with specific reference/controls to identified TEC areas.	Negligible	Low

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 5.2.1		Application of proposed mitigation measures presented in Table 5.3 by "Environmental value impacted" and "Delivery phase" and inclusion of species-specific measures	Residual impact significance following the application of Project mitigation measures presented in Table 5.3[3]	
			Magnitude[1]	Significance		Magnitude	Significance
					TEC-specific: Monitoring of Swamp tea-tree TEC against relevant key performance criteria in the MNES Monitoring Plan. Potential criteria may include level of dieback and recruitment, dust deposition on leaves, changes to the local hydrology through observations of soil moisture with these criteria to be determined in consultation with relevant specialist. Corrective actions to be implemented if Project-associated impacts are identified.		
	Operation	Displacement of flora and fauna species from invasion of weed and pest species Erosion and sedimentation	Negligible	Low	Weeds and pests (operation).	Negligible	Low

Table notes:

1 Refer Table 3.8 for 'sensitivity' and 'magnitude' criteria.

2 Potential impacts to MNES in the above table are based upon those presented in Section 5.1.

3 The use of offsets has not been considered as a mitigation measure for the purposes of Project mitigation for the assessment of potential impacts. Refer EIS Appendix J: Terrestrial and Aquatic Ecology Technical Report for information relating to the use of offset to compensate Project related impacts that are not sufficiently reduced in the above table.

Table 5.6 Initial impact assessment of the Project upon identified matters of national environmental significance – threatened flora

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 5.2.1		Application of proposed mitigation measures presented in Table 5.3 and inclusion of species-specific measures	Residual impact significance following the application of Project mitigation measures presented in Table 5.3[3]	
			Magnitude[1]	Significance		Magnitude	Significance
Lychnothamnus barbatus							
High	Pre-construction and construction	Habitat loss from temporary waterway impoundment Displacement of flora species from invasion of weed and pest species Dust impacts Aquatic habitat degradation Erosion and sedimentation	High	Major	▪ MNES (detailed design), flora and fauna (pre-construction, construction and commissioning) ▪ Flora (detailed design, construction and commissioning) ▪ Weeds and pests (pre-construction, construction and commissioning) ▪ Erosion and sediment control (pre-construction, construction and commissioning) ▪ Riparian vegetation and aquatic habitats (detailed design, construction and commissioning) **Species-specific:** Pre-construction surveys of waterways identified as *potential habitat* of species (e.g. Warrill Creek, refer Appendix G) to identify whether species occurs within the Project disturbance footprint Where found quantification of the area of threatened flora species removed to enable the Environmental Offsets Delivery Strategy - Qld to be refined Undertake aquatic and riparian weed assessment of Warrill Creek. Develop Air Quality Sub-plan (refer EIS Chapter 12: Air Quality) and will include measures to minimise dust impacts including dust monitoring and suppression methods. Develop Surface Water Sub-plan (refer EIS Chapter 13: Surface Water and Hydrology) and implement prior to construction.	Moderate	High (refer to Section 5.3.4.1 for assessment against MNES Guidelines)
	Commissioning and reinstatement	Displacement of flora species from invasion of weed and pest species	Low	Moderate	▪ Weeds and pests (pre-construction, construction and commissioning) ▪ Erosion and sediment control (pre-construction, construction and commissioning)	Negligible	Low

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 5.2.1		Application of proposed mitigation measures presented in Table 5.3 and inclusion of species-specific measures	Residual impact significance following the application of Project mitigation measures presented in Table 5.3[3]	
			Magnitude[1]	Significance		Magnitude	Significance
		Erosion and sedimentation			▪ Landscape, rehabilitation and stabilisation (pre-construction, construction and commissioning) ▪ Riparian vegetation and aquatic habitats (detailed design, construction and commissioning) In accordance with the MNES Monitoring Plan, regular monitoring and maintenance of erosion and sediment devices/infrastructure with specific reference/controls to identified MNES areas. **Species-specific:** Monitoring of previously identified *Lychnothamnus barbatus* habitat in accordance with the MNES Monitoring Plan. Corrective actions to be implemented where Project-associated impacts are identified.		
	Operation	Erosion and sedimentation	Low	Moderate	Weeds and pests (operation).	Negligible	Low
Hairy-joint grass (*Arthraxon hispidus*) and Lloyd's olive (*Notelaea lloydii*)							
High	Pre-construction and construction	Habitat loss from vegetation clearing/removal Reduction in biological viability of soil to support plant growth due to soil compaction Displacement of flora species from invasion of weed species Edge effects Dust impacts Erosion and sedimentation	High	Major	▪ MNES (detailed design), flora and fauna (pre-construction, construction and commissioning) ▪ Flora (detailed design, construction and commissioning) ▪ Landscape, rehabilitation and stabilisation (pre-construction, construction and commissioning) ▪ Erosion and sediment control (pre-construction, construction and commissioning) ▪ Weeds and pests (pre-construction, construction and commissioning)	Moderate	High (refer to Section 5.3.4 for assessment against MNES Guidelines)

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 5.2.1		Application of proposed mitigation measures presented in Table 5.3 and inclusion of species-specific measures	Residual impact significance following the application of Project mitigation measures presented in Table 5.3[3]	
			Magnitude[1]	Significance		Magnitude	Significance
					Species-specific: Pre-construction protected flora surveys as per DES guidelines (2020f) to place particular focus within Teviot Range identified as habitat for Lloyd's olive (refer species habitat mapping in Appendix G). This includes assessing the condition and health of the population above the tunnel prior to construction and monitoring the population during construction to determine if any changes to the population occur as a result of the Project or due to natural attrition. Potential criteria may include recruitment and presence of fertile material, plus signs of water stress Avoid works above the tunnel as this area is known to support an important population of Lloyd's olive Where a new population is detected and impacts from the Project are likely specific measures will be developed in consultation with relevant specialists, the project team and the construction team. Develop Air Quality Sub-plan (refer EIS Chapter 12: Air Quality) and will include measures to minimise dust impacts including dust monitoring and suppression methods.		
	Commissioning and reinstatement	Displacement of flora species from invasion of weed species Edge effects Erosion and sedimentation	Negligible	Low	▪ Flora and fauna (detailed design, pre-construction, construction and commissioning) ▪ Flora (detailed design, construction and commissioning) ▪ Weeds and pests (pre-construction, construction and commissioning) ▪ Landscape, rehabilitation and stabilisation (pre-construction, construction and commissioning) ▪ Erosion and sediment control (pre-construction, construction and commissioning) In accordance with the MNES Monitoring Plan, undertake regular monitoring and maintenance of erosion and sediment devices/infrastructure to identified threatened flora habitat areas.	Negligible	Low

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 5.2.1		Application of proposed mitigation measures presented in Table 5.3 and inclusion of species-specific measures	Residual impact significance following the application of Project mitigation measures presented in Table 5.3[3]	
			Magnitude[1]	Significance		Magnitude	Significance
					Species-specific: Weed monitoring within identified Hairy-joint grass (*Arthraxon hispidus*) and Lloyd's olive (*Notelaea lloydii*) habitat in accordance with the MNES Monitoring Plan, with required control protocols in place where weed invasion is identified. Annual monitoring of previously identified Hairy-joint grass (*Arthraxon hispidus*) and Lloyd's olive (*Notelaea lloydii*) habitat in accordance with the MNES Monitoring Plan. Corrective actions to be implemented where Project-associated impacts are identified.		
	Operation	Displacement of flora species from invasion of weed and pest species Erosion and sedimentation	Negligible	Low	Ongoing monitoring of the population of Lloyd’s olive in accordance with the MNES Monitoring Plan. Corrective actions to be implemented where Project-associated impacts are identified.	Negligible	Low
Miniature moss-orchid (*Bulbophyllum globuliforme*), Boonah tuckeroo (*Cupaniopsis tomentella*) and Shiny-leaved condoo (*Planchonella eerwah*)							
High	Pre-construction and construction	Habitat loss from vegetation clearing/removal Reduction in biological viability of soil to support plant growth due to soil compaction Displacement of flora species from invasion of weed species Edge effects Dust impacts Erosion and sedimentation	Low	Moderate	▪ Flora and fauna (detailed design, pre-construction, construction and commissioning) ▪ Flora (detailed design, construction and commissioning) ▪ Erosion and sediment control (pre-construction, construction and commissioning) ▪ Weeds and pests (pre-construction, construction and commissioning) ▪ Landscape, rehabilitation and stabilisation (pre-construction, construction and commissioning) **Species-specific:** Pre-construction protected flora surveys as per DES guidelines (2020f) targeting the relic rainforest and other potential habitat within and adjacent the Project disturbance footprint. This includes areas of Woollaman Creek and dense vegetation within the gullies of Teviot (refer species habitat mapping in Appendix G).	Negligible	Low (refer to Section 5.3.4 for assessment against MNES Guidelines)

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 5.2.1		Application of proposed mitigation measures presented in Table 5.3 and inclusion of species-specific measures	Residual impact significance following the application of Project mitigation measures presented in Table 5.3[3]	
			Magnitude[1]	Significance		Magnitude	Significance
					Where a species is detected specific measures will be developed in consultation with relevant specialists, the project team and the construction team (e.g. micrositing to avoid population or minimise impacts, ensuring ancillary works avoid these areas, collection of seed and other fertile material) Develop Air Quality Sub-plan (refer EIS Chapter 12: Air Quality) and will include measures to minimise dust impacts including dust monitoring and suppression methods.		
	Commissioning and reinstatement	Displacement of flora species from invasion of weed species Edge effects Erosion and sedimentation	Negligible	Low	■ Flora and fauna (detailed design, pre-construction, construction and commissioning) ■ Flora (detailed design, construction and commissioning) ■ Weeds and pests (pre-construction, construction and commissioning) ■ Landscape, rehabilitation and stabilisation (pre-construction, construction and commissioning) ■ Erosion and sediment control (pre-construction, construction and commissioning) In accordance with the MNES monitoring plan, undertake regular monitoring and maintenance of erosion and sediment devices/infrastructure to identified threatened flora habitat areas. **Species-specific:** Weed monitoring within identified Miniature moss-orchid (*Bulbophyllum globuliforme*), Boonah tuckeroo (*Cupaniopsis tomentella*) and Shiny-leaved condoo (*Planchonella eerwah*) habitat in accordance with the MNES monitoring plan with required control protocols in place where weed invasion is identified.	Negligible	Low

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 5.2.1		Application of proposed mitigation measures presented in Table 5.3 and inclusion of species-specific measures	Residual impact significance following the application of Project mitigation measures presented in Table 5.3[3]	
			Magnitude[1]	Significance		Magnitude	Significance
					Annual monitoring of previously identified Miniature moss-orchid (*Bulbophyllum globuliforme*), Boonah tuckeroo (*Cupaniopsis tomentella*) and Shiny-leaved condoo (*Planchonella eerwah*) habitat in accordance with the MNES monitoring plan. Corrective actions to be implemented where Project-associated impacts are identified.		
	Operation	Displacement of flora species from invasion of weed and pest species Erosion and sedimentation	Negligible	Low	Weeds and pests (operation)	Negligible	Low

Table notes:

1 Refer Table 3.8 for 'sensitivity' and 'magnitude' criteria.
2 Potential impacts to MNES in the above table are based upon those presented in Section 5.1.
3 The use of offsets has not been considered as a mitigation measure for the purposes of Project mitigation for the assessment of potential impacts. Refer EIS Appendix J: Terrestrial and Aquatic Ecology Technical Report for information relating to the use of offset to compensate Project related impacts that are not sufficiently reduced in the above table.

Table 5.7 Initial impact assessment of the Project upon identified matters of national environmental significance – threatened fauna

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 5.2.1		Application of proposed mitigation measures presented in Table 5.3 and inclusion of species-specific measures	Residual impact significance following the application of Project mitigation measures presented in Table 5.3[3]	
			Magnitude[1]	Significance		Magnitude	Significance
Australian lungfish							
High	Pre-construction and construction	Habitat loss from temporary waterway impoundment Displacement of fauna species from invasion of weed and pest species Barrier effects Dust impacts Aquatic habitat degradation Erosion and sedimentation	High	Major	▪ Flora and fauna (detailed design, pre-construction, construction and commissioning) ▪ Weeds and pests (pre-construction, construction and commissioning) ▪ Erosion and sediment control (pre-construction, construction and commissioning) ▪ Landscape, rehabilitation and stabilisation (pre-construction, construction and commissioning) ▪ Riparian vegetation and aquatic habitats (detailed design, construction and commissioning) ▪ Aquatic fauna (detailed design, construction and commissioning) ▪ Fauna passage (detailed design, construction and commissioning) **Species-specific:** Pre-construction surveys of waterways identified as potential habitat of species (e.g. Bremer River) to identify whether Australian lungfish occurs. Surveys will follow the *Survey guidelines for Australia's threatened fish* (DSEWPaC 2011c). Avoid clearing within and along major watercourses, in particular Bremer River and Teviot Brook, through the use of bridge structures and the placement of pylons away from bed and banks Where a temporary impoundment or diversion is required for construction purposes and the species is found to be present, an appropriately qualified person will be consulted to make an assessment on the method of recovery, transport and release of fish and will follow relevant State (DAF) fish salvage guidelines during construction activities.	Moderate	High (refer to Section 5.3.5.3 for assessment against MNES Impact guidelines)

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 5.2.1		Application of proposed mitigation measures presented in Table 5.3 and inclusion of species-specific measures	Residual impact significance following the application of Project mitigation measures presented in Table 5.3[3]	
			Magnitude[1]	Significance		Magnitude	Significance
					Dewatering and fish salvage activities to include measures to manage the risk of translocating non-endemic flora and fauna (i.e. Biosecurity Management Sub-Plan) Maintain low flows during drought conditions and avoid fluctuations to water levels downstream during spawning period (i.e. Bremer River) Develop Air Quality Sub-plan (refer EIS Chapter 12: Air Quality) and will include measures to minimise dust impacts including dust monitoring and suppression methods. Though final Project design changes to hydrological conditions in the area are expected to be minor at worst, localised and transient (during flood events) and are unlikely to impact *potential habitat* for the Australian lungfish. Surface Water Sub-plan developed and in place prior to construction. The Sub-plan will be developed to include measures to maintain low flows during drought conditions and avoid fluctuations to water levels downstream during spawning period (i.e. Bremer River). To include at a minimum: ▪ Watercourse-specific water quality criteria based on baseline data ▪ A surface water quality sampling monitoring detailing water quality parameters and schedule ▪ Response framework where water quality impacts identified from Project activities.		

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 5.2.1		Application of proposed mitigation measures presented in Table 5.3 and inclusion of species-specific measures	Residual impact significance following the application of Project mitigation measures presented in Table 5.3[3]	
			Magnitude[1]	Significance		Magnitude	Significance
	Commissioning and reinstatement	Displacement of fauna species from invasion of weed and pest species Aquatic habitat degradation Erosion and sedimentation	Low	Moderate	■ Flora and fauna (detailed design, pre-construction, construction and commissioning) ■ Weeds and pests (pre-construction, construction and commissioning) ■ Riparian vegetation and aquatic habitats (detailed design, construction and commissioning) ■ Fauna passage (detailed design, construction and commissioning) ■ Aquatic fauna (detailed design, construction and commissioning) ■ Erosion and sediment control (pre-construction, construction and commissioning) ■ Landscape, rehabilitation and stabilisation (pre-construction, construction and commissioning) **Species-specific:** Where possible, instream habitat will be reinstated to pre-construction state (e.g. replacement of large woody debris and ensure no or limited change to instream flows and allow fish passage). Surface Water Sub-plan monitoring and evaluation ongoing. Continued aquatic weed monitoring within waterways with required control protocols in place where weed invasion is identified.	Negligible	Low
	Operation	Erosion and sedimentation	Negligible	Low	■ Weeds and pests (operation) ■ Fauna passage (operation) including ongoing maintenance of fish passage structures ■ Riparian vegetation and aquatic habitats (operation)	Negligible	Low

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 5.2.1		Application of proposed mitigation measures presented in Table 5.3 and inclusion of species-specific measures	Residual impact significance following the application of Project mitigation measures presented in Table 5.3[3]	
			Magnitude[1]	Significance		Magnitude	Significance
Wetland birds: Australian painted snipe, Australasian bittern and Curlew sandpiper							
High	Pre-construction and construction	Habitat loss from vegetation clearing/removal Fauna species injury or mortality Displacement of fauna species from invasion of weed and pest species Edge effects Noise, dust, and light impacts Aquatic habitat degradation Erosion and sedimentation	Moderate	High	▪ Flora and fauna (detailed design, pre-construction, construction and commissioning) ▪ Weeds and pests (pre-construction, construction and commissioning) ▪ Fauna fencing (detailed design, construction and commissioning) ▪ Riparian vegetation and aquatic habitats (detailed design, construction and commissioning) ▪ Aquatic fauna (detailed design, construction and commissioning) ▪ Erosion and sediment control (pre-construction, construction and commissioning) ▪ Landscape, rehabilitation and stabilisation (pre-construction, construction and commissioning) **Species-specific:** Flora and Fauna Sub-plan to include pre-construction surveys of wetlands identified as potential habitat of species to identify whether habitat and/or any of these species occurs. Surveys will follow the *Survey guidelines for Australia's threatened birds* (DEWHA 2010b). Restricted works/avoidance measures in place should nesting of Australian painted snipe or Australasian bittern be detected. Though final Project design changes to hydrological conditions in the area are expected to be minor at worst, localised and transient (during flood events) and are unlikely to impact *potential habitat* for the Australian painted snipe, Curlew sandpiper and Australasian bittern. A Surface Water Sub-plan will be developed and in place prior to construction, including as a minimum: ▪ Wetland and watercourse-specific water quality criteria based on baseline data	Low	Moderate (refer to Section 5.3.5 for assessment against MNES Guidelines)

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 5.2.1		Application of proposed mitigation measures presented in Table 5.3 and inclusion of species-specific measures	Residual impact significance following the application of Project mitigation measures presented in Table 5.3[3]	
			Magnitude[1]	Significance		Magnitude	Significance
					▪ A surface water quality sampling monitoring detailing water quality parameters and schedule ▪ Response framework where water quality impacts identified from Project activities. ▪ Project lighting is constructed in accordance with Project design. Clearing/construction works in potential habitat areas will be timed where possible to avoid wet conditions where habitat is likely to be most suitable. Project CEMP to include measures to minimise noise as much as feasible and Air Quality Sub-plan will include measures to minimise dust impacts including dust monitoring and suppression methods. The CEMP biosecurity management plan will include site hygiene and waste management measures to ensure pest predator fauna are not attracted to works areas or utilising Project disturbance footprint. Should the wetland species be found to occur Plan to include the following for further pre-clearance activities: ▪ Engagement of a qualified fauna spotter/ecologist for further pre-clearance surveys and measures to ensure safe movement of species away from works area should the species still be found to occur ▪ Restricted works/avoidance measures in place should nesting of Australian painted snipe or Australasian bittern be detected.		
	Commissioning and reinstatement	Displacement of fauna species from invasion of weed and pest species Edge effects Noise, dust, and light impacts	Low	Moderate	▪ Flora and fauna (detailed design, pre-construction, construction and commissioning) ▪ Weeds and pests (pre-construction, construction and commissioning) ▪ Riparian vegetation and aquatic habitats (detailed design, construction and commissioning) ▪ Aquatic fauna (detailed design, construction and commissioning)	Negligible	Low

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 5.2.1		Application of proposed mitigation measures presented in Table 5.3 and inclusion of species-specific measures	Residual impact significance following the application of Project mitigation measures presented in Table 5.3[3]	
			Magnitude[1]	Significance		Magnitude	Significance
		Aquatic habitat degradation Erosion and sedimentation			▪ Erosion and sediment control (pre-construction, construction and commissioning) ▪ Landscape, rehabilitation and stabilisation (pre-construction, construction and commissioning) **Species-specific:** Continued aquatic/wetland weed monitoring within waterways with required control protocols in place where weed invasion is identified Continued monitoring in accordance with the Biosecurity Management Plan to ensure pest predator fauna are not utilising Project infrastructure for shelter. Continue implementation of Noise and Air Quality Sub-plan measures. Project lighting constructed and operated in accordance with the Project design. Rehabilitate of temporary construction areas including riparian habitat, in accordance with the Reinstatement and Rehabilitation Plan. Continue the implementation of the Surface Water Sub-plan. Ongoing annual weed monitoring within wetland habitat in vicinity in accordance with the MNES Monitoring Plan, with required control protocols in place where weed invasion is identified In accordance with the MNES Monitoring Plan, undertake regular monitoring and maintenance of erosion and sediment devices/infrastructure associated with all waterways.		
	Operation	Displacement of fauna species from invasion of weed and pest species Light impacts Erosion and sedimentation	Negligible	Low	Weeds and pests (operation) **Species-specific:** Project lighting operated in accordance with the Project design.	Negligible	Low

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 5.2.1		Application of proposed mitigation measures presented in Table 5.3 and inclusion of species-specific measures	Residual impact significance following the application of Project mitigation measures presented in Table 5.3[3]	
			Magnitude[1]	Significance		Magnitude	Significance
Koala and Greater glider							
High	Pre-construction and construction	Habitat loss from vegetation clearing/removal Fauna species injury or mortality Displacement of fauna species from invasion of weed and pest species Reduction in the connectivity of biodiversity corridors Habitat fragmentation Barrier effects Noise, dust, and light impacts	High	Major	▪ Flora and fauna (detailed design, pre-construction, construction and commissioning) ▪ Weeds and pests (pre-construction, construction and commissioning) ▪ Fauna passage (detailed design, construction and commissioning) ▪ Fauna fencing (detailed design, construction and commissioning) **Species-specific:** Pre-construction surveys of woodlands identified as *potential habitat* of species (refer species habitat mapping in Appendix G) to identify whether individuals occur within disturbance footprint. Measures to ensure safe retrieval of tree hollows during vegetation clearing and allow safe movement of species away from works area Vegetation clearing within the disturbance footprint in Koala habitat will be carried out in a manner to minimise stress on potential individuals as much as is practicably possible (e.g. sequential clearing and minimising time of disturbance to animals). Measures to allow safe handling of fauna (where required) and repatriation in suitable habitat away from site Koalas subject to handling will be examined and if suspected of Chlamydia infection will be taken to a predesignated veterinarian/wildlife care facility for treatment prior to release. A procedure will be developed to guide koala interactions, including any translocations. Appropriate construction traffic speed limits will be established and managed to minimise vehicle strike risk.	Moderate	High (refer to Sections 5.3.4 and 5.3.5 for assessment against MNES Guidelines)

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 5.2.1		Application of proposed mitigation measures presented in Table 5.3 and inclusion of species-specific measures	Residual impact significance following the application of Project mitigation measures presented in Table 5.3[3]	
			Magnitude[1]	Significance		Magnitude	Significance
					Biosecurity Management Plan will consider relevant guidelines to control potential deleterious pathogens including *Phytophthora cinnamomi* and Myrtle rust (e.g. DotE 2015b) associated with Project activities both of which may impact eucalypt species. Project design to incorporate fauna crossing structures to allow fauna movement across alignment. The location and frequency of the passages will be based on an understanding of local Koala and Greater glider movements and in consultation with relevant stakeholders (e.g. DTMR and local councils). Fauna and fencing in accordance with ARTC guidelines and DTMR's Fauna Sensitive Road Design Manual (DTMR 2010). Fencing extent will be determined by the availability of suitable habitat adjacent to alignment. Also, where possible, avoid the use of barb wire particularly on the top strand, to prevent threatened species (particularly Greater glider, flying-foxes and microbats) from becoming entangled. Fauna friendly fencing must be used, whilst being in accordance with landowner and/or structural requirements. Viaducts and the bridge structures will assist in the retention of corridor(s) of at least 100 m width. While the tunnel will ensure a corridor over 1 km wide is maintained through the Teviot Range. Project CEMP to include measures to minimise noise as much as feasible and Air Quality Sub-plan will include measures to minimise dust impacts including dust monitoring and suppression methods. Project design to incorporate minimum lighting requirements feasible for Project safety Project lighting is constructed in accordance with Project lighting design.		

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 5.2.1		Application of proposed mitigation measures presented in Table 5.3 and inclusion of species-specific measures	Residual impact significance following the application of Project mitigation measures presented in Table 5.3[3]	
			Magnitude[1]	**Significance**		**Magnitude**	**Significance**
	Commissioning and reinstatement	Fauna species injury or mortality Displacement of fauna species from invasion of weed and pest species Reduction in the connectivity of biodiversity corridors Habitat fragmentation Barrier effects Noise, dust, and light impacts	Low	Moderate	▪ Flora and fauna (detailed design, pre-construction, construction and commissioning) ▪ Weeds and pests (pre-construction, construction and commissioning) ▪ Fauna passage (detailed design, construction and commissioning) ▪ Fauna fencing (detailed design, construction and commissioning) ▪ Landscape, rehabilitation and stabilisation (pre-construction, construction and commissioning) **Species-specific:** Appropriate construction traffic speed limits will be established and managed to minimise vehicle strike risk. CEMP to include fauna management and incident register. Fauna crossing structures and fencing in place and completed. Continue to implement the Noise and Air Quality Sub-plan measures. Project lighting constructed and operated in accordance with the Project design. Rehabilitation of temporary construction areas where woodland habitat has been cleared in accordance with the Reinstatement and Rehabilitation Plan. Fauna crossing structures and fencing in place and monitoring of effectiveness of structures for fauna passage carried out for at least two consecutive years within two years of Project completion.	Negligible	Low

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 5.2.1		Application of proposed mitigation measures presented in Table 5.3 and inclusion of species-specific measures	Residual impact significance following the application of Project mitigation measures presented in Table 5.3[3]	
			Magnitude[1]	Significance		Magnitude	Significance
	Operation	Fauna species injury or mortality Displacement of fauna species from invasion of weed and pest species Reduction in the connectivity of biodiversity corridors Habitat fragmentation Barrier effects Light impacts	Negligible	Low	▪ Fauna fencing (operation) ▪ Fauna passage (operation) ▪ Weeds and pests (operation) **Species-specific:** Fauna management and incident register including observed collisions associated with rail operations Information on collisions used to inform potential for further measures to be applied to minimise/eliminate incidents. Record vehicle strikes with Koalas and Greater gliders and investigate potential source of the issue Where applicable implement corrective measures (e.g. erect fauna friendly fencing, glider poles etc) Fauna fencing (operation) including ongoing maintenance of fauna passages and fencing during the operational life of the Project (i.e. 100 years) Project lighting operated in accordance with Project design.	Negligible	Low
New Holland mouse							
High	Pre-construction and construction	Habitat loss from vegetation clearing/removal Fauna species injury or mortality Displacement of fauna species from invasion of weed and pest species Reduction in the connectivity of biodiversity corridors Habitat fragmentation Barrier effects	Moderate	High	▪ Flora and fauna (detailed design, pre-construction, construction and commissioning) ▪ Weeds and pests (pre-construction, construction and commissioning) ▪ Fauna fencing (detailed design, construction and commissioning) ▪ Fauna passage (detailed design, construction and commissioning)	Low	Moderate (refer to Section 5.3.5 for assessment against MNES Guidelines)

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 5.2.1		Application of proposed mitigation measures presented in Table 5.3 and inclusion of species-specific measures	Residual impact significance following the application of Project mitigation measures presented in Table 5.3[3]	
			Magnitude[1]	Significance		Magnitude	Significance
		Noise, dust, and light impacts			**Species-specific:** Pre-construction survey of species-specific habitat (refer species habitat mapping in Appendix G) and habitat features considered suitable for species presence (e.g. well developed ground/shrub layer). Within the disturbance footprint the Teviot Range may provide habitat for the New Holland mouse. Targeted surveys as per relevant QLD guidelines (Eyre et al 2018) where suitable habitat is identified (noted New Holland mouse is not included in MNES guidelines). Pre-construction weed and *Phytophthora cinnamomi* assessment of *potential habitat* of New Holland mouse Project design to incorporate fauna crossing structures to allow fauna movement across alignment. Fauna passage and fauna-proof fencing design will be used to guide fauna to crossing structures. Fauna crossings will be consistent with the intent of DTMR's Fauna Sensitive Road Design Manual (DTMR 2010) and where applicable species-specific requirements. Fencing extent will be determined by the availability of suitable habitat adjacent to alignment. Project CEMP to include measures to minimise noise as much as feasible and Air Quality Sub-plan will include measures to minimise dust impacts including dust monitoring and suppression methods. Project design to incorporate minimum lighting requirements feasible for Project safety. Project lighting constructed in accordance with Project design.		
	Commissioning and reinstatement	Fauna species injury or mortality Displacement of fauna species from invasion of weed and pest species	Low	Moderate	▪ Flora and fauna (detailed design, pre-construction, construction and commissioning) ▪ Weeds and pests (pre-construction, construction and commissioning) ▪ Fauna passage (detailed design, construction and commissioning)	Negligible	Low

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 5.2.1		Application of proposed mitigation measures presented in Table 5.3 and inclusion of species-specific measures	Residual impact significance following the application of Project mitigation measures presented in Table 5.3[3]	
			Magnitude[1]	Significance		Magnitude	Significance
		Reduction in the connectivity of biodiversity corridors Habitat fragmentation Barrier effects Noise, dust, and light impacts			▪ Fauna fencing (detailed design, construction and commissioning) ▪ Landscape, rehabilitation and stabilisation (pre-construction, construction and commissioning) **Species-specific:** Measures to control vehicle speed limits onsite to no more than 40 km/hr Continued weed and *Phytophthora cinnamomi* monitoring and with required control protocols in place where weed invasion is identified. Fauna crossing structures and fencing in place and completed. Noise and Air Quality Sub-plan measures ongoing. Project lighting constructed and operated in accordance with Project design. Rehabilitation of temporary construction areas where woodland habitat has been cleared in accordance with the Reinstatement and Rehabilitation Plan. Revegetation species to be obtained from source certified free of *Phytophthora cinnamomi.* Fauna crossing structures and fencing in place and monitoring of effectiveness of structures for fauna passage carried out in accordance with the post-construction MNES Monitoring Plan.		

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 5.2.1		Application of proposed mitigation measures presented in Table 5.3 and inclusion of species-specific measures	Residual impact significance following the application of Project mitigation measures presented in Table 5.3[3]	
			Magnitude[1]	Significance		Magnitude	Significance
	Operation	Fauna species injury or mortality Displacement of fauna species from invasion of weed and pest species Reduction in the connectivity of biodiversity corridors Habitat fragmentation Barrier effects Light impacts	Low	Moderate	Fauna fencing (operation) including ongoing maintenance of fauna passages and fencing during the operational life of the Project (i.e. 100 years) Weeds and pests (operation) Project lighting operated in accordance with Project design.	Negligible	Low
Spotted-tail quoll, Brush-tailed rock-wallaby, Collared delma and Large-eared pied bat							
High	Pre-construction and construction	Habitat loss from vegetation clearing/removal Fauna species injury or mortality Displacement of fauna species from invasion of weed and pest species Reduction in the connectivity of biodiversity corridors Habitat fragmentation Barrier effects Noise, dust, and light impacts	High	Major	▪ Flora and fauna (detailed design, pre-construction, construction and commissioning) ▪ Weeds and pests (pre-construction, construction and commissioning) ▪ Fauna passage (detailed design, construction and commissioning) ▪ Fauna fencing (detailed design, construction and commissioning) **Species-specific:** Targeted surveys for identified mammal species will follow the *Survey guidelines for Australia's threatened mammals* (DSEWPaC 2011c) and include the identification of species-specific habitat (refer species habitat mapping in Appendix G) and habitat features considered suitable for species presence (e.g. cliff faces/boulder piles for Brush-tailed rock-wallaby, Large-eared pied bat and spotted-tail quoll)	Moderate	High (refer to Section 5.3.5 for assessment against MNES Guidelines)

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 5.2.1		Application of proposed mitigation measures presented in Table 5.3 and inclusion of species-specific measures	Residual impact significance following the application of Project mitigation measures presented in Table 5.3[3]	
			Magnitude[1]	Significance		Magnitude	Significance
					Targeted surveys for Collared delma as per *Survey guidelines for Australia's threatened reptiles* (DSEWPaC 2011e) where suitable habitat is identified refer species habitat mapping in Appendix G). Measures to ensure retrieval of potential habitat elements (e.g. loose surface rock, large fallen timber) during vegetation clearing and placement in adjacent unimpacted habitat Restricted works measures in place should larger species (Spotted-tail quoll and Brush-tailed rock-wallaby) be observed within or adjacent to disturbance footprint to allow safe movement away from works area Appropriate construction traffic speed limits will be established and managed to minimise vehicle strike risk. Project design to incorporate fauna crossing structures to allow fauna movement across alignment. Fauna passage and fauna fencing design will be used to guide fauna to crossing structures. Fauna crossings will be consistent with the intent of DTMR's Fauna Sensitive Road Design Manual (DTMR 2010) and where applicable species-specific requirements. Fencing extent will be determined by the availability of suitable habitat adjacent to alignment. As part of the MNES monitoring plan, establish camera traps above the tunnel areas to monitor fauna movement across this area during construction Project CEMP to include measures to minimise noise as much as feasible and Air Quality Sub-plan will include measures to minimise dust impacts including dust monitoring and suppression methods. Project design to incorporate minimum lighting requirements feasible for Project safety Project lighting constructed in accordance with Project design.		

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 5.2.1		Application of proposed mitigation measures presented in Table 5.3 and inclusion of species-specific measures	Residual impact significance following the application of Project mitigation measures presented in Table 5.3[3]	
			Magnitude[1]	Significance		Magnitude	Significance
	Commissioning and reinstatement	Fauna species injury or mortality Displacement of fauna species from invasion of weed and pest species Reduction in the connectivity of biodiversity corridors Habitat fragmentation Barrier effects Noise, dust, and light impacts	Low	Moderate	▪ Flora and fauna (detailed design, pre-construction, construction and commissioning) ▪ Weeds and pests (pre-construction, construction and commissioning) ▪ Fauna passage (detailed design, construction and commissioning) ▪ Fauna fencing (detailed design, construction and commissioning) ▪ Landscape, rehabilitation and stabilisation (pre-construction, construction and commissioning) **Species-specific:** Appropriate construction traffic speed limits will be established and managed to minimise vehicle strike risk. Fauna crossing structures and fencing in place and completed. Noise and Air Quality Sub-plan measures ongoing. Project lighting constructed and operated in accordance with Project design. Rehabilitation of temporary construction areas where woodland habitat has been cleared in accordance with the Reinstatement and Rehabilitation Plan. Fauna crossing structures and fencing in place and monitoring of effectiveness of structures for fauna passage carried out in accordance with the post-construction MNES Monitoring Plan.	Negligible	Low

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 5.2.1		Application of proposed mitigation measures presented in Table 5.3 and inclusion of species-specific measures	Residual impact significance following the application of Project mitigation measures presented in Table 5.3[3]	
			Magnitude[1]	Significance		Magnitude	Significance
	Operation	Fauna species injury or mortality Displacement of fauna species from invasion of weed and pest species Reduction in the connectivity of biodiversity corridors Habitat fragmentation Barrier effects Light impacts	Low	Moderate	Fauna fencing (operation) Weeds and pests (operation) **Species-specific:** Project lighting operated in accordance with Project design.	Negligible	Low
Grey-headed flying-fox							
High	Pre-construction and construction	Habitat loss from vegetation clearing/removal Fauna species injury or mortality Noise, dust, and light impacts Aquatic habitat degradation	High	Major	▪ Flora and fauna (detailed design, pre-construction, construction and commissioning) ▪ Weeds and pests (pre-construction, construction and commissioning) ▪ Riparian vegetation and aquatic habitats (detailed design, pre-construction, construction and commissioning) **Species-specific:** Pre-construction surveys to be undertaken of riparian habitat identified as potential roost sites of species to identify whether camps occur within or near the disturbance footprint. It is noted no roost sites have been previously identified within 5 km of the Project. Where possible, reduce the disturbance footprint in winter foraging, including avoiding clearing for ancillary works. Incorporate winter foraging species into the rehabilitation/ revegetation plans for the Project	Moderate	High (refer to Section 5.3.5 for assessment against MNES Guidelines)

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 5.2.1		Application of proposed mitigation measures presented in Table 5.3 and inclusion of species-specific measures	Residual impact significance following the application of Project mitigation measures presented in Table 5.3[3]	
			Magnitude[1]	Significance		Magnitude	Significance
					Work with the design team and property team to incorporate fencing which minimises the risk of entanglement (e.g. barbed wire fencing with a high tensile wire strand as the top wire). Should a roost site be found to occur management actions will incorporate the mitigation standards detailed in the Commonwealth's *Referral guideline for management actions in grey-headed and spectacled flying-fox camps* (DotE 2015a). Project CEMP to include measures to minimise noise as much as feasible and Air Quality Sub-plan will include measures to minimise dust impacts including dust monitoring and suppression methods. Project design to incorporate minimum lighting requirements feasible for Project safety. Project lighting constructed in accordance with Project design.		
	Commissioning and reinstatement	Noise, dust, and light impacts Aquatic habitat degradation	Negligible	Low	Riparian vegetation and aquatic habitats (operation) **Species-specific:** Project lighting constructed and operated in accordance with Project design. Noise and Air Quality Sub-plan measures ongoing	Negligible	Low
	Operation	Light impacts	Negligible	Low	**Species-specific:** Project lighting operated in accordance with Project design.	Negligible	Low
Woodland birds: Swift parrot, Painted honeyeater, Regent honeyeater and Red goshawk							
High	Pre-construction and construction	Habitat loss from vegetation clearing/removal Fauna species injury or mortality	High	Major	- Flora and fauna (detailed design, pre-construction, construction and commissioning) - Weeds and pests (pre-construction, construction and commissioning) - Riparian vegetation and aquatic habitats (detailed design, pre-construction, construction and commissioning)	Moderate	High (refer to Section 5.3.5 for assessment against MNES Guidelines)

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 5.2.1		Application of proposed mitigation measures presented in Table 5.3 and inclusion of species-specific measures	Residual impact significance following the application of Project mitigation measures presented in Table 5.3[3]	
			Magnitude[1]	Significance		Magnitude	Significance
		Displacement of fauna species from invasion of weed and pest species Noise, dust, and light impacts Aquatic habitat degradation			**Species-specific:** Where possible through design, reduce the disturbance footprint in winter foraging habitat, including avoiding clearing for ancillary works Project CEMP to include measures to minimise noise as much as feasible and Air Quality Sub-plan will include measures to minimise dust impacts including dust monitoring and suppression methods Surface Water Sub-plan developed and in place prior to construction. To include at a minimum: ▪ Wetland and watercourse-specific water quality criteria based on baseline data ▪ A surface water quality sampling monitoring detailing water quality parameters and schedule ▪ Response framework where water quality impacts identified from Project activities. Project design to incorporate minimum lighting requirements feasible for Project safety. Project lighting constructed in accordance with Project design. Three of these species are generalist nectivores which are nomadic, following flowering events. None of these species nest in the area. Red goshawk requires large areas of woodland habitat and is only likely to occur in the Teviot Range. Where possible, reduce the disturbance footprint in winter foraging, including avoiding clearing for ancillary works. Incorporate winter foraging species into the rehabilitation/ revegetation plans for the Project		

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 5.2.1		Application of proposed mitigation measures presented in Table 5.3 and inclusion of species-specific measures	Residual impact significance following the application of Project mitigation measures presented in Table 5.3[3]	
			Magnitude[1]	Significance		Magnitude	Significance
					The Flora and Fauna Sub-plan will detail pre-construction surveys of woodlands identified as *potential habitat* for Red goshawk (refer species habitat mapping in Appendix G) to identify whether individuals occur and potentially nest within the disturbance footprint. Surveys for nest sites within or near the disturbance footprint will be as per MNES guidelines where suitable nesting habitat (i.e. large emergent trees near water) is identified. ▪ Should an active Red goshawk nest site be identified the Plan will incorporate restricted works measures during construction to allow nesting to continue undisturbed as determined by pre-clearance surveys (e.g. micrositing of works to avoid nests or maximise separation distance, 100 m buffer and signage around nests, no disturbance to nests until after breeding season (being until fledglings / offspring no longer use the nest / roost for habitat. Some limited works may occur in the buffer zone during this period (e.g. cultural heritage surveys).		
	Commissioning and reinstatement	Displacement of fauna species from invasion of weed and pest species Noise, dust, and light impacts Aquatic habitat degradation	Low	Moderate	▪ Flora and fauna (detailed design, pre-construction, construction and commissioning) ▪ Weeds and pests (pre-construction, construction and commissioning) ▪ Riparian vegetation and aquatic habitats (detailed design, pre-construction, construction and commissioning) **Species-specific:** Noise and Air Quality Sub-plan measures ongoing. Rehabilitation of temporary construction areas where woodland habitat has been cleared. Project lighting to be constructed and operated in accordance with Project design. Surface Water Sub-plan monitoring and evaluation ongoing.	Negligible	Low

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (application of initial mitigation measures) presented in Section 5.2.1		Application of proposed mitigation measures presented in Table 5.3 and inclusion of species-specific measures	Residual impact significance following the application of Project mitigation measures presented in Table 5.3[3]	
			Magnitude[1]	Significance		Magnitude	Significance
					Continued monitoring to ensure pest predator fauna are not utilising Project infrastructure for shelter.		
	Operation	Displacement of fauna species from invasion of weed and pest species Noise and light impacts	Negligible	Low	Weeds and pests (operation) **Species-specific:** Project lighting operated in accordance with Project design. Continued opportunistic monitoring to ensure pest predator fauna are not utilising Project infrastructure for shelter.	Negligible	Low

Table notes:

1 Refer Table 3.8 for 'sensitivity' and 'magnitude' criteria.

2 Potential impacts to MNES in the above table are based upon those presented in Section 5.1.

3 The use of offsets has not been considered as a mitigation measure for the purposes of Project mitigation for the assessment of potential impacts. Refer EIS Appendix J: Terrestrial and Aquatic Ecology Technical Report for information relating to the use of offset to compensate Project related impacts that are not sufficiently reduced in the above table.

5.3.3 Significant residual impact assessment for threatened ecological communities

Of the five TECs identified from the desktop assessment, one has been confirmed as occurring within the MNES study area. This TEC consists of the following:

- Swamp Tea-tree (*Melaleuca irbyana*) Forest of South-east Queensland (refer Section 4.4.1.3)

Assessment of the significance of impact in accordance with the criteria contained within the MNES Guidelines has been undertaken for this TEC. In accordance with the guidelines, an action is likely to have a significant impact on a critically endangered or endangered ecological community if there is a real chance or possibility that it will:

- Reduce the extent of an ecological community
- Fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines
- Adversely affect habitat critical to the survival of an ecological community
- Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns
- Cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting
- Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to:
  - Assisting invasive species, that are harmful to the listed ecological community, to become established, or
  - Causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community
- Interfere with the recovery of an ecological community.

A range of mitigation measures have been proposed to ameliorate potential impacts to occurrences of TEC wherever possible (refer Section 5.2.2 and specific measures in Table 5.5). These include measures considered as effective in addressing the recognised threats for Swamp tea-tree TEC as recognised in the approved conservation advice, and DAWE-adopted threat abatement plans including but not restricted to:

- Continue to refine the extent of the TEC within the disturbance footprint in response to changes to the Project disturbance footprint and outcomes from ecological surveys. Provide these outcomes to relevant agencies to inform their mapping and understanding of this community
- The MNES Monitoring Plan will incorporate monitoring strategies including detailed pre-construction site surveys and operational monitoring to ensure degradation to adjacent occurrences of TEC can be identified and relevant corrective actions implemented
- Work with the design team to minimise the direct impact on Swamp Tea-tree (*Melaleuca irbyana*) Forest of South-east Queensland communities. This includes ensuring that communities (remnant and regrowth) identified within the construction disturbance footprint are avoided (e.g. Lots 3 and 4 on RP178669 contain approximately 7 ha of TEC, with these lots identified as a potential laydown area), siting access roads to avoid and minimise impacts in the Warrill Creek area and ensuring that changes to the predicted hydrology outcomes consider this TEC.
- Biosecurity Management Plan to protect flora habitats adjacent to the Project from deleterious impacts including weed invasion, pest fauna and invasion by introduced pathogens (such as Myrtle rust and *Phytophthora cinnamomi*)

- Erosion and Sediment Control Plan and Surface Water Sub-plan to protect water quality values associated with wetlands and waterways
- Air Quality Sub-plan includes measures to minimise dust impacts on vegetation/habitats including dust monitoring and suppression methods
- Reinstatement and Rehabilitation Plan to detail rehabilitation of temporary construction areas not required for Project operation.

The assessment of significant impacts on the identified MNES flora species from the Project is based on:

- Habitat modelling based on ecological surveys and TEC descriptions and threshold conditions (refer Section 4.4.1.3)
- The design and layout of the Project (refer Section 1.8)
- Information on potential impacts of Project during construction and operation (refer Section 5.1)
- Proposed Project mitigation measures (refer Section 5.2 and Table 5.5).

The Project is predicted to impact up to 30.45 ha of the Swamp tea-tree TEC. While the majority of the disturbance footprint has been surveyed it is acknowledged that further surveys are required in some areas which are currently mapped as comprising regrowth vegetation analogous to the TEC (refer Section 4.4.1.3). Assessment against the significant impact criteria for the Swamp Tea-tree (*Melaleuca irbyana*) Forest of South-east Queensland TEC is presented in Table 5.8.

Table 5.8 Assessment of the Swamp Tea-tree (*Melaleuca irbyana*) Forest of South-east Queensland TEC against the EPBC Act matters of national environmental significance significant impact criteria for Critically Endangered TECs

Significant impact criteria	Potential impact to the Swamp Tea-tree (*Melaleuca irbyana*) Forest of South-east Queensland TEC
Reduce the extent of an ecological community	**Yes** – Clearing is a major threat to this community, with the Project likely to result in the clearing of up to 30.45 ha. This includes patches such as those on Lots 3 and 4 on RP178669 and Lot 7 on RP198306 which contain approximately 7 ha of TEC, which are only likely to be impact by construction (i.e. laydown areas). Ancillary works on these parcels will aim to utilise already cleared sections of land and avoid the TEC.
Fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines	**Yes** – The Project is linear in nature and will cause further fragmentation to this TEC. That is, the Project will traverse a number of TEC patches to the south of Paynes Road resulting in further fragmentation of these communities (refer Figure 4.4).
Adversely affect habitat critical to the survival of an ecological community	**Yes** – Areas of land currently containing this TEC will be used to construct the Project. Furthermore, *Melaleuca irbyana* regrowth and potentially the eucalypt woodland, which will be cleared as a result of this Project has high conservation/habitat value in providing corridors between and buffers for mature Swamp Tea-tree vegetation (Porche 2008) and 'vegetation reservoirs' for re-establishment of the listed ecological community.
Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns	**Yes** – There is potential for the Project to alter hydrology and modify abiotic factors essential to the survival of the TEC. The hydrology modelling indicates changes to the local flow paths upgradient and downgradient of the alignment. However, these changes are generally not considered to be substantial with the Project flooding and groundwater modelling indicating little to no change to the hydrology in areas of known TEC (refer EIS Appendix N: Hydrology and Flooding Technical Report). For example: ▪ There are no impacts from flooding to the communities identified at Hayes Road, Lot 59 on SP284955 ▪ There is little change to the community on Lot 301 on CC3491, with the peak water level and time of submergence being reduced

Significant impact criteria	Potential impact to the Swamp Tea-tree (*Melaleuca irbyana*) Forest of South-east Queensland TEC
	▪ There is little change in the hydrology within the patch located on Lot 2 on SP238337 and Lot 83 on CC3477, along with Purga Nature Refuge a known refuge for this TEC Groundwater levels are unlikely to be impacted by the Project within the vicinity of these communities, however some damming and seepage may occur. Refer EIS Chapter 13: Surface Water and Hydrology, EIS Chapter 14: Groundwater and EIS Appendix N: Hydrology and Flooding Technical Report.
Cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting	**No** – Rehabilitation and management of weeds will be undertaken as part of the Project mitigation measures. It is expected that these activities will reduce the likelihood of significant alterations to species diversity associated with the TEC.
Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to: ▪ Assisting invasive species, that are harmful to the listed ecological community, to become established, or ▪ Causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community	**No** – The threats outlined in the threat abatement plan for the biological effects, including lethal toxic ingestion, caused by cane toads, will be managed by the following measures: Rehabilitation and management of pests and weeds will be undertaken as part of the Project mitigation measures. In addition, management measures will be in place to reduce the risk of herbicides, chemicals, run-off and sediment entering the TEC. These control measures are likely to reduce the chance of a substantial reduction in the quality or integrity of an occurrence of an ecological community.
Interfere with the recovery of an ecological community	**Yes** – The Project may potentially result in the removal of up to 30.45 ha, including approximately 9 ha of regrowth. Any removal of this TEC will affect the recovery of the ecological community
Assessment of potential for significant residual impacts	**Under the seven-part test detailed above, there is likely to be a 'significant residual impact' on Swamp Tea-tree (*Melaleuca irbyana*) Forest of South-east Queensland TEC as a result of the Project. This impact is likely to result in the unavoidable loss of up to 30.45 ha of this community.**

5.3.4 Significant residual impact assessment for threatened flora

This section assesses the potential for significant residual impacts from the Project on each MNES using the relevant criteria outlined in the MNES Guidelines. Within the MNES Guidelines there are specific criteria depending on whether the species is listed as critically endangered or endangered compare to a species listed as vulnerable. Key terms relevant to the assessment include:

A 'population of a species' is defined under the EPBC Act as an occurrence of the species in a particular area. In relation to critically endangered, endangered or vulnerable species, occurrences include but are not limited to:

- A geographically distinct regional population, or collection of local populations, or
- A population, or collection of local populations, that occurs within a particular bioregion.

An 'invasive species' is an introduced species, including an introduced (translocated) native species, which out-competes native species for space and resources or which is a predator of native species. Introducing an invasive species into an area may result in that species becoming established. An invasive species may harm listed threatened species or ecological communities by direct competition, modification of habitat or predation.

'Habitat critical to the survival of a species or ecological community' refers to areas that are necessary:

- For activities such as foraging, breeding, roosting, or dispersal
- For long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators)

- To maintain genetic diversity and long-term evolutionary development
- For the reintroduction of populations or recovery of the species or ecological community.

Such habitats may be, but are not limited to: habitat identified in a recovery plan for the species or ecological community as habitat critical for that species or ecological community; and/or habitat listed on the register of Critical Habitat maintained by the minister under the EPBC Act.

The following sections assess the potential for significant residual impacts on the six endangered or vulnerable flora species identified as potentially occurring within the MNES study area using the relevant criteria set out in the MNES Guidelines.

There are six threatened flora species listed as MNES relevant to the MNES study area being four species listed as vulnerable and two species listed as endangered. The ecology, life history and distribution of these species are summarised in Appendix B. Relevant Commonwealth documents applicable to each species including threat abatement plans, Approved Conservation Advice, and recovery plans are also summarised in Appendix B.

As noted in Section 4.3.1.1, only one species (*Notelaea lloydii*) was confirmed as occurring within the Project disturbance footprint.

Key impacts to terrestrial threatened flora are considered to be restricted to direct clearing of individuals/populations. Given the degraded nature of much of the woodlands within the disturbance footprint (due to vegetation clearance, previous tree thinning and weed invasion) indirect impacts such as edge effects (such as dust deposition) are considered to be suitably mitigated under the Projects mitigation measures and restricted to the construction period. Impacts to aquatic species (i.e. *Lychnothamnus barbatus*) include temporary barrier works in waterways, impacts to riparian and instream habitat, and surface water quality. Again, these impacts are expected to be temporary and are predominately associated with Project construction.

A range of mitigation measures have been proposed to ameliorate these impacts wherever possible (refer Section 5.2.2 and species-specific measures in Table 5.6). These include measures considered as effective in addressing the recognised threats for each species as recognised in recovery plans, approved conservation advice, and DAWE-adopted threat abatement plans (as identified in the following sections for each species) including but not restricted to:

- Flora and Fauna Sub-plan will incorporate species-specific monitoring strategies including detailed pre-construction site surveys and operational monitoring to ensure degradation to adjacent habitats is not occurring as a result of the Project – applicable to all species
- Biosecurity Management Plan to protect flora habitats adjacent to the Project from deleterious impacts including weed invasion, pest fauna (such as feral pigs and European rabbit) and invasion by introduced pathogens (such as Myrtle rust and *Phytophthora cinnamomi*) – applicable to all species
- Erosion and Sediment Control Plan and Surface Water Sub-plan to protect water quality values associated with wetlands and waterways – applicable to aquatic species
- Air Quality Sub-plan includes measures to minimise dust impacts on vegetation/habitats including dust monitoring and suppression methods – applicable to all species
- Reinstatement and Rehabilitation Plan to detail rehabilitation of temporary construction areas not required for Project operation – applicable to all species

The assessment of significant impacts on the identified MNES flora species from the Project is based on:

- Current knowledge of the species, including local populations and habitat requirements (refer Appendix C)
- Predictive habitat modelling for each species (refer Table 5.4) based on the habitat assumptions associated with each species, along with the findings of ecological surveys (refer Appendix A)
- The design and layout of the Project (refer Section 1.8)
- Information on potential impacts of the Project during construction and operation (refer Section 5.1)
- Proposed Project mitigation measures (refer Section 5.2 and Table 5.6).

In addition, it is noted that targeted surveys for MNES flora species have not been carried out throughout the entirety of the alignment as part of Project ecology surveys. Where protected plant surveys have been undertaken including in areas of *potential habitat* for the species listed in Table 5.9 only one species was detected (*Notelaea lloydii* (Lloyd's olive)) indicating that predicted habitat mapping overestimates the extent of habitat present for these species.

ARTC is committed to undertaking additional ecological surveys in accordance with relevant State survey guidelines to verify and further refine the habitat mapping and extent of local populations (where applicable) which will inform relevant approvals and management plans, along with offset requirements and disturbance limits.

A summary of the findings of the significant residual impact assessment for threatened flora is provided in Table 5.9. Section 5.3.4.1 provides significant impact assessments for critically endangered and endangered flora species, and Section 5.3.4.2 provides the significant impact assessment for vulnerable flora species.

Table 5.9 Summary of the results of the significant impact assessment for matters of national environmental significance flora species

Flora species	EPBC Act status*	Results of assessment	Table containing assessment against MNES Guidelines
Lychnothamnus barbatus (an algae)	E	No significant residual impact predicted for this species. Works are temporary in predicted habitat (e.g. Warrill Creek)	Table 5.10
Planchonella eerwah (Shiny-leaved condoo)	E	No significant residual impact predicted for this species	Table 5.11
Arthraxon hispidus (Hairy-joint grass)	V	No significant residual impact - no important populations have been identified for this species within the disturbance footprint	Table 5.12
Bulbophyllum globuliforme (Miniature moss-orchid)	V	No significant residual impact - no important populations have been identified for this species within the disturbance footprint	Table 5.12
Cupaniopsis tomentella (Boonah tuckeroo)	V	No significant residual impact - no important populations have been identified for this species within the disturbance footprint	Table 5.12
Notelaea lloydii (Lloyd's olive)	V	Project is likely to cause 'significant residual impacts' on an important population of Lloyd's olive	Table 5.13

Table notes:

* CE = Critically endangered, E = Endangered, V = Vulnerable

ARTC are committed to undertaking additional protected plants surveys throughout the Project disturbance footprint. Where any of the species listed in the table above (or additional threatened species) are encountered (as only Lloyd's olive (*Notelaea lloydii*) is known from the footprint), or habitat critical for the survival of the species is identified, the habitat mapping and the above assumptions will be reassessed and appropriate mitigation measures will be developed with regard to relevant recovery plans and conservation advices, including changes to offset requirements and disturbance limits.

5.3.4.1 Critically endangered/endangered flora species

Under the MNES Guidelines an action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

- Lead to a long-term decrease in the size of a population
- Reduce the area of occupancy of the species
- Fragment an existing population into two or more populations
- Adversely affect *Habitat critical to the survival of the species*

- Disrupt the breeding cycle of a population
- Modify, destroy, remove, isolate, or decrease the availability or quality of habitat to the extent that the species is likely to decline
- Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat
- Introduce disease that may cause the species to decline
- Interfere with the recovery of the species.

Lychnothamnus barbatus - endangered

Ecology and distribution

The species is an aquatic freshwater macrophyte (algae). The species occurs in clear flowing waters of semi-permanent to permanent creeks and rivers (DEWHA 2008c). It has a global distribution but in Australia it is only known from Warrill Creek and Wallace Creek west and south of Boonah, in the Bremer River catchment.

Distribution in context to the Project

Lychnothamnus barbatus has not been identified within or near the MNES study area. Database records are located 20 km south-west and 26 km south (upstream) of the Project disturbance footprint including Warrill Creek (refer Figure 1.24 in Appendix B). The Project crosses Warrill Creek downstream of the known occurrences of the species. Aquatic habitat assessment and water quality sampling was carried out at the location of the Project crossing on Warrill Creek for the EIS studies. The habitat assessment noted a large pooled area with clear water and a range of aquatic macrophytes as occurring. *Lychnothamnus barbatus* was not observed. Water quality sampling was carried out at this site in September 2017 but was not carried out during a subsequent sampling event in February 2018 due to dry conditions (indicating this section of Warrill Creek is ephemeral) (refer EIS Appendix J: Terrestrial and Aquatic Ecology Technical Report for further information regarding aquatic habitat and surface water assessment).

Recovery plans/threat abatement plans

A recovery plan is not deemed as required and there are no adopted threat abatement plans for this species. The Approved conservation advice for the species (DEWHA 2008c) identifies the following threats:

- Increased turbidity from land clearance upstream of its habitat
- Sand or gravel extraction
- Reduced stream flows from increased water extraction
- Changes in flow conditions from impoundments
- Eutrophication.

Important populations and *Habitat critical to the survival of the species*

There are no important populations or habitat identified as critical to the species in published information. It may be inferred the only known Australian populations which are located upstream of the Project may be considered as important and the associated habitat is *Habitat critical to the survival of the species*. However, these locations are a substantial distance (over 20 km) upstream from the Project itself.

There are no records of this species within or close to the MNES study area. This species was not observed during the field surveys, while the majority of the watercourses intersected by the Project would be described as ephemeral. In the absence of a definition for Habitat critical to the species this assessment has applied a 1 km buffer on known records that intersect '*potential habitat*' (refer Appendix A for methodology). As such, there is no 'Habitat critical for the survival of the species' identified within or close to the disturbance footprint. Predictive habitat mapping indicated that the Project is likely to impact upon 6.9 ha of *potential habitat* for this species (refer Table 5.4 and habitat figure in Appendix G). However, this includes watercourses associated with other catchments, including the Logan River (in which the species is not known to occur), along with ephemeral watercourses that are less likely to constitute potential habitat for the species.

Impacts and mitigation measures associated with this species are identified within Table 5.6. Assessment against the significant impact criteria for endangered species is shown in Table 5.10.

Table 5.10 Assessment against the significant impact criteria – *Lychnothamnus barbatus*

Criterion	Assessment against significance criteria
Lead to a long-term decrease in the size of a population	As noted above there are no identified important populations or inferred *Habitat critical to the survival of the species* within or within the vicinity of the Project. Given the species limited occurrence it may be inferred that existing populations are important and that habitat in which the species occurs is *Habitat critical to the survival of the species*. However, the nearest known populations are over 20 km south (upstream) of the Project. No individuals have been observed during field investigations associated with the Project. As noted in Section 5.1.2 the Project has the potential to impact on aquatic habitats within and downstream of the Project disturbance footprint. Construction activity at watercourse crossings will disturb the riparian zone and instream habitats, including potential habitat for the species. Activities will include clearing of vegetation, reprofiling of banks and instream substrate, deposition of material (e.g. rip rap for erosion and sediment control), erection of temporary barriers (e.g. coffer dam), water extraction, disturbance of sediment causing elevated nutrients and turbidity, and result in the loss of instream habitat and direct disturbance of local populations (should they occur within the Project disturbance footprint). In addition, land clearing and disturbance of substrate within the wider catchment, along with run-off from hard stand areas may impact on environmental values of the wetlands and watercourses intersected by and downstream of the Project. However, this disturbance is expected to be restricted to the construction period with occasional maintenance works during the operation of the Project (design life of 100 years). The Project will not create any permanent barriers to flow as watercourse crossings will consist of bridges or culverts. Following construction localised *potential habitat* for the species is expected to return to its prior natural conditions. Water may be sourced from Warrill Creek and other surface water sources as part of the Project, with this action to be undertaken in accordance with relevant water plans and licences, The location of any extraction point is yet to be determined but is likely to be downstream of known populations. Predictive mapping indicates 6.9 ha of *potential habitat* for the species occurs within the disturbance footprint, although this is likely to be a substantial overestimate. (i.e. species is only known from Warrill Creek catchment upstream of the Project and the mapping was based on watercourses which are stream order of 3 or greater and does not consider whether the watercourses are perennial or ephemeral, with the latter being a key limitation on the species habitat requirements and therefore presence). Impacts on these watercourses will also be localised and temporary with the environmental flows to be maintained and geomorphology to be similar to pre-existing conditions. The use of bridge structures across some of the major watercourses will also avoid and/or minimise the impact to riparian zones and instream habitat (i.e. footings are outside the channel or the highwater banks). There are no known populations downstream of the Project and as such impacts to water quality (e.g. increase turbidity and sedimentation and potential nutrient loading), changes to environmental flows and water extraction are unlikely to impact known populations. The Project is not considered likely to result in a long-term decrease in the size of a population.

Criterion	Assessment against significance criteria
Reduce the area of occupancy for the species	There are no records of this species within or close to the Project. Predictive mapping indicates 6.9 ha of *potential habitat* for the species occurs within the disturbance footprint, although this is likely to be a substantial overestimate (i.e. species is only known from Warrill Creek catchment upstream of the Project and the mapping was based on watercourses which are stream order of 3 or greater and does not consider whether the watercourses are perennial or ephemeral, with the latter being a key limitation on the species habitat requirements and therefore presence). Impacts on these watercourses will also be localised and temporary with the environmental flows to be maintained and geomorphology to be similar to pre-existing conditions. The use of bridge structures across some of the major watercourses will also avoid and/or minimise the impact to riparian zones and instream habitat (i.e.. footings are outside the channel or the highwater banks). As such there is the potential for the species to naturally colonise other sections of catchment, though there is no evidence to support natural spread in the past. The Project is considered unlikely to reduce the occupancy for the species in the long-term.
Fragment an existing population into two or more populations	There are no records of this species within or close to the Project with only two known populations located over 20 km upstream of the Project. The Project will impact several watercourses which may provide habitat for the species, however environmental flows will not be impaired following construction. The Project will not fragment an existing population into two or more populations (should a population occur in the disturbance footprint) more than temporarily during the construction period.
Adversely affect *Habitat critical to the survival of the species*	There are no records of this species within or close to the Project with only two known populations located over 20 km upstream of the Project. No habitat considered critical to the survival of the species has been identified in published information. The species prefers clear flowing waters. Much of the waterway habitat associated with the Project has been identified as ephemeral and therefore unsuitable during Project-associated surveys. Predictive mapping indicates 6.9 ha of potential habitat for the species occurs within the disturbance footprint, although this is likely to be a substantial overestimate (i.e. mapping was based on watercourses which are stream order of 3 or greater and does not consider whether the watercourses are perennial or ephemeral, with the latter being a key limitation on the species habitat requirements and therefore presence). The Project impacts on potential habitat will be localised and temporary. The use of bridge structures across some of the major watercourses will also avoid and/or minimise the impact to riparian zones and instream habitat (i.e. footings are outside the channel or the highwater banks). While there is no known habitat critical to survival of the species downstream of the Project, impacts to downstream receiving environments as a result of the project are likely minimal if appropriate mitigation measures are implemented. For example, the current design will have minimal impact on current hydrology and environmental flows based on the hydrology/flooding assessment undertaken. As such, it is considered unlikely that the Project will adversely affect *Habitat critical to the survival of the species*.
Disrupt the breeding cycle of a population	There are no records of this species within or close to the Project. Predictive mapping indicates 6.9 ha of *potential habitat* for the species occurs within the disturbance footprint, although this is likely to be a substantial overestimate. It is uncertain what the breeding requirements of the species may entail. Should a population occur within the Project disturbance footprint there may be some potential to temporarily disrupt the breeding cycle of a population during construction, however no long-term impacts are likely.

Criterion	Assessment against significance criteria
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	As noted above the Project has the potential to remove 6.9 ha of *potential habitat* for the species, However, the species is only known from two populations upstream (20 km) from the Project. The Project impacts on potential habitat will be localised and temporary. The use of bridge structures across some of the major watercourses will also avoid and/or minimise the impact to riparian zones and instream habitat (i.e. footings are outside the channel or the highwater banks). While there is no known habitat critical to survival of the species downstream of the Project, impacts to downstream receiving environments as a result of the project are likely minimal if appropriate mitigation measures are implemented. For example, the current design will have minimal impact on current hydrology and environmental flows based on the hydrology/flooding assessment undertaken. As such it is unlikely that the Project will modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.
Result in invasive species that are harmful to an endangered species becoming established in the endangered species' habitat	At least two aquatic weed species were identified as present in the MNES study area during Project surveys – Canadian pondweed (*Elodea* spp.) and Water hyacinth (*Eichhornia crassipes*)). Waterways subject to assessment for the Project were observed as being in 'fair' to 'poor' condition during assessments of physical habitat values (refer EIS Appendix J: Terrestrial and Aquatic Ecology Technical Report). Weed and pest control measures will be incorporated into the Project Biosecurity Management Plan to control the introduction of novel weeds and spread of existing weed species across the Project disturbance footprint. This will include measures to ensure aquatic weeds are not introduced as a result of the Project. The Biosecurity Management Plan will be in place for the life of the Project (construction and operation) and will minimise the potential for weed invasion and may in the long-term improve habitat condition within vegetation communities located adjacent to Project infrastructure. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.
Introduce disease that may cause the species to decline	The Project Biosecurity Management Plan will incorporate the management of invasive species which will assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.
Interfere with the recovery of the species	There is no recovery plan for the species. The Approved conservation advice for the species (DEWHA 2008c) identifies research priorities and regional priority actions including: ▪ Monitoring known populations and management actions where disturbance occurs ▪ Managing hydrological changes where populations are known to occur ▪ Minimising impacts on stream health (i.e. raising turbidity and nutrient levels) from land use such as gravel extraction The Project is considered unlikely to interfere with the recovery actions listed above and may add to current knowledge of the species if it is found to occur within the Project disturbance footprint. It is considered unlikely the Project will interfere with the recovery of the species.
Assessment of potential for significant residual impacts	Under the nine-part test detailed above, it is considered unlikely a 'significant residual impact' on *Lychnothamnus barbatus* will result from the Project.

Shiny-leaved condoo (*Planchonella eerwah*) - endangered

Ecology and distribution

The Shiny-leaved condoo is a tree growing up to 40 m high. This species is associated with rocky slopes and drainage lines on a variety of soils, in Araucarian Notophyll Vine Forest and Araucarian Microphyll Vine Forest dominated by *Flindersia* species, with occasional emergent *Araucaria cunninghamii* and *Harpullia pendula.* All known areas in which the Shiny-leaved condoo occurs are warm and subtropical with an annual rainfall of between 650 mm to 1,000 mm. It grows on a variety of soils including basaltic well-drained, dark reddish brown sandy loams and nutrient poor soils derived from metasediments. It typically occurs in gullies or on slopes in both the canopy and lower strata of forests (DAWE 2020b).

The Shiny-leaved condoo is restricted to the Nambour-Maleny district, Beenleigh-Ormeau-Pimpama district and Ipswich-Beaudesert district in southeast Queensland.

Distribution in context to the Project

The desktop searches identified records within the MNES study area and disturbance footprint along Woollaman Creek (within the Teviot Range to the east of Jimboomba). Three historical specimen records (all from 1985) are found approximately 240 m north of Chainage 46 of the Project alignment, however nothing within the last 30 years. There are a number of database records (i.e. AoLA, Wildlife Online) surrounding the MNES study area associated with the Teviot Range and immediate surrounds. The majority of these are records that are over 30 years old. More recent specimen backed records occurring within 10 km of the Project include two records between Jimboomba and Beaudesert (2015 and 2007) and a single record (2016) to the north near Flinders Peak (refer Figure 1.38 in Appendix B).

Shiny-leaved condoo was not identified during any Project-associated field surveys, including protected plant surveys within the Teviot Range and Woollaman Creek. As noted in Section 4.4.3, habitat for the species in the form of Araucarian Notophyll Vine Forest and Araucarian Microphyll Vine Forest is also not present within the Project disturbance footprint.

Recovery plans/threat abatement plans

A recovery plan is not considered as required for this species and there are no adopted/made recovery plans available. The following threat abatement plan has been identified as relevant to this species:

- *Threat abatement plan for predation, habitat degradation, competition and disease transmission by feral pigs (Sus scrofa)* (DotEE 2017a).

The DAWE Approved conservation advice (DEWHA 2008d) notes the following potentially threatening processes identified for Shiny-leaved condoo:

- Fire impacts
- Grazing and seed predation by insects and feral pigs
- Weed invasion especially by *Lantana camara*
- Destruction of seedlings by fire.

Important populations and *Habitat critical to the survival of the species*

No important populations or *Habitat critical to the survival of the species* has been noted in published information. There are seven known populations of this species with an estimated combined population of 160 to 180 individuals. These populations could be considered important populations, while the habitat in which they occur can be considered *Habitat critical to the survival of the species* (e.g. species was recorded from a small patch of Hoop pine (*Araucaria cunninghamii*) - vine scrub in a gorge with large sandstone boulders on the north side of Woollaman Creek (AoLA, 2020)). Furthermore, in the absence of a definition for *Habitat critical to the survival of the species* this assessment has applied a 1 km buffer on known records (less than 30 years old) that intersect '*potential habitat*' (refer Appendix A for methodology).

Predictive mapping indicates the MNES study area incorporates 6.29 ha of potential dry rainforest habitat for this species (refer Table 5.4 and habitat figure in Appendix G). The species is mapped as may occur in the eastern portion of the Project (refer DAWE mapping in Appendix B) and as such the predictive mapping aligns with this assessment. However, this community is located approximately 180 m north and upslope of the Project disturbance footprint and will not be impacted either directly, and is unlikely to be subject to indirect impacts from Project activities (refer Table 5.4). Assessment against the significant impact criteria for endangered species is shown in Table 5.11.

Table 5.11 Assessment against the significant impact criteria: *Planchonella eerwah*

Criterion	Assessment against significance criteria
Lead to a long-term decrease in the size of a population	As noted above there are no identified important populations or *Habitat critical to the survival of the species* as identified for the species. Given the limited species occurrence it may be inferred that existing populations are important. Three older historical records (1985) exist close to Woollaman Creek within or close to the Project disturbance footprint (e.g. species was recorded from a small patch of Hoop pine (*Araucaria cunninghamii*) - vine scrub in a gorge with large sandstone boulders on the north side of Woollaman Creek (AoLA, 2020)). No individuals were observed during field investigations associated with the Project, including targeted surveys of suitable habitat (e.g. Jacobs-GHD 2016a). There are two other populations in the region: ▪ Two populations (4–5 individuals and 2–3 individuals) at Ivory's Knob, approximately 10 km south-southwest of Flinders Peak ▪ A population of 50–60 individuals over 15 ha at Scott's Scrub and Mt Elliot. The recently gazetted 'Flinders Peak Conservation Estate' includes the northwest corner of Scott's Scrub. Predictive habitat mapping indicates that 6.29 ha of dry rainforest habitat that may potentially support this species has been identified as occurring within the MNES study area, but no habitat is predicted to occur with the disturbance footprint. Potential habitat is located approximately 180 m north and upslope of the disturbance footprint and will not be subject to direct impact and is unlikely to be subject to indirect impacts. Bushfires as a result of the Project (construction and operations) are unlikely. Access roads associated with the Project may also provide access to manage bush fires in remote sections of Teviot Range and an opportunity to work with the local rural fire services and groups to seek inclusion of mitigative measures in bush fire risk management plans, risk registers and/or operation maps. In addition, the Project is unlikely to result in the proliferation of *Lantana camara* and pest species so as to pose a direct threat to known populations of this species (i.e. the local landscape is fragmented, patches are likely to be subject to edge effects including weed invasion and *Lantana camara* was observed to be common in the existing landscape). The Project is over 180 m from the identified *potential habitat* and is unlikely to exacerbate this impact). Other indirect impacts such as dust deposition, changes to hydrology, soils, topography and groundwater (refer Section 5.1.2) are unlikely to be an issue given the separation distance and the level of impact predicted from these matters. The Project is unlikely to result in a long-term decrease in the size of a population.
Reduce the area of occupancy of the species	Three older historical records (1985) exist close to Woollaman Creek within or close to the disturbance footprint, however no individuals were observed during field investigations associated with the Project. Predictive mapping indicates there is 6.29 ha of suitable habitat for the species within the MNES study area, but no habitat is predicted to occur within the Project disturbance footprint. The Project is considered unlikely to reduce the potential area of occupancy for the species.
Fragment an existing population into two or more populations	Three older historical records (1985) exist close to Woollaman Creek within or close to the Project disturbance footprint (~240m). This population, estimated to be 24 plants at the time, may be one of seven known populations of the Shiny-leaved condoo (*Planchonella eerwah*) if it still occurs. There are two other populations in the region: ▪ Two populations (4–5 individuals and 2–3 individuals) at Ivory's Knob, approximately 10 km south-southwest of Flinders Peak ▪ A population of 50–60 individuals over a 15 ha at Scott's Scrub and Mt Elliot. The recently gazetted 'Flinders Peak Conservation Estate' includes the northwest corner of Scott's Scrub.

Criterion	Assessment against significance criteria
	Given the nature of the Project, despite being a linear infrastructure, it is unlikely that the genetic flow of the population will be reduced. Seed carriers for this species are likely to be insects, rodents or birds which are unlikely to be inhibited in their movements across the area. Furthermore, the Project does not intersect any known populations of the species, with no individuals identified from the Project surveys. It is unlikely that the Project will fragment an existing population into two or more populations.
Adversely affect habitat critical to the survival of a species	No habitat considered critical to the survival of the species has been identified in published information. However, a known population recorded within the vicinity of Woollaman Creek and the habitat in which the species has previously been recorded may be considered *Habitat critical to the survival of the species* (e.g. Hoop pine (*Araucaria cunninghamii*) - vine scrub in a gorge with large sandstone boulders on the north side of Woollaman Creek). This habitat is located outside of the Project disturbance footprint. Furthermore, predictive mapping indicates the disturbance footprint does not include suitable dry rainforest habitat for the species. As such, it is considered unlikely that the Project will adversely affect *Habitat critical to the survival of the species*.
Disrupt the breeding cycle of a population	A known population occurs within the vicinity of Woollaman Creek approximately 240m north of the Project. The habitat in which the species occurred may be considered *Habitat critical to the survival of the species* (e.g. Hoop pine (*Araucaria cunninghamii*) - vine scrub in a gorge with large sandstone boulders on the north side of Woollaman Creek). This community is to the north of the Project. This habitat is located outside of the Project disturbance footprint. Furthermore, predictive mapping indicates the disturbance footprint does not include suitable dry rainforest habitat for the species (refer Table 4.5 and Table 4.6). Pollinators and seed carriers for this species are likely to be insects, rodents or birds which are unlikely to be inhibited in their movements across the area. Furthermore, the Project does not intersect any known populations of the species, with no individuals identified from the Project surveys. It is considered unlikely that the Project will disrupt the breeding cycle of a population.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	As described above there are a number of populations within the Teviot Range, with the closest potentially located 240 m to the north of the Project disturbance footprint. However, predictive mapping indicates there is no *potential habitat* for the species within the Project disturbance footprint. As such the Project will not destroy or modify any habitat known to support this species Bushfires as a result of the Project (construction and operations) are unlikely. Access roads associated with the Project may also provide access to manage bush fires in remote sections of Teviot Range and an opportunity to work with the local rural fire services and groups to seek inclusion of mitigative measures in bush fire risk management plans, risk registers and/or operation maps. The Project is over 180 m from the identified *potential habitat* and is unlikely to exacerbate this impact. Other indirect impacts such as dust deposition, changes to hydrology, soils, topography and groundwater (refer Section 5.1.2) are unlikely to be an issue given the separation distance and the level of impact predicted from these matters. The Project is not considered to impact the species to the extent that the species is likely to decline.
Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat	Weed invasion (particularly *Lantana camara*) (DEWHA 2008d) and grazing/trampling by pigs (*Sus scrofa*) are potential threats to the species (DotEE 2017). Pigs were identified as commonly present and *Lantana camara* was recorded as common throughout wooded habitats within the MNES study area during field surveys for the Project (Jacobs-GHD 2016a). Other Project-associated surveys have noted areas within the Project disturbance footprint are already heavily infested with weed species including 20 species listed as restricted matters under the Queensland *Biosecurity Act 2014* (EMM 2018b, 2018c). Weed and pest control measures will be incorporated into the Project Biosecurity Management Plan to control the introduction of novel weeds and spread of existing weed species across the disturbance footprint. The Biosecurity Management Plan will be in place for the life of the Project and will minimise the potential for weed invasion and may in the long-term improve habitat condition within vegetation communities located adjacent to Project infrastructure. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.

Criterion	Assessment against significance criteria
Introduce disease that may cause the species to decline	The Project Biosecurity Management Plan will incorporate the management of invasive species which will assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.
Interfere with the recovery of the species	There is no recovery plan for the species. The Approved conservation advice for the species (DEWHA 2008d) identifies research priorities and regional priority actions including: ▪ Limiting the impact of habitat loss and disturbance ▪ Controlling problem weed species ▪ Limiting the impact of grazing and trampling The Project is considered unlikely to interfere with the recovery strategies listed above. Given the species preferred habitat is not predicted to occur within the Project disturbance footprint it is considered unlikely the Project will interfere with the recovery of the species.
Assessment of potential for significant residual impacts	Under the nine-part test detailed above, there will be no 'significant residual impact' on *Planchonella eerwah* as a result of the Project.

5.3.4.2 Vulnerable flora species populations

In accordance with the MNES Guidelines, an action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

- Lead to a long-term decrease in the size of an important population of a species
- Reduce the area of occupancy of an important population
- Fragment an existing important population into two or more populations
- Adversely affect habitat critical to the survival of a species
- Disrupt the breeding cycle of an important population
- Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline
- Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat
- Introduce disease that may cause the species to decline
- Interfere substantially with the recovery of the species.

As evident the criteria, the impact is only applicable if the population is important. An 'important population' as defined within the MNES Guidelines is:

'*An important population is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:*

- *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.*

An initial assessment was undertaken to determine whether an 'important population' is present in the MNES study area and if other criteria relevant to vulnerable species were likely to be impacted as a result of the project works. Where an 'important population' or impacts were not identified, an assessment against the above criteria was not undertaken.

Given the specificity of the above definition and the scarcity of information and records available for most listed species and populations in the region (and Australia), it is difficult to determine: 1) attributes such as breeding and dispersal behaviour and whether the population is a 'key source' and 2) the genetic diversity of individuals inhabiting a population or sub-population. It is noted the Project is linear and is not expected to impact the potential distribution of local pollinators for most (if not all) plant species and as such is not considered likely to impact dispersal or genetic exchange within a plant population.

Given the paucity of information available, significance of impacts to threatened species has been based on experience of the assessment team and the latest available information.

Impacts and mitigation measures associated with this species are identified within Table 5.6 and Table 5.12 provides an evaluation of the populations of vulnerable flora species considered as potentially associated with the MNES study area.

Table 5.12 Assessment of status of vulnerable flora species population against matters of national environmental significance guidelines criteria

Species name	Common name	MNES study area population evaluation
Arthraxon hispidus	Hairy-joint grass	The species is mapped as may occur only in isolated portions of the Project disturbance footprint (refer DAWE mapping in Appendix B). The species was not identified within any Project-associated field surveys. There are no database records of this species within or adjacent to the MNES study area. Database records indicate the species has been recorded in the wider region surrounding the Project. The nearest database record is dated from 1941 and is located approximately 14 km south of the disturbance footprint (to the south of Wyaralong Dam) in cleared habitat. There are a number of other records within a 50 km radius located to the south, east and north-east. The nearest recent record (2009) is from Main Range National Park over 30 km south of the MNES study area (refer Figure 1.16 in Appendix B). The species occurs from Port Douglas (north Queensland) south to Kempsey in NSW (DEWHA 2008e). The MNES study area is not located near the limit of the species range. There is no recovery plan adopted by the Commonwealth for this species. A review of the available literature including the Approved conservation advice for the species (DEWHA 2008e) has not revealed any important populations or *Habitat critical to the survival of the species*. No populations that are important for the long-term survival and recovery of the species have been identified. The species can be found in a variety of habitats including edges of rainforest, wet eucalypt forest, woodland, creek banks and beds, shaded gullies and mound springs (DEWHA 2008e). Recent studies of the species in New South Wales indicate a preference for native dominated freshwater wetlands, drainage lines, and groundwater seepages with little canopy cover (White et al. 2019). As such, no habitat can be identified as critical in the absence of the species presence. In the absence of a definition for *Habitat critical to the survival of the species*, this assessment has applied a 1 km buffer on known records that intersect '*potential habitat*' (refer Appendix A for methodology). The Project is linear and is not expected to impact dispersal or breeding capacity. Predictive habitat mapping indicates that the Project may disturb 4.15 ha of *potential habitat* for this species (refer Table 5.4 and habitat figure in Appendix G). No important populations or *Habitat critical to the survival of the species* have been identified for this species in relation to the Project, the species occurs across a wide area, and there are no recent records of the species within 30 km of the Project. The impact area is minor and will not conceivably impact the species such that it is likely to decline or impact recovery of the species. Therefore, the Project is unlikely to significantly impact this species and it is not considered further.
Bulbophyllum globuliforme	Miniature moss-orchid	The species was not identified within any Project-associated field surveys. There are no historic records of this species within or close to the disturbance footprint. Database records indicate that this species is known to occur within 50 km of the Project. However, the nearest record is from Lamington National Park located around 45 km south of the Project with the record taken in 2002. Database records indicate the species is restricted in its local distribution to the Lamington and Border Ranges National Parks (refer Figure 1.28 in Appendix B) (AoLA 2020). The species occurs in in notophyll vine forest and some microphyll vine forest with hoop pine (*Araucaria cunninghamii*) emergents. There is 6.29 ha of dry rainforest habitat suitable for this species within the MNES study area, however no habitat is located within the Project disturbance footprint (refer Table 5.4 and habitat figure in Appendix G).

Species name	Common name	MNES study area population evaluation
		The species is mapped as likely to occur in the eastern portion of the Project (refer DAWE mapping in Appendix B) and as such the predictive mapping aligns with this assessment. The habitat is located approximately 180 m north and upslope of the disturbance footprint and will not be impacted directly and is unlikely to be indirectly impacted by Project activities. There is no recovery plan for this species. A review of the available literature has not revealed any important populations or definition of *Habitat critical to the survival of the species* when referring to the Approved conservation advice for the species (DEWHA 2008f). No populations have been identified that are key to the long-term survival and recovery of this species. However, the species is only known from four locations, including Puzzle Creek near Paluma (north-east Queensland), Kroombit Tops near Calliope (Central Queensland), Cainbable Creek in Lamington National Park (south-east Queensland) and Levers Plateau (north-east New South Wales, with these locations being likely important populations for the species. *Habitat critical to the survival of the species* is likely to be Hoop pines in excess of 100 years old within notophyll vine forest and some microphyll vine forest. Based on this no important populations or *Habitat critical to the survival of the species* will be impacted by the Project. The linear nature of the Project is not expected to impact dispersal or breeding capacity. Therefore, under the MNES guidelines the Project is unlikely to significantly impact this species and it is not considered further.
Cupaniopsis tomentella	Boonah tuckeroo	The species is mapped as likely to occur to the south of the Project and a small area to the north around Flinders Peak (refer DAWE mapping in Appendix B). The species was not identified within any Project-associated field surveys. There are no historic records of this species within or directly adjacent to the disturbance footprint. Database records indicate a population of this species was known to occur south of the Project (from several 1980s records), within an area of the Teviot Range (Ivory's Knob). The nearest of these records is approximately 5 km south of the Project disturbance footprint. There is a single AoLA record from north of the Project located in Ipswich. The record does not have a collection date and has an error margin of 25 km on the record location. All other records are from south of the Project. The species is only known from an area between Ipswich and Boonah, with the population estimated at between 120 to 140 individuals. Database records indicate that the Project is north of the edge of the eastern distribution for this species (AoLA 2020) (refer Figure 1.38 in Appendix B). There is 6.29 ha of dry rainforest habitat suitable for this species within the MNES study area, however no habitat is located within the disturbance footprint (refer Table 5.4 and habitat figure in Appendix G). This habitat is located approximately 180 m north and upslope of the disturbance footprint and will not be impacted directly or indirectly. There is no recovery plan for this species. A review of the available literature has not revealed any important populations or definition of *Habitat critical to the survival of the species* when referring to DAWE's SPRAT database (2020b). No populations have been identified that are key to the long-term survival and recovery of this species. Nevertheless, given the overall population of the species is small it may be considered the entire population can be considered as important and that all habitat in which the species occur could be considered as critical to the species. The linear nature of the Project is not expected to impact dispersal or breeding capacity, particularly given the species largely occurs in areas south of the Project. Weed invasion is considered a threat to the habitat of this species. Weed management associated with the disturbance footprint will be a key measure under the Project Biosecurity Management Plan. The Project is located north of the current distribution of the species. The only available suitable habitat close to the Project is located north and upslope of the disturbance footprint and will not be impacted. Therefore, the Project is unlikely to significantly impact this species and it is not considered further.

Species name	Common name	MNES study area population evaluation
Notelaea lloydii	Lloyd's olive	Eight individuals were recorded within 200 m of the disturbance footprint during Project-associated protected plant surveys in 2018 (refer Figure 4.3). Multiple database records for this species exist for areas within the MNES study area, mainly associated with Teviot Range. It is estimated that the Project is likely to impact habitat in which this species is predicted to occur (refer Table 5.4). Database records indicate that this species occurs within the MNES study area. A review of the available literature has not revealed any important populations (DEWHA 2008b). However, given that the database records are in such close proximity to and have potential to be impacted by the Project there is potential to impact a population for the species. This species has a restricted distribution, has undergone historical loss and will encounter future loss resulting from rural and urban development. As such the population that is relevant to the Project can be considered an important population and therefore key to the long-term survival of this species. The potential for significant residual impacts on an important population of *Lloyd's olive* is assessed under the MNES Guidelines in Table 5.13.

5.3.4.3 Significant impact assessment – Vulnerable flora

Lloyd's olive (*Notelaea lloydii*) – vulnerable

Ecology and distribution

Lloyd's olive (*Notelaea lloydii*) is a shrub that grows to an approximate height of 1 m to 4 m. The species is known to occur in open eucalypt forest, often near the margins of vine thickets, vine forests and softwood scrub. It is usually found on stony, shallow and rocky soils derived from sandstone or acid volcanic rocks, often on steep slopes, or near drainage lines (DAWE 2020b). Most of the records are known from remnant vegetation and generally only involve a few plants.

The species occurs from the Somerset Dam area to south of Beaudesert and west to Mount Berryman near Laidley. The species is estimated to have an area of occupancy of 3,700 km^2 (DAWE 2020b).

Distribution in context to the Project

The species is mapped as likely to occur in the Teviot Range including within the MNES study area (refer DAWE mapping in Appendix B). Eight specimens were identified during the protected plant surveys (in 2018) associated with the Project (two separate surveys have targeted this area) within 200 m of the disturbance footprint on the eastern edge of the Teviot Range (refer Figure 4.3). There are a number of database records surrounding the Project including several with 5 km of the MNES study area in the Ivory's Rock/Flinders Peak area in the Teviot Range. The nearest recent records are from near Ivory's Rock (2003) and records (2011 and 2017) from the Mount Grandchester area to the north-west of the Project. The majority of records are from Ipswich and further north (refer Figure 1.22 in Appendix B).

Recovery plan/threat abatement plans

No recovery plan or threat abatement plans have been adopted for this species. The Approved conservation advice for the species (DEWHA 2008b) identifies the following threats:

- Habitat fragmentation for urban development and associated infrastructure (Halford 1998)
- Inappropriate fire regimes. Mature Lloyd's olive are known to withstand fire, but frequent fire kills juvenile plants and seedlings, supressing species recruitment (Halford 1998)
- Road maintenance
- Weed invasion, in particular *Lantana camara* is known to invade forest margins, smothering plants, reducing light and increasing fuel loads

- Some remnant populations occur on roadsides and therefore are potentially affected by road widening and maintenance.

Important population and *Habitat critical to the survival of the species*

There are no important populations or habitat critical to the survival of Lloyd's olive identified in published information. Nevertheless, given the small area of occurrence of the species it may be inferred that a population in the Teviot Range could be considered as both isolated and on the edge of the species range. As such, for the purposes of this assessment the local population within the Teviot Range which is intersected by the Project is considered as an 'important population'. In the absence of a definition for *Habitat critical to the survival of the species* for the species and given the species is known to be present this assessment has applied a conservative approach and included all potential habitat as '*Habitat critical to the survival of the species*' (refer Appendix A for methodology).

Impacts and mitigation measures associated with this species are identified within Table 5.6. Predictive habitat mapping indicates the Project may impact 26.77 ha of *Habitat critical to the survival of the species* as identified under the predictive mapping approach used for this assessment (refer Table 5.4 and habitat figure in Appendix G). Assessment against the significant impact criteria for vulnerable species is shown in Table 5.13.

Table 5.13 Assessment against the significant impact criteria – *Notelaea lloydii*

Criterion	Assessment against significance criteria
Lead to a long-term decrease in the size of an important population	The species has a restricted range encompassing the MNES study area. Eight individuals were identified above the proposed tunnel, approximately 200m from the Project disturbance footprint (i.e. no clearing is proposed above the tunnel) during Project-associated surveys. The individuals are located above the proposed tunnel area and are not expected to be directly or indirectly impacted (refer Section 5.1.2.13). Given the population is located above the tunnel it is unlikely that the construction or operation of the Project will impact this population. However, it is noted that the Project may be a point source for bush fires (construction and operation) though the risk is considered to be low. The Project may also benefit the population by providing access to otherwise inaccessible areas during a bushfire event. In addition, the species and known habitat are not considered to be reliant on groundwater, with the local groundwater resources potentially impacted by the construction and operation phases of the tunnel (refer 5.1.2.13). Based on a 1 km buffer around this record, there is potentially 26.77 ha of *Habitat critical to the survival of the species* (under the conservative approach used for this assessment) predicted to occur within the disturbance footprint. However, no individuals have been identified within the Project disturbance footprint during targeted protected plant surveys. As part of the Flora and Fauna Sub-plan additional protected plant surveys targeting this species will be undertaken prior to construction to confirm the extent of the population and inform any secondary approvals, Project EMPs and where required offset requirements and disturbance limits. Should the species occur within the disturbance footprint there is potential for the Project to result in a long-term decrease in the size of an important population.
Reduce the area of occupancy of an important population	An 'important population' has been identified as occurring above the proposed tunnel. However, no individuals have been identified within the Project disturbance footprint during targeted protected plant surveys. Based on a 1 km buffer around this record, there is potentially 26.77 ha of *Habitat critical to the survival of the species* (under the conservative approach used for this assessment) predicted to occur within the disturbance footprint. Though it should be noted that no individuals are likely to be cleared as a result of the Project (i.e. individuals are located above the tunnel). While indirect impacts to the population from the construction and operation of the tunnel are unlikely. The Project has potential to reduce the area of occupancy of an 'important population' for the species.
Fragment an existing important population into two or more populations	An 'important population' has been identified as occurring above the proposed tunnel. However, no individuals have been identified within the Project disturbance footprint during targeted protected plant surveys. Given the population is located above the tunnel it is unlikely that the construction or operation of the Project will impact this population. As such the Project is considered unlikely to fragment an existing important population into two populations.

Criterion	Assessment against significance criteria
Adversely affect *Habitat critical to the survival of the species*	The species occurs in open eucalypt forest which is a widespread vegetation type. Predictive mapping indicates 26.77 ha of habitat considered as *Habitat critical to the survival of the species* (for the purposes of this assessment) occurs within the Project disturbance footprint. As such, there is potential that the Project will adversely affect *Habitat critical to the survival of the species*.
Disrupt the breeding cycle of an important population	Little information is available on the flowering/fruiting season for the species. An 'important population' has been identified as occurring above the proposed tunnel. However, no individuals have been identified within the Project disturbance footprint during targeted protected plant surveys. Given the population is located above the tunnel it is unlikely that the construction or operation of the Project will impact this population, including the species life cycle.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	An 'important population' has been identified as occurring above the proposed tunnel. However, no individuals have been identified within the Project disturbance footprint during targeted protected plant surveys. It is noted the Project may be a point source for bush fires (construction and operation) though the risk is considered to be low. The Project may also benefit the population by providing access to otherwise inaccessible areas during a bushfire event. The species and known habitat are not considered to be reliant on groundwater, with the local groundwater resources potentially impacted by the construction and operation phases of the tunnel (refer 5.1.2.13). Predictive mapping indicates 26.77 ha of *Habitat critical to the survival of the species*. However, there is 1,089.16 ha of suitable habitat within 1 km of the disturbance footprint (i.e. the MNES study area. The species is thought to have an area of occupancy of 3,700 km^2 (DAWE 2020a). Given the relatively small area the Project occupies within this area and that the population is located above the tunnel, the Project is not considered to impact habitat suitable for the species to the extent that the species is likely to decline.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	Weed invasion, particularly by *Lantana camara* is a potential threat to the species (DEWHA 2008b). *Lantana camara* was noted as prominent in the location where the species was identified during Project surveys, as well as throughout wooded areas within the MNES study area (Jacobs-GHD 2016a). Other Project-associated surveys have noted areas within the alignment are already heavily infested with weed species including 20 species listed as restricted matters under the Queensland *Biosecurity Act 2014* (EMM 2018b, 2018c). Weed and pest control measures will be incorporated into the Project Biosecurity Management Plan to control the introduction and spread of weed and pest species across the disturbance footprint and surrounds covering both construction and operation activities. The Plan will be in place for the life of the Project and will minimise the potential for weed invasion and may in the long-term improve habitat condition within vegetation communities located adjacent to Project infrastructure. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.
Introduce disease that may cause the species to decline	The Project Biosecurity Management Plan will incorporate the management of invasive species which will assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.
Interfere substantially with the recovery of the species	There is no recovery plan for the species. The Approved conservation advice for the species (DEWHA 2008a) identifies research priorities and regional priority actions including: ▪ Monitoring known populations and identifying high conservation value populations ▪ Limiting the impact of disturbance from adjacent land use and activities associated with road maintenance and upgrading ▪ Identifying and controlling problem weed species including *Lantana camara* ▪ Developing a fire management strategy for the species. The Project is considered unlikely to interfere with the recovery strategies listed above. Given the species is known to occur in the area as a result of Project activities it may be argued the Project is increasing knowledge on the species distribution. The Project will control the impact of problem weed species in the vicinity of the disturbance footprint. Given the relatively small area of suitable habitat impacted the Project is considered unlikely to substantially interfere with the recovery of the species.

Criterion	Assessment against significance criteria
Assessment of potential for significant residual impacts	Under the nine-part test detailed above, there is potential for the Project to cause 'significant residual impacts' on *an important population* of Lloyd's olive.

5.3.5 Significant residual impact assessment for threatened fauna

There are 17 threatened fauna species listed as MNES relevant to the MNES study area including 11 species listed as vulnerable, three species listed as endangered and 3 species listed as critically endangered. The ecology, life history and distribution of these species are summarised in Appendix C. Relevant Commonwealth documents applicable to each species including threat abatement plans, approved conservation advices, and recovery plans are also summarised in Appendix C. This section of the MNES report assesses the potential for significant residual impacts from the Project on threatened fauna species using the MNES Guidelines.

Key impacts to threatened fauna are considered to include the following:

- Direct clearing of species habitats
- Injury/mortality to individuals during vegetation clearing in the construction period (arboreal fauna and terrestrial fauna)
- Ongoing collisions with trains during operation of the rail line (larger arboreal and terrestrial mammal fauna)
- Potential fragmentation of suitable habitats/populations due to the linear nature of the Project (largely in the Teviot Range).

A range of mitigation measures have been proposed to ameliorate these impacts wherever possible (refer Section 5.2.2 and species-specific measures in Table 5.7). These include measures considered as effective in addressing the recognised threats for each species as recognised in recovery plans, approved conservation advices, and DAWE-adopted threat abatement plans (as identified in the following sections for each species) including but not restricted to:

- Flora and Fauna Sub-plan will incorporate species-specific monitoring strategies including detailed pre-construction site surveys and operational monitoring to ensure degradation to adjacent habitats is not occurring as a result of the Project – applicable to all species
- Biosecurity Management Plan to protect fauna habitats adjacent to the Project from deleterious impacts including weed invasion, proliferation of pest predators and invasion by introduced pathogens (such as Myrtle rust and *Phytophthora cinnamomi*) – applicable to all species
- Erosion and Sediment Control Plan and Surface Water Sub-plan to protect water quality values associated with wetlands and waterways – applicable to aquatic species/wetland birds
- Air Quality Sub-plan includes measures to minimise dust impacts on vegetation/habitats including dust monitoring and suppression methods – applicable to all species
- Fauna crossing structures and associated fencing and site-specific (crossing) vegetation rehabilitation to allow continued landscape connectivity for fauna across the alignment – applicable to terrestrial fauna
- Reinstatement and Rehabilitation Plan to detail rehabilitation of temporary construction areas not required for Project operation – applicable to all species.

Given the degraded nature of the majority of the woodlands within the disturbance footprint (due to vegetation clearance, previous tree thinning and weed invasion) indirect impacts such as edge effects (such as dust deposition) are considered to be suitably mitigated under the Projects mitigation measures and restricted to the construction period.

Impacts to aquatic species (i.e. Australian lungfish) include temporary barrier works in waterways, impacts to riparian and instream habitat, and surface water quality (refer Table 5.7). These impacts are expected to be temporary and largely during Project construction (i.e. sporadic maintenance works may be required at sites during the Project operation). The proposed tunnel will require ongoing release of groundwater seeping into the tunnel during the life of the Project. Groundwater entering the tunnel will be released as surface water flows via the eastern portal. The groundwater will be treated prior to discharge and there are no predicted impacts to downstream habitats (refer EIS Chapter 14: Groundwater for further detail).

The assessment of significant impacts on the identified MNES species from the Project is based on:

- The design and layout of the Project (refer Section 1.8)
- Currently known information about the MNES affected (refer Appendix B)
- Predictive habitat modelling for MNES species (refer Table 5.4) based on the habitat assumptions associated with each species (refer Appendix A)
- Information on potential impacts of Project construction and operation (refer Section 5.1)
- Proposed Project mitigation measures (refer Section 5.2 and Table 5.7).

In addition, it is noted that targeted surveys in accordance with the relevant guidelines for some fauna species have not been carried out thus far or that some of the surveys (e.g. wetland bird surveys were limited due to the dry conditions) are now over two years old. ARTC is committed to undertaking additional ecological surveys in accordance with relevant Commonwealth and/or State surveys guidelines to verify and further refine the habitat mapping and extent of local populations (where applicable) which will inform relevant approvals and management plans, along with necessary offset requirements and disturbance limits.

A summary of the findings of the assessment of the significant residual impact assessment for threatened fauna is provided in Table 5.14. Section 5.3.5.1 provides the significant impact assessment for Critically endangered and endangered species, and Section 5.3.5.3 provides the significant impact assessment for vulnerable species with potential to be impacted by)the Project.

Table 5.14 Summary of the results of the significant impact assessment for matters of national environmental significance fauna species

Flora species	EPBC Act status*	Results of assessment	Table containing assessment against MNES Guidelines
Regent honeyeater (*Anthochaera phrygia*)	E	No important populations or *Habitat critical to the survival of the species* has been identified for this species - no significant residual impact	Table 5.15
Australasian bittern (*Botaurus poiciloptilus*)	E	No important populations or *Habitat critical to the survival of the species* has been identified for this species - no significant residual impact	Table 5.16
Curlew sandpiper (*Calidris ferruginea*)	CE	No important populations or *Habitat critical to the survival of the species* has been identified for this species - no significant residual impact	Table 5.17
Spotted-tail quoll (*Dasyurus maculatus maculatus*)	E	Possible that the Project will have a significant impact	Table 5.18
Swift parrot (*Lathamus discolor*)	CE	Possible that the Project will have a significant impact	Table 5.19
Australian painted snipe (*Rostratula australis*)	E	Possible that the Project will have a significant impact	Table 5.20
Large-eared pied bat (*Chalinolobus dwyeri*)	V	No important populations or *Habitat critical to the survival of the species* has been identified for this species - no significant residual impact	Table 5.21
Collared delma (*Delma torquata*)	V	Significant residual impact likely	Table 5.22
Red goshawk (*Erythrotriorchis radiatus*)	V	Possible that the Project will have a significant residual impact	Table 5.23

Flora species	EPBC Act status*	Results of assessment	Table containing assessment against MNES Guidelines
Painted honeyeater (*Grantiella picta*)	V	No important populations or *Habitat critical to the survival of the species* have been identified for this species - no significant residual impact	Table 5.21
Australian lungfish (*Neoceratodus forsteri*)	V	No significant residual impact	Table 5.24
Greater glider (*Petauroides volans volans*)	V	No important populations or *Habitat critical to the survival of the species* has been identified for this species - no significant residual impact	Table 5.25
Brush-tailed rock-wallaby (*Petrogale penicillata*)	V	Possible that the Project will have a significant residual impact.	Table 5.26
Koala (*Phascolarctos cinereus*)	V	Significant residual impact likely	Table 5.27 and Table 5.28
Long-nosed potoroo (*Potorous tridactylus tridactylus*)	V	No important populations have been identified for this species - no significant residual impact	Table 5.21
New Holland mouse (*Pseudomys novaehollandiae*)	V	No important populations have been identified for this species - no significant residual impact	Table 5.21
Grey-headed flying-fox (*Pteropus poliocephalus*)	V	Possible that the Project will have a significant impact.	Table 5.29

Table notes:

* CE = Critically endangered, E = Endangered, V = Vulnerable

ARTC are committed to undertaking additional pre-clearing surveys in accordance with relevant State and Commonwealth guidelines throughout the Project disturbance footprint and where any of these species are encountered (or any additional threatened species) or habitat critical for the survival of the species is identified the habitat mapping and the above assumptions will be reassessed and appropriate mitigation measures developed with regard to the recovery plans and conservation advices, including changes to offset requirements and disturbance limits.

5.3.5.1 Critically endangered and endangered fauna species

A 'population of a species' is defined under the EPBC Act as an occurrence of the species in a particular area. In relation to critically endangered, endangered or vulnerable species, occurrences include but are not limited to:

- A geographically distinct regional population, or collection of local populations
- A population, or collection of local populations, that occurs within a particular bioregion.

Under the Guidelines an action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

- Lead to a long-term decrease in the size of a population
- Reduce the area of occupancy of the species
- Fragment an existing population into two or more populations
- Adversely affect *Habitat critical to the survival of the species*
- Disrupt the breeding cycle of a population
- Modify, destroy, remove, isolate, or decrease the availability or quality of habitat to the extent that the species is likely to decline
- Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat

- Introduce disease that may cause the species to decline
- Interfere with the recovery of the species.

An ‘invasive species’ is an introduced species, including an introduced (translocated) native species, which out-competes native species for space and resources or which is a predator of native species. Introducing an invasive species into an area may result in that species becoming established. An invasive species may harm listed threatened species or ecological communities by direct competition, modification of habitat or predation.

‘Habitat critical to the survival of a species or ecological community’ refers to areas that are necessary:

- For activities such as foraging, breeding, roosting, or dispersal
- For long-term maintenance of the species or ecological community (including the maintenance of species essential to the survival of the species or ecological community, such as pollinators)
- To maintain genetic diversity and long-term evolutionary development
- For the reintroduction of populations or recovery of the species or ecological community.

Such habitats may be, but are not limited to: habitat identified in a recovery plan for the species or ecological community as habitat critical for that species or ecological community; and/or habitat listed on the register of Critical Habitat maintained by the Minister under the EPBC Act.

Impacts and mitigation measures associated with these species are identified within Table 5.7. The following sections assess the potential for significant residual impacts on the 10 endangered or critically endangered fauna species identified as potentially occurring within the disturbance footprint using the criteria set out in the Guidelines.

Regent honeyeater (*Anthochaera phrygia*) - endangered

Ecology and distribution

Regent honeyeater is largely known to occur in box-ironbark eucalypt woodlands. The preferred habitat is wet areas containing fertile soils that provide reliable nectar seasonally in areas of creek flats, river valleys and lower slopes. They are also found in dry eucalypt woodland and open forest in both rural and urban environments with mature eucalypts (DES 2017a). The Regent honeyeater’s diet consists of nectar from key species such as Yellow box (*Eucalyptus melliodora*), White box (*Eucalyptus albens*) and Mugga ironbark (*Eucalyptus sideroxylon*) as well as sugary exudates. It also forages in Swamp mahogany (*Eucalyptus robusta*) and Spotted gum (*Corymbia maculata*) close to the coast. The species is also known to consume insects particularly when breeding (Birdlife International 2016a). The species prefers mature large trees that produce more flowers, particularly those on fertile soils and in riparian areas (DotE 2016). The species breeds as individual pairs or sometimes in loose colonies with the female honeyeater incubating eggs whilst both parents feed the young.

The Regent honeyeater is endemic to south-east Australia, ranging from south-east Queensland to central Victoria. In south-east Queensland, the Regent honeyeater’s distribution ranges from the Cooloola Plains in the north to inland areas such as Dalby, and further south into areas such as Narrabri (NSW). Regent honeyeater is known to breed in small numbers regularly to the west of Warwick in Durikai State Forest (100 km south-west of the Project). The species is considered to comprise one population with some movements of individuals between regularly used areas (Garnett et al 2011).

Distribution in context to the Project

Regent honeyeater is transient in the Lockyer Valley/greater Brisbane region, being sporadically recorded in the winter months. It is noted AoLA records of the species have been generalised to protect the species and so may not reflect the actual occurrence location. There are a large number of records from 2019 located within 20 km to the north of the Project from 2019 located within 20 km of the disturbance footprint. All of these records are likely associated with a well known pair of birds that occurred in urban parklands in the Springfield Lakes area over an extended period of time in winter 2019 (pers. comm. B Taylor) and located 18 km north-west of the Project. There are a number of other records from the wider Brisbane area to the north of the Project including relatively recently records from Ipswich (2013 and 2015) (refer Figure 6.23 in Appendix B). Records to the south of the Project include Main Range National Park (2000) and an older record (<1980) from Mount Alford area. Both of these records are over 30 km south of the disturbance footprint (AoLA 2020).

Recovery plans/threat abatement plans

The *National Recovery Plan for the Regent Honeyeater (Anthochaera phrygia)* (DotE 2016) has been adopted by DAWE and has been in effect since May 2016. The Plan identifies the following threatening processes as applicable to the species:

- Small population size
- Habitat loss, fragmentation and degradation
- Competition with other nectivorous bird species as well as European honeybees (*Apis mellifera*).

Other identified threats include:

- Suppression of natural regeneration of overstorey tree species and shrub species as a result of overgrazing
- Disturbance to nesting sites leading to abandonment (DES 2017a).

The following threat abatement plan has been identified has been adopted as relevant to this species:

- *Threat abatement plan for competition and land degradation by rabbits* (DotE 2016).

Important populations and *Habitat critical to the survival of the species*

The species is considered to occur as single widespread inter-breeding population (Garnett et al 2011). The overall population is difficult to define due to fluctuating numbers between years but is estimated at 350 to 400 mature individuals (Garnett et al 2011). The *National Recovery Plan for the Regent Honeyeater (Anthochaera phrygia)* (DotE 2016) identifies the following as habitat critical to the survival of the Regent honeyeater:

- Any breeding or foraging area where the species is likely to occur
- Any newly discovered breeding or foraging areas.

Three known key breeding regions include:

- North-east Victoria (Chiltern-Albury)
- Capertee Valley NSW
- Bundarra-Barraba region NSW (DotE 2016).

The nearest breeding site to the Project is the Durikai area over 100 km south-west of the Project. The species appears to irregularly occur in the Ipswich area to the north of the Project. The species forages widely and may as easily occur in modified urban environments as well as natural woodlands and has not been identified as occurring in the MNES study area. The species may sporadically occur as foraging individuals/pairs within the disturbance footprint during flowering events but it is not considered 'likely to occur'. This assessment has defined *Habitat critical to the survival of the species* by applying a 1 km buffer on known records that intersect '*potential habitat*' for the species (refer Appendix A for methodology). As such, the disturbance footprint is not considered to comprise habitat critical to the survival of the species.

Impacts and mitigation measures associated with this species are identified within Table 5.7. Impact assessment for this species predicts that 11.43 ha of *potential habitat* used for foraging may be impacted under the current disturbance footprint (refer Table 5.4 and habitat figure in Appendix G). Assessment of potential impacts to this species against the MNES significant impact assessment criteria is provided in Table 5.15.

Table 5.15 Assessment against the significant impact criteria – Regent honeyeater

Criterion	Assessment against significance criteria
Lead to a long-term decrease in the size of a population	As noted above there are no identified important populations, breeding locations or *Habitat critical to the survival of the species* as identified in the *National Recovery Plan for the Regent Honeyeater (Anthochaera phrygia)* (DotE 2016) which are within or near the MNES study area. The nearest known breeding location is Durikai State Forest which is over 100 km south-west of the Project. However, the species now rarely visits the Durikai (Gore-Karara) region (NESPTSRH 2019). Key breeding regions include: ▪ North-east Victoria (Chiltern-Albury) ▪ Capertee Valley NSW ▪ Bundarra-Barraba region NSW (DotE 2016). The species is considered to occur as a single interbreeding population across its range. The species is only likely to occur in the MNES study area transiently (in winter during flowering events) in small numbers, if the species occurs in the area at all. No individuals have been observed during field investigations associated with the Project. It is uncertain how many individuals occur in the area or if the species occurs in the area at all. The nearest database record (AoLA) is located approximately 6 km from the Project, however this record is classified as sensitive and has been generalised to 0.1 degrees and is likely to be located further away from the Project. It is considered likely that foraging individuals disturbed by construction activities will temporarily move away from the area of disturbance and return post-construction. Predictive mapping for this species predicts that 11.43 ha of potential foraging habitat may be impacted under the current disturbance footprint. Nevertheless, the species can occur in woodland, and disturbed habitats (including urban areas). The Project alignment is linear and there will be substantial tracts of foraging habitat remaining undisturbed adjacent to the north and south of the Project. The Project is considered unlikely to result in a long-term decrease in the size of a population.
Reduce the area of occupancy of the species	The area of occupancy is estimated to be 300 km^2, with the species mainly occurring in dry box ironbark open-forest and woodland areas inland of the Great Dividing Range, particularly favouring those on the wettest, most fertile soils, such as along creek flats and broad river valleys. The Project is located to the east of the Great Dividing Range, with the species known from vagrant records in the region. The nearest database record (AoLA) is located approximately 6 km from the Project (generalised to 0.1 degrees) and no individuals were observed during field investigations associated with the Project. The species now rarely visits the Durikai (Gore-Karara) region of Queensland (NESPTSRH 2019) where the majority of Queensland records are from. This may be a result of recent dry conditions in the region. Drought conditions reduces the number of locations where high quality food may be found in the landscape by suppressing flowering events in key eucalypt species). It is estimated the Project will result in the loss of 11.43 ha of *potential habitat* for the species, although this represents predicted habitat. The species is only likely to occur in the MNES study area transiently (in winter during flowering events) in small numbers, if the species occurs in the area at all. Therefore, the Project is not likely to reduce the potential area of occupancy for the species.

Criterion	Assessment against significance criteria
Fragment an existing population into two or more populations	The species is highly mobile and the Project is not considered to represent a barrier to movement for the species. It is considered unlikely that the Project will fragment an existing population into two or more populations.
Adversely affect *Habitat critical to the survival of the species*	The *National Recovery Plan for the Regent Honeyeater (Anthochaera phrygia)* (DotE 2016) identifies the following as habitat critical to the survival of the Regent honeyeater: ▪ Any breeding or foraging area where the species is likely to occur ▪ Any newly discovered breeding or foraging areas. The Project is located east of the Great Dividing Range in an area mapped as where the species may occur (DAWE 2020a), The Project is located 100 km north-east of a key region known to support this species (breeding and foraging) in Queensland (i.e. Durikai State Forest and surrounds). No individuals have been observed foraging or breeding within or adjacent the Project disturbance footprint, with the nearest database record (AoLA) located approximately 6 km from the Project (generalised to 0.1 degrees). The absence of the species may be the extended dry weather reducing the number of sites where high quality food may be found in the landscape, noting that over 920 ha of *potential habitat* has been predicted to occur with the MNES study area. Recent studies have however noted this species now rarely visits the Durikai (Gore-Karara) region (NESPTSRH 2019), much less the area associated with the Project. As such the Project disturbance footprint does not include any habitat critical to the survival of the species. It is considered unlikely that the Project will adversely affect *Habitat critical to the survival of the species*.
Disrupt the breeding cycle of a population	The species' distribution extremely patchy with a small number of known breeding sites. There are three known key breeding regions include: ▪ North-east Victoria (Chiltern-Albury) ▪ Capertee Valley NSW ▪ Bundarra-Barraba region NSW (DotE 2016). The nearest breeding records are located in Durikai State Forest and are over 100 km south-west of the Project. This area is considered to be habitat critical for the species given the area is known to support the species. No breeding habitat of breeding is likely to occur within or adjacent the Project. It is considered unlikely that the Project will disrupt the breeding cycle of a population.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	There are no historical records of the species within the MNES study area and the species is currently considered as rare in the region. The Project alignment is linear and there will be substantial tracts of suitable habitat remaining undisturbed adjacent to the north and south of the disturbance footprint. The 11.43 ha of predicted habitat that is estimated to be cleared is not considered critical to the survival of the species. The nearest *Habitat critical to the survival of the species* is in Durikai State Forest over 100 km south-west of the disturbance footprint. The species can occur in woodland, and disturbed habitats (including urban areas). The Project alignment is linear and there will be substantial tracts of suitable habitat remaining undisturbed adjacent to the north and south of the disturbance footprint. This impact is not considered to be of the extent that the species is likely to decline.
Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the critically endangered or endangered species' habitat	Habitat degradation by European rabbit (*Oryctolagus cuniculs*) has been identified as a threatening process for Regent honeyeater (DotEE 2016). Rabbits were identified as present but uncommon during Project-associated surveys. There are no particular weed species identified as relevant to the species. Project-associated surveys have noted areas within the alignment are already heavily infested with weed species including 20 species listed as restricted matters under the Queensland *Biosecurity Act 2014* (EMM 2018b, 2018c). Relevant habitats for the species (eucalypt open forest and woodlands) within the MNES assessment area were often noted to have high levels of introduced species including *Lantana camara* and *Opuntia* species (Jacobs-GHD 2016a). Weed and pest control measures will be incorporated into the Project Biosecurity Management Plan to control the introduction and spread of weed and pest species across the disturbance footprint and surrounds covering both construction and operation activities. The Plan will be in place for the life of the Project and will minimise the potential for weed invasion and potential use of Project infrastructure as shelter by pest fauna such as European rabbit. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.

Criterion	Assessment against significance criteria
Introduce disease that may cause the species to decline	The Project Biosecurity Management Plan will incorporate the management of invasive species which will assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.
Interfere with the recovery of the species	Recovery strategies listed in the *National Recovery Plan for the Regent Honeyeater (Anthochaera phrygia)* (DotE 2016) include: ▪ Improve the extent and quality of Regent honeyeater habitat ▪ Bolster the wild population with captive-bred birds until the wild population becomes self-sustaining ▪ Increase understanding of the size, structure, trajectory and viability of the wild population ▪ Maintain and increase community awareness, understanding and involvement in the recovery program The Project is considered unlikely to interfere with any of the recovery strategies listed above to the extent it will interfere with the recovery of the species. Should Regent honeyeater be identified during Project activities this will contribute to current information on the species in the south-east Queensland region.
Assessment of potential for significant residual impacts	Under the nine-part test detailed above, there is unlikely to be a 'significant residual impact' on Regent honeyeater as a result of the Project.

Australasian bittern (*Botaurus poiciloptilus*) - endangered

Ecology and distribution

The Australasian bittern (*Botaurus poiciloptilus*) is a large stocky, partially nocturnal heron which can reach up to a total body length of 75 cm with a wingspan just over 1 m. Australian bittern is largely a solitary species although sometimes can be found in pairs or small dispersed groups. Preferred habitat for the Australasian bittern consists of permanent freshwater wetlands with tall dense vegetation including bulrushes (*Tyhpa* spp.), spikerushes (*Eleocharis* spp.) and tall emergent sedges. Rice paddies within the Murray-Darling basin are a known habitat for the species who disperse widely during periods of droughts to coastal wetlands and to ephemeral wetlands. The species breed around summer, between October and February, as solitary pairs and begin building nests in secluded, densely vegetated wetlands on platforms of reeds approximately 30 cm above water level. (Birdlife International 2016b; Office of Environment and Heritage (OEH) 2017a).

This species occurs from Bundaberg in south-east Queensland south to Victoria and west into South Australia.

Distribution in context to the Project

The species was not identified during Project surveys, although dry conditions at the time likely precluded the species from being present. Database records indicate that the species is known from within approximately 10 km of the disturbance footprint with the closest record located 5 km west of the Project in the Harrisville area. It is noted this record is undated and has been generalised to protect the species and so may not reflect the actual occurrence location. There are several similar records in the region to the north of the Project. The nearest dated records include from Lake Clarendon (near Gatton) (2009) approximately 25 km north-west of the disturbance footprint and from Mount Tamborine (2001) located 24 km to the east (AoLA 2020) (refer Figure 6.2 in Appendix A). Lake Clarendon is identified as a 'key area' for sightings of the species. Population estimates of the number of adult birds in Queensland from 2009 to 2010 are 3 to 16 individuals in Queensland (Garnett et al 2011).

Wetland habitats within the MNES study area include dams and reservoirs (lacustrine), wetlands associated with the floodplains of major watercourses (riverine) and vegetated swamps (palustrine). Dams and reservoirs are generally unlikely to provide suitable habitat values for the species (abundant tall aquatic vegetation). Riverine wetlands associated with floodplains are ephemeral and typically vegetated by a mixture of native and non-native grasses and grass-like plants and Queensland blue gum (*Eucalyptus tereticornis*). Floodplain areas were all observed to be dry during the site surveys for the Project. Palustrine wetlands within the MNES study area typically occur on alluvial floodplains and are dominated by grasses (*Poaceae*), rushes (*Restionaceae*) and sedges (*Cyperaceae*) (refer EIS Appendix J: Terrestrial and Aquatic Ecology Technical Report for further detail regarding wetland values). Areas of remnant Palustrine wetland within the MNES study area are represented by RE 12.3.8 and are considered the most likely wetland habitat present with suitable values for Australasian bittern although these areas are highly ephemeral in nature (refer Section 4.4.4.5). Current Queensland vegetation mapping indicates this community occupies 42.43 ha within the disturbance footprint.

Recovery plans/threat abatement plans

There is currently a draft *National recovery plan for the Australasian bittern (Botaurus poiciloptilus*) (DotEE 2019b) awaiting adoption by DAWE. The draft Plan identifies the following threatening processes as applicable to the species:

- Reduced wetland availability due to changed hydrology
- Habitat loss and degradation such as reduced water quality
- Low genetic diversity
- Invasive species including herbivores impacting habitat (horses, pigs, goats and deer) and predators (red fox, cats, rats and pigs)
- Climate variability and change.

The following threat abatement plans have been identified as being relevant to this species:

- *Threat abatement plan for predation by feral cats* (DotE 2015c)
- *Threat abatement plan for predation by the European red fox* (DEWHA 2008g).

Important populations and *Habitat critical to the survival of the species*

The draft *National recovery plan for the Australasian bittern (Botaurus poiciloptilus*) (DotEE 2019b) identifies all populations of Australasian bittern should be considered as important. Habitat 'critical to the survival of the species' is described as:

- Any wetland habitat where the species is known or likely to occur (breeding or foraging habitat) within the indicative distribution map
- Any location with suitable habitat outside the above area that may be periodically occupied by Australasian Bittern.

It is uncertain the disturbance footprint is located within the known or likely to occur habitat mapped within the distribution map.

Impacts and mitigation measures associated with this species are identified within Table 5.7. Predictive habitat modelling for the species estimates that 42.43 ha of *potential habitat* may be impacted under the current disturbance footprint (refer Table 5.4 and habitat figure in Appendix G). *Habitat critical to the survival of the species* is not considered to occur. The predictive habitat mapping has been approached in a conservative manner and is based on the inclusion of all wetland habitat within the disturbance footprint (refer Appendix A for methodology). This is largely modelled on available vegetation and corresponding wetland community mapping as provided by DES. This includes creek line vegetation and waterbodies and farm dams which are much less likely to present suitable habitat values (tall aquatic vegetation) for the species. Given the ephemeral nature of most natural wetlands in the area the predictive habitat figure is likely to be an overestimation of the available habitat suitable for this species in the disturbance footprint.

Nevertheless, given suitable habitat is predicted to be present and under the definition identified above there is potential the Project will impact *potential habitat* for Australasian bittern. Assessment of potential impacts to this species against the MNES significant impact assessment criteria is provided in Table 5.16.

Table 5.16 Assessment against the significant impact criteria – Australasian bittern

Criterion	Assessment against significance criteria
Lead to a long-term decrease in the size of a population	The species occurs as a widely dispersed population (estimated at 3,500 individuals) across south-eastern Australia. As such, no resident population can be attributed to the MNES study area or immediate surrounds. There are no records of this species within or adjacent to the MNES study area, though habitat is known to exist in the Lockyer Valley which is likely to be large permanent wetlands (DotEE 2019b). This is supported by database records, with several records of the species in the wider area surrounding the Project including Lake Clarendon and Warrill Creek upstream of the Project. Should the species occur within the disturbance footprint it is unlikely to occur as more than one or two individuals at a site (i.e. the Project is unlikely to impact a population). As outlined in Section 4.4.4 and above there are a number of wetlands present within and surrounding the Project. Predictive mapping estimates that 42.43 ha of *potential habitat* will be impacted by the Project although this is likely to be a substantial overestimation given that the wetlands systems present are ephemeral and have limited vegetation cover with dense vegetation a key feature of preferred habitat. The condition characteristics of these systems across the Project disturbance footprint is variable, with it unknown at this stage to what extent the predicted wetland habitat comprises values suitable for the presence of Australasian bittern (i.e. the majority of the wetlands were dry during the field surveys and the values could not be confirmed). As noted in Section 5.1.2 the Project has the potential to impact on aquatic habitats within and downstream of the Project disturbance footprint. Construction activity at watercourse crossings will disturb the riparian zone and instream habitats, including *potential habitat* for the species. Activities will include clearing of vegetation, reprofiling of banks and instream substrate, deposition of material (e.g. rip rap for erosion and sediment control), erection of temporary barriers (e.g. coffer dam), water extraction, disturbance of sediment causing elevated nutrients and turbidity, and result in the loss of wetlands and direct disturbance of local populations (should they occur within the Project disturbance footprint). However, the species is less likely to occur in riverine environments and this disturbance is expected to be restricted to the construction period with occasional works during the operation of the Project (design life of 100 years). The Project will not create any permanent barriers to flow as watercourse crossings will consist of bridges or culverts. Following construction localised habitat suitable for the species is expected to return to its prior natural conditions. The use of bridge structures across some of the major watercourses and associated floodplains (e.g. Bremer River) will also avoid and/or minimise the impact to riparian zones, wetlands and instream habitat (e.g. footings are outside the channel or the highwater banks). Flood modelling (refer EIS Appendix N: Hydrology and Flooding Technical Report) indicates local changes to the catchment hydrology is minimal, including on Ten Mile Swamp and Gammies Swamp which are likely to be used by a range of wetland species when conditions are more optimal. Under the Project Flora and Fauna Sub-plan pre-construction surveys will be carried out following optimal (wet) conditions to assess whether wetland habitat values are suitable for the species, and if so, if the species actually occurs. Surveys will follow Commonwealth survey guidelines for the species (e.g. DEWHA 2010a). If the species or habitat is identified during pre-construction surveys, further pre-clearance surveys will be carried out to assess whether the species is present with mitigation measures in place should this be the case (refer Table 5.7). Should the species be found individuals would be expected to disperse as a result of construction activities. The impacts of the Project are considered unlikely to lead to a long-term decrease in the size of the population.

Criterion	Assessment against significance criteria
Reduce the area of occupancy of the species	There are no records of this species within or adjacent to the disturbance footprint. Predictive mapping estimates that 42.43 ha of *potential habitat* may be impacted by the Project, although this is likely to be a substantial overestimation. It is unknown at this stage to what extent the predicted wetland habitat within the disturbance footprint comprises values suitable for the presence of Australasian bittern. No database records of the species occur within the MNES study area, although there are several records in the wider surrounds. It is unknown to what extent the species may utilise wetland habitats associated with the disturbance footprint, or if it occurs at all. The species is highly nomadic and unlikely to use these areas in more than a transient manner dependent on local conditions. The impacts of the Project are considered unlikely to reduce the area of occupancy of the species.
Fragment an existing population into two or more populations	The species is highly mobile. Individuals have been shown to disperse over 100 km in response to changing wetland conditions (Bitterns in Rice Project 2016). The Project is not considered to represent a barrier to movement for the species. It is considered unlikely that the Project will fragment an existing important population into two or more populations.
Adversely affect *Habitat critical to the survival of the species*	There are no records of this species within or adjacent to the disturbance footprint. Predictive mapping estimates that 42.43 ha of *potential habitat* will be impacted by the Project, although this is likely to be a substantial overestimation. *Habitat critical to the survival of the species* is not considered to occur within or adjacent the Project disturbance footprint. There Project is considered unlikely to adversely affect *Habitat critical to the survival of the species*.
Disrupt the breeding cycle of a population	The species is known to breed from October to February, nesting in densely vegetated freshwater wetlands, building nests within dense cover over shallow water placed about 30 cm above the water level. This type of habitat is absent/limited from the Project disturbance footprint, but is potentially present in association with Ten Mile Swamp and Gammies Swamp (i.e. these swamps were dry at the time of the surveys and as such were more open wetland systems). It is noted that if population densities are high, the species may resort to more open wetlands for nesting (DotEE 2019a). However, the population in Queensland is considered low, with Garnet (2011) estimating it to be between 3 and 16 mature individuals. Pre-clearance surveys will be carried out during more optimal periods to assess whether wetland habitat values are suitable for the species within and surrounding the Project disturbance footprint, and where suitable habitat is identified whether the species actually occurs. Should the species be observed as nesting measures will developed and implemented within the Project EMP to allow nesting to occur undisturbed (refer Table 5.7). It is considered unlikely that the Project will disrupt the breeding cycle of a population.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	There are no records of this species within of adjacent to the disturbance footprint. Predictive mapping estimates that 42.43 ha of *potential habitat* will be impacted by the Project, although this is likely to be a substantial overestimation. Predictive habitat mapping also identifies approximately 550 ha of additional *potential habitat* within the MNES study area. It is unlikely much of this area is of a suitable quality to support the species (i.e. most are riverine wetlands open palustrine wetlands), though Ten Mile Swamp and Gammies Swamp may be suitable habitat for the species. Through Project design considerations changes to hydrological conditions in the area are expected to be minor at worst, localised and transient (during flood events) and are unlikely to impact *potential habitat* for the species. Mitigation measures will be in place to ensure surface water quality associated with the Project surrounds is not impacted as a result of Project activities (e.g. erosion and sediment controls and water quality monitoring program) (refer Table 5.7). The Project would impact suitable habitat to the extent the species would decline.

Criterion	Assessment against significance criteria
Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the critically endangered or endangered species' habitat	There are no particular weed species identified as relevant to Australasian bittern, although invasion of wetland habitat by weeds is considered a potential threat (TSSC 2019). Project-associated surveys have noted aquatic weeds (Canadian pondweed (*Elodea* spp.) and Water hyacinth (*Eichhornia* crassipes)) as currently present within the MNES study area. Surveys also recorded predators thought to be a threat to the species: Red fox (*Vulpes Vulpes*), feral pig (*Sus scrofa*) and Black rat (*Rattus rattus*). Feral cat was not recorded but is likely present. Weed and pest control measures will be incorporated into the Project Biosecurity Management Plan to control the introduction and spread of weed and pest species across the disturbance footprint and surrounds covering both construction and operation activities. This will include measures to ensure aquatic weeds are not introduced as a result of the Project. The Project is not expected to lead to increased abundances of introduced predator species. Nevertheless, measures will be incorporated to monitor pest species observations associated with Project activities, and pest control actions where considered necessary. The Plan will be in place for the life of the Project and will minimise the potential for weed invasion and pest proliferation and may in the long-term improve habitat condition within vegetation communities located adjacent to Project infrastructure. Pest measures will ensure feral predators (i.e. wild dogs/dingo, Red fox and pigs) are controlled in areas associated with Project activities. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.
Introduce disease that may cause the species to decline	The Project Biosecurity Management Plan will incorporate the management of invasive species which will assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.
Interfere with the recovery of the species	Conservation objectives listed in the draft Commonwealth recovery plan for the species (DotEE 2019b) include: ▪ Identify the key sites where Australasian Bitterns occur throughout their range and establish a baseline measure of abundance. This baseline will then be used to track change over time. ▪ Manage key sites to ensure habitat is suitable for Australasian Bitterns. This will require measures that primarily target adequate water flow and quality, and measures to ensure weed species and grazing animals do not compromise wetland structure and function. ▪ Improve understanding of foraging and breeding behaviour, in order to better design recovery actions. ▪ Engage community and stakeholders in Australasian Bittern conservation. The Project is considered unlikely to interfere with any of the recovery strategies listed above. Key sites are unlikely to occur and should Australasian bittern be identified during Project activities this will contribute to current information on the species in the south-east Queensland region.
Assessment of potential for significant residual impacts	Under the nine-part test detailed above, there is unlikely to be a 'significant residual impact' on Australasian bittern as a result of the Project.

Curlew sandpiper (*Calidris ferruginea*) – critically endangered

Ecology and distribution

In Australia, the Curlew sandpiper forages mainly on invertebrates, including worms, molluscs, crustaceans, and insects, as well as seeds. Curlew sandpipers usually forage by pecking and probing in water, near the shore or on bare wet mud at the edge of wetlands. They glean from mud, from the surface of water, or in drier areas above the edge of the water. Curlew sandpipers mainly occur on intertidal mudflats in sheltered coastal areas, such as estuaries, bays, inlets and lagoons, non-tidal swamps, lakes and lagoons near the coast, and ponds in saltworks and sewage farms. They have also been recorded inland around ephemeral and permanent lakes, dams, waterholes and bore drains, usually with bare edges of mud or sand (DAWE 2020b).

The species breeds in Siberia in the northern hemisphere summer. The species has been recorded in all Australian states and territories. In Queensland, widespread records occur along the coast south of Cairns with sparsely scattered records inland. The species migrates to Australia in the non-breeding season arriving in early September and leaving in March-April. Younger birds may over-winter in Australia (DotE 2015d).

Distribution in context to the Project

Database records (i.e. AoLA, Wildlife Online) indicate the species is known from within 50 km of the Project disturbance footprint. A single older record (<1982) is located on the edge of the MNES study area (north-east of Peak Crossing), however, this record has a high spatial uncertainty attached and no location information and as such has been disregarded. The closest recent inland record (2001) of the species to the Project is from Lake Dyer (Bill Gunn dam) in the Laidley area approximately 15 km west of the western extent of the MNES study area (AoLA 2020). There are also recent records from the wider Gatton area including 2017 and 2018 records from Lake Clarendon (25 km north-west of the Project), a 2009 record from Janke's Swamp (25 km north-west of the Project) and 2003 records from Atkinson's Lagoon in Gatton (27 km north of the Project). The majority of records from the region are coastal or from inshore islands in Moreton Bay (refer Figure 6.13 in Appendix B).

Recovery plans/threat abatement plans

There is no Commonwealth adopted recovery plan or threat abatement plans applicable to this species.

The DAWE Approved conservation advice (DotE 2015d) notes the following potentially threatening processes identified for Australian habitat as relevant to Curlew sandpiper:

- In non-breeding grounds in Australia, this species mostly occurs in highly populated areas and is therefore vulnerable to possible habitat alteration
- Threats to the Curlew sandpiper include the loss and fragmentation of feeding and roosting habitat from human development, human disturbance at roost and feeding sites, disturbance by wild dogs, water pollution and invasive plants.

Important populations and *Habitat critical to the survival of the species*

The breeding population of Curlew sandpiper migrating to Australia occurs across much of the Australian coastline as well as some inland sites. As such there is no important population relevant to individual locations. There is no description of *Habitat critical to the survival of the species*. '*Nationally important habitat'* for migratory shorebirds in Australia is described as comprising 0.1 per cent of the flyway population of a single species of migratory shorebird (DotE 2017). For Curlew sandpiper this equates to 90 individuals based on current population estimates (Hansen et al 2016). There is no evidence the disturbance footprint or surrounding MNES study area comprises any areas of suitable wetland habitat capable of supporting this many individuals. All known inland records of the species occurrence in the local region are located on large permanent or semi-permanent waterbodies in the Lockyer Valley (e.g. Lake Clarendon and Atkinson's Lagoon) and located well away from the Project. The nearest '*nationally important habitat'* for migratory waders to the Project is the Moreton Bay Ramsar wetland area which is located over 30 km downstream of the Project.

Impacts and mitigation measures associated with this species are identified within Table 5.7. The Project is predicted to impact 38.15 ha of *potential habitat* for Curlew sandpiper under the predictive mapping approach used for this assessment (refer Table 5.4 and habitat figure in Appendix G). However, the predictive habitat mapping has been approached in a conservative manner and is largely modelled on available vegetation and corresponding wetland communities mapping provided by DES. This includes riverine habitats and farm dams which are much less likely to provide suitable habitat values for the species. Given the species coastal habits and the ephemeral nature of most natural wetlands in the area the predictive habitat figure is likely to be a substantial overestimation of the available habitat suitable for this species in the disturbance footprint. In the absence of a definition for *Habitat critical to the survival of the species* this assessment has applied a 1 km buffer on known records that intersect '*potential habitat*' (refer Appendix A for methodology). As such, there is no *Habitat critical to the survival of the species* identified within or close to the disturbance footprint.

Assessment against the significant impact criteria for endangered species is shown in Table 5.17.

Table 5.17 Assessment against the significant impact criteria – Curlew sandpiper

Criterion	Assessment against significance criteria
Lead to a long-term decrease in the size of a population	Based on habitat modelling the Project is predicted to impact 38.15 ha of *potential habitat* for Curlew sandpiper although this is likely a substantial overestimation (i.e. habitat mapping includes watercourses mapped as riverine wetlands/waterbodies, although the species is not associated with this type of habitat). In addition, bridge structures will be provided to avoid/minimise impacts on instream habitats and wetlands (e.g. a 684 m viaduct is proposed across the Bremer River and associated floodplain). As noted in Section 5.1.2 the Project has the potential to impact on aquatic habitats within and downstream of the Project disturbance footprint. Construction activity at watercourse crossings will disturb the riparian zone and instream habitats, including potential habitat for the species. Activities will include clearing of vegetation, reprofiling of banks and instream substrate, deposition of material (e.g. rip rap for erosion and sediment control), erection of temporary barriers (e.g. coffer dam), water extraction, disturbance of sediment causing elevated nutrients and turbidity, and result in the loss of wetlands and direct disturbance of local populations (should they occur within the Project disturbance footprint). However, the species is very unlikely to occur in riverine environments and this disturbance is expected to be restricted to the construction period with occasional works during the operation of the Project (design life of 100 years). The Project will not create any permanent barriers to flow as watercourse crossings will consist of bridges or culverts. Following construction localised habitat suitable for the species is expected to return to its prior natural conditions. The use of bridge structures across some of the major watercourses and associated floodplains (e.g. Bremer River) will also avoid and/or minimise the impact to riparian zones, wetlands and instream habitat (e.g. footings are outside the channel or the highwater banks). As outlined in Section 4.4.4 there are a number of habitats present within and surrounding the Project disturbance footprint, including Ten Mile Swamp and Gammies Swamp. Flood modelling (refer EIS Appendix N: Hydrology and Flooding Technical Report) indicates local changes to the catchment hydrology is minimal, including on Ten Mile Swamp and Gammies Swamp which are likely to be used by a range of wetland species when conditions are more optimal. The Project is unlikely to impact feeding and roosting habitat for the species which is likely the key threat from the Project that would lead to the long term decrease in the size of the population. Noting the species breeds in the northern hemisphere and predominantly utilise intertidal wetlands (i.e. the species occurs as a dispersed population around coastal Australia, with inland records potentially individuals resting during migration). The Project is unlikely to result in a long-term decrease in the size of a population of Curlew sandpiper.

Criterion	Assessment against significance criteria
Reduce the area of occupancy of the species	Based on habitat modelling the Project is predicted to impact 38.15 ha of *potential habitat* for Curlew sandpiper although this is likely a substantial overestimation. However, it is unknown if the species actually occurs within or near the Project, and it is unlikely the disturbance footprint or surrounds comprises habitat likely to support large numbers of individuals of the species. There are no historic records of this species within or adjacent to the disturbance footprint. The species occurrence is largely coastal and the nearest reliable database record is located inland in the region (15 km west of the disturbance footprint). Inland records are also thought to be individuals resting along the migratory pathway. The species occurs as a dispersed population around coastal Australia. The Project is considered unlikely to reduce the potential area of occupancy for the species.
Fragment an existing population into two or more populations	The population of Curlew sandpiper is distributed across much of coastal Australia. It is considered inconceivable the Project will fragment an existing population into two or more populations.
Adversely affect habitat critical to the survival of a species	The disturbance footprint does not comprise *Habitat critical to the survival of the species* as described for this assessment (refer Table 5.4 and Appendix A), or *nationally important habitat* as described by DotE (2017). There is also no *Habitat critical to the survival of the species* within the MNES study area or directly downstream (10 km) of the Project. It is considered unlikely that the Project will adversely affect *Habitat critical to the survival of the species*.
Disrupt the breeding cycle of a population	The species breeds in the northern hemisphere and it is considered unlikely that the Project will disrupt the breeding cycle of a population.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	There are no historic records of this species within or adjacent to the disturbance footprint. However, based on habitat modelling the Project is predicted to impact 38.15 ha of suitable habitat for Curlew sandpiper although this is likely a substantial overestimation (i.e. habitat mapping includes watercourses mapped as riverine wetlands/waterbodies, although the species is not associated with this type of habitat). In addition, bridge structures will be provided to avoid/minimise impacts on instream habitats and wetlands (e.g. a 684 m viaduct is proposed across the Bremer River and associated floodplain). Predictive habitat mapping also identifies approximately 560 ha of additional *potential habitat* within the MNES study area. It is unlikely much of this area is of a suitable quality to support the species (i.e. most are riverine wetlands), although Ten Mile Swamp and Gammies Swamp may be suitable habitat for the species. Through Project design considerations changes to hydrological conditions in the area are expected to be minor at worst, localised and transient (during flood events) and are unlikely to impact potential habitat for the species. Mitigation measures will be in place to ensure surface water quality associated with the Project surrounds is not impacted as a result of Project activities (e.g. erosion and sediment controls and water quality monitoring program) (refer Table 5.7). Nevertheless, the species occurrence is largely coastal. The Project is not considered likely to impact habitat for the species to the extent that the species is likely to decline.
Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat	There are no particular weed species identified as relevant to Curlew sandpiper, although invasion of wetland habitat by weeds is considered a potential threat (DotE 2015d). Project-associated surveys have noted aquatic weeds (Canadian pondweed (*Elodea* spp.) and Water hyacinth (*Eichhornia* crassipes)) as currently present within the MNES study area. Weed and pest control measures will be incorporated into the Project Biosecurity Management Plan to control the introduction and spread of weed and pest species across the disturbance footprint and surrounds covering both construction and operation activities. This will include measures to ensure aquatic weeds are not introduced as a result of the Project. The Plan will be in place for the life of the Project and will minimise the potential for weed invasion and may in the long-term improve habitat condition within vegetation communities located adjacent to Project infrastructure. Pest measures will ensure feral predators (i.e. wild dogs/dingo) are controlled in areas associated with Project activities. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.
Introduce disease that may cause the species to decline	The Project Biosecurity Management Plan will incorporate the management of invasive species which will assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.

Criterion	Assessment against significance criteria
Interfere with the recovery of the species	There is no recovery plan for Curlew sandpiper or migratory shorebirds in general. The Approved conservation advice for this species (DotE 2015d) notes the following management actions: ▪ Improve protection, management, and monitoring of roosting and feeding sites ▪ Control of invasive species at important sites ▪ Manage disturbance at important sites (e.g. horse riding, pet dog controls, and vehicle access) ▪ Incorporate coastal planning and management requirements addressing Curlew sandpiper. The Project is considered unlikely to interfere with the management actions listed above and is very unlikely to interfere with the recovery of the species.
Assessment of potential for significant residual impacts	Under the nine-part test detailed above, there will be no 'significant residual impact' on Curlew sandpiper as a result of the Project.

Spotted-tail quoll (Dasyurus maculatus maculatus) - endangered

Ecology and distribution

Spotted-tail quolls have been recorded from a wide range of habitats, including temperate and subtropical rainforests in mountain areas, wet sclerophyll forest, lowland forests, open and closed eucalypt woodlands, inland riparian and River red gum (*Eucalyptus camaldulensis*) forests, dry 'rainshadow' woodland, sub-alpine woodlands, coastal heathlands and occasionally in open country/other treeless areas. Habitat requirements include suitable den sites such as hollow logs, tree hollows, rock outcrops or caves (DAWE 2020b). The species requires large home ranges of several hundred hectares (Victorian Department of Environment, Land, Water and Planning (DELWP) 2016).

In Queensland, the Spotted-tail quoll occurs in the southeast, coastally from Bundaberg to the NSW border, and inland to Monto and Stanthorpe. Spotted-tail quolls are known from five broad geographic regions: four from coastal ranges and the Great Dividing Range from the NSW border to Gladstone. The fifth is centred on the eastern Darling Downs-Inglewood Sandstone provinces of the Brigalow Belt South Bioregion. Unconfirmed reports suggest the subspecies may also occur in the Clarke and Conway Range areas, along the central Queensland coast.

Distribution in context to the Project

There are a number of database records in the region surrounding the MNES study area. The nearest records are two older records (1930 and 1970) located in the Wyaralong area 6 km south of the disturbance footprint, and a 1975 record near Rosewood (4.5 km north). There are a number of recent (post 2000) records located between 10 km east and 25 km north-east of the Project in the Greenbank-Jimboomba area (refer Figure 5.18 in Appendix B) (AoLA 2020). Recent surveys using scent detection dogs carried out by the Wildlife Preservation Society of Queensland indicate the species may still occur in the Flinders Peak area. The overall population (including all subspecies) is not reliably known but is estimated to be 20,000 mature individuals (Woinarski et al 2014).

Habitat assessments carried out for the EIS studies identified very little suitable rocky denning habitat within the MNES study area and none within the disturbance footprint itself (refer habitat assessment sheets in Appendix I). However, other den features such as hollow logs and tree hollows were noted throughout the MNES study area, including Teviot Range.

Recovery plan/threat abatement plans

The *National recovery plan for the Spotted-tail quoll (Dasyurus maculatus*) (DEWLP 2016) identifies the following threatening processes as applicable to the species:

- Habitat loss and fragmentation
- Targeted killing and poison baiting (directed at introduced predators)
- Ingestion of Cane toads (*Rhinella marina*)
- Invasive predators (red fox, cats and wild dogs)
- Road mortality
- Climate change and increased fire frequency/intensity.

The following threat abatement plans have been identified as being relevant to this species:

- *Threat abatement plan for predation by feral cats* (DotE 2015c)
- *Threat abatement plan for predation by the European red fox* (DEWHA 2008g).

Important populations and *Habitat critical to the survival of the species*

Important populations in southern Queensland include the Granite belt region around Stanthorpe, the Cherrabah area, the ranges extending from Main Range to Lamington National Parks, the Burnett Range and the Dalby region (DEWLP 2016). Main Range and Lamington National Parks are located over 30 km south from the MNES study area.

The recovery plan describes habitat critical to the survival of Spotted-tail quoll as 'large patches of forest with adequate denning resources and relatively high densities of medium-sized mammalian prey' (DEWLP 2016). The recovery plan also notes given the difficulty defining the threshold habitat requirements of these resources it is currently impossible to map *Habitat critical to the survival of the species*. This assessment has taken a conservative approach and included all areas of '*potential habitat*' that intersect with remnant vegetation that are greater than 200 ha in size (given the species extensive home range) as *Habitat critical to the survival of the species* (refer Appendix A for further information).

Impacts and mitigation measures associated with this species are identified within Table 5.7. The Teviot Range extending north and south of the eastern portion of the disturbance footprint comprises an extensive tract of relatively contiguous habitat which may support the species. The Project is predicted to impact 69.44 ha of *potential habitat* and 6.92 ha of *Habitat critical to the survival of the species* for the species under the approach used for this assessment (refer Table 4.5, Table 5.4 and habitat figure in Appendix G). This assessment has taken a conservative approach and the identified habitat is likely to comprise foraging habitat rather than denning/breeding sites. The following significant impact assessment (refer Table 5.18) has been informed by the information detailed above.

Table 5.18 Assessment against the significant impact criteria – Spotted-tail quoll

Criterion	Assessment against significance criteria
Lead to a long-term decrease in the size of a population of a species	There are no records of this species within or close to the MNES study area. The nearest recent (post 2000) records are located between 10 km east and 25 km north-east of the Project. Nevertheless, predictive habitat modelling indicated that the Project may impact 76.36 ha of suitable habitat (69.44 ha of *potential habitat* and 6.92 ha of *Habitat critical to the survival of the species*) for the species. This habitat is largely associated with the extensive habitat in the Teviot Range. In this area the Project preferentially impacts cleared low-lying lands adjacent to Woollaman Creek. Preferred rocky shelter sites for the species have been avoided.

Criterion	Assessment against significance criteria
	Where the alignment intersects higher altitude habitat within the Teviot Range the Project is largely comprised within a tunnel (1,015 m long). This will maintain connectivity along the vegetated habitat within this wildlife corridor. In addition, where clearing and infrastructure is proposed outside of the tunnel but within the Teviot Range measures will be implemented to facilitate fauna movement during construction and operations (e.g. fauna passage under the rail infrastructure). This includes the incorporation of fauna crossing structures as part of the final Project. Fauna crossing structures will be applied as part of the Project design to enhance fauna movement across the Project alignment and the wider landscape. These measures will also help to avoid or at the very least significantly reduce the risk of vehicle strikes during operations. This species is susceptible to road mortality due to scavenging for carrion with juvenile males most likely at risk due to extensive ranging behaviour. The Project will result in increased traffic through or adjacent potential habitat for this species (e.g. Teviot Range) during construction increasing the risk of vehicle strikes. Similarly, the operating rail line may also pose a threat once operational. However, it is unlikely to lead to the long-term decline of the species. This is due in part to a large section of the Teviot Range being constructed in tunnel and the use of temporary and permanent fauna fencing. The Project may also result in changes to prey interactions, including competition from feral animals such as the Red fox, Wild dogs and feral cats. Under the Project EMP pre-clearance surveys will be carried out if suitable denning habitat for this species is identified within or adjacent to the final construction footprint to identify whether the species actually occurs or not. Should the species be found individuals are expected to be moved away from the area of disturbance prior to construction activities. The species requires large home ranges. The Project alignment is linear and there will be substantial tracts of suitable habitat remaining undisturbed adjacent to the north and south of the disturbance footprint. The Project is considered unlikely to lead to a long-term decrease in an important population.
Reduce the area of occupancy for a population	The recovery plan notes the extent of occurrence (EOO) is estimated at 596,344 km^2 and the area of occupancy at 2,512 km^2 . These areas are based on records from between 1997 and 2017. There are no records of this species within or close to the MNES study area. The nearest recent (post 2000) records are located between 10 km east and 25 km north-east of the Project. Predictive habitat modelling indicated that the Project will impact 76.36 ha of habitat considered suitable for the species. The Project is unlikely to reduce the occupancy of a population given the species large home range and that connectivity will be maintained through the Teviot Rane, with the Project also located in fragmented landscapes adjacent to Woollaman Creek.
Fragment an existing population into two or more populations	This species has large home ranges with the female home ranges (88–1515 ha) generally non-overlapping, while male home ranges are much larger, from 359–5512 ha in size, and overlap and encompass multiple female home ranges (DEWLP 2016). There are no records of this species within or close to the MNES study area. Predictive habitat modelling indicated that the Project may impact 76.36 ha of habitat considered suitable for the species. The majority of this habitat is associated with the Teviot Range where habitat connectivity will be maintained (at least in part) via the tunnel, while in other sections of the Teviot Range fauna fencing and dedicated fauna passage with facilitate fauna movement. Outside of these areas the railway is unlikely to be a major impediment to the species. The disturbance footprint largely intersects already disturbed (cleared) habitat where it passes through the Teviot Range, with the species known to be absent or with a reduced abundance in cleared areas. Ranges are associated with the eastern portion of the disturbance footprint. The final Project design will incorporate fauna crossing structures to allow fauna movement north and south of the alignment within the Teviot Range. There is also an extensive portion of the alignment above the proposed rail tunnel within the Teviot Range which will remain unimpacted and function as a movement corridor. The Project is considered unlikely to fragment an existing important population.
Adversely affect *Habitat critical to the survival of the species*	The Project includes a tunnel through Teviot Range avoiding habitat considered to be critical to the survival of the species. However, the Project also intersects 6.92 ha of habitat considered as 'critical' to the species (for the purposes of this assessment) as well as a further 69.44 ha of 'potential' habitat. These areas are associated with already disturbed (cleared) habitat where the Project passes through the Teviot Range. The Project has potential to adversely affect *Habitat critical to the survival of the species*.

Criterion	Assessment against significance criteria
Disrupt the breeding cycle of a population	There are no records of this species within or close to the MNES study area. Predictive habitat modelling indicated the project may impact 76.36 ha of suitable habitat including 6.92 ha of habitat considered critical for the species. Where the alignment intersects the Teviot Range it preferentially impacts cleared low-lying lands adjacent to Woollaman Creek. Preferred rocky shelter sites potentially used for denning/breeding for the species have been avoided, though other den sites such as hollow logs and trees may be used in the absence of these features. The Project will result in the removal and potential relocation of hollow logs and hollow bearing trees into adjacent landscapes. While the disturbance of these features during breeding season (i.e. the winter months (June to August)) may result in the death of individuals. In addition, connectivity will be maintained (construction and operations) during the breeding season to allow roaming males the potential to mate with multiple females. Pre-clearance surveys will be carried to assess whether suitable den habitat for this species occurs within or adjacent to the construction footprint. Den habitat within the footprint will likely be relocated to adjacent areas. Where possible the Project will avoid clearing/construction activities in sensitive habitat during the breeding season. The Project has potential to disrupt the breeding cycle of an important population (should an important population occur in the area) when clearing within the winter months.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The subspecies occurs from central coastal Queensland, south to south-west Victoria. It's uncertain whether the species occurs within or close to the disturbance footprint. The disturbance footprint intersecting potential habitat within the Teviot Range preferentially impacts cleared low-lying lands adjacent to Woollaman Creek. As noted above the Project will directly impact on 76.36 ha of suitable habitat including 6.92 ha of habitat considered critical for the species. The predictive mapping also identified an additional area of approximately 356.59 ha of habitat critical for the survival of the species, along with approximately 1,571.09 ha of *potential habitat* within the immediate surrounds within the MNES study area. As outlined in Section 5.1.2, the Project may impact the quality of habitat available as a result of edge effects; displacement and mortality of fauna, habitat fragmentation and barrier effects. These changes may influence predator-prey interactions with many of the prey species hollow-dependent and the loss of these resources as a result of the Project impacting their abundance and distribution. However, where possible microhabitat features such as hollow logs, hollow bearing trees and rocky outcrops will be relocated into adjacent habitats. Given the extent of occurrence of Spotted-tail quoll the Project is considered unlikely to decrease the availability and quality of habitat to the extent that the species is likely to decline.
Result in invasive species that are harmful to a endangered species becoming established in the endangered species' habitat	Relevant threat abatement/recovery plans for Spotted-tail quoll include management measures to address the impact of feral cats, wild dogs and European red fox. Feral predators including the Red fox and Dog have been identified as common in the area during multiple Project-associated surveys. Weed and pest control measures will be incorporated into the Project Biosecurity Management Plan to control the introduction and spread of weed and pest species across the disturbance footprint and surrounds covering both construction and operation activities. The Plan will be in place for the life of the Project and will minimise the potential for weed invasion and may in the long-term improve habitat condition within vegetation communities located adjacent to Project infrastructure. Pest measures will ensure feral predators (i.e. wild dogs/dingo) are controlled in areas associated with Project activities. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.
Introduce disease that may cause the species to decline	The Project Biosecurity Management Plan will incorporate the management of invasive species which will assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.
Interfere substantially with the recovery of the species	Recovery strategies listed in the *National Recovery Plan for the Spotted-tail quoll Dasyurus maculata* (DEWLP 2016) include: ▪ Determine population trends for the species including distribution and abundance ▪ Investigate key aspects of the species biology/ecology to improve management ▪ Reduce the rate of habitat loss and fragmentation ▪ Determine and manage threats from introduced predators and uncontrolled fires

Criterion	Assessment against significance criteria
	▪ Assess and minimise sources of mortality including road deaths, deliberate killings and the threat of cane toads. If the species does occur on and around the disturbance footprint there is some potential for the Project to interfere with the recovery objectives outlined in the Recovery Plan through habitat loss and fragmentation. The Project Biosecurity Management Plan will control introduced predators associated with Project infrastructure. Nevertheless any impact on the species will be minor, and is considered unlikely to interfere with the recovery of the species.
Assessment of potential for significant residual impacts	The Project will result in the clearance of 69.44 ha of *potential habitat* and 6.92 ha of *Habitat critical to the survival of the species* that potentially supports a population. The project also has some potential to fragment a population should the species occur south of the Project. Although it remains uncertain the assessment has been carried out in a conservative manner and the Project has potential to have significant residual impacts on Spotted-tail quoll.

Swift parrot (Lathamus discolor) – critically endangered

Ecology and distribution

The Swift parrot feeds mostly on nectar, mainly from eucalypts, but also eats psyllid insects and lerps (waxy secretion on Eucalypt leaves produced as a protection by young psyllid insects), seeds and fruit. Foraging habitat on the mainland includes inland box-ironbark and grassy woodlands, and coastal Swamp mahogany (*Eucalyptus robusta*) and Spotted gum (*Corymbia maculata*) woodland when in flower. In northern NSW and south-east Queensland, Forest red gum (*E. tereticornis*) forests and Yellow box (*E. melliodora*) forest are commonly utilised by Swift parrots (Saunders and Tzaros 2011, OEH 2017b). In northern New South Wales the species is known to use Northern grey box (*E. moluccana*) and Blackbutt (*E. pilularis*) (Saunders and Heinsohn 2008), both of which also occur in south-east Queensland.

The Swift parrot typically inhabits dry eucalypt forests and woodlands, occasionally wet sclerophyll forests, suburban parks and sometimes gardens with flowering fruit trees (Saunders and Tzaros 2011). Coastal forests from eastern Victoria to the central coast of New South Wales are utilised during periods of drought as refuge habitats. The species is found to prefer large mature trees for foraging as these provide more reliable resources than smaller immature trees (Saunders and Tzaros 2011).

The Swift parrot breeds in Tasmania during summer (mid-September to late-January) and migrates north to mainland Australia during the winter. Small numbers of Swift parrots occur in south-east Queensland on a regular basis (TSSC 2016a).

Distribution in context to the Project

This species was identified foraging in Northern grey box (*E. moluccana*) in a patch of woodland adjacent to the disturbance footprint in the Rosewood area during protected plant surveys in June 2018 (EMM 2018a) (refer Figure 4.5). The nearest database record (AoLA) of Swift parrot is located 1.5 km from the disturbance footprint but of uncertain provenance (i.e. no date and location generalised to 0.1 degree). The species is an uncommon but regular visitor to south-east Queensland in the winter months. In south-east Queensland it is a significant species to birdwatchers and sightings of the species become well known and recorded rapidly. Nevertheless, there are only scattered records to the north and south-east of the Project. The nearest records are from 2019 in the Springfield Lakes area and a 1994 record near Beaudesert (20 km north and 16 km south of the eastern extent of the Project respectively) (AoLA 2020) (refer Figure 6.27 in Appendix A).

Recovery plans/threat abatement plans

The *National Recovery Plan for the Swift Parrot (Lathamus discolor)* (Saunders and Tzaros 2011) identifies the following threatening processes as applicable to the species:

- Habitat loss and alteration from forestry activities (including firewood harvesting), and land developments
- Suppression of tree regeneration and loss/dieback of eucalypts on agricultural land

- Climate change and frequent fires
- Mortality resulting from collision with wire netting or mesh fences
- Competition with noisy miner (*Manorina melanocephala*) and other aggressive honeyeaters.

The following threat abatement plans have been identified as being relevant to this species:

- *Threat abatement plan for predation by feral cats* (DotE 2015c).

Important populations and *Habitat critical to the survival of the species*

The wintering population of Swift parrot is spread across much of mainland south-east Australia although most of the population spends the winter in Tasmania and Victoria (TSSC 2016a). The overall population is poorly known but estimated at 2000 mature individuals and is declining (Garnett et al 2011). As such there is no important population relevant to individual locations. The species' recovery Plan does not define *Habitat critical to the survival of the species* but does identify priority habitats which are used by large proportions of the population (*repeatedly between seasons* or for *prolonged periods of time*).

Priority habitat areas identified in south-east Queensland include the following localities:

- Bowman Park, Bardon
- Rafting Ground Reserve, Kenmore
- Glen Lomond Park, Toowoomba (Saunders and Tzaros 2011).

The nearest of these to the MNES study area (Rafting Ground Reserve) is located on the western outskirts of Brisbane and is over 30 km north of the Project. Other habitats considered important for the species are nesting and habitats used by a large proportion of the population (Saunders and Tzaros 2011). The species nests in Tasmania and although the species was recorded close to the disturbance footprint during Project surveys there is no evidence provided by available records indicating the disturbance footprint, MNES study area or surrounds provides habitat considered as a 'priority habitat' i.e. regularly used by the species either repeatedly or for extended periods. For the purposes of this assessment habitat considered 'critical to the survival' of Swift parrot has been considered as foraging habitat in mature (remnant) vegetation communities comprising the tree species discussed above as relevant to south-east Queensland (refer Appendix A for methodology).

Impacts and mitigation measures associated with this species are identified within Table 5.7. Predictive habitat mapping estimates that 129.44 ha of *potential habitat* and 11.74 ha of *Habitat critical to the survival of the species* for the Swift parrot will be impacted by the Project (refer Table 4.5, Table 5.4 and habitat figure in Appendix G). There is no habitat identified as important (priority habitat areas) within or near the Project disturbance footprint. The predictive habitat modelling has taken a conservative approach and includes regrowth woodlands (that dominate the mapped vegetation in the MNES study area) and which may not be likely to provide favoured foraging habitat given the species prefers large mature trees (Saunders and Tzaros 2011). There is approximately 2,966.22 ha of identical habitat within the immediate surrounds of the MNES study area (refer Table 5.4) and over 283,000 ha within a 50 km radius of the disturbance footprint (refer Table 7.1). Assessment of potential disturbance of this species against the MNES Significant impact guidelines is provided in Table 5.19.

Table 5.19 Assessment against the significant impact criteria – Swift parrot

Criterion	Assessment against significance criteria
Lead to a long-term decrease in the size of a population	The population of Swift parrot is dispersed across mainland south-eastern Australia in the winter months. Small numbers of individuals occur sporadically in south-east Queensland in a variety of habitats including urban areas. The species was recorded adjacent to the disturbance footprint during Project-associated surveys in 2018. The nearest database record (AoLA) of Swift parrot is located 1.5 km from the disturbance footprint (generalised to 0.1 degree). There is no evidence the species uses the MNES study area or surrounds on a regular basis or provides habitat considered to be of importance to the species.

Criterion	Assessment against significance criteria
	It is considered very unlikely the Project will result in direct mortality of individuals of the species. The Project will not impact any of the identified priority habitat areas (where the species is thought to regularly occur) in Queensland. However, predictive habitat modelling indicates the Project may impact 129.44 ha of potential and 11.74 ha of critical foraging habitat for the species although this may be an overestimate of the potential for the species to occur. The opening up of corridors within tracts of habitat may have potential to lead to an increase in aggressive/competitive honeyeater species accessing previously undisturbed woodlands. Nevertheless, this is not expected to be an impact from the Project. The Project occurs largely in heavily disturbed lands. Where the Project intersects the Teviot Range it preferentially occurs in already cleared areas adjacent to Woollaman Creek and the proposed tunnel will leave a substantial area of vegetation in the range undisturbed. Nevertheless, the species ranges widely and can occur in woodland, and disturbed habitats (including urban areas). The Project alignment is linear and there is extensive identical habitat in the immediate surrounds and throughout the wider region that will not be impacted. There is over 2,966.22 ha of identical habitat adjacent to the Project (within the MNES study area) and over 283,000 ha estimated within a 50 km radius that will remain undisturbed. The Project is considered unlikely to result in a long-term decrease in the size of a population.
Reduce the area of occupancy of the species	Small numbers of individuals sporadically occur in south-east Queensland in winter. The species was recorded adjacent to the disturbance footprint during Project-associated surveys in 2018. The Project will not impact any identified priority habitat areas in Queensland. Predictive habitat modelling indicates the project may impact 129.44 ha of potential and 11.74 ha of *Habitat critical to the survival of the species* (i.e. foraging habitat) for the species although this may be an overestimate of the potential for the species to occur. Nevertheless, the species ranges widely and can occur in woodland, and disturbed habitats (including urban areas). The Project alignment is linear and there is extensive identical habitat in the immediate surrounds and throughout the wider region that will not be impacted. There is over 2,966.22 ha of identical habitat adjacent to the Project (within the MNES study area) and over 283,000 ha estimated within a 50 km radius that will remain undisturbed. The Project will not reduce the area of occupancy of the species.
Fragment an existing population into two or more populations	The Project is not considered to represent a barrier to movement for the species. It is considered very unlikely that the Project will fragment an existing important population into two or more populations.
Adversely affect *Habitat critical to the survival of the species*	The Project will not impact any identified priority habitat areas in Queensland. Small numbers of individuals occur in Queensland in winter. The species breeds in Tasmania. Predictive habitat modelling indicates the project may impact 11.74 ha of foraging habitat considered as *Habitat critical to the survival of the species* under the approach used for this assessment. The Project may impact a further 129.44 ha of potential foraging habitat for the species although this may be an overestimate of the potential for the species to occur. Nevertheless, the species ranges widely and can occur in woodland, and disturbed habitats (including urban areas). The Project alignment is linear and there is extensive identical habitat in the immediate surrounds and throughout the wider region that will not be impacted. There is over 2,800 ha of identical habitat adjacent to the Project (within the MNES study area) and over 283,000 ha estimated within a 50 km radius that will remain undisturbed. Nevertheless, given *Habitat critical to the survival of the species* may occur there is potential the Project may adversely affect *Habitat critical to the survival of the species*.
Disrupt the breeding cycle of a population	The species breeds in Tasmania in summer. Small numbers of birds occur in Queensland each year. It is considered unlikely that the Project will disrupt the breeding cycle of a population.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The Project will not impact any identified priority habitat areas in Queensland. The Project has been predicted to impact 129.44 ha of potential and 11.74 ha of habitat critical to the survival of the species. Nevertheless, the species may utilise a wide variety of habitats including urban parklands. The Project alignment is linear and there is extensive identical habitat in the immediate surrounds and throughout the wider region that will not be impacted. That is, the predictive modelling indicates that there is over 2,750 ha of *potential habitat* and approximately 200 ha of *Habitat critical to the survival of the species* in the MNES study area. As outlined in Section 5.1.2, the Project may impact the quality of habitat available as a result of edge effects; habitat fragmentation and barrier effects. These impacts however are unlikely to result in changes to flowering events or result in the suppression of tree regeneration and loss/dieback of eucalypts.

Criterion	Assessment against significance criteria
	The Project will not impact habitat suitable for Swift parrot to the extent that the species is likely to decline.
Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the critically endangered or endangered species' habitat	The relevant threat abatement plan for Swift parrot include management measures to address the impact of feral cats. This species was not noted during multiple Project-associated surveys but is likely present. Weed and pest control measures will be incorporated into the Project Biosecurity Management Plan to control the introduction and spread of weed and pest species across the disturbance footprint and surrounds covering both construction and operation activities. The Plan will be in place for the life of the Project and will minimise the potential for weed invasion and may in the long-term improve habitat condition within vegetation communities located adjacent to Project infrastructure. Pest measures will ensure feral predators are controlled in areas associated with Project activities. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.
Introduce disease that may cause the species to decline	The Project Biosecurity Management Plan will incorporate the management of invasive species which will assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.
Interfere with the recovery of the species	The National Recovery Plan for the Swift Parrot *Lathamus discolor* (Saunders and Tzaros 2011) lists the following recovery actions: ▪ Identify the extent and quality of habitat ▪ Manage and protect Swift Parrot habitat at the landscape scale ▪ Monitor and manage the impact of collisions, competition and disease ▪ Monitor population and habitat. The Project is considered unlikely to interfere with any of the recovery actions listed above to the extent it is likely to interfere with the recovery of the species.
Assessment of potential for significant residual impacts	The Project is considered to have some potential to have a significant impact on Swift parrot through clearing of 11.74 ha of habitat identified as 'critical to the survival' of the species.

Australian painted snipe (*Rostratula australis*) – endangered

Ecology and distribution

The Australian painted snipe generally inhabits shallow terrestrial freshwater wetlands, including temporary and permanent lakes, swamps and claypans. The species has also been observed to use inundated or waterlogged grassland or saltmarsh, dams, rice crops, sewage farms and bore drains. The Australian painted snipe has been recorded nesting in and near swamps, canegrass swamps, flooded areas, including samphire, grazing land, among cumbungi, sedges, grasses, salt water couch, saltbush (*Halosarcia* sp.) and grass, in ground cover of water-buttons and grasses, at the base of tussocks and under low saltbush (DAWE 2020b).

Australian painted snipe is a very cryptic species that generally occurs in low numbers and has been recorded at wetlands in all states and territories of Australia but is more common in eastern Australia, where it has been recorded at scattered locations throughout much of Queensland, NSW, Victoria and south-eastern South Australia. It is a highly nomadic species dependent on wetland conditions throughout its range. There is evidence that part of the population may migrate from south-eastern Australia to central and northern Queensland during autumn and winter. Its known distribution has likely declined by approximately 50 per cent in Australia since European settlement (Garnett et al 2011).

Breeding has been recorded at all times of the year and is likely a response to wetland conditions. Nesting habitat appears quite specific requiring shallow wetlands, exposed mud and nearby vegetative cover. Nests are often located on or near islands within the wetland (DAWE 2020b).

Distribution in context to the Project

The species was not identified during Project surveys, although dry conditions during the survey events likely precluded the species potential presence. There are numerous database records within 50 km of the MNES study area. These occur in all directions around the Project with most occurring to the north-west, north, north-east and east. This includes several records within 5 km of the MNES study area. There are no existing records within or immediately adjacent to the Project disturbance footprint. The nearest records include several 2011 and 2012 records recorded at or close to Rosewood Lagoon (3 km north of the western section of the Project), 2000 and 2002 records from Lake Dyer, Laidley (16 km west of the western extent of the Project), and a 2013 record at Ripley's Lagoon, South Ripley (8.5 km north-east of the central section of the Project) (refer Figure 6.4 in Appendix B). The Australian population is thought to range between 1,000 to 1,500 mature individuals (Garnett et al 2011).

Wetland habitats within the MNES study area include dams and reservoirs (lacustrine), wetlands associated with the floodplains of major watercourses (riverine) and vegetated swamps (palustrine). Dams and reservoirs are less likely to provide suitable habitat values for the species. Riverine wetlands associated with floodplains are ephemeral and typically vegetated by a mixture of native and non-native grasses and grass-like plants and Queensland blue gum (*Eucalyptus tereticornis*). Palustrine wetlands within the MNES study area typically occur on alluvial floodplains and are dominated by grasses (Poaceae), rushes (Restionaceae) and sedges (Cyperaceae). Floodplain areas were all observed to be dry during the site surveys for the Project. (refer EIS Appendix J: Terrestrial and Aquatic Ecology Technical Report for further detail regarding wetland values). Naturally occurring wetland swamps in the MNES study area may be represented by a variety or remnant and non-remnant habitats but include RE 12.3.8 (specifically described as a swamp community) which may be considered the most likely wetland habitat present with suitable values for Australian painted snipe although these areas are highly ephemeral in nature (refer Section 4.4.4.5). Current Queensland vegetation mapping indicates this community occupies 0.75 ha within the disturbance footprint (refer Table 4.6). There are also two large wetlands in the close proximity to the Project, Ten Mile Swamp and Gammies Swamp which may provide habitat for this species and which may be impacted (indirectly) by the Project.

Recovery plans/threat abatement plans

There is currently a draft *National recovery plan for the Australian painted snipe (Rostratula australis*) (DotEE 2019c) awaiting adoption by DAWE. The draft Plan identifies the following threatening processes as applicable to the species:

- Reduced wetland availability due to draining, fragmentation and changed hydrology
- Habitat degradation such as reduced water quality
- Low genetic diversity
- Invasive species including herbivores impacting habitat (horses, pigs, goats and deer) and predators (red fox and cats)
- Wetland vegetation structure change caused by native plants (e.g. *Typha* spp.) and non-native plants ((e.g. Lippia (*Phyla canescens*))
- Climate variability and change.

There are no Commonwealth adopted threat abatement plan considered relevant to this species.

Important populations and *Habitat critical to the survival of the species*

The draft *National recovery plan for the Australian painted snipe (Rostratula australis*) (DotEE 2019c) identifies the population as a single homogenous breeding population spread thinly across much of Australia. The species is widespread with an extent of occurrence estimated at 7,100,000 km^2 (Garnett et al 2011). As such there is no population relevant to individual locations. Habitat critical to the survival of the species is described as:

- Any wetland habitat where the species is known or likely to occur (especially with suitable breeding habitat) within the indicative distribution map
- Any location with suitable habitat outside the above area that may be periodically occupied by Australian painted snipe when conditions are favourable.

The Project is located within the 'known or likely to occur' habitat mapped within the distribution map from the draft recovery plan.

Impacts and mitigation measures associated with this species are identified within Table 5.7. Predictive habitat mapping indicates that the Project is predicted to impact 3.60 ha of *potential habitat* and 34.55 ha of habitat critical to the survival of the Australian painted snipe (refer Table 4.5, Table 5.4 and habitat figure in Appendix G). However, the predictive habitat mapping has been approached in a conservative manner and is largely modelled on available vegetation and corresponding wetland communities mapping provided by DES (refer Appendix A for methodology). This includes creek lines, associated riparian habitat and farm dams which are less likely to provide habitat for Australian painted snipe (prefers large shallow wetlands with dense vegetative cover). The predictive habitat figure is likely to be an overestimation of the available habitat suitable for this species within the Project disturbance footprint.

Assessment of potential impacts to this species against the MNES significant impact assessment criteria is provided in Table 5.20.

Table 5.20 Assessment against the significant impact criteria – Australian painted snipe

Criterion	Assessment against significance criteria
Lead to a long-term decrease in the size of a population	Australian painted snipe occurs as a single homogenous breeding population dispersed thinly across much of Australia. As such, no resident population can be attributed to the MNES study area or immediate surrounds. No database records of the species occur within the MNES study area, although there are many records in the wider surrounds. These are mostly concentrated to the north of the MNES study area. As outlined in Section 4.4.4 and above there are a number of wetlands present within and surrounding the Project. Predictive habitat mapping indicates the Project has the potential to impact 38.15 ha of suitable habitat for this species (comprising 3.60 ha of *potential habitat* and 34.55 ha of *Habitat critical to the survival of the species*), although this is likely to be a substantial overestimate. The condition characteristics of these systems across the Project disturbance footprint is variable, with it unknown at this stage to what extent the predicted wetland habitat comprises values suitable for the presence of Australian painted snipe (i.e. the majority of the wetlands were dry during the field surveys and the values could not be confirmed). As noted in Section 5.1.2 the Project has the potential to impact on aquatic habitats within and downstream of the Project disturbance footprint. Construction activity at watercourse crossings will disturb the riparian zone and instream habitats, including potential habitat for the species. Activities will include clearing of vegetation, reprofiling of banks and instream substrate, deposition of material (e.g. rip rap for erosion and sediment control), erection of temporary barriers (e.g. coffer dam), water extraction, disturbance of sediment causing elevated nutrients and turbidity, and result in the loss of wetlands and direct disturbance of local populations (should they occur within the Project disturbance footprint). However, the species is less likely to occur in riverine environments and this disturbance is expected to be restricted to the construction period with occasional works during the operation of the Project (design life of 100 years). The Project will not create any permanent barriers to flow as watercourse crossings will consist of bridges or culverts. Following construction localised habitat suitable for the species is expected to return to its prior natural conditions. The use of bridge structures across some of the major watercourses and associated floodplains (e.g. Bremer River) will also avoid and/or minimise the impact to riparian zones, wetlands and instream habitat (e.g. footings are outside the channel or the highwater banks).

Criterion	Assessment against significance criteria
	Flood modelling (refer EIS Appendix N: Hydrology and Flooding Technical Report) indicates local changes to the catchment hydrology is minimal, including on Ten Mile Swamp and Gammies Swamp which are likely to be used by a range of wetland species when conditions are more optimal. Water extraction and dewatering of farm dams are proposed, though these activities are unlikely to reduce wetland availability. Under the Project Flora and Fauna Sub-plan pre-construction surveys will be carried out following optimal (wet) conditions (where possible) to assess whether wetland habitat values are suitable for the species, and if so, if the species actually occurs. Surveys will follow Commonwealth survey guidelines for the species (e.g. DEWHA 2010a). If the species or habitat is identified during pre-construction surveys, further pre-clearance surveys will be carried out to assess whether the species is present with mitigation measures in place should this be the case (refer Table 5.7). Should the species be found individuals would be expected to disperse as a result of construction activities. The impacts of the Project are considered unlikely to lead to a long-term decrease in the size of the population.
Reduce the area of occupancy of the species	Predictive habitat mapping indicates the Project has the potential to impact 38.15 ha of habitat suitable for this species (comprising 3.60 ha of *potential habitat* and 34.55 ha of *Habitat critical to the survival of the species*), although this is likely to be a substantial overestimate. It is unknown at this stage to what extent the predicted wetland habitat within the disturbance footprint comprises values suitable for the presence of Australian painted snipe. No database records of the species occur within the MNES study area, although there are many records in the wider surrounds. It is unknown to what extent the species may utilise wetland habitats associated with the disturbance footprint, or if it occurs at all. The species is highly nomadic and unlikely to use these areas in more than a transient manner dependent on local conditions. The impacts of the Project are considered unlikely to reduce the area of occupancy of the species.
Fragment an existing population into two or more populations	Australian painted snipe occurs as a single homogenous breeding population dispersed thinly across much of Australia. As such, no resident population can be attributed to the disturbance footprint. The species is highly mobile and dispersive. The Project is not considered to represent a barrier to movement for the species. It is considered unlikely that the Project will fragment an existing population into two or more populations.
Adversely affect *Habitat critical to the survival of the species*	Predictive habitat mapping indicates the Project has the potential to impact 34.55 ha of *Habitat critical to the survival of the species*, although this is likely to be an overestimate. It is unknown at this stage to what extent the predicted wetland habitat within the disturbance footprint comprises values suitable for the presence of Australian painted snipe. Pre-construction surveys will be carried out to assess whether wetland habitat values are suitable for the species, and where suitable habitat is identified whether the species actually occurs. Predictive habitat mapping also identifies approximately 510 ha of additional *Habitat critical to the survival of the species* within the MNES study area, including Ten Mile Swamp and Gammies Swamp which may be suitable habitat for the species. Through Project design considerations changes to hydrological conditions in the area are expected to be minor at worst, localised and transient (during flood events) and are unlikely to impact potential habitat for the species. Mitigation measures will be in place to ensure surface water quality associated with the Project surrounds is not impacted as a result of Project activities (e.g. erosion and sediment controls and water quality monitoring program) (refer Table 5.7). The Project will adversely affect *Habitat critical to the survival of the species*.
Disrupt the breeding cycle of a population	Australian painted snipe occurs as a single homogenous breeding population dispersed thinly across much of Australia. As such, no resident population can be attributed to the disturbance footprint. The species is known to breed in SEQ, with breeding habitat considered to be quite specific (i.e. shallow wetlands with areas of bare wet mud and mixed heights of low vegetation) (DotEE 2019c). Predictive habitat mapping indicates the Project has the potential to impact 38.15 ha of suitable habitat for this species (comprising 3.60 ha of *potential habitat* and 34.55 ha of *Habitat critical to the survival of the species*), although this is likely to be a substantial overestimate (i.e. mapping includes riverine wetlands and regional ecosystem wetlands, with palustrine wetlands generally limited). As noted above breeding habitat for the species appears specific and it is unknown to what extent breeding habitat may actually occur within or near the disturbance footprint given the conditions were dry during the surveys. The species may breed at any time of year dependent on local wetland conditions, with the likely breeding habitat associated with Ten Mile Swamp and Gammies Swamp.

Criterion	Assessment against significance criteria
	Pre-clearance surveys will be carried out to assess whether wetland habitat values are suitable for the species, and where suitable habitat is identified whether the species actually occurs. Should the species be observed as nesting measures will be in place within the Project Flora and Fauna Sub-plan to allow nesting to occur undisturbed (refer Table 5.7). It is possible that Australian painted snipe individuals will be disrupted during breeding, but it is considered unlikely that the Project will disrupt the breeding cycle of a population.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	No database records of the species occur within the MNES study area. The species is widespread with an extent of occurrence estimated at 7,100,000 km^2 (Garnett et al 2011). Predictive habitat mapping indicates the Project has the potential to impact 38.15 ha of habitat suitable for this species (including 34.55 ha of *Habitat critical to the survival of the species*), although this is likely to be a substantial overestimate. Predictive habitat mapping also identifies approximately 510 ha of additional *Habitat critical to the survival of the species* within the MNES study area, including Ten Mile Swamp and Gammies Swamp which may be suitable habitat for the species. Through Project design considerations changes to hydrological conditions in the area are expected to be minor at worst, localised and transient (during flood events) and are unlikely to impact potential habitat for the species. Mitigation measures will be in place to ensure surface water quality associated with the Project surrounds is not impacted as a result of Project activities (e.g. erosion and sediment controls and water quality monitoring program) (refer Table 5.7). The Project is not considered likely to impact habitat for the species to the extent that the species is likely to decline.
Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the critically endangered or endangered species' habitat	Aquatic weed species have been identified as a potential threat to Australian painted snipe habitat (DotEE 2019c). Project-associated surveys have noted aquatic weeds (Canadian pondweed (*Elodea* spp.) and Water hyacinth (*Eichhornia* crassipes)) as currently present within the MNES study area. Native plants (e.g. *Typha* spp.) can also be an issue given the proliferation of some species may change the vegetation structure of the wetland. Typha was noted within the wetland systems associated with the Project, though mainly in riverine wetlands and artificial dams. Project surveys have recorded pest fauna thought to be a threat to the species: Red fox (*Vulpes Vulpes*) and feral pig (*Sus scrofa*). Both were found to be common in the area. Weed and pest control measures will be incorporated into the Project Biosecurity Management Plan to control the introduction and spread of weed and pest species across the disturbance footprint and surrounds covering both construction and operation activities. This will include measures to ensure aquatic weeds are not introduced as a result of the Project. The Project is not expected to lead to increased abundances of introduced predator species. Nevertheless, measures will be incorporated to monitor pest species observations associated with Project activities, and pest control actions where considered necessary. The Plan will be in place for the life of the Project and will minimise the potential for weed invasion and pest proliferation and may in the long-term improve habitat condition within vegetation communities located adjacent to Project infrastructure. Pest measures will ensure feral species (i.e. wild dogs/dingo, Red fox and pigs) are controlled in areas associated with Project activities. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.
Introduce disease that may cause the species to decline	The Project Biosecurity Management Plan will incorporate the management of invasive species which will assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.
Interfere with the recovery of the species	The draft recovery Plan for the species identifies the following recovery objectives for Australian painted snipe: ▪ Manage and protect known Australian Painted Snipe breeding habitats at the landscape scale ▪ Develop and apply techniques to measure changes in population trajectory in order to measure the success of recovery actions ▪ Reduce, or eliminate threats at breeding and non-breeding habitats ▪ Improve knowledge of the habitat requirements, biology and behaviour of Australian Painted Snipe ▪ Engage community stakeholders to improve awareness of the conservation of Australian Painted Snipe ▪ Coordinate, review and report on recovery process (DotEE 2019c).

Criterion	Assessment against significance criteria
	At this stage it is uncertain the disturbance footprint comprises habitat likely to support breeding. The Project is considered unlikely to interfere with any of the recovery actions listed above to the extent it will interfere with the recovery of the species. Should Australian painted snipe be identified during Project activities this will contribute to current information on the species in the south-east Queensland region. Weed and pest mitigation measures applied within the Project Biosecurity Management Plan will contribute to eliminating threats to the species across the wider area.
Assessment of potential for significant residual impacts	The Project has the potential to have a significant impact on Australian painted snipe through impacts to wetland habitat which is considered critical to the survival of the species (i.e. habitat critical to survival exists as a mosaic of wetland habitats, with carrying capacity fluctuating with seasonal or episodic rainfall and flooding events). Extended dry conditions in the disturbance footprint during construction may minimise any direct impacts on the species; while risks of impacts may be increased where optimal conditions are present, including potential impacts to breeding habitat.

5.3.5.2 Vulnerable fauna species populations

The significant residual impact assessments commence with an evaluation of the likely importance of the population of vulnerable fauna species associated with the MNES study area. Under the MNES guidelines vulnerable species are considered as subject to significant impacts when an 'important population' is impacted. Therefore, those species that are not considered to have an important population present are not considered further in the assessment.

An 'important population' as defined within the MNES guideline significant impact criteria for vulnerable species is as follows:

'*An important population is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:*

- *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.'*

Given the specificity of the above definition and the scarcity of information and records available for most listed species and populations in the region (and Australia), it is difficult to determine:

- Attributes such as breeding and dispersal behaviour and whether the population is a 'key source'
- The genetic diversity of individuals inhabiting a population or sub-population.

Given the paucity of information available, significance of impacts to threatened species has been based on professional experience of the assessment team and the latest available information relating to habitat and ecological requirements and distribution. This information is compiled in Appendix B for all of the species assessed including mapping of database records associated with the wider disturbance footprint.

Table 5.21 provides an evaluation of the populations of vulnerable fauna species associated with the MNES study area.

Table 5.21 Assessment of status of vulnerable fauna species population against Guideline criteria

Species name	Common name	MNES study area population evaluation
Chalinolobus dwyeri	Large-eared pied bat	Predictive habitat mapping indicates that the Project has the potential to impact 2.89 ha of *potential habitat* for this species (refer Table 5.4). There are no known records of this species within or adjacent to the disturbance footprint. The nearest database record is from 1994 and located approximately 30 km south of the western extent of the Project at Shingle Hut Creek Nature Refuge, adjacent to Main Range National Park area are located 30 km south-east. Other more recent records (from the 2000s) are from the Lamington National Park area between 32 km and 45 km south-east of the eastern extent of the Project (refer Figure 5.10 in Appendix B). There are no other records to the north, east or west within 100 km of the Project. The species occurs from the Rockhampton region, inland to the Carnarvon Range, and potentially as far south as the Wollongong area. The disturbance footprint is not located near the limit of the species range (AoLA 2020). The *National recovery plan for the Large-eared pied bat Chalinolobus dwyeri* (Department of Environment and Resource Management (DERM) 2011) identifies important populations as the largest known populations occurring in areas dominated by sandstone escarpments in Carnarvon National Park, Blackdown Tableland National Park, Expedition National Park and Isla Gorge National Park. The Shoalwater Bay population occurs at the northern limit for the species and has been identified as an important population when referring to DAWE's SPRAT database (2020b). None of these areas are relevant to the MNES study area. The recovery plan identifies 'sandstone cliffs and fertile wooded valley habitat within close proximity' as *Habitat critical to the survival of the species*. In SEQ this also includes rainforest and wet eucalypt habitats on volcanic substrates in high elevations are of similar importance (e.g. Main Range and Lamington National Parks (DERM 2011). Cliff/rocky escarpments occur in the range to the north (e.g. Flinders Peak Conservation Park, ~ 4 km to the north) and south, but not in the vicinity of the Project alignment which preferentially passes through a relatively low elevation section of the range. The Project will not impact sandstone cliffs or rainforest and wet eucalypt habitats on volcanic substrates in high elevations. Therefore, the Project will not impact a potential roost site (should the species occur). Predictive habitat mapping indicates the Project has the potential to impact 2.89 ha of *potential habitat* and this is likely to be restricted to foraging habitat only (refer Table 5.4 and habitat figure in Appendix G). There are no records of the species ever occurring within 30 km and only to the south of the Project. No important populations or *Habitat critical to the survival of the species* have been identified that are relevant to the Project. It is not conceivable the Project will affect the recovery of the species or impact habitat such that the species may decline. The Project is considered unlikely to significantly impact this species and it is not considered further.
Delma torquata	Collared delma	There are no known records of this species within or adjacent to the Project disturbance footprint. Predictive habitat mapping indicates that the Project has the potential to impact 9.56 ha of *important habitat* for this species (refer Table 5.4). Database records (AoLA) indicate that this species occurs within 50 km of the Project. The nearest database record is from 1993 taken from within approximately 25 km north of the Project in Karana Downs, north of Ipswich. There is also a single 2019 record of uncertain provenance/accuracy located in the Richlands area approximately 26 km north-east of the Project. There are a number of more recent records in the area north of Karana Downs, the Lockyer Forest Reserves (35 km north-west of the Project) the Toowoomba Range (over 50 km west of the Project), Bunya Mountains National park and Yarraman State Forest and surrounds (AoLA 2020). The MNES study area is located near the southern limit of the species range. There is no recovery plan for this species. Given the difficulty in detecting this species the *Draft referral guidelines for the nationally listed Brigalow Belt reptiles* (DSEWPaC 2011a) considers the presence of known important habitat for this species a surrogate for an important population of the species. Known important habitat is considered as suitable habitat within the mapped 'known/likely to occur' distribution within the guidelines. The Project occurs partially within this mapped distribution and there is suitable habitat present in the Teviot Range based on field investigations. Therefore, *important habitat* for this species is present and will be impacted by the Project.

Species name	Common name	MNES study area population evaluation
		Given that *important habitat* under the referral guidelines has been identified for this species (in relation to the Project) there is potential for the Project to significantly impact the Collared delma and it is considered further in the following section (refer Table 5.22).
Erythrotriorchis radiatus	Red goshawk	Predictive habitat mapping indicates that the Project has the potential to impact 1.8 ha of *potential habitat* and 77.25 ha of *Habitat critical to the survival of the species* in which this species is predicted to occur (refer Table 4.5 and Table 5.4). The species has not been recorded within the MNES study area, including nest sites. Database records indicate this species has been recorded within 50 km of the Project. It is noted available records have all been generalised in order to protect the species (i.e. records have a high spatial uncertainty). The nearest record is from 1973 and is located approximately 20 km north-east of the Project in South Ripley (south of Ipswich). There are several more recent records to the north and north-west of the Project (AoLA 2020). The Project is located near the southern limit of the species current range (the species may be extinct in northern NSW). The *National recovery plan for the red goshawk Erythrotriorchis radiatus* (DERM 2012) does not identify important populations. Delineating an important population for this species is complicated by the ecology of the species (large home ranges and very sparse distribution). Habitat 'critical to the species survival' is considered extensive areas which may support nesting and associated habitat factors to support nesting. This habitat may occur in the Teviot Range area, with nesting generally within 1 km of permanent water. Given the species occurs at the southern limit of its distribution in relation to nearby records the Project could impact an important population. The Project may also impact *Habitat critical to the survival of the species*. Therefore there is potential for the Project to significantly impact the Red goshawk and it is considered further in the following section (refer Table 5.23).
Grantiella picta	Painted honeyeater	Database records indicate this species does not occur within the MNES study area although has occurred within 50 km of the Project. The nearest database record is of uncertain provenance (no date) and located 28 km west of the Project at Lake Apex, Gatton. A second older bird atlas record (1977-1981) is located 26 km north-east of the Project (western Brisbane) but has a high spatial uncertainty. Other database records occurring largely to the west of the Project and are well outside of the 50 km buffer (refer Figure 6.19 in Appendix B). The species population is sparsely dispersed across south-east Australia to north-west Queensland and eastern Northern Territory. There are a few scattered coastal records to the north and south of the Project, but the vast majority of records lie on the western slopes of the Great Dividing Range. Coastal records may be considered as vagrant individuals. Rowland (2012) notes non-breeding individuals are recorded occasionally from coastal areas along the eastern seaboard. There is no Commonwealth adopted recovery plan for this species. A review of the available literature has not revealed any important populations when referring to DAWE's SPRAT database (2020b) or the Approved conservation advice for the species (DotE 2015e). The species is considered to occur as a single population (Garnett et al 2011). As such no important populations have been identified that are key to the long-term survival and recovery of this species. The Approved conservation advice for the species (DotE 2015e) notes the greatest concentrations of individuals and almost all breeding records are located on the inland slopes of the Great Dividing Range. The Project is located to the east of the Great Dividing Range. In the absence of a definition for *Habitat critical to the survival of the species* this assessment has applied a 1 km buffer on known records that intersect '*potential habitat*' (refer Appendix A for methodology). As such, there is no *Habitat critical to the survival of the species* identified within or close to the Project. Predictive habitat mapping indicates that the Project has the potential to impact 30.10 ha of *potential habitat* in which this species may occur (refer Table 5.4 and habitat figure in Appendix G). There is 311.23 ha of *potential habitat* within 1 km of the disturbance footprint (the MNES study area) and widespread identical habitat surrounding the Project that will remain unimpacted.

Species name	Common name	MNES study area population evaluation
		The Project is located well to the east of the species normal distribution. There are no identified important populations and there is no habitat critical to the species survival associated with the Project. It is not conceivable the Project will affect the recovery of the species or impact habitat such that the species may decline. Therefore, under the MNES guidelines the Project is unlikely to significantly impact this species and it is not considered further.
Turnix melanogaster	Black-breasted button-quail	The species was not recorded during Project surveys which included targeted searches for the distinctive platelets the species leaves when foraging. Database records (i.e. AoLA) indicate this species has occurred within 50 km of the Project. The nearest database records are from the Flinders Goolman Conservation Estate within the Teviot Range recorded in 1980 and 2010 and approximately 5 km north of the Project disturbance footprint. There are recent records from the Rosewood area (2015) and Spring Mountain (2013) located 9 km and 14 km north of the Project respectively. There is also a very old record (1901) approximately 5 km south of the disturbance footprint (refer Figure 6.6 in Appendix B). Further away from the Project there are a number of confirmed records from all directions including commonly from north of Ipswich and west of Brisbane, and west of Boonah (AoLA 2020). The *National Recovery Plan for the Black-breasted button quail Turnix melanogaster* (Mathieson and Smith 2009) identifies important populations in the following areas: Yarraman-Nanango, the Jimna-Conondale Range, the Great Sandy region, populations in Barakula State Forest and Palmgrove National Park, and all populations in New South Wales. None of these are relevant to the MNES study area. Habitat identified as '*Habitat critical to the survival of the species* includes dry vine thickets and rainforest types, low thickets or woodlands with a dense understorey, and littoral areas with dry vine scrubs, *Acacia* thickets and shrubby areas. The Project is not located at the limit of the species range and will not impact the dispersal of individuals should a population occur in the area. Predictive habitat mapping indicates there is 4.19 ha of potential dry rainforest habitat (*Habitat critical to the survival of the species*) within the MNES study area. The identified habitat is located approximately 180 m north and upslope of the disturbance footprint and will not be impacted directly or indirectly. There is no *potential habitat* within the disturbance footprint (refer Table 5.4 and habitat figure in Appendix G). There are no identified important populations and there is no habitat critical to the species survival within the disturbance footprint. Therefore, the Project is unlikely to significantly impact this species and it is not considered further.
Neoceratodus forsteri	Australian lungfish	Predictive habitat mapping indicates that the Project has the potential to impact 27.62 ha of *potential habitat* in which this species may occur (refer Table 5.4). Database records indicate this species has not been recorded within the MNES study area. The nearest database record is from 1989 taken from approximately 5 km east of the eastern extent of the Project from the Logan River (south-west of Jimboomba). There is a 1971 record from the Bremer River located 5 km downstream of the disturbance footprint. The nearest recent record (2017) is from the Bremer River located 12 km north of the Project in the Ipswich city area (refer Figure 3.2 in Appendix B). The species is native to the Mary and Burnett Rivers and was potentially in the Brisbane River catchment. A number of individuals were translocated from the Mary River in the 1890s. Creeks crossed by the Project alignment are within the upper catchment of the Brisbane River and also the Logan River catchment. The MNES study area is therefore located at the southern limit of the species range (AoLA 2020). The *Draft national recovery plan for the Australian lungfish (Neoceratodus forsteri*) (DotEE 2019a) defines *Habitat critical to the survival of the species* as 'breeding or foraging habitat in areas where the species occurs' as defined by the Plan's distribution map for the Brisbane River catchment. The Project intersects the Bremer River within the mapped distribution although site surveys indicate this section of the river does not provide suitable habitat able to support the species (i.e. no permanent pools). Nevertheless, as per the species recovery plan the Project has potential to impact *Habitat critical to the survival of the species* and is considered further in the following section (refer Table 5.24).

Species name	Common name	MNES study area population evaluation
Petauroides volans volans	Southern greater glider	The species has not been recorded during any Project-associated surveys. Database records indicate this species has occurred within the MNES study area. The nearest database record (1999) is approximately 500 m north of the in the Peak Crossing area (refer Figure 4.2). A second record (1989) lies approximately 5 km north of the Project between Rosewood and Marburg. Other database records occur to the north and south of the Project, although none within 12 km form the disturbance footprint (AoLA 2020) (refer Figure 5.4 in Appendix B). These records are concentrated to the north-east (Ipswich and Brisbane areas). Records to the south and south-west are largely associated with Main Range and Lamington National Parks and are over 35 km from the MNES study area. A single record from Moogerah Peaks (south-west of Boonah) is approximately 30 m south-west of the Project. The species occurs from south-east Australia to central and north-east Queensland. The northern subspecies (*Petauroides volans minor*) occurs on the Atherton Tablelands. The Project is not located near the limit of the species range. No recovery plan exists for this species. A review of the available literature has not revealed any important populations when referring to DAWE's SPRAT database (2020b) or the Approved conservation advice for the species (TSSC 2016b). No populations have been identified that are key to the long-term survival and recovery of this species. There is no *Habitat critical to the survival of the species* defined for the species in Approved conservation advice for the species (TSSC 2016b). In the absence of a definition for *Habitat critical to the survival of the species* this assessment has applied a 1 km buffer on known records that intersect '*potential habitat*' (refer Appendix A for methodology). The predictive habitat mapping indicates there is 16.6 ha of *potential habitat* within the Project disturbance footprint for the species (refer Table 5.4 and habitat figure in Appendix G). It is noted there is no suitable remnant or regrowth vegetation in the vicinity of the buffered record referred to above and therefore no *Habitat critical to the survival of the species* will be impacted. No important populations or *Habitat critical to the survival of the species* have been identified for this species in relation to the Project. However, given the Project may impact 16.6 ha of *potential habitat* for the species. The assessment has taken a conservative approach for this species and it is considered further in the following section (refer Table 5.25).
Petrogale penicillata	Brush-tailed rock-wallaby	The predictive habitat mapping indicates there is no habitat (i.e. rocky refuge habitat) within the Project disturbance footprint for the species (refer Table 5.4). Database records indicate this species has been recently recorded (2018) within the MNES study area, although there is substantial spatial uncertainty (29 km) as to the exact location. There are numerous records from the Flinders Peak/Teviot Range area within 10 km north of the MNES study area which may indicate this could be an important source population (refer Figure 5.1 in Appendix B). This is effectively an isolated colony and is at the eastern limit of its local distribution. Other database records occur to the north-west and south-west of the Project, many within the 50 km buffer (AoLA 2020). The *National Recovery Plan for the Brush-tailed Rock-wallaby Petrogale penicillata* (Menkhorst and Hynes 2010) identifies important populations in Victoria and NSW and outlines important populations as being at the limit of the species' range, outlying populations, stronghold populations, research populations and others where recovery actions are being implemented. Whilst the disturbance footprint is not located at the limit of the species range but it may be adjacent to a stronghold population and given the linear nature of the Project may impact the dispersal of individuals from this population. The population in the Teviot Range is the subject of recovery actions implemented by Ipswich City Council under the *Brush-tailed rock wallaby recovery plan* (ICC 2018). Therefore, the Project has potential to impact an important population (e.g. barrier effect) and is considered further in the following section (refer Table 5.26).

Species name	Common name	MNES study area population evaluation
Phascolarctos cinereus	Koala combined populations of QLD, NSW and the ACT)	Predictive habitat mapping indicates that the Project has the potential of 124.31 ha of *Habitat critical to the survival of the species* (refer Table 5.4). This species has been detected during Project-associated surveys including direct observations of an individual and records of Koala scats throughout wooded areas of the alignment (Jacobs-GHD 2016a). Database records indicate this species occurs from multiple records within the MNES study area. The nearest database record (2015) in relation to the disturbance footprint occurs within 1 km of the disturbance footprint. There are a further 10 sightings from the same year within this area, nine of which occur within the MNES study area. There are a further four records from within the MNES study area from 2019 from Mount Forbes. *Habitat critical to the survival of the species* for Koala is used as a 'surrogate' for important populations as per the *EPBC Act referral guideline for the vulnerable Koala* (DoE 2014). An assessment has been carried out based on the available habitat within the MNES study area (refer Table 5.27). Based on this assessment there is *Habitat critical to the survival of the species* for Koala within the disturbance footprint. The potential for significant impacts are assessed further in Table 5.28.
Potorous tridactylus tridactylus	Long-nosed potoroo (SE mainland)	Database records indicate this species does not occur within the MNES study area however the species has been recorded within 50 km of the Project. Species mapping on the SPRAT database shows the species or species habitat as 'may occur' only where the MNES study area intersects the Teviot Range (DAWE 2020a). The nearest database records are from Mt Tamborine (1982) and Canungra (1976) and located 27 km south-east and 35 km south of the Project respectively. Other database records occurring within the 50 km buffer including the D'Aguilar Range (30 km to the north) and Main Range and Lamington National Parks (over 40 km to the south-west and south) (AoLA 2020) (refer Figure 5.8 in Appendix B). The subspecies occurs in patchy populations from south-east of Gladstone through to Victoria. The Project is not located near the limit of the species range. No recovery plan exists for this species. A review of the available literature has not revealed any important populations when referring to DAWE's SPRAT database (2020b) which notes, with reference to the Project, the species occurring in Lamington National Park (to the south) and the Belthorpe (80 km north of the Project). It is noted the Queensland populations are considered as being reasonably secure (DAWE 2020b). No populations have been identified that are key to the long-term survival and recovery of this species and *Habitat critical to the survival of the species* has not been identified or defined. In the absence of a definition for *Habitat critical to the survival of the species* this assessment has applied a 1 km buffer on known records that intersect '*potential habitat*' (refer Appendix A for methodology). As such, there is no *Habitat critical to the survival of the species* identified within or close to the Project (refer Table 5.4 and habitat figure in Appendix G). The Project is predicted to impact 9.56 ha of *potential habitat* for the species under the approach used for this assessment. No important populations or *Habitat critical to the survival of the species* have been identified for this species in relation to the Project. There is no evidence the species has ever occurred in the area. It is considered highly unlikely that the potential impacts from the Project (direct or indirect) on the species, or the species habitat, would be of an extent such that the species will decline or the Project would impede the species recovery. Therefore, the Project is unlikely to significantly impact this species and it is not considered further.

Species name	Common name	MNES study area population evaluation
Pseudomys novaehollandiae	New Holland mouse	Predictive habitat mapping indicates that the Project has the potential to impact 9.56 ha of *potential habitat* in which this species may occur (refer Table 5.4). Database records indicate this species does not occur within the MNES study area but has occurred within 50 km of the Project. Species mapping shows the species or species habitat as 'likely to occur' only in the very western portion of the MNES study area near Calvert (this does not extend east to habitat in the Teviot Range) (DAWE 2020a). The species is not considered to occur elsewhere within the MNES study area. The nearest database record is from 1982 taken from approximately 27 km north-west of the Project near Gatton. The location data associated with this record appears to be erroneous. Van dyck and Lawrie (1997) note the location of the find as likely to be from an area south of Flagstone Creek (approximately 40 km west of the MNES study area). More recent database records occur further north of this record in the Crow's Nest and Helidon areas (35 km north-west of the Project). There are also records (from 1997) approximately 40 to the south-west of the Project from Main Range National Park (refer Figure 5.14 in Appendix B). The Project is located outside of the potential distribution for the species (AoLA 2020). No recovery plan exists for this species. A review of the available literature has not revealed any important populations when referring to DAWE's SPRAT database (2020b). No populations have been identified that are key to the long-term survival and recovery of this species and *Habitat critical to the survival of the species* for the species has not been identified or defined. In the absence of a definition for *Habitat critical to the survival of the species* this assessment has applied a 1 km buffer on known records that intersect '*potential habitat*' (refer Appendix A for methodology). As such, there is no *Habitat critical to the survival of the species* identified within or close to the Project disturbance footprint (refer Table 5.4 and habitat figure in Appendix G). No important populations or *Habitat critical to the survival of the species* have been identified for this species in relation to the Project. There is no evidence the species has ever occurred in the area. It is considered highly unlikely that the potential impacts from the Project (direct or indirect) on the species, or the species habitat, would be of an extent such that the species will decline or the Project would impede the species recovery. Therefore, the Project is unlikely to significantly impact this species and it is not considered further.
Pteropus poliocephalus	Grey-headed flying-fox	Database records indicate this species has not been recorded within the MNES study area however there are records within 50 km of the Project. The nearest database record is from 2008 taken from within 10 km east of the Project on the Flinders Goolman Conservation Estate. Database searches indicate a number of records in all directions around the Project (AoLA 2020) (refer Figure 5.6 in Appendix B). The species distribution extends from Rockhampton south to Victoria and South Australia. The MNES study area is not at the limit of the species range. Based on quarterly flying-fox data collected by DES in the south-east Queensland region there are five flying-fox camps located within 15 km of the Project which regularly comprise Grey-headed flying-fox: three in the Ipswich area, one at Laidley, and one from Cedar Grove (east of Kagaru). The draft *National recovery plan for the Grey-headed flying-fox (Pteropus poliocephalus*) (DotEE 2017b) does not identify important populations for the species. The Plan does not specifically identify *Habitat critical to the survival of the species* but does recommend management of habitat associated with a number of tree species located within the MNES study area. This is a highly mobile species and the linear nature of the Project is not expected to impact dispersal or breeding capacity. Predictive impact assessment has taken a conservative approach for this species and included all habitat within a 15 km radius of the known regular roost sites for the species that are local to the MNES study area (refer Appendix A for methodology). As such, the predictive assessment estimates that 71.44 ha of *Habitat critical to the survival of the species* may be impacted under the current disturbance footprint (refer Table 5.4). The Project has potential to impact habitat considered critical to the survival of the species under the approach used for this assessment. The potential for significant impacts are assessed further in Table 5.29.

5.3.5.3 Significant impact assessment – Vulnerable fauna species

Collared delma (*Delma torquata*) - vulnerable

Ecology and distribution

The Collared delma typically inhabits eucalypt-dominated woodlands and open-forests in Queensland on RE land zones 3, 9 and 10 (Brigalow Belt Reptiles Workshop 2010). Recent studies in the Toowoomba Range associated with the species indicated the species was frequently associated with open *Eucalyptus crebra* woodland located on northwest facing slopes on land zone 9 (Schell and Stark pers. obs. 2017).

The Collared delma has been recorded from rocky areas associated with dry open forests. This species occurs in open eucalypt and *Acacia* woodland with an understorey of native grasses and loose rocks. The Collared delma has also been recorded from Eucalypt woodland adjacent to semi-evergreen vine thicket. This species shelters under rocks, fallen timber, leaf litter and in soil cracks (Richardson 2006). The presence of rocks, logs, bark and other coarse woody debris, and mats of leaf litter (typically 30 to 100 mm thick) appears to be an essential characteristic of the Collared delma microhabitat and is always present where the species occurs (Brigalow Belt Reptiles Workshop 2010; Davidson 1993; Schell and Stark pers. obs. 2017).

The Collared delma is endemic to the South-east Queensland and Southern Brigalow Belt bioregions. The known distribution of the species includes Western Creek near Millmerran, the Toowoomba Range, and the Lockyer Forest Reserves north of Helidon, eastward to Moggill on the western outskirts of Brisbane. The largest known occurrence of this species occurs on the Toowoomba Range where large numbers of this species were subject to translocation activities associated with the Toowoomba second range crossing project (DAWE 2020b; Schell and Stark pers. obs. 2017).

Distribution in context to the Project

The Collared delma has not been recorded within or close to the MNES study area. Database records (AoLA) indicate that this species occurs within 50 km of the Project. The nearest database record is from 1993 taken from within approximately 25 km north of the Project in Karana Downs, north of Ipswich. There is also a single 2019 record of uncertain provenance/accuracy located in the Richlands area approximately 26 km north-east of the Project (refer Figure 4.2 in Appendix B). There are a number of more recent records in the area north of Karana Downs, the Lockyer Forest Reserves (35 km north-west of the Project) the Toowoomba Range (over 50 km west of the Project), Bunya Mountains National Park and Yarraman State Forest and surrounds (AoLA 2020).

Project associated surveys noted potential habitat for the species (woodlands with loose surface rocks) as occurring where the Project disturbance footprint intersects Teviot Range (refer assessment proformas in Appendix I).

Recovery plans/threat abatement plans

There is no Commonwealth adopted recovery plans or threat abatement plans applicable to this species However the *Draft Referral guidelines for the nationally listed Brigalow Belt reptiles* (DSEWPaC 2011a) is applicable to this species and outlines primary threats, impacts and mitigations to this species and other Brigalow Belt reptiles.

The DAWE Approved conservation advice (DEWHA 2008h) notes the following potentially threatening processes identified for Australian habitat as relevant to Collared delma:

- Loss and modification of habitat due to urban and agricultural development
- Landscaping activities removing surface rocks
- Fire and invasive weed species, particularly Dwarf lantana (*Lantana montevidensis*).

Important populations and *Habitat critical to the survival of the species*

There are no identified important populations or definitions of *Habitat critical to the survival of the species*. The *Draft referral guidelines for the nationally listed Brigalow Belt reptiles* (DSEWPaC 2011a) considers the presence of suitable and *important habitat* for this species a surrogate for an important population of the species. This includes known/likely habitat for the species as mapped within the guidelines. The Project lies to the south of known/likely habitat and is mapped as 'may occur' only. Other important habitat factors include: habitat near the limit of the species known range; and large patches of contiguous, suitable habitat and viable landscape corridors. Habitat within the Teviot Range is extensive, acts as a wildlife corridor, and includes the following habitat types which the species is known to occur in:

- Open forest eucalypt woodland dominated by Iron barks
- Woodland adjacent to exposed rocky areas
- Regional ecosystems on land zones 3, 9 and 10 (DAWE 2020b).

As such, the MNES study area includes habitat that may be considered as '*important habitat*' for Collared delma.

Impacts and mitigation measures associated with this species are identified within Table 5.7. Predictive habitat mapping for this species estimates that 9.56 ha of *important habitat* may be impacted by the Project (refer Table 5.4 and habitat figure in Appendix G). This habitat is associated with the Teviot Range in the eastern portion of the Project alignment (note this value does not include the extent of habitat located above the proposed tunnel area). Assessment against the significant impact criteria for vulnerable species is shown in Table 5.22.

Table 5.22 Assessment against the significant impact criteria – Collared delma

Criterion	Assessment against significance criteria
Lead to a long-term decrease in the size of an important population of a species	Predictive habitat mapping indicates the Project has the potential to impact 9.56 ha of '*important habitat*' for the species. However, there are no known records of this species within or close to the Project disturbance footprint. The closest known records and population are located at least 25 km north of the Project in the Ipswich area. The vast majority of the disturbance footprint impacts already cleared lands and avoids suitable rocky habitat where possible. However, the Project impacts 9.56 ha of Important habitat for this species within the Teviot Range. In accordance with the Draft referral guidelines for the nationally listed Brigalow Belt reptiles (DSEWPaC 2011a) the presence of *important habitat* is a surrogate for an important population. As such, should the species be found to occur, the Project has the potential to result in the long-term decrease in the size of an important population through: ▪ Loss of habitat ▪ Fragmentation of an important population ▪ Mortality of individuals during construction Pre-clearance surveys in accordance with the Commonwealth guidelines for threatened reptiles will be carried out where potential habitat for this species is identified within the final construction footprint to confirm whether the species actually occurs or not. Noting that the species' distribution is highly fragmented and restricted (i.e. home ranges are small) to only a few locations within areas of suitable habitat. Should the species be found individuals are expected to be relocated from the area of disturbance prior to construction activities (refer Table 5.7). The Project alignment is linear and there will be substantial tracts of potential habitat remaining undisturbed adjacent to the north and south of the disturbance footprint. The Project has the potential (i.e. important population is not confirmed but is based on the presence of *important habitat*) to lead to a long-term decrease in an important population.
Reduce the area of occupancy for an important population	Predictive habitat mapping indicates the Project has the potential to impact 9.56 ha of '*important habitat*' for the species. However, there are no known records of this species within or close to the disturbance footprint. Pre-construction surveys will be carried out where potential habitat for this species is identified within the final construction footprint to identify whether the species actually occurs or not. The Project has the potential (i.e. important population is not confirmed but is based on the presence of *important habitat*) to reduce the occupancy of an important population across the local region.

Criterion	Assessment against significance criteria
Fragment an existing important population into two or more populations	The *Draft referral guidelines for the nationally listed Brigalow Belt reptiles* notes that fragmentation of *important habitat* or landscape corridors through the introduction of a barrier to dispersal. The Project is linear and will fragment *important habitat* for the species and will also be a potential barrier to dispersal. As such the Project has the potential to fragment an existing important population into two or more populations (i.e. under the referral guidelines *important habitat* can be used as a surrogate for an important population). The Project has the potential (i.e. important population is not confirmed but is based on the presence of *important habitat*) to fragment an existing important population into two or more populations.
Adversely affect *Habitat critical to the survival of the species*	The *Draft referral guidelines for the nationally listed Brigalow Belt reptiles* notes that the loss of 2 ha of habitat for this species poses a high risk of causing a significant residual impact to the species. The Project will impact 9.56 ha of *important habitat* for the species, with this habitat considered critical to survival of the species. As such the Project has the potential (i.e. important population is not confirmed but is based on the presence of *important habitat*) habitat considered critical to survival of the species.
Disrupt the breeding cycle of an important population	This species is known to produced eggs in December, which hatch in February–March. As noted above the Project disturbance footprint incorporates 9.56 ha of *important habitat* and clearing activities within this habitat between December and March has the potential to impact the species breeding cycle. The Project has the potential (i.e. important population is not confirmed but is based on the presence of *important habitat*) to disrupt the breeding cycle of an important population.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	As noted above the Project will directly impact 9.56 ha of '*important habitat*' for the species. The mapping also notes that there is approximately 890 ha of *potential habitat* surrounding the Project. As noted in Section 5.1.2, Project impacts are not restricted to the footprint and there is the potential to impact on potential habitat as a result of edge effects, dust deposition, noise and light, changes to soil and changes to hydrology. These indirect impacts on habitat are not likely to be of the extent that the species is likely to decline. The *Draft Referral guidelines for the nationally listed Brigalow Belt reptiles* note that the introduction of invasive weeds, including the deliberate or accidental sowing of pasture grasses, within 30 m of important reptile habitat without appropriate and ongoing control measures also poses a high risk to the species. The rail corridor will be cleared and stabilised, including revegetation using grass species (i.e. woody vegetation will be permanently cleared from the operational rail corridor). Lands within the construction footprint not required for operations will also be rehabilitated, with rehabilitation works likely to reflect pre-existing conditions and as such there is a risk that pastoral grass may be re-introduced to areas within 30 m of *important habitat*. Fire is also a key threat to the species and species habitat with both construction and operation activities potential points sources. The risk of bushfires as a result of the Project are low, while the Project may also provide access to manage bushfires in remote sections of Teviot Range. As noted above the Project will remove, destroy or modify *important habitat* for this species (i.e. important population is not confirmed but is based on the presence of *important habitat*), however the Project is not likely modify or degrade the quality of habitat outside of the Project disturbance footprint to the extent that the species is likely to decline.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	Project-associated surveys have noted areas within the alignment are already heavily infested with weed species including 20 species listed as restricted matters under the Queensland *Biosecurity Act 2014* (EMM 2018b, 2018c). Dwarf lantana has been identified as a particular threat to Collared delma habitat (DEWHA 2008h) and noted as present within the alignment during all Project-associated surveys. Relevant habitats for the species (eucalypt woodlands) within the MNES study area were often noted to have high levels of introduced species including *Lantana montevidensis* which is thought to be a key threat to the species. Feral predators including Red fox and Dog have been identified as present during multiple Project-associated surveys. Weed and pest control measures will be incorporated into the Project Biosecurity Management Plan to control the introduction and spread of weed and pest species across the Project disturbance footprint and surrounds covering both construction and operation activities. The Plan will be in place for the life of the Project and will minimise the potential for weed invasion and may in the long-term improve habitat condition within vegetation communities located adjacent to Project infrastructure. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.

Criterion	Assessment against significance criteria
Introduce disease that may cause the species to decline	The Project Biosecurity Management Plan will incorporate the management of invasive species which will assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.
Interfere substantially with the recovery of the species	There is no recovery plan for this species. The Approved conservation advice (DEWHA 2008h) notes the following priority actions applicable to the species: ▪ Protect and monitor known populations and identify threats ▪ Develop a fire management strategy for known populations and habitat ▪ Minimise adverse impacts from land use including road widening and maintenance ▪ Identify and control threatening weeds in Collared delma habitat. It is not known if the species occurs in the area. The Project is considered unlikely to interfere with any of the priority actions listed above such that it will substantially interfere with the recovery of the species. The Project Biosecurity Management Plan will help to control weeds in the vicinity of the Project. Should Collared delma be identified during Project activities this will contribute to current information on the species in the south-east Queensland region.
Assessment of potential for significant residual impacts	The Project is considered to have potential (i.e. an important population is not confirmed as present but is based on the presence of *important habitat*) for a significant residual impact on Collared delma.

Red goshawk (*Erythrotriorchis radiatus*)

The solitary Red goshawk is known to mostly prey on larger birds such as Australian brush-turkeys (*Alectura lathami*), Kookaburras (*Dacelo novaeguineae* and *leachii*), Rainbow lorikeet (*Trichoglossus moluccanus*), and other parrots, as well as small mammals, reptiles and insects. The species is known to attack its prey from the air, gliding straight down or chasing it down. The species occupies large home ranges estimated to be up to 120 km^2 (females) and 200 km^2 (males). Preferred habitat requirements are extensive tracts or remnant woodlands/forests on fertile soils with a mosaic of vegetation types, access to permanent water, and large populations of birds (DERM 2012).

The male of the species will build nests using dead sticks lined with twigs and green leaves within an exposed fork in the upper quarter of a tree between 10 to 20 m above ground and used each year. Nest sites are usually located on an emergent tree within 1 km of permanent water. The breeding season for Red goshawk occurs from September to December with one to two eggs being laid by the females between August and October in the southeast regions (DES 2017b; OEH 2017c).

The species is sparsely distributed across coastal and near-coastal areas of northern Australia, with occasional records along major inland rivers. The distribution range of Red goshawk previously included north-eastern NSW but has contracted since European settlement (DERM 2012). The southern limit of the species in NSW has undergone a 500 km northward contraction (Debus and Czechura 1988).

Distribution in context to the Project

Database records indicate this species has been recorded within 50 km of the Project. It is noted available records (AoLA) have all been generalised in order to protect the species and so accurate locations have not been published. Recent database records in the region are relatively few. The nearest record is from 2009 and located 7.3 km north of the Project in the Rosewood area (although attached location data indicates Ipswich as the locality). A second record is from 1973 and located 9 km north-east of the Project in South Ripley (south of Ipswich) (refer Figure 6.21 in Appendix B). There are several more recent records (post 2000) to the north (Lowood area) and west of the Project (Gatton area and the Toowoomba Range) (AoLA 2020).

No individuals were observed during Project associated survey works, including targeted surveys for breeding places along the Project alignment (e.g. ELA and EMM). The population in the south-east Queensland bioregion is thought to consist of 10 to 30 breeding pairs (Garnett et al 2011). An intensive study on the species was carried out in favoured sites (largely well-vegetated montane and foothill areas) in south-east Queensland over 60 survey days from December 2013 to May 2014. No individuals and a single potential nest site were observed across the survey period (Seaton 2014).

Recovery plans/threat abatement plans

The *National recovery plan for the Red goshawk (Erythrotriorchis radiatus)* (DERM 2012) came into effect under the EPBC Act in July 2012. The Plan identifies the following threatening processes as applicable to the species:

- Loss of habitat
- Fragmentation of existing habitat
- Reduction in nest sites through the loss of mature trees
- Reduction to the prey base
- Threats to prey availability
- Knowledge and communication gaps for this species
- Poor management practices.

There are no Commonwealth adopted threat abatement considered relevant to this species.

Important populations and *Habitat critical to the survival of the species*

Specific important populations have not been identified for this species due to the sparse distribution of the species. It is considered likely that the south-east Queensland population of Red goshawk represents the southernmost limit of the species at the time of this assessment. Under the definition provided in the MNES Guidelines (DotE 2013a), any individuals occurring in or near the Project may be considered an important population as they are part of a population near the limit of the species range.

Under the recovery plan habitat critical for the species survival comprises all required habitat elements including 'sites for nesting, food resources, water, shelter, essential travel routes, dispersal, buffer areas, and sites needed for the future recovery' (DERM 2012). This requires riverine areas with permanent water which may be limited across the disturbance footprint (e.g. Teviot Brook, Warrill Creek and sections of Purga Creek).

Impacts and mitigation measures associated with this species are identified within Table 5.7. Predictive impact assessment for this species estimates that 1.8 ha of *potential habitat* and 77.25 ha of *Habitat critical to the survival of the species* may be impacted under the current disturbance footprint (refer Table 4.5, Table 5.4 and habitat figure in Appendix G).The habitat mapping has used a conservative approach and may overestimate the amount of habitat available (refer Appendix A for methodology). This habitat is largely associated with the Teviot Range. It is noted where the alignment intersects the Teviot Range it preferentially impacts cleared lands adjacent to Woollaman Creek. Assessment against the significant impact criteria for vulnerable species is shown in Table 5.23.

Table 5.23 Assessment against the significant impact criteria – Red goshawk

Criterion	Assessment against significance criteria
Lead to a long-term decrease in the size of an important population of a species	No historical records exist within the MNES study area and no individuals were observed during field investigations. The nearest recent record is located 7.3 km from the disturbance footprint although the actual locality of the sighting is uncertain. All other recent records (post 2000) are located well away from the Project to the north and west. Should individuals occur in the area they may be considered as part of an 'important population'. The species requires large home ranges of between 120 km^2 and 200 km^2 of suitable woodlands. The species does not generally occur in cleared habitat or in dense vegetation and there are no breeding records from areas where vegetation is extensively fragmented. Predictive habitat mapping indicates the Project has the potential to impact 1.8 ha of *potential habitat* and 77.25 ha of *Habitat critical to the survival of the species*. This habitat is largely associated with the Teviot Range which still retains large tracts of woodlands and is close to Woollaman Creek. Through this area the Project will remove mature trees reducing the availability of potential nest trees, though no nests have been identified from the Project disturbance footprint. The Project also has the potential to impact this species through the following: ▪ Fragmentation of existing habitat ▪ Reduction to the prey base ▪ Threats to prey availability The Project alignment is linear and there will be substantial tracts of suitable habitat remaining undisturbed adjacent to the north and south of the Project in the Teviot Range. It is also noted where the alignment intersects the Teviot Range it preferentially impacts cleared lands adjacent to Woollaman Creek. The potential area of impact would be a very minor percentage of an individuals overall range. Potential nesting habitat (emergent trees within 1 km of permanent waterbodies in the Teviot Range) will be inspected prior to clearing activity (refer Table 5.7). Provisions to protect Red Goshawk nest sites will be in place within the Project Flora and Fauna Sub-plan should any nest sites be recorded. It is considered likely that foraging individuals disturbed by construction activities will temporarily move away from the area of disturbance and return post-construction. The Project is considered unlikely to result in a long-term decrease in the size of an important population should the species be found to occur in the area.
Reduce the area of occupancy for an important population	Predictive habitat mapping indicates the Project has the potential to impact a total of 79.05 ha of habitat for the species. It is uncertain if the species occurs in the area. The nearest recent record is located 7.3 km from the disturbance footprint although the actual locality of the sighting is uncertain. All other recent records (post 2000) are located well away from the MNES study area to the north and west. The species requires large home ranges of between 120 km^2 and 200 km^2. The Project alignment is linear and there will be substantial tracts of suitable habitat remaining undisturbed adjacent to the north and south of the disturbance footprint in the Teviot Range. It is considered likely that foraging individuals disturbed by construction activities will temporarily move away from the area of disturbance and return post-construction. The Project is considered unlikely to reduce the potential area of occupancy for the species should the species be found to occur in the area.
Fragment an existing important population into two or more populations	The species is highly mobile though habitat fragmentation is a key threat to the species with the species known to avoid cleared habitats. In addition, for a widespread but sparse species, most developments are only likely to affect one or two pairs. The Project is located in a fragmented landscape between Calvert and Teviot Range. Within Teviot Range the Project is not considered to represent a barrier to movement for the species. It is considered unlikely that the Project will fragment an existing important population into two or more populations.
Adversely affect *Habitat critical to the survival of the species*	Predictive habitat mapping indicates the Project has the potential to impact 77.25 ha of *Habitat critical to the survival of the species* (under the habitat modelling approach used for this assessment). The Project alignment is linear and there will be substantial tracts of identical habitat remaining undisturbed adjacent to the north and south of the disturbance footprint in the Teviot Range. It is also noted where the alignment intersects the Teviot Range it preferentially impacts cleared lands adjacent to Woollaman Creek. The species requires large home ranges and the Project will impact a very minor proportion of the available 'critical' habitat in the wider area. Nevertheless there is potential for the Project to adversely affect *Habitat critical to the survival of the species*.

Criterion	Assessment against significance criteria
Disrupt the breeding cycle of an important population	No historical records or recent field observations for the species exist within or close to the MNES study area itself. No breeding sites are known to the MNES study area. Potential nesting habitat (emergent trees within 1 km of permanent waterbodies in the Teviot Range) will be inspected prior to clearing activity. The recovery plan notes Red goshawks are very tolerant of moderate numbers of people visiting their nest sites. However, the Project will result in the clearing of mature trees up to a kilometre from watercourses, with these trees as potential suitable nest sites. No raptor nests were identified from the Project disturbance footprint during the EIS studies, including within large mature trees within 1 km of a major watercourse. Tree clearing during the breeding season (generally occurs in spring), egg-laying (August to October) or fledging (65-80 days) may present a direct impact on the species breeding cycle. Provisions to protect Red goshawk nest sites will be in place within the Project EMP should any nest sites be recorded. This will likely include buffer zones and the erection of barriers and/or signage around the trees during construction and micrositing of the clearing works to avoid nests. It is considered unlikely that the Project will disrupt the breeding cycle of an important population.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	There are no historical records of the species within the MNES study area and the species is currently considered as rare in the region. Predictive habitat mapping indicates the Project has the potential to impact a total of 79.05 ha of habitat for the species. However, the species has large home ranges and the Project alignment is linear. There will be substantial tracts of suitable habitat remaining undisturbed adjacent to the north and south of the disturbance footprint. Impacts will be temporary and restricted to the construction period. This impact is not considered to be of the extent that the species is likely to decline, should the species be found to occur in the area.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	There are no weeds or pests identified as relevant to Red goshawk. Project-associated surveys have noted areas within the alignment are already heavily infested with weed species including 20 species listed as restricted matters under the Queensland *Biosecurity Act 2014* (EMM 2018b, 2018c). Habitats within the MNES assessment area were often noted to have high levels of introduced species including *Lantana camara* and *Opuntia* species (Jacobs-GHD 2016a). Feral predators including Red fox and Dog have been identified as present during multiple Project-associated surveys. Weed and pest control measures will be incorporated into the Project Biosecurity Management Plan to control the introduction and spread of weed and pest species across the disturbance footprint and surrounds covering both construction and operation activities. The Plan will be in place for the life of the Project and will minimise the potential for weed invasion and may in the long-term improve habitat condition within vegetation communities located adjacent to Project infrastructure. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.
Introduce disease that may cause the species to decline	The Project Biosecurity Management Plan will incorporate the management of invasive species which will assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.
Interfere substantially with the recovery of the species	Recovery strategies listed in the Commonwealth recovery plan for the species include: - Identify and map important Red goshawk habitat - Protect and appropriately manage *important habitat* area to ensure long-term survival of the Red goshawk - Increase knowledge about the Red goshawk's productive success and its survival - Identify important populations of Red goshawks - Increase community awareness about the Red goshawk and the conservation of the species (DERM 2012). The Project is considered unlikely to interfere with any of the recovery strategies listed above. Should Red goshawk be identified during Project activities this would contribute to current information on the species in the south-east Queensland region.
Assessment of potential for significant residual impacts	The Project has potential to have a significant impact on the Red goshawk through impacts to habitat identified as *Habitat critical to the survival of the species*, although it is uncertain if the species occurs.

Australian lungfish (*Neoceratodus forsteri*)

Ecology and distribution

Australian lungfish prefers still or slow-flowing, shallow waters with clear, vegetated pools to allow feeding, shelter and spawning. Vegetation such as Red bottle-brush (*Callistemon saligna*), She-oak (*Casuarina* spp.) and aquatic macrophytes are the dominant species used by the lungfish. Despite the capability of the species to breathe aerially using its single lung, it requires permanent water and cannot live in saline environments (Brooks and Kind 2002). The primary source of food for the Australian lungfish is molluscs and other small animals. The species is known to be a low level benthic carnivore with hatchlings and juveniles feeding on small invertebrates as active predators during the developmental stage (Kemp 1996).

The breeding cycle of the lungfish occurs at around 15 years of age for the male and 20 years for the female with spawning at night between August and December in preferably clear waters. The species is known to abandon any spawning sites upon disturbance (DAWE 2020b).

The lungfish is an endemic species to Australia and limited in distribution to southeast Queensland. River systems such as the Mary, Burnett and Brisbane Rivers are currently inhabited. The species has also been translocated successfully to the Condamine, Albert and Logan Rivers (DAWE 2020b). The species is native to the Mary and Burnett Rivers and was potentially present in the Brisbane River catchment, although this remains uncertain. A number of individuals were translocated from the Mary River in the 1890s to several locations including a farm dam in the upper Brisbane River, the North Pine River, a lagoon near the Albert River, Enoggera Reservoir and the Condamine River (DotEE 2019a).

Distribution in context to the Project

Database records (i.e. AoLA, Wildlife Online) indicate this species has not been recorded within the MNES study area. The nearest database record is from 1989 taken from approximately 5 km east (and downstream) of the eastern extent of the Project from the Logan River (south-west of Jimboomba). There is a 1971 record from the Bremer River located 5 km downstream of the Project. The nearest recent record (2017) is from the Bremer River located 12 km north of the Project in the Ipswich city area (refer Figure 3.2 in Appendix B). There are further records to the north of the Project from elsewhere in the Brisbane River catchment including Lockyer Creek. There are no records upstream of the Project. Mapping of the species distribution indicates the species occurs in the Brisbane River catchment (including the Bremer River) but does not occur in the Logan-Albert River catchment (DotEE 2019a).

Waterways crossed by the western section of the Project alignment are within the upper catchment of the Brisbane River and include the Bremer River. The eastern section of the Project lies within the Logan River catchment which includes the alignment crossing at Teviot Brook. Teviot Brook, Bremer River and a tributary of Purga Creek were subject to targeted fish assessments at points close to the location of Project crossings (Jacobs-GHD 2016a). This included electrofishing and fyke netting. Australian lungfish were not recorded. The targeted fish assessment on the Bremer River recorded only small native species such as gudgeon and rainbowfish species as well as the introduced Mosquito-fish (*Gambusia holbrooki*).

Habitat values across the catchment appeared poor with little canopy cover over creeks, heavily impacted riparian zones, and cattle access. Aquatic habitat assessment at the location of the Project crossing on the Bremer River in September 2017 noted little water and no macrophytes present and few deeper pooled areas likely to be suitable for Australian lungfish. Cattle access was evident and this reach of the Bremer River occurs in a heavily modified landscape. Habitat values for Australian lungfish at this site would appear poor being narrow, shallow and highly disturbed (refer Photograph 5.1). This site was inspected for water quality sampling for the Project on three occasions (September 2017, February 2018 and March 2019) with water present only on one occasion (February 2018) (indicating ephemeral habitat is present).

Photograph 5.1 Bremer River crossing point – May 2016 (Jacobs-GHD 2016a)

Aquatic habitat assessment at the location of the Project crossing on Warrill Creek in September 2017 noted a large pooled area with good quality habitat components including emergent macrophyte cover. Water quality sampling was carried out at this site in September 2017 but was not carried out during a subsequent sampling event in February 2018 due to dry conditions (indicating this section of Warrill Creek is ephemeral). The site could not be accessed in March 2019. Site assessment at the alignment crossing of Teviot Brook recorded reasonable conditions although with limited pool habitat, existing restrictions to fish movements and minimal macrophyte cover in the form of lilypads (*Nymphoides* sp.) (refer EIS Appendix J: Terrestrial and Aquatic Ecology Technical Report for further detail).

Recovery plan/threat abatement plans

There is currently a draft *National recovery plan for the Australian lungfish (Neoceratodus forsteri*) (DotEE 2019a) awaiting adoption by DAWE. The draft Plan identifies the following threatening processes as applicable to the species:

- Instream barriers preventing movements and impacting habitat conditions
- Regulated stream flows impacting habitat conditions (considered a specific threat to Brisbane River populations)
- Stream habitat and water quality degradation from land clearing, livestock access and increased salinity
- Potential competition with invasive species and native species. Small species such as the introduced Mosquito-fish (*gambusia holbrooki*) may compete with the larval stage of cod. Native species such as Australian bass (*Macquaria novaemaculeata*) and Golden perch (*Macquaria ambigua*) have been stocked outside of their natural range and may predate on juvenile lungfish and eggs. Introduced species such as Tilapia (*Oreochromis mossambicus*) and European carp (*Cyprinus carpio*) may impact lungfish habitat.
- Fishing and boating activities.

There is no Commonwealth adopted threat abatement plan considered relevant to this species.

Important populations and *Habitat critical to the survival of the species*

The *Draft national recovery plan for the Australian lungfish (Neoceratodus forsteri*) (DotEE 2019a) does not identify important populations but suggests all populations are under threat. The MNES study area is located at the southern edge of the species range and as such any populations present may be considered part of an ‘important population’ under the MNES guidelines.

The Plan defines *Habitat critical to the survival of the species* as 'breeding or foraging habitat in areas where the species occurs' as defined by the Plan's distribution map for the Brisbane River catchment. The Project intersects the Bremer River within the mapped distribution. However, as noted above, the Bremer River at the point of intersection with the alignment does not provide values likely to support the species. As such, it is not considered to provide *Habitat critical to the survival of the species*.

Impacts and mitigation measures associated with this species are identified within Table 5.7. Predictive habitat mapping estimates that 27.62 ha of *potential habitat* will be impacted by the Project (refer Table 5.4 and habitat figure in Appendix G) with the majority of this area composed of ephemeral watercourses (i.e. potential habitat is all watercourses with a stream of three or above). Assessment of potential disturbance of this species against the MNES Significant impact guidelines is provided in Table 5.24.

Table 5.24 Assessment against the significant impact criteria – Australian lungfish

Criterion	Assessment against significance criteria
Lead to a long-term decrease in the size of a population	There are no recent records within, or close to the disturbance footprint and no records upstream. Nevertheless, should the species be found to occur there is potential the population may be considered as an 'important population'. Predictive habitat mapping indicates that the Project may impact 27.62 ha of *potential habitat*, within the upper reaches of the Brisbane and Logan catchments. Nevertheless, general habitat values for Australian lungfish appear poor at the waterway crossing points associated with the Project and most sites are ephemeral (refer Section 4.4.4). As noted in Section 5.1.2 the Project has the potential to impact on aquatic habitats within and downstream of the Project disturbance footprint. As noted above, some of these impacts are recognised threats to the species. Physical barriers that prevent individuals from accessing breeding sites and the flooding of spawning sites are two key threats (DotEE 2019a). It should be noted that breeding and spawning sites within and upstream of the Project are likely limited (i.e. habitats are ephemeral systems with limited macrophyte richness and abundance). The Project design incorporates culverts and bridges to allow fish passage, including bridge crossings of the Bremer River, Warrill Creek, Purga Creek and Teviot Brook. This should ensure that fish passage is maintained in these systems, while flood modelling indicates that there will be limited change to peak flows, inundation areas and times of submergence as a result of the Project (refer EIS Appendix N: Hydrology and Flooding Technical Report). The culvert design will also incorporate (where applicable) measures to maintain fish passage, minimise changes to environmental flows and water quality, with ongoing maintenance of these structures also required. Construction activity at watercourse crossings will also disturb the riparian zone and instream habitats, including potential habitat for the species. These impacts are likely to be localised and occur in areas which are unlikely to be breeding or foraging habitat for the species. The Project's construction phase may require temporary stream impoundments at waterway crossing points, along with the removal of instream habitat. These works will be temporary and localised and will predominantly occur in perennial systems/permanent pools such as Warrill Creek and Teviot Brook. Dewatering activities of impounded areas will be carried out with consideration of the Queensland Department of Agriculture and Fisheries Guidelines for fish salvage in impounded areas under the Project Flora and Fauna Sub-plan (refer Table 5.7). The impacts of the Project are considered unlikely to lead to a long-term decrease in the size of a population.
Reduce the area of occupancy of the species	There are no recent records within, or close to the disturbance footprint and no records upstream. Nevertheless, should the species be found to occur there is potential the population may be considered as an 'important population'. Predictive habitat mapping indicates that the Project may impact 27.62 ha of *potential habitat*, within the upper reaches of the Brisbane and Logan catchments The Project design incorporates culverts and bridges to allow fish passage, including bridges over Bremer River, Warrill Creek, Purga Creek and Teviot Brook. Construction works within these watercourses will also result in changes to instream habitats which may temporarily influence the species behaviour and distribution (should it be present). Stream impoundments may be required temporarily during the construction phase and as part of maintenance activities during operations. The Project will also result in some infilling and diversions of drainage lines and minor watercourses, however these areas are not considered habitat for this species.

Criterion	Assessment against significance criteria
	The impacts of the Project are temporary and considered unlikely to reduce the area of occupancy of the species.
Fragment an existing population into two or more populations	The Project is not considered to represent a barrier to movement for the species. The Project design incorporates culverts and bridges to allow fish passage, including bridges over Bremer River, Warrill Creek, Purga Creek and Teviot Brook. Stream impoundments may be required temporarily only during the construction phase. These structures and construction measures will avoid fragmentation of an existing population. It is considered unlikely that the Project will fragment an existing important population into two or more populations.
Adversely affect *Habitat critical to the survival of the species*	The Project will intersect *Habitat critical to the survival of the species* as mapped under the species recovery plan where it crosses the Bremer River. However, onsite assessments indicate this section of the river provides poor habitat values for Australian lungfish. There are no recent records within, or close to the disturbance footprint and no records upstream. Project disturbance to this area will be temporary being primarily restricted the construction period (there will be maintenance activities during the operation phase). The Project will also have a temporary impact on environmental flows noting the downstream receiving environment is *Habitat critical to the survival of the species* (i.e. during construction coffer dams will be erected within watercourses preventing and/or regulating stream flows). Changes to water quality may also occur if not appropriately managed during construction (e.g. overland flow from cleared lands, loss of riparian zones and instead habitats, erosion and sediment controls) or operations (accidental spills and maintenance of waterway barriers). However, the risk of impact is likely to be low and localised. Mitigation measures will be in place to ensure surface water quality associated with the Project surrounds is not impacted as a result of Project activities (e.g. erosion and sediment controls and water quality monitoring program) (refer Table 5.7). It is considered unlikely that the Project will adversely affect *Habitat critical to the survival of the species*.
Disrupt the breeding cycle of a population	The Australian lungfish is restricted to areas of permanent water and is known to complete their lifecycle entirely within freshwater habitats (i.e. potamodromous). Breeding occurs from August through to December in shallow runs and along river margins in close proximity to aquatic vegetation. Submerged aquatic plants are an important habitat feature for breeding grounds, nursery areas and adult foraging zones. In general habitat values for Australian lungfish appear poor at the waterway crossing points associated with the Project (e.g. limited submerged plants are present if at all) and most sites are ephemeral. As such it is unlikely that the species breeds within the reach intersected by the Project or upstream of these crossings. The temporary impoundment of these watercourses may pose a risk to these species given they are potamodromous. However, the Project design incorporates culverts and bridges to allow fish passage, including bridges over Bremer River, Warrill Creek, Purga Creek and Teviot Brook. Stream impoundments may be required temporarily only during the construction phase. Project disturbance to waterways will be temporary being restricted the construction period. It is considered unlikely that the Project will disrupt the breeding cycle of a population.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	Aquatic habitat degradation is contributing a factor to the decline in Australian lungfish populations. The degradation generally occurs at a catchment scale such as land clearing, pesticide use and irrigation abstraction which influence water quality. Under the recovery plan potential threats relevant to habitat degradation is relevant to populations within both the Bremer and Logan River catchments. Despite this the Project will require works within instream habitats, which will result in the removal of woody debris and changes to the local geomorphology. There features are believed to be important to the species but are not utilised as extensively as macrophytes habitats. The majority of the water crossing points are ephemeral and instream habitat complexity is limited, in particular the presence of aquatic plants. Project disturbance to waterways will be localised and temporary primarily being restricted the construction period. Changes to water quality may also occur if not appropriately managed during construction (e.g. overland flow from cleared lands, loss of riparian zones and instead habitats, erosion and sediment controls) or operations (accidental spills and maintenance of waterway barriers). However, the risk of impact is likely to be low and localised. Mitigation measures will be in place to ensure surface water quality associated with the Project surrounds is not impacted as a result of Project activities (e.g. erosion and sediment controls and water quality monitoring program) (refer Table 5.7). The impacts of the Project are considered unlikely to be of the extent that the species is likely to decline.

Criterion	Assessment against significance criteria
Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the critically endangered or endangered species' habitat	Under the recovery plan potential threats relevant to the populations within the Brisbane River and Logan River catchments include the introduction of pest species, including competition/predation by introduced species (especially Tilapia and Banded grunter (*Amniataba percoides*). Introduced fish species are identified as a potential threat to the species. Aquatic assessments identified four introduced species in Teviot Brook including European carp (*Cyprinus carpio*) and Tilapia (*Oreochromis mossambicus*). Only smaller native species and the Mosquito-fish (*Gambusia holbrooki*) were identified in the Bremer River crossing area (Jacobs-GHD 2016a). As such it is likely there is already elevated competition levels from these species with Australian lungfish assuming they occur in the waterways crossed by the alignment. Weed and pest control measures will be incorporated into the Project Biosecurity Management Plan to control the introduction of novel weeds and spread of existing weed species across the disturbance footprint. This will include measures to ensure aquatic weeds and pest species are not introduced as a result of the Project. The Plan will be in place for the life of the Project and will minimise the potential for weed invasion and may in the long-term improve habitat condition within vegetation communities located adjacent to Project infrastructure. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.
Introduce disease that may cause the species to decline	The Project Biosecurity Management Plan will incorporate the management of invasive species which will assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.
Interfere with the recovery of the species	The draft recovery Plan for the species includes the following recovery actions: ▪ Reduce the impacts of, and remove any redundant, artificial barriers ▪ Manage waterways to optimise breeding and recruitment opportunities ▪ Limit habitat degradation and maintain or enhance water quality ▪ Reduce the impacts of introduced pest and weed species ▪ Manage the impacts of water-based recreational activities ▪ Address key knowledge gaps to improve Australian lungfish management ▪ Facilitate high levels of community participation and support in the implementation of Australian lungfish management strategies (DotEEc 2019). With mitigation measures in place, particularly for the construction phase, the Project is considered unlikely to interfere with any of the recovery actions listed above and will not interfere with the recovery of the species. Should Australian lungfish be identified during Project activities this will contribute to current information on the species in the south-east Queensland region.
Assessment of potential for significant residual impacts	The Project is considered unlikely to have a significant impact on Australian lungfish

Greater glider (*Petauroides volans*)

Ecology and distribution

The Greater glider (*Petauroides volans*) is the largest species of gliding possum. It has large ears fringed with thick fur and a gliding membrane which attaches to the elbows and ankles. Greater gliders are typically found in mature eucalypt forests and woodlands with a variety of eucalypt species and a high density of large tree hollows (van der Ree et al. 2004). The diet is largely composed of eucalypt leaves and sometimes flowers. Large hollows in old trees are favoured as shelter sites during the daytime (Goldingay 2012). Sites with a high abundance of suitable hollows appear to support higher populations. The species uses relatively small home ranges of 1 ha – 4 ha in more productive forests (Gibbons and Lindenmayer 2002), but up to 16 ha in more open and dry habitats (Smith et al. 2007).

Females breed in their second year giving birth to a single young each year (March to June). Their low birth rate may cause isolated populations in small forest fragments to be vulnerable to extinction (van der Ree et al. 2004).

The Greater glider occurs in eucalypt forests along the ranges and coastal plains of eastern Australia from central Victoria near Daylesford to the Windsor Tablelands in far northern Queensland. It has an elevational range from sea level to 1,200 m above sea level (TSSC 2016b; OEH 2018a).

Distribution in context to the Project

The species has not been recorded during any Project-associated surveys. Database records indicate this species has occurred within the MNES study area. The nearest record (1999) is approximately 500 m north of the Project disturbance footprint in the Peak Crossing area (refer Figure 4.2). A second record (1989) lies approximately 5 km north of the Project between Rosewood and Marburg. Other database records occur to the north and south of the Project, although none within 12 km of the Project disturbance footprint (AoLA 2020) (refer Figure 5.4 in Appendix B). These records are concentrated to the north-east (Ipswich and Brisbane areas) with the nearest records in the White Rock/Spring Mountain areas (from the 1990s to 2001). Records to the south and south-west are largely associated with Main Range and Lamington National Parks and are over 35 km from the MNES study area. A single record from Moogerah Peaks (south-west of Boonah) is approximately 30 m south-west of the Project.

In general, the Project EIS surveys observed that suitable habitat containing large tree hollows suitable for Greater glider was generally uncommon, being restricted to some patches of floodplain woodland on grazing properties (e.g. near Paynes Road, Ebenezeer) and remnant vegetation within the Teviot Range (refer Appendix I). It is noted that much of the MNES study area is dominated by regrowth communities that are unlikely to comprise mature trees with larger hollows.

Recovery plan/threat abatement plans

There is no Commonwealth adopted recovery plan or threat abatement plans applicable to this species.

The DAWE Approved conservation advice (TSSC 2016b) notes the following potentially threatening processes identified for Australian habitat as relevant to Greater glider:

- Habitat loss and fragmentation through tree clearing and logging (including for timber production) and loss of dead stag trees (with hollows) due to prescribed burning
- Changed fire regimes (including from climate change) leading too intense and/or frequent fires
- Entanglement in barbed wire is a minor threat
- Impacts from native bird species including hyper-predation by owls and competition with cockatoos for tree hollows
- Impact to habitat from *Phytophthora cinnamomi*.

Important populations and *Habitat critical to the survival of the species*

There are no important populations or definition of *Habitat critical to the survival of the species* in any available literature for the species. The species occurs across eastern Australia and the Project disturbance footprint is not located on the edge of the species range and there is no evidence to suggest the area supports a key source population. In the absence of any other habitat definition for the species this assessment has defined *Habitat critical to the survival of the species* by applying a 1 km buffer on known records that intersect '*potential habitat*' for the species (refer Appendix A for methodology). Although there is a database record located close to the Project disturbance footprint there is no nearby mapped vegetation within the footprint or MNEs study area. As such, the Project disturbance footprint is not considered to comprise habitat 'critical to the survival of the species'. Predictive habitat mapping indicate the Project may impact 16.60 ha of *potential habitat* in which this species may occur (refer Table 5.4 and habitat figure in Appendix G).

Impacts and mitigation measures associated with this species are identified within Table 5.7. Assessment against the significant impact criteria for vulnerable species is shown in Table 5.25.

Table 5.25 Assessment against the significant impact criteria – Greater glider

Criteria	Assessment against significance criteria (vulnerable species)
Lead to a long-term decrease in the size of an important population of the species	The species has not been recorded within or near the Project disturbance footprint during Project surveys and no 'important population' is predicted to occur in the area. There is a single database record (1999) within 500 m of the Project disturbance footprint and an older record (1989) 5 km north in the Rosewood area. There are no records in the Teviot Range in the vicinity of the Project disturbance footprint. The nearest relatively recent records (2001) are located over 12 km north-east of the Project disturbance footprint in the White Rock/Spring Mountain area. It is uncertain to what extent the habitat within the Project disturbance footprint retains suitable large tree hollows that may support the species. The majority of the area impacted by the Project supports regrowth vegetation which is much less likely to support the species. The species is known to glide over a distance of up to 100 m, but usually tends not to glide further than 30 m. The species also has a steeper trajectory than other species of glider. As the rail corridor is over 60 m wide there is the potential for the Project to impact movement, noting that individuals appear to use the same routes repeatedly as they move from hollows to feeding areas and occupy relatively small home ranges (average 1 ha to 4 ha in productive habitat). Where the Project intersects the Teviot Range this habitat is largely unsuitable for the species as hollows are generally in low abundance (regrowth or non-remnant vegetation communities). More suitable remnant eucalypt habitat located above the tunnel area is not expected to be impacted. Pre-construction surveys (as per DAWE survey guidelines) will be carried out where suitable habitat for this species is identified within the final temporary construction disturbance footprint. Provisions to protect the species will be in place within the Project Flora and Fauna Management Sub-plan should individuals be located within the disturbance footprint (refer Table 5.7). Should the species be found individuals will be relocated from the area of disturbance by qualified fauna spotter-catchers. The Project is predicted to impact 16.6 ha of *potential habitat* for the species, although this is a likely overestimate. Nevertheless, there is abundant similar habitat in the region surrounding the Project disturbance footprint including 1,007 ha within the MNES study area. It is considered unlikely the Project will lead to a long-term decrease in the size of an important population of the species.
Reduce the area of occupancy of an important population	The species has not been recorded within or near the Project disturbance footprint during Project surveys and there is no evidence an 'important population' occurs in the area. A single older record (1999) occurs near the Project disturbance footprint but there are few records in the wider surrounds and no records in the Teviot Range in the vicinity of the Project disturbance footprint. It is uncertain to what extent the habitat within the Project disturbance footprint retains suitable large tree hollows that may support the species. Pre-construction surveys (as per DAWE survey guidelines) will be carried out where suitable habitat for this species is identified within the final temporary construction disturbance footprint. The Project is predicted to impact 16.6 ha of *potential habitat* for the species, although this is likely a substantial overestimate. Nevertheless, there is abundant similar habitat in the region surrounding the Project disturbance footprint including 1,007 ha within the MNES study area. The Project is considered unlikely to reduce the area of occupancy of an important population of the species.
Fragment an existing important population into two or more populations	There is no evidence an 'important population' occurs in the area. Lands surrounding the disturbance footprint (excluding the Teviot Range) have been substantially cleared although some connectivity remains along vegetated creeks and rivers. The Project is linear and when constructed may present a barrier to movement, although this will be mitigated with the incorporation of fauna crossing structures as part of the final Project design. The species is known to glide over a distance of up to 100 m, but usually tend not to glide further than 30 m. The species also has a steeper trajectory than other species of glider. As the rail corridor is over 60 m wide there is the potential for the Project to impact movement, noting that individuals appear to use the same routes repeatedly as they move from hollows to feeding areas. If any of these routes are impacted by the Project there is the potential to fragment a population unless appropriate fauna passage is provided. While there is also an extensive portion of the alignment (approximately 1 km) above the proposed rail tunnel within the Teviot Range which will remain unimpacted and retain function as a movement corridor. It is considered unlikely that the Project will fragment an existing important population into two or more populations.

Criteria	Assessment against significance criteria (vulnerable species)
Adversely affect *Habitat critical to the survival of the species*	It is uncertain if the species occurs in the Project disturbance footprint. The Project is predicted to impact 16.6 ha of *potential habitat* for the species, although this is a likely overestimate. This includes habitat within the Teviot Range where the species has not been recorded previously. There is no *Habitat critical to the survival of the species* (as defined for this assessment). The Project is located within an area already subject to substantial disturbance. As such The Project is considered unlikely to adversely affect habitat critical to the survival of Greater glider.
Disrupt the breeding cycle of an important population	It is uncertain if the species occurs in the Project disturbance footprint. The species has not been recorded within or near the Project disturbance footprint and no 'important population' is predicted to occur in the area. It is uncertain to what extent the habitat within the Project disturbance footprint retains suitable large tree hollows that may support the species, noting hollows were detected in varying density across the Project disturbance footprint. The species is known to breed from March to June. Pre-clearance surveys (as per DAWE survey guidelines) will be carried out where suitable habitat for this species is identified within the final construction footprint. It is considered unlikely the Project will disrupt the breeding cycle of an important population.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	It is uncertain if the species occurs in the Project disturbance footprint. The Project is predicted to impact 16.6 ha of *potential habitat* for the species, although this is a likely overestimate. This includes habitat within the Teviot Range where the species has not been recorded previously. There is no *Habitat critical to the survival of the species* (as defined for this assessment) with the Project located within an area already subject to substantial disturbance. Intense fires are a recognised threat to the species and species habitat with both construction and operation activities providing potential points sources of ignition. Nevertheless the risk of bushfires as a result of the Project are low, while the Project may also provide access to manage bushfires in remote sections of Teviot Range. Predictive mapping identified approximately 990 ha of additional habitat within the MNES study area. As noted in Section 5.1.2, Project impacts are not restricted to the footprint and there is the potential to impact on potential habitat as a result of edge effects, dust deposition, noise and light, changes to soil and changes to hydrology. These indirect impacts on habitat is not likely to be to the extent that the species is likely to decline. As such The Project is considered unlikely to adversely affect habitat critical to the survival of Greater glider.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species habitat	There are no particular weed species identified as relevant to Greater glider. Project-associated surveys have noted areas within the alignment are already heavily infested with weed species including 20 species listed as restricted matters under the Queensland *Biosecurity Act 2014* (EMM 2018b, 2018c). Relevant habitats for the species (eucalypt open forest and woodlands) within the MNES assessment area were often noted to have high levels of introduced species including *Lantana camara* and *Opuntia* species (Jacobs-GHD 2016a). Weed and pest control measures will be incorporated into the Project Biosecurity Management Plan to control the introduction and spread of weed and pest species across the disturbance footprint and surrounds covering both construction and operation activities. The Plan will be in place for the life of the Project and will minimise the potential for weed invasion and may in the long-term improve habitat condition within vegetation communities located adjacent to Project infrastructure. The local landscape is already subject to extensive weed infestation with *Lantana camara* in forest habitats and exotic grasses in agricultural habitats. Pest measures will ensure feral predators (e.g. wild dogs/dingo) are controlled in areas associated with Project activities. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.
Introduce disease that may cause the species to decline	The Project Biosecurity Management Plan will incorporate the management of invasive species which will assist in the prevention of pest plant introduction and *Phytophthora cinnamomi* and Myrtle rust outbreaks resulting from Project activities. The Plan will consider relevant guidelines to control *Phytophthora cinnamomi* and Myrtle rust (e.g. DotE 2015b) associated with Project activities. This will include at a minimum vehicle washdown procedures and contractor education (including procedures regarding cleaning clothing). This will be particularly important during any revegetation activities in the vicinity of Greater glider habitat. Revegetation plant species will be obtained from a reliable source that is certified free of these pathogens. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.

Criteria	Assessment against significance criteria (vulnerable species)
Interfere substantially with the recovery of the species	There is no State or Commonwealth recovery plan for Greater glider. The Approved conservation advice (TSSC 2016b) notes the following priority management actions applicable to the species: ▪ Active threat mitigation in Greater glider habitat including managing fire regimes, constraining timber harvesting activity and clearing in forests with significant subpopulations ▪ Avoid fragmentation and habitat loss from developments and upgrades of transport corridors ▪ High priority monitoring actions include designing an integrated monitoring program across major subpopulations and monitor the abundance/size structure of critical tree species and their responses to management actions ▪ Assess the impacts of fire management strategies on habitat values and Greater glider populations ▪ Assess the abundance, density and types of hollow-bearing trees required to support viable populations It is not known if the species occurs within the Project disturbance footprint. The Project Biosecurity Management Plan will control introduced predators and weeds associated with Project infrastructure, and ensure *Phytophthora cinnamomi* is not introduced to the area as a result of Project activities. Should the species occur any impact will be minor, and is considered unlikely to interfere substantially with the management actions identified above or the recovery of the species.
Assessment of potential for significant residual impacts	Based on the nine-part test above the Project is considered unlikely to have a significant residual impact on Greater glider.

Brush-tailed rock-wallaby (*Petrogale penicillata*)

Ecology and distribution

Brush-tailed rock-wallaby requires rocky habitat including rock faces, boulder piles and isolated rock stacks for refuge sites. The species forages in adjacent grassy woodlands and includes cleared pasture. Rocky outcrops appear crucial to current habitat selection by rock-wallabies, however, vegetation structure and composition is also considered to be an important factor determining habitat suitability. In many parts of their range, including at the Warrumbungles, Brush-tailed rock-wallabies are closely associated with dense arboreal cover, especially fig trees. The vegetation on and below the cliff appear to be important to this species as a source of food and shelter and in some cases may provide some protection from predation. A range of vegetation types are associated with Brush-tailed rock-wallaby habitat, including dense rainforest, wet sclerophyll forest, vine thicket, dry sclerophyll forest, and open forest (DAWE 2020b).

Brush-tailed rock-wallabies are known to shelter during the day in rock crevices, caves and overhangs, but have been observed to bask in exposed sunny spots. Within their home range, rock-wallabies habitually use the same refuges, sunning spots, feeding areas and pathways and these are often defended vigorously (DAWE 2020b).

In south-east Queensland the species historically occurred throughout the Great Diving Range but has since declined significantly undergoing localised extinction and is now patchily distributed along the range from Yarraman (north of Toowoomba) to the upper Snowy River in eastern Victoria (DAWE 2020b). The distribution is broken up into three distinct Ecologically Significant Units with the Northern Ecologically Significant Units ranging from northern NSW to south-eastern Queensland. Several populations in south-east Queensland occur in protected areas including the following locations:

- Queen Mary Falls
- Mt Barney
- Sundown and Main Range National Parks.

Distribution in context to the Project

Database records indicate Brush-tailed rock-wallaby has been recently recorded (2018) within the MNES study area (approximately 2 km north of the disturbance footprint) where it intersects with the Teviot Range, although there is substantial spatial uncertainty (29 km) applied to the location of the record. There are numerous records from the Flinders Peak/Teviot Range area within 10 km north of the MNES study area which may indicate this could be an important source population. This is effectively an isolated colony and is at the eastern limit of its local distribution. Other database records occur to the north-west and south-west of the Project, many within the 50 km buffer (AoLA 2020) (refer Figure 5.2 in Appendix B). There are no records to the immediate south of the Project although this may be an artefact of lack of access and survey effort. The Australian population is estimated at comprising between 15,000 to 30,000 individuals with 17 per cent thought to occur in Queensland (Woinarski et al 2014).

Habitat assessments carried out for the Project EIS studies identified no rocky shelter habitat suitable for Brush-tailed rock-wallaby within the sites visited within the MNES study area or disturbance footprint (refer habitat assessment sheets in Appendix I). Analysis of aerial imagery shows the database records located north of the Project are mostly associated with steep rocky peaks and escarpments located in the area including Flinders Peak, Ivory's Rock, Mount Blaine and Mount Goolman. This habitat was not observed within the disturbance footprint.

The population in the Teviot range has been subject to monitoring since 2013 under activities implemented by Ipswich City Council. The monitoring commenced following high intensity fires that occurred in the Flinders Peak area. Observations on the Teviot range population includes the following:

- Data from 2013-2017 indicates Brush-tailed rock-wallabies persist in relatively high numbers in some areas around Flinders Peak with a focus on western and south-western slopes
- Other areas are occupied by small numbers of individuals
- Some areas vacated post-fire had not been re-colonised
- High levels of habitat degradation including feral pig damage, weed and shrubby *Acacia* regrowth invasion impacting foraging habitat (ICC 2018).

Recovery plan/threat abatement plans

The *National Recovery Plan for the Brush-tailed Rock-wallaby (Petrogale penicillata)* (Menkhorst and Hynes 2010) came into effect under the EPBC Act in February 2012. The Plan identifies the following threatening processes as applicable to the species:

- Historical hunting and persecution for fur and meat
- Habitat degradation and loss
- Predation from native and feral species
- Competition with native and introduced herbivores
- Decline in genetic diversity.

Other threats identified for the species includes the following:

- The invasion of grassy feeding areas by weed species such as *Lantana camara* is thought to reduce habitat quality for the species (DAWE 2020b)
- Bioclimatic changes resulting in lower rainfall and a decline in rainforest vegetation, may have contributed to the recently contracting distribution of *P. penicillata* throughout its range (Department of Environment and Conservation 2005).
- Small, fragmented populations which exhibit low migration rates are highly vulnerable to local catastrophes (Department of Environment and Conservation 2005).

The following threat abatement plans have been identified as being relevant for this species:

- *Threat abatement plan for predation by feral cats* (DotE 2015c)

- *Threat abatement plan for competition and land degradation by rabbits* (DotEE 2016)
- *Threat abatement plan for predation by the European red fox* (DEWHA 2008g)
- *Threat abatement plan for competition and land degradation by unmanaged goats* (DEWHA 2008i).

Important populations and *Habitat critical to the survival of the species*

The National recovery plan identifies several populations important to the survival of the species however these are located in New South Wales and Victoria only. Other important populations may be identified 'based on populations at the limits of its range, outlying populations, stronghold populations, research populations and others where recovery actions (e.g. predator control, reintroductions) are being implemented' (Menkhorst and Hynes 2010). The population in the Teviot Range is the subject of recovery actions implemented by Ipswich City Council under the *Brush-tailed rock wallaby recovery plan* (ICC 2018) which uses the National recovery plan as a framework. Given the Teviot Range population could be considered as on the eastern edge of its range, an outlying population and is subject to recovery actions then any individuals, should they occur in the disturbance footprint, although uncertain, may be considered as part of an important population and they are assessed as such.

The National recovery plan also notes *Habitat critical to the survival of the species* includes 'includes rocky refuge habitat, foraging habitat and commuting routes between the two', but also notes this has not been mapped/defined precisely and requires further work (Menkhorst and Hynes 2010). In the absence of a concise definition for *Habitat critical to the survival of the species* this assessment has included potential habitat within a 1 km buffer of an accurate database record to be *Habitat critical to the survival of the species*. It is noted the specimen record located within the MNES study area referred to above has a high location error margin applied.

Impacts and mitigation measures associated with this species are identified within Table 5.7. Under the habitat assessment approach used for this assessment (refer Appendix A for method) the Project is not expected to directly impact on any critical or potential rocky shelter habitat suitable for this species (refer Table 5.4 and habitat figure in Appendix G). The disturbance footprint largely occurs in unsuitable cleared/alluvial habitat adjacent to Woollaman Creek where it intersects lands located to the south of the concentration of database records around Flinders Peak. No potential shelter habitat (rocky cliffs or boulder piles) were observed within the alignment (refer habitat assessment result in Appendix I). The following significant impact assessment (refer Table 5.26) under the MNES guidelines (DotE 2013a) has been informed by the information detailed above.

Table 5.26 Assessment against the significant impact criteria: Brush-tailed rock-wallaby

Criterion	Assessment against significance criteria
Lead to a long-term decrease in the size of an important population of a species	This species has not been recorded within the disturbance footprint. However, there is potential for an important population to exist in the Teviot Range, particularly to the north of the Project. Predictive habitat mapping indicated no potential rocky shelter habitat will be impacted within the disturbance footprint. The recovery plan (Menkhorst and Hynes 2010) notes that in most parts of its range the species has probably always occurred as a metapopulation comprised of colonies centred on areas of high-quality rock habitat that provided adequate refuges within reach of reliable food resources. Although adults show high fidelity to refuge sites, sub-adults (mostly males) moved between colonies, which probably overcame genetic problems associated with isolation of small populations.

Criterion	Assessment against significance criteria
	The Project will not result in the direct removal of *Habitat critical to the survival of the species*, with preferred rocky shelter sites for the species avoided. Where the alignment intersects the Teviot Range it preferentially impacts cleared low-lying lands adjacent to Woollaman Creek. The proposed tunnel through the range avoids impacting steeper, more elevated habitat in the range. Nevertheless, the disturbance footprint is located to the south of the known population and largely intersects unsuitable habitat. Under the Project Flora and Fauna Sub-plan pre-construction surveys for the species will be carried out in accordance with relevant Commonwealth survey guidelines where suitable habitat is identified within or adjacent to the final construction footprint to identify whether the species actually occurs or not. Should the species be found individuals are expected to be moved away from the area of disturbance during pre-clearance activities (e.g. through the use of temporary exclusion fencing) and prior to any construction activities. The Project alignment is linear and there will be substantial tracts of suitable habitat remaining undisturbed adjacent to the north and south of the disturbance footprint. The Project is considered unlikely to lead to a long-term decrease in an important population.
Reduce the area of occupancy for an important population	There may be an important population existing within the Teviot Range, particularly to the north of the Project, although it is uncertain whether the species will occur within or near the disturbance footprint itself. The Project is not predicted to impact potential rocky shelter habitat for the species. The disturbance footprint has been located to intersect unsuitable habitat. The Project alignment is linear and there will be substantial tracts of suitable habitat remaining undisturbed adjacent to the north and south of the disturbance footprint. Nevertheless, should the species occur in the area the Project has potential to reduce the occupancy of an important population across the local region although to no more than a minor extent.
Fragment an existing important population into two or more populations	There may be an important population existing within the area to the north of the Project. It is uncertain whether the species occurs within or south of the disturbance footprint. The final Project design will incorporate fauna crossing structures to allow fauna movement north and south of the alignment within the Teviot Range. There is also an extensive portion of the alignment above the proposed rail tunnel within the Teviot Range which will remain unimpacted and function as a movement corridor. The Project has some potential to fragment an existing important population if the species occurs to the south of the disturbance footprint.
Adversely affect *Habitat critical to the survival of the species*	The Project is not predicted to impact habitat considered as critical for the species. The disturbance footprint is located to the south of the known population to the north largely intersects unsuitable habitat. The Project is not considered to adversely affect *Habitat critical to the survival of the species*.
Disrupt the breeding cycle of an important population	Breeding habitat for this species is recognised as rocky habitat with an abundant supply of ledges, caves and potential pathways. Sites with a northerly aspect are found to be important. The species may breed at any time of year. The Project is located to the south of a known and likely important population of the species. The Project also largely intersects unsuitable habitat, intersecting the Teviot Range in cleared low-lying lands adjacent to Woollaman Creek or is located within a proposed tunnel in a steeper area. Preferred rocky shelter sites (used for breeding) for the species have been avoided. The Project is considered unlikely to disrupt the breeding cycle of an important population.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The species occurs across numerous areas of south-east Queensland, New South Wales and Victoria. It's uncertain whether the species occurs within the disturbance footprint and predictive habitat modelling indicates that suitable habitat exists within the disturbance area. The disturbance footprint located to the south of the known population to the north largely intersects unsuitable habitat. Given the extent of occurrence of Brush-tailed rock wallaby the Project is considered unlikely to decrease the availability of habitat to the extent that the species is likely to decline.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	Relevant threat abatement/recovery plans for Brush-tailed rock-wallaby include management measures to address the impact of feral cats, rabbits, European red fox and goats. Feral predators including Red fox and Dog have been identified as common during multiple Project-associated surveys. Rabbits were noted as present but uncommon. Feral pigs were also noted as common and have been identified as adversely impacting the species habitat in the area (ICC 2018).

Criterion	Assessment against significance criteria
	Invasive weed species have also been noted as impacting rock-wallaby habitat in the area, particularly foraging habitat (ICC 2018). Project-associated surveys have noted areas within the alignment are already heavily infested with weed species including 20 species listed as restricted matters under the Queensland Biosecurity Act 2014 (EMM 2018b, 2018c). Habitats within the MNES assessment area were often noted to have high levels of introduced species including *Lantana camara* and *Opuntia* species (Jacobs-GHD 2016a). Weed and pest control measures will be incorporated into the Project Biosecurity Management Plan to control the introduction and spread of weed and pest species across the disturbance footprint and surrounds covering both construction and operation activities. The Plan will be a part of the overall Project CEMP. The Plan will be in place for the life of the Project and will minimise the potential for weed invasion and may in the long-term improve habitat condition within vegetation communities located adjacent to Project infrastructure. Pest measures will ensure feral predators (i.e. wild dogs/dingo) are controlled in areas associated with Project activities. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.
Introduce disease that may cause the species to decline	The Project Biosecurity Management Plan will incorporate the management of invasive species which will assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.
Interfere substantially with the recovery of the species	Recovery strategies listed in the Commonwealth recovery plan for the species (Menkhorst and Hynes 2010) include: ▪ Determine and manage threats to the species habitat ▪ Determine population trends for the species including distribution and abundance ▪ Investigate key aspects of the species biology/ecology to improve management ▪ Undertake translocations to improve genetic viability of populations. There is no reason for the Project to substantially interfere with the recovery objectives outlined in the *National Recovery Plan for the Brush-tailed rock-wallaby Petrogale penicillata* (Menkhorst and Hynes 2010). Any impact on the species will be minor and is considered unlikely to interfere with the recovery of the species.
Assessment of potential for significant residual impacts	The Project has a minor potential to fragment an important population should the species also occur south of the Project. The Teviot Range is mapped as where species is likely to occur, however it remains uncertain as to whether the known population area of occupancy extends from Flinders Peak south to and beyond the disturbance footprint. The assessment has been carried out in a conservative manner and the Project has potential to have significant residual impacts on Brush-tailed rock-wallaby.

Koala (*Phascolarctos cinereus*) (QLD, NSW and ACT populations)

Ecology and distribution

The Koala is a leaf-eating specialist feeding primarily during dawn, dusk or during the night. Its diet is restricted mainly to foliage of *Eucalyptus* spp.; however, it may also consume foliage of related genera, including *Corymbia* spp., *Angophora* spp. and *Lophostemon* spp. Koala habitat can be broadly defined as any environment containing Koala food tree species or shelter trees. Along the Great Dividing Range and the coastal belt throughout the species' range, Koalas inhabit moist forests and woodlands dominated by *Eucalyptus* species. Koalas are also known to occur in highly modified (e.g. urbanised) or regenerating native vegetation communities. Home range size is dependent on the quality of habitat. In central Queensland home ranges may be as large as 135 ha (Ellis et al. 2002) and as little as 37 ha in northern New South Wales (Goldingay and Dobner 2014). Koalas are generally sedentary with longer movements largely restricted to dispersing males which may extend several kilometres through lands cleared of vegetation (DAWE 2020b).

Female Koalas generally produce one offspring each year with births occurring between October and May (DAWE 2020b). Males are not involved with parental care. Mothers engage in increased feeding and related movements while lactating (Logan and Sanson 2003). The young vacate the pouch permanently at 7 months and then travels with the mother (generally carried on her back) becoming fully weaned at 12 months (van Dyck and Strahan 2009).

The Koala is distributed along the east coast of Australia extending from Queensland to NSW (refer Figure 5.7 in Appendix B). In Queensland, the Koala's distribution extends across several bioregions, encompassing a great diversity of habitats with the greatest concentration in south-east Queensland. In NSW, the species occurs mostly in central and north coasts with populations known to inhabit the area west of the Great Dividing Range (DES 2017c; OEH 2018b).

Distribution in context to the Project

Database records (i.e. AoLA and Wildlife Online) indicated Koala has been identified as potentially occurring within the temporary and permanent disturbance footprint. A number of records occur within the MNES study area to the east of Purga Nature Reserve all from July 2015. More recent records (2019) occur to the west of Gum Tips Nature Reserve (Mount Forbes area) within the MNES study area (refer Figure 4.2). There are numerous records to the north of the eastern section of the MNES study area associated with the Flinders Peak reserves (AoLA 2020) (refer Figure 5.8 in Appendix B). Project associated surveys have recorded Koala close to the disturbance footprint in the Peak Crossing area (Jacobs-GHD 2016a) and within the MNES study area in the Ebenezer area. There have also been records of scats through much of the alignment including within the disturbance footprint (refer Figure 4.5).

The South East Queensland Koala Conservation Strategy 2020–2025 (DES 2020d was recently introduced by the Queensland Government. The Strategy aims to arrest the decline of Koalas in the region through the following targeted outcomes:

- Stabilise Koala population numbers in SEQ.
- A net increase in the total core koala habitat area in the region.
- Commence rehabilitation to restore 10,000 hectares of koala habitat.
- Commence 10 programs in threat priority areas to support at least a 25 per cent reduction in disease, injury and mortality rates in those locations.

The Strategy is supported by new Koala habitat mapping which maps the following key areas within the Project disturbance footprint: Koala priority areas – 258.48 ha; and Koala core habitat areas – 145.57 ha (refer EIS Appendix J: Terrestrial and Aquatic Ecology Technical Report for further detail regarding State based mapping of Koala habitat values).

Recovery plans/threat abatement plans

There is no Commonwealth adopted recovery plan or threat abatement plan applicable to Koala. The National Koala Conservation and Management Strategy 2009-2014 (Natural Resource Management Ministerial Council2009) expired in 2014. The DAWE Approved conservation advice (DSEWPaC 2012b) notes the following potentially threatening processes identified for Koala:

- Habitat loss, modification or fragmentation as a result of urbanisation
- Secondary threats such as predation by domestic dogs, vehicle strikes and stress
- Extreme heat events and drought
- Chlamydia and other diseases (such as Koala retrovirus) which reduces the life expectancy of the species
- Myrtle rust (*Austropuccinia psidii*) is an introduced fungus impacting trees in the Myrtaceae family which includes eucalypts. A small number of trees used by Koalas for foraging have been infected although it is uncertain if this is currently a threat to the species (DAWE 2020b).

Important populations and *Habitat critical to the survival of the species*

There are no 'important populations' identified for Koala in the Approved conservation advice (DSEWPaC 2012b) or the (lapsed) National Koala Conservation and Management Strategy 2009 – 2014 (Natural Resource Management Ministerial Council 2009). The species occurs from north Queensland south to Victoria and west to central Queensland. The area is not on the edge of the species distribution and there is no evidence to suggest Koalas in the area are a source for breeding or dispersal or for maintaining genetic diversity. However, estimates for the Ipswich City Council local government area (encompassing the western half of the Project alignment) suggest the koala population is in the order of 4,000 individuals (Bussey and Ellis 2016). Within the context of the broader south-east Queensland region, where koalas are progressively declining due to ongoing habitat loss together with exposure to mortality from vehicle strike and dog attacks and restricted movement, this represents an important population (Maunsell 2008). Population modelling based on field survey data carried out in south-east Queensland shows the species occurs in low-medium densities in areas encompassed by the Project (Rhodes et al 2015).

The *EPBC Act referral guidelines for the vulnerable Koala* (DotE 2014) does not refer to any 'important populations' but provides a 'koala habitat assessment tool' to assist in the determining the sensitivity, value and quality of lands potentially impacted under development proposals. The assessment tool is used to determine whether lands may be considered as 'critical to the survival of the Koala' and therefore critical to the long-term survival and recovery of the species. The results of the assessment are to aid the decision-making process and determine whether a Project may need to be referred to DAWE based on potential significant impacts to Koalas and/or *Habitat critical to the survival of the species*. The identification of habitat 'critical to the survival of the Koala' may be used as a surrogate for 'important populations' when assessing a Project's impacts under the Guidelines. The assessment summarised in Table 5.27 is based on information obtained during opportunistic surveys within the MNES study area.

Table 5.27 Koala habitat assessment tool (DotE 2014) - disturbance footprint

Attribute	Score	Details
Koala occurrence	2	Fauna surveys found evidence of koala (individuals and scats) within the MNES study area.
Vegetation composition	2	The vegetation communities contain woodlands/open forest with two or more koala food trees.
Habitat connectivity	2	Based on koala habitat extent, the areas in the Teviot Range are a part of a contiguous landscape that is greater than 1000 ha.
Key existing threats	1	There are populations of feral dogs that roam the area, that would result in koala mortality. The area is close to a busy highway where car mortality may be an issue. Records of sick and injured koalas have been reported from a broad distribution throughout the region (Ipswich Koala Protection Society cited in Bussey and Ellis 2016).
Recovery value	1	It is uncertain whether the habitat is important for achieving interim recovery, as: ▪ Much of the vegetation is identified as non-remnant under the state vegetation framework and is at risk of being thinned for timber and livestock purposes ▪ Continued mortality due to vehicle strikes and dog attacks
Koala habitat score	**8**	Habitat is 'critical to the survival of Koala' where Koala habitat score is ≥ 5

Habitat within the disturbance footprint is considered 'critical to the survival of Koala' based on the Koala habitat score (8) for the disturbance footprint. Under the referral guidelines for Koala (DotE 2014) it is recommended that a project be referred where it is proposed to 'clear ≥ 20 ha of habitat containing known Koala food trees in an area with a habitat score ≥ 8.' For the significant impact assessment this habitat is considered a surrogate for an 'important population'.

The main impacts predicted from the Project include habitat removal, injury/mortality to individuals during clearing and vehicle/train collision, and habitat fragmentation/barrier effects. The predictive habitat modelling indicates 124.31 ha of Habitat critical to the survival of the species occurs within the disturbance footprint (refer Table 5.4 and habitat figure in Appendix G) under the habitat modelling approach used for this assessment (refer Appendix A). Critical habitat includes all mapped remnant and regrowth vegetation communities containing eucalypt species (i.e. does not include areas of dense Swamp tea-tree (*Melaleuca irbyana*) communities which are unlikely to be used for foraging) and includes drainage lines which may provide suitable riparian habitat trees located outside of known vegetation mapping.

In addition to *Habitat critical to the survival of the species*, 474.17 ha of *potential habitat* has been identified within the Project disturbance footprint. Potential habitat is based on a 1 km buffer placed on recent species records (refer Figure 4.2) located outside of the vegetation communities mapped as *Habitat critical to the survival of the species*. This encompasses habitat comprising vegetation in which the species is unlikely to occur (e.g. dense thickets of Swamp Tea-tree vegetation) unmapped woodlands that are partially cleared/thinned, scattered trees in grazing paddocks (in which the species may occur but do not necessarily link larger patches of vegetation) and grazing and cropped areas which do not feature trees at all. As such, potential habitat significantly over-estimates areas of available habitat for the species. Habitat determination will be subject to further refinement during the final design stage of the Project.

The draft *Guide to nationally protected species significantly impacted by paddock tree removal* (DoEE 2020) notes for Koala that an impact requiring approval (under the EPBC Act) may be required when 'removing paddock trees where they are habitat critical to the species survival or provide the only movement opportunity/refuge to or between areas of habitat critical to the species survival'. No areas of isolated paddock trees have been identified as Habitat critical to the species survival of the Koala in this assessment. Movement opportunities are not expected to occur as a result of the Project given it is linear. There will be habitat trees located adjacent to the Project disturbance footprint that will continue to allow connection between habitat patches outside of the footprint (e.g. as is evident in Figure 4.6a-e there is a strong landscape connectivity/linkage north and south of the Project in the Ebeneezer area). Impacts and mitigation measures associated with this species are identified within Table 5.7. The following significant impact assessment (refer Table 5.28) under the MNES guidelines (DotE 2013a) has been informed by the information detailed above.

Table 5.28 Matters of environmental significance significant residual impact criteria - Koala

Criteria	Assessment against significance criteria (vulnerable species)
Lead to a long-term decrease in the size of an important population of the species	The MNES study area may comprise habitat supporting an 'important population' within the context of the south-east Queensland population. The project will impact 124.31 ha of *Habitat critical to the survival of the species* and 474.17 ha of *potential habitat* (although this is likely a substantial overestimate as it encompasses largely cleared lands) within the disturbance footprint. The species was identified as present in eucalypt habitat within the MNES study area. Evidence suggests the species occurs in low-medium densities in the area. In addition to loss of habitat, the Project (construction and operations) will act as a potential barrier to movement (generally north south, with east west connectivity maintained). Fauna passage will be provided at a number of locations along the alignment to facilitate fauna movement (refer Section 5.2.1), with these measures to consider the DTMR fauna sensitive design manual (DTMR 2010) which are known to be used by koalas (such as Koala refuge poles) especially in association with fauna friendly fencing. Koala-proof fencing will be used to guide Koalas through crossing structures with extent of Koala proof fencing dependent on surrounding Koala habitat availability and known movement corridors. There is some potential for ongoing Koala mortality during the Project's operational phase through collisions with trains. This will be mitigated with the incorporation of fauna crossing structures as part of the final Project Fauna crossing structures will be applied as part of the Project design to enhance Koala movement across the Project alignment and the wider landscape. These structures will target key movement areas such as around Paynes Road, along major watercourses and from the floodplains west to Teviot Range (refer to Figure 5.1a-e).

Criteria	Assessment against significance criteria (vulnerable species)
	The Project is predicted to require clearing up to 124.31 ha of *Habitat critical to the survival of the species* and a further 474.17 ha of *potential habitat* (comprising largely cleared lands). The Project is linear and there is abundant similar habitat in the region surrounding the Project alignment including over 7,600 ha within the immediate surrounds of the MNES study area. Within the surrounds there is good linkage between large patches of Koala habitat allowing for Koala movements in an east/west direction across the landscape. In addition fauna crossing structures will be applied as part of the Project design to enhance Koala movement across the Project alignment and the wider landscape in a north/south direction. It is considered unlikely the Project will lead to a long-term decrease in the size of an important population of Koala.
Reduce the area of occupancy of an important population	The MNES study area may comprise habitat supporting an 'important population' within the context of the south-east Queensland population. Evidence suggests the species occurs in low-medium densities in the area. The Project is predicted to require clearing up to 124.31 ha of *Habitat critical to the survival of the species* and a further 474.17 ha of *potential habitat* (comprising largely cleared lands). The Project will likely reduce the potential area of occupancy of the local populations.
Fragment an existing important population into two or more populations	Evidence suggests the species occurs in low-medium densities in the area. Lands surrounding the disturbance footprint (excluding the Teviot Range) have been substantially cleared although some connectivity remains along vegetated creeks and rivers. Nevertheless, the species is known to traverse cleared lands when foraging. The Project is linear and when constructed may present a barrier to movement, although this will be mitigated with the incorporation of fauna crossing structures (including Koala-proof fencing) as part of the final Project design. There is also an extensive portion of the alignment (approximately 1 km) above the proposed rail tunnel within the Teviot Range which will remain unimpacted and function as a movement corridor. The Project is predicted to require clearing up to 124.31 ha of *Habitat critical to the survival of the species* and a further 474.17 ha of *potential habitat* (comprising largely cleared lands) and has some potential to fragment an existing local population.
Adversely affect *Habitat critical to the survival of the species*	*Habitat critical to the survival of the species* for Koala has been assessed as occurring on the site as defined under the Koala referral guidelines. The Project is predicted to require clearing of up to 124.31 ha of *Habitat critical to the survival of the species* (refer Table 5.27). As such the Project will adversely affect habitat critical to the survival of the Koala.
Disrupt the breeding cycle of an important population	Provisions to protect Koalas will be in place within the Project Flora and Fauna Sub-plan should individuals be located within the disturbance footprint (refer Table 5.3 and Table 5.7). For example, should the species be found individuals will remain undisturbed and allowed to leave the construction area of their own volition or be relocated from the area of disturbance by qualified fauna spotter-catchers. There are no particular breeding requirements associated with the species (young travel with the mothers within the individuals' territory). Design elements to enhance movement and dispersal have been incorporated into the design of the Project (fauna crossing structures, fencing and avoidance of habitat above the tunnel). Should the species be found during construction activities individuals will remain undisturbed and allowed to leave the construction area of their own volition or be relocated from the area of disturbance by qualified fauna spotter-catchers. It is considered unlikely the Project will disrupt the breeding cycle of an important population.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	There is suitable woodland habitat for the species within the disturbance footprint. However; there is abundant suitable habitat for the species in the area surrounding the Project and the wider southeast Queensland region. The species occurs across a wide area from northern central Queensland south to Victoria. As noted in Section 5.1.2, Project impacts are not restricted to the footprint and there is the potential to impact on potential habitat as a result of edge effects, dust deposition, noise and light, changes to soil and changes to hydrology. These indirect impacts on habitat is not likely to be to the extent that the species is likely to decline.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species habitat	There are no particular weed species identified as relevant to Koala. Project-associated surveys have noted areas within the alignment are already heavily infested with weed species including 20 species listed as restricted matters under the Queensland *Biosecurity Act 2014* (EMM 2018b, 2018c). Relevant habitats for the species (eucalypt open forest and woodlands) within the MNES assessment area were often noted to have high levels of introduced species including *Lantana camara* and *Opuntia* species (Jacobs-GHD 2016a). Feral predators are identified as a threat to the species (DSEWPaC 2012b). Wild dog and Red fox were recorded as common in the area during Project-associated surveys. Dogs are a significant threat to the species with koala mitigation measures on other projects adversely impacted due to wild dogs.

Criteria	Assessment against significance criteria (vulnerable species)
	Weed and pest control measures will be incorporated into the Project Biosecurity Management Plan to control the introduction and spread of weed and pest species across the disturbance footprint and surrounds covering both construction and operation activities. The Plan will be in place for the life of the Project and will minimise the potential for weed invasion and may in the long-term improve habitat condition within vegetation communities located adjacent to Project infrastructure. The local landscape is already subject to extensive weed infestation with *Lantana camara* in forest habitats and exotic grasses in agricultural habitats. Pest measures will ensure feral predators (i.e. wild dogs/dingo) are controlled in areas associated with Project activities. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.
Introduce disease that may cause the species to decline	The Project Biosecurity Management Plan will incorporate the management of invasive species which will assist in the prevention of pest plant introduction, *Phytophthora cinnamomi*, Myrtle rust outbreaks and associated diseases (such as Chlamydia) resulting from Project activities. The Plan will consider relevant guidelines to control *Phytophthora cinnamomi* and Myrtle rust (e.g. DotE 2015b) associated with Project activities. This will include at a minimum vehicle washdown procedures and contractor education (including procedures regarding cleaning clothing). This will be particularly important during any revegetation activities in the vicinity of Koala habitat. Revegetation plant species will be obtained from a reliable source that is certified free of these pathogens. Vegetation clearing within the disturbance footprint in Koala habitat will be carried out in a manner to minimise stress on potential individuals as much as is practicably possible (e.g. sequential clearing and minimising time of disturbance to animals) as stressed animals are more susceptible to Chlamydia infection. Where individuals are required to be handled during vegetation clearing they will be examined by experienced personnel. If the individual is suspected of Chlamydia infection it will be taken to a veterinarian/wildlife care facility for treatment prior to release. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.
Interfere substantially with the recovery of the species	There is no State or Commonwealth recovery plan for Koala. The *EPBC Act referral guidelines for the vulnerable Koala* (DotE 2014) notes the following actions that may substantially interfere with the recovery of the Koala in areas associated with *Habitat critical to the survival of the species*: ▪ Increasing koala fatalities due to dog attacks to a level that is likely to result in multiple, ongoing mortalities ▪ Increasing koala fatalities due to vehicle-strikes to a level that is likely to result in multiple, ongoing mortalities. ▪ Facilitating the introduction or spread of disease or pathogens for example Chlamydia or *Phytophthora cinnamomi*, to habitat critical to the survival of the koala ▪ Creating a barrier to movement that is likely to result in a long-term reduction in genetic fitness or access to habitat critical to the survival of the koala ▪ Changing hydrology which degrades habitat critical to the survival of the koala to the extent that the carrying capacity of the habitat is reduced in the long-term. The Project will employ a range of mitigation measures (refer Table 5.7) to minimise these impacts including measures identified in Section 8 of the referral guidelines (DotE 2014). Of the identified actions the Project may increase mortality due to ongoing vehicle (rail line) strikes in the long-term. Evidence suggests the species occurs in low-medium densities in the area. With mitigation of potential Project impacts through measures incorporated within the Project EMP, any potential impact on Koala will be minor and is considered unlikely to interfere substantially with the recovery of the species.
Assessment of potential for significant residual impacts	The Project will result in the clearance of up to 124.31 ha of *Habitat critical to the survival of the species* and has potential to fragment local populations. Based on the nine-part test for significance the Project is likely to have a significant residual impact on Koala.

Grey-headed flying-fox (*Pteropus poliocephalus*)

Ecology and distribution

The Grey-headed flying-fox is a canopy-feeding species that eats fruit and nectar. This species utilises a range of vegetated habitats, including rainforests, open forests, closed and open woodlands, Melaleuca swamps and Banksia woodlands. In an urban setting, this species is known to feed on commercial fruit crops, and on introduced tree species. Roost sites are generally located near water bodies. This species is known to roost in vegetation ranging from rainforest, Melaleuca stands, mangroves and riparian vegetation. The species has a high level of roost site fidelity, although new sites have been known to be colonised (DAWE 2020b). The species travels to foraging areas usually located within 15 km of the roost site (Tidemann 1998), although they are capable of travelling up to 50 km when local foraging resources change (Eby 1991).

Nectar and pollen from *Eucalyptus*, *Corymbia, Angophora, Melaleuca*, and *Banksia* species are considered the primary food source for Grey-headed flying-foxes. This species is known to supplement its diet with a wide range of rainforest fruits and introduced species (Duncan et al. 1999). Mating is known to occur in the early autumn months, after which time the larger camps begin to separate, reforming in late spring/early summer when food resources become more abundant. Males and females typically separate in October, when the young are born.

The Grey-headed flying-fox occurs in the coastal belt of Eastern Australia, typically ranging from Rockhampton in central Queensland to Melbourne in Victoria. It is noted that only a small portion of this range is used at any one time, as the species selectively forages where resources are available. The availability of food resources have a direct influence on the occurrence and relative abundance within the Grey-headed flying foxes distribution in various seasons and years (DAWE 2020b). As such, the species is known to make seasonal movements between camps. Dispersal from large breeding camps in the Brisbane area to regional areas occurs in winter (Nelson 1965).

Distribution in context to the Project

Database records indicate this species has not been recorded within the MNES study area however has commonly occurred within 50 km of the Project. There are three recent database records (post 2007) located within 5 km north of the Project in the Teviot Range area. Database searches indicate a large number of records in all directions around the Project, although these are largely concentrated to the north (AoLA 2020) (refer Figure 5.6 in Appendix B). Based on quarterly flying-fox data collected by DES in the south-east Queensland region (extending from 2007 to November 2019) there are five Flying-fox camps located within 20 km of the Project which regularly comprise Grey-headed flying-fox: three in the Ipswich area, one at Laidley, and one from Cedar Grove (east of Kagaru). The nearest of these is the camp at Cedar Grove which is located 5 km east of eastern extent of the Project. Population estimates from the camp are highly variable. Over the last ten years the population count has been 2,000 individuals or less (including none at present). On only two occasions have there been more: 4,500 individuals (August 2019) and 3,000 individuals (October 2013) (DES 2020b). There are no known flying-fox camps within the Project disturbance footprint.

The *Referral guideline for management actions in grey-headed and spectacled flying-fox camps* (DotE 2015a) identifies 'nationally important' camps for Grey-headed flying-fox as:

- Camps that have contained ≥ 10,000 Grey-headed flying-foxes in more than one year in the last 10 years, or
- Have been occupied by more than 2,500 Grey-headed flying-foxes permanently or seasonally every year for the last 10 years.

Two of the five camps identified from the Ipswich area have contained 10,000 Grey-headed flying-foxes within the last 10 years. A camp at Woodend (12.5 km north of the Project disturbance footprint) has contained large numbers of the species on several occasions until 2014. Recent surveys have counted low numbers or no individuals. A camp at Bundamba (15 km north of the Project disturbance footprint) recorded 11,000 individuals in May 2019 although all other counts at the site have counted less than 1,000. None of the roosts have been occupied by more than 2,500 Grey-headed flying-foxes permanently or seasonally every year for the last 10 years based on the available count data.

Recovery plan/threat abatement plans

There is currently a draft *National recovery plan for the Grey-headed flying-fox (Pteropus poliocephalus*) (DotEE 2017b) awaiting adoption by DAWE. The draft Plan identifies the following threatening processes as applicable to the species:

- Loss of roosting and foraging sites (particularly winter foraging habitat)
- Human animal conflict, particularly in rural areas where flying-foxes can impact fruit orchards and in urban areas where roosts are perceived to impact local residents. This is a particular issue applicable to flying-fox camps in urban areas.
- Heat stress during extreme heat waves
- Entanglement in backyard netting and electrocution on power lines
- Potential threats include the impacts of climate change (particularly with reference to extended heat waves) and zoonotic diseases.

Important populations/*Habitat critical to the survival of the species*

Important populations are not identified in the draft *National recovery plan for the Grey-headed flying-fox (Pteropus poliocephalus*) (DotEE 2017b). The species distribution extends from Rockhampton south to Victoria and South Australia. The MNES study area is not at the limit of the species range. This is a highly mobile species and the linear nature of the Project is not expected to impact dispersal or breeding capacity.

The Plan does not specifically identify *Habitat critical to the survival of the species* but does recommend management of habitat associated with a number of tree species located within the MNES study area including *Eucalyptus tereticornis, E. crebra, E. siderophloia, Corymbia citriodora,* and *Grevillea robusta*. Vegetation communities associated with the Project disturbance footprint generally comprise at least one of these species. All mapped vegetation communities within the footprint are considered foraging habitat for the species. Predictive impact assessment has taken a conservative approach for this species and included all remnant and regrowth vegetation communities within a 15 km radius of a known regular roost site for the species that are local to the MNES study area as *Habitat critical to the survival of the species* .

Impacts and mitigation measures associated with this species are identified within Table 5.7. The predictive assessment estimates that 72.45 ha of *potential habitat* (>15 km from known roost sites) and 71.44 ha of *Habitat critical to the survival of the species* (<15 km from known roost sites) may be impacted by the Project (refer Table 5.4 and habitat figure in Appendix G). Assessment against the significant impact criteria for vulnerable species is shown in Table 5.29.

Table 5.29 Matters of environmental significance significant residual impact criteria – Grey-headed flying-fox

Criteria	Assessment against significance criteria (vulnerable species)
Lead to a long-term decrease in the size of an important population of the species	There are no 'important populations' defined for this species. The species was not observed during Project surveys and no roost sites were observed in the vicinity of the MNES study area. Although there are no records within the MNES study area the species has been commonly recorded in the wider area surrounding the Project, largely to the north.

Criteria	Assessment against significance criteria (vulnerable species)
	There are at least five camp locations regularly used by the species located within 15 km of the MNES study area. The nearest of these is located 5 km east of the Project disturbance footprint. The Project will not conceivably directly or indirectly impact these camps. A study by Law and Eby 2008 (Ranking the feeding habitats of Grey-headed flying foxes for conservation management) noted that the during winter productive areas are concentrated in coastal floodplains, coastal dunes and inland slopes of SEQ. In addition, the study noted that the majority of winter habitats are heavily cleared, poorly conserved and recognised as endangered vegetation communities. The Project is located in the coastal floodplains and inland slopes of SEQ and as such pose a risk to the species (i.e. loss of foraging habitat in particular winter and spring is a key threat to the species). Important winter and spring habitats include vegetation communities that contain *Eucalyptus tereticornis, E. albens, E. crebra, E. fibrosa, E. melliodora, E. paniculata, E. pilularis, E. robusta, E. siderophloia, Banksia integrifolia, Castanospermum australe, Corymbia citriodora citriodora, C. eximia, C. maculata (south of Nowra, New South Wales), Grevillea robusta or Melaleuca quinquenervia*) with these communities known from the Project disturbance footprint. That is the disturbance footprint encompasses 143.89 ha of *potential habitat*, including 71.44 ha of *Habitat critical to the survival of the species* (as defined for this assessment). The species will sporadically utilise these resources based on local flowering patterns, with the species known to have a high degree of annual variation in the occurrence at a local scale, It is not likely that the Project will degrade foraging habitat adjacent to the footprint (with over 3,000 ha, including over 1,200 ha of habitat critical for the survival of the species available in the surrounding MNES study area), in a manner which will lead to the long-term loss of the species. As outlined in Section 5.1.2 the Project will result in edge effects, changes to biological viability of soil or from the deposition of dust, which may result in the degradation of foraging habitat. However, the extent of these impacts will vary spatially and temporarily across the Project disturbance footprint. As noted above there is an abundance of foraging habitat in the region surrounding the Project and the linear nature of the Project. This species may also exploit resources in heavily modified habitats such as urban gardens and agricultural areas. Given there are no 'camps within or near the Project and abundant resources in the MNES study area the Project will not lead to a long-term decrease in the size of an important population of the species.
Reduce the area of occupancy of an important population	There are no 'important populations' defined for this species. The Project will not impact local roost sites the species is known to regularly use. Foraging habitat for Grey-headed flying-fox occurs across the disturbance footprint encompassing 143.89 ha, and including 71.44 ha of *Habitat critical to the survival of the species* (as defined for this assessment). Nevertheless, there is abundant similar habitat in the region surrounding the Project and the species will forage in heavily modified habitats such as urban gardens. Given there are no 'camps within or near the Project and abundant resources in the MNES study area the Project is unlikely to reduce the area of occupancy of an important population.
Fragment an existing important population into two or more populations	The species is highly mobile, and the Project is not considered to represent a barrier to movement for the species. It is considered unlikely that the Project will fragment an existing important population into two or more populations.
Adversely affect *Habitat critical to the survival of the species*	Foraging habitat for Grey-headed flying-fox occurs across the disturbance footprint encompassing 143.89 ha, and including 71.44 ha of *Habitat critical to the survival of the species* (as defined for this assessment). It is noted this is a conservative approach given there is abundant suitable habitat for the species in the area surrounding the Project and the wider southeast Queensland region. The Project is not likely to impact known (or historic camps) however the Project will adversely affect habitat critical to the survival of the Grey-headed flying-fox.
Disrupt the breeding cycle of an important population	The recovery plan for the species notes that roosting requirements are not well understood, nor are the impacts on the species of loss of long-term sites which may be selected to meet specific requirements. Five camps have been identified from the Ipswich area have contained 10,000 Grey-headed flying-foxes within the last 10 years. A camp at Woodend (12.5 km north of the Project disturbance footprint) has contained large numbers of the species on several occasions until 2014. Recent surveys have counted low numbers or no individuals. A camp at Bundamba (15 km north of the Project disturbance footprint) recorded 11,000 individuals in May 2019 although all other counts at the site have counted less than 1,000.

Criteria	Assessment against significance criteria (vulnerable species)
	In addition, the recovery plan notes that flying-foxes are prone to abort foetuses and mass abortions and premature births are known to occur in the wild in response to environmental stress. The nearest camp is 5 km east of the Project and there is negligible risk of this scenario occurring as a result of the Project. The Project will not impact (directly or indirectly) these camps. As such it is considered unlikely the Project will disrupt the breeding cycle of an important population.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	Foraging habitat for Grey-headed flying-fox occurs across the disturbance footprint encompassing 143.89 ha, and including 71.44 ha of *Habitat critical to the survival of the species* (as defined for this assessment) and will be subject to removal during construction. The operational rail corridor will not be rehabilitated/landscaped with woody vegetation, however there will be an opportunity to rehabilitate temporary construction areas and riparian zones. There is an abundance of foraging habitat for the species in the area surrounding the Project with over 3,000 ha, including over 1,200 ha of habitat critical for the survival of the species within the immediate surrounds of the MNES study area. As outlined in Section 5.1.2 the Project will result in edge effects, changes to biological viability of soil or from the deposition of dust, which may result in the degradation of foraging habitat but is unlikely to lead to a decline in the species. However, the extent of these impacts will vary spatially and temporarily across the Project disturbance footprint. Given the mobility of the species it is unlikely that any habitat will be isolated, with the species known to utilise heavily modified environments including urban gardens and commercial orchards. It is considered unlikely the Project will impact the availability or quality of habitat to the extent that the species is likely to decline.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species habitat	There are no particular weed or pest species identified as relevant to Grey-headed flying-fox. Project-associated surveys have noted areas within the alignment are already heavily infested with weed species including 20 species listed as restricted matters under the Queensland *Biosecurity Act 2014* (EMM 2018b, 2018c). Weed and pest control measures will be incorporated into the Project Biosecurity Management Plan to control the introduction and spread of weed and pest species across the disturbance footprint and surrounds covering both construction and operation activities. The Plan will be in place for the life of the Project and will minimise the potential for weed invasion and may in the long-term improve habitat condition within vegetation communities located adjacent to Project infrastructure. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.
Introduce disease that may cause the species to decline	The Project Biosecurity Management Plan will incorporate the management of invasive species which will assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.
Interfere substantially with the recovery of the species	The draft recovery Plan for the species includes the following recovery objectives: ▪ Identify, protect and enhance roosting habitat and native foraging *Habitat critical to the survival of the species* ▪ Determine population trends in Grey-headed flying-foxes so as to monitor the species' national distribution and conservation status ▪ Increase public awareness and understanding of Grey-headed flying-foxes and build community capacity to coexist with flying-foxes and minimise the impacts on urban settlements from existing camps without resorting to dispersal ▪ Improve the management of Grey-headed flying-fox camps in sensitive areas and support research activities that will improve the conservation status and management of the species. ▪ Significantly reduce levels of deliberate Grey-headed flying-fox destruction associated with commercial horticulture ▪ Assess and reduce the impact on Grey-headed flying-foxes of electrocution on power lines, and entanglement in netting and on barbed-wire (DotEE 2017b) The Project will impact foraging habitat which is a relatively minor portion of the habitat available within the surrounding landscape. No roost sites are located within or adjacent to the Project. None of the other recovery objectives are applicable to the Project. The Project is considered unlikely to interfere substantially with any of the recovery objectives listed above and will not interfere with the recovery of the species.

Criteria	Assessment against significance criteria (vulnerable species)
Assessment of potential for significant residual impacts	Under the current disturbance footprint there is proposed to be clearance of up to 71.44 ha of *Habitat critical to the survival of the species* (as defined for this assessment). A conservative approach has been applied to the assessment of habitat within the disturbance footprint which may not reflect actual impacts on the species. Nevertheless, based on the nine-part test for significance it is possible that the Project may have a significant residual impact on Grey-headed flying-fox.

5.4 Biodiversity offsets for significant residual impacts

Residual impacts are those impacts that remain after the successful implementation of the avoidance hierarchy and mitigation measures identified in Section 5.2. The significance of residual impacts reflects the effectiveness of the proposed mitigation measures but allows for the identification of areas where further management measures may be required.

The significance ratings of most potential impacts identified in Section 5.1 will be reduced after the implementation of mitigation measures, including the avoidance, minimisation and mitigation strategies. In addition, the implementation of the mitigation measures identified in Section 5.2 will considerably reduce the significance of these impacts potentially resulting from the Project's activities.

Although terrestrial and aquatic ecological MNES will be avoided where practicable and potential impacts will be minimised and mitigated to the greatest extent practical (refer Table 5.5), in some instances the magnitude and significance ratings will remain unchanged following the implementation of the mitigation measures.

There is the potential for some Project activities to have a cumulative, irreversible and/or permanent impact upon some terrestrial MNES TEC and species, even after the implementation of all mitigation measures, including rehabilitation. In these cases, the residual impact to *Habitat critical to the survival of the species* or *Important habitat* will require to be offset should the residual impact be considered significant in accordance with the EPBC Act Matters of National Environmental Significance Significant Impact Assessment (DotE 2013a) (refer Sections 5.3.3, 5.3.4 and 5.3.5).

The EPBC Act Offsets Policy states: 'Offsets provide environmental benefits to counterbalance the impacts that remain after avoidance and mitigation measures. These remaining, unavoidable impacts are termed 'residual impacts'. Offsets will be required to compensate for the significant residual impacts on MNES to *Habitat critical to the survival of the species* or *Important habitat* as a result of the Project. Post EIS and during the detailed design stage of the Project, offsets will be delivered to offset significant residual impacts to MNES *Habitat critical to the survival of the species* that are significant in accordance with the relevant Commonwealth guidelines/policies.

A 'significant impact' is defined as 'an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value, and quality of the environment, which is impacted, and upon the intensity, duration, magnitude and geographic extent of the impacts' (DotE 2013a).

An offset is likely to be required for MNES that experience a significant residual impact which may include areas containing *Habitat critical to the survival of a species* or *Important habitat* for EPBC Act listed species and any area occupied by an EPBC Act listed TEC.

An assessment of the relevant MNES to the Project has been undertaken in accordance with the MNES significant impact criteria within the MNES Guidelines (refer Sections 5.3.3, 5.3.4 and 5.3.5). Analysis indicates that Residual impacts to *Habitat critical to the survival of the species* or *Important habitat* for the following sensitive environmental values have potential to occur:

- Swamp Tea-tree (*Melaleuca irbyana*) Forest of South-east Queensland (refer Section 5.3.3)
- Lloyd's olive (*Notelaea lloydii*) (refer Section 5.3.4.3)
- Spotted-tail quoll (*Dasyurus maculatus maculatus*) (refer Section 5.3.5.1)

- Collared delma (*Delma torquata*) (refer Section 5.3.5.3)
- Red goshawk (*Erythrotriorchis radiatus*) (refer Section 5.3.5.3)
- Swift parrot (*Lathamus discolor*) (refer Section 5.3.5.1)
- Brush-tailed rock-wallaby (*Petrogale penicillata*) (refer Section 5.3.5.3)
- Koala (*Phascolarctos cinereus*) (refer Section 5.3.5.3)
- Grey-headed flying-fox (*Pteropus poliocephalus*) (refer Section 5.3.5.3)
- Australian painted snipe (*Rostratula australis*) (refer Section 5.3.5.1).

The current identified extent of significant residual impact to each specific MNES is quantified in Table 5.30. These extents will be subject to further refinement through ongoing targeted field surveys as the Project progresses.

Table 5.30 Quantification of anticipated significant residual impacts to matters of national environmental significance

Sensitive environmental receptor (MNES)	Identified Significant residual impact
Swamp Tea-tree (*Melaleuca irbyana*) Forest of Southeast Queensland TEC	30.45 ha
Notelaea lloydii (Lloyd's olive)	26.77 ha
Spotted-tail quoll (*Dasyurus maculatus maculatus*)	6.92 ha
Australian painted snipe (*Rostratula australis*)	34.55 ha
Collared delma (*Delma torquata*)	9.56 ha
Swift parrot (*Lathamus discolor*)	11.74 ha
Red goshawk (*Erythrotriorchis radiatus*)	77.25 ha
Brush-tailed rock-wallaby (*Petrogale penicillata*)	Potential population fragmentation impact (no direct impact to suitable habitat)
Koala (*Phascolarctos cinereus*)	124.31 ha and potential population fragmentation
Grey-headed flying-fox (*Pteropus poliocephalus*)	71.44 ha

ARTC's Environmental Offset Delivery Strategy – Qld (Strategy) is contained in Appendix J of this report. This Strategy informs the development of offset delivery components including an Environmental Offset Delivery Plan and Offset Area Management Plans. A Detailed Environmental Offset Delivery Plan and Offset Area Management Plans will be developed and implemented by ARTC prior to construction commencement subject to the approval under the EPBC Act.

The Environmental Offset Delivery Plan will:

- Quantify the significant residual impact of the Project on MNES
- Detail offsets to address significant residual impacts for MNES
- Include:
  - Details of milestones to establish the offset
  - Evidence that significant residual impacts can be offset
  - The offset delivery mechanisms, comprising one or more of: land-based offsets, direct benefit management plans, offset transfers or offset payments
  - Identification of land required to provide the offset
  - A legally binding mechanism that ensures protection and management of land-based offset areas.

6 Commitments

The approach outlined in this report is considered to be adequate to address the controlling provisions relevant to the Project. The report describes the particular aspects of the environment relevant to these matters and addresses the relevant sections of the EIS ToR.

As the Project moves into the detailed design and construction phases, more focused and comprehensive ecological surveys in accordance with the Commonwealth's survey guidelines will be undertaken. The surveys will aim to address any changes to the Project design and footprint, along with informing the design and construction, including specific measures to avoid, mitigate, minimise impacts on a particular species, along with ongoing monitoring activities.

The surveys will also have the added benefit in addressing some of the recommendations in conservation advices, recovery plans and threat abatement plans including:

- Surveys may identify extent and quality of habitat
- Identify new populations and knowledge of the species ecology
- Surveys may be designed to monitor known populations for certain species
- The Project is also a mechanism to engage the public about a species.

As part of these surveys, ARTC will look to collaborate and supplement existing studies being undertaken by local councils, environmental groups and government agencies.

During detailed design ARTC will also finalise the location and design of fauna movement structures across Project alignment, targeting key locations (for example, in the Ebenezer and Mount Forbes area, and in the Woolooman and Undullah areas within the Mount Flinders range). ARTC will work with the relevant stakeholders including DTMR, local councils, DES and where applicable local environmental groups to finalise the location and design of any crossing structures. This will be especially important in areas of future development or complementary to any ecological corridor strategies within the MNES study area, including those associated with the Ebenezer Regional Industrial Area, the Draft South-east Queensland Koala Conservation Strategy and the Flinders-Karawatha Corridor.

ARTC is committed to implementing ongoing monitoring of the effectiveness of the measures with contingency (under an adaptive management framework) to change/improve management strategies where deleterious impacts to the identified environmental values are observed, or are not minimised, as per the objectives of the proposed mitigation measures.

An Environmental Offset Delivery Plan and Offset Area Management Plans will be developed and implemented by ARTC prior to construction subject to approval under the EPBC Act. The Environmental Offset Delivery Plan will quantify the significant residual impacts of the Project and detail offsets to address these significant residual impacts.

7 Cumulative impact assessment

Cumulative impacts were assessed using the methodology identified in Section 3.5, incorporating the projects identified in Table 3.11 and depicted in Figure 3.4. The assessment has been based on MNES occurring within the disturbance footprint (refer Table 7.1) and uses a conservative approach to assessment of habitat lost (i.e. combines the habitat categories as identified in Table 4.5 to identify the maximum *potential habitat* loss).

The cumulative impacts of multiple projects occurring in the vicinity of the disturbance footprint will likely include the continued loss of biodiversity in the SEQ bioregion. The major potential impacts identified as a result of the Project are common to all projects throughout the region and are therefore cumulative in nature. Six projects have been identified within the cumulative impact assessment impact study area, which are either currently underway or are going through the EIS process, all of which will likely result in some extent of:

- Habitat loss and degradation from vegetation clearing/removal
- Fauna species injury or mortality
- Reduction in biological viability of soil to support growth due to soil compaction
- Displacement of flora and fauna species from invasion of weed and pest species
- Reduction in the connectivity of biodiversity corridors
- Edge effects
- Habitat fragmentation
- Barrier effects
- Noise, dust, and light
- Increase in litter (waste)
- Aquatic habitat degradation
- Erosion and sedimentation.

Cumulative impacts range from short-term to long-term. The total impact area for all habitat categories (i.e. Potential, Important and *Habitat critical to the survival of the species*) of significant MNES contained within the footprint of the projects occurring within the cumulative impact assessment study area, based on bioregional and State extents, is provided in Table 7.1. The results of the significance assessment of these cumulative impacts are presented in Table 7.2. Total habitat areas have been used to represent a highly conservative estimation of impacts. The extent of impact is based on the assumed habitat loss with the actual impacts on known populations unknown and therefore habitat values are likely overestimated for some, if not all species. It is also noted the total residual impacts as a result of the current project are expected to be significantly less than those reported within this section.

The greatest potential predicted cumulative impacts (including all habitat categories) as a result of the Project and other similar projects that occur within the CIA study area may be upon the following MNES:

- Threatened Ecological Communities:
  - Swamp Tea-tree (*Melaleuca irbyana*) Forest of South-east Queensland TEC - cumulative removal of 728.99 ha of which the Project contributes up to 4.18 per cent
- Flora and fauna species habitat
  - *Lychnothamnus barbatus* - cumulative removal of 256.19 ha of habitat, of which the Project contributes up to 2.38 per cent
  - Lloyd's olive (*Notelaea lloydii*) - cumulative removal of 2,115.79 ha of habitat, of which the Project contributes up to 1.27 per cent

- Australasian bittern (*Botaurus poiciloptilus*) - cumulative removal of 713.92 ha of habitat, of which the Project contributes up to 5.94 per cent
- Curlew sandpiper (*Calidris ferruginea*) - cumulative removal of 839.31 ha of habitat, of which the Project contributes up to 4.55 per cent
- Spotted-tailed quoll (*Dasyurus maculatus maculatus*) - cumulative removal of 3,894.03 ha of habitat, of which the Project contributes up to 1.96 per cent
- Red goshawk (*Erythrotriorchis radiatus*) - cumulative removal of 3,356.28 ha of habitat, of which the Project contributes up to 2.35 per cent
- Koala (*Phascolarctos cinereus*) - cumulative removal of 10,915.50 ha of habitat, of which the Project contributes up to 5.48 per cent
- Australian painted snipe (*Rostratula australis*) - cumulative removal of 806.21 ha of habitat, of which the Project contributes up to 4.73 per cent.

Table 7.1 Cumulative impact assessment of magnitude for ecological matters of environmental significance

MNES	A. Extent within CIA study area (50 km extent) (ha) (i.e. 1,282,147 ha)	B. Extent within cumulative impact disturbance footprint (defined projects Figure 3.4)	C. Extent within cumulative impact disturbance footprint (defined projects Figure 3.4) including the disturbance footprint	D. Percentage (%) total disturbance to MNES within CIA study area	E. Percentage (%) contribution of the Project to disturbance within the cumulative impact disturbance footprint	F. Magnitude of contribution to disturbance (refer Table 3.6 for magnitude criteria) considering D and E
Commonwealth significant ecological constraints						
Threatened ecological communities (EPBC Act)						
Swamp Tea-tree (*Melaleuca irbyana*) Forest of South-east Queensland TEC	1,691.90	698.53	728.99	43.09	4.18	Low
Threatened flora habitat * (EPBC Act)						
Hairy-joint grass (*Arthraxon hispidus*)	104,128.13	269.22	273.37	0.26	1.52	Low
A green algae (*Lychnothamnus barbatus*)	8,091.83	250.11	256.19	3.17	2.38	Low
Lloyd's olive (*Notelaea lloydii*)	99,789.76	2,089.02	2,115.79	2.12	1.27	Low
Threatened fauna habitat * (EPBC Act)						
Regent honeyeater (*Anthochaera phrygia*)	220,117.11	3,765.80	3,777.23	1.72	0.30	Low
Australasian bittern (*Botaurus poiciloptilus*)	76,933.28	671.49	713.92	0.93	5.94	Low
Curlew sandpiper (*Calidris ferruginea*)	78,227.91	801.16	839.31	1.07	4.55	Low
Large-eared pied bat (*Chalinolobus dwyeri*)	115,583.01	727.13	730.02	0.63	0.40	Low
Spotted-tailed quoll (*Dasyurus maculatus maculatus*)	288,242.90	3,817.67	3,894.03	1.35	1.96	Low
Collared delma (*Delma torquata*)	150,679.60	3,646.33	3,655.89	2.43	0.26	Low
Red goshawk (*Erythrotriorchis radiatus*)	46,570.58	3,279.03	3,356.28	7.21	2.35	Low
Painted honeyeater (*Grantiella picta*)	29,837.16	1,020.97	1,051.07	3.52	2.86	Low
Swift parrot (*Lathamus discolor*)	283,706.43	5,841.67	5,982.85	2.11	2.36	Low
Australian lungfish (*Neoceratodus forsteri*)	34,879.46	302.86	313.36	0.90	3.35	Low
Greater glider (*Petauroides volans volans*)	157,915.78	4,425.30	4,441.90	2.80	0.37	Low
Brush-tailed rock wallaby (*Petrogale penicillata*)	65,921.18	22.70	22.7	0.03	0.00	Negligible

MNES	A. Extent within CIA study area (50 km extent) (ha) (i.e. 1,282,147 ha)	B. Extent within cumulative impact disturbance footprint (defined projects Figure 3.4)	C. Extent within cumulative impact disturbance footprint (defined projects Figure 3.4) including the disturbance footprint	D. Percentage (%) total disturbance to MNES within CIA study area	E. Percentage (%) contribution of the Project to disturbance within the cumulative impact disturbance footprint	F. Magnitude of contribution to disturbance (refer Table 3.6 for magnitude criteria) considering D and E
Koala (*Phascolarctos cinereus*)	539,314.06	10,317.02	10,915.50	2.02	5.48	Low
Long-nosed potoroo (*Potorous tridactylus tridactylus*)	173,217.23	3,513.68	3,523.24	2.03	0.27	Low
New Holland mouse (*Pseudomys novaehollandiae*)	157,652.17	3,541.13	3,550.69	2.25	0.27	Low
Grey-headed flying-fox (*Pteropus poliocephalus*)	1,215,056.95	30,732.68	30,876.57	2.54	0.47	Low
Australian painted snipe (*Rostratula australis*)	83,861.04	768.06	806.21	0.96	4.73	Low

Table note:

* There is potential for each of the MNES value impacts to overlap spatially. As a result, addition of disturbance values presented in the above table would not represent a true reflection of the total disturbance footprint.

Table 7.2 **Significance assessment of cumulative impacts to ecological matters of national environmental significance**

<table>
<tr><th rowspan="2">MNES(s)</th><th rowspan="2">Potential impacts[#]</th><th colspan="4">Relevance factor of aspects</th><th rowspan="2">Sum of relevance factors</th><th rowspan="2">Impact significance</th></tr>
<tr><th>Probability</th><th>Duration</th><th>Magnitude</th><th>Sensitivity</th></tr>
<tr><td rowspan="8">Commonwealth significant ecological constraint (community listed under the EPBC Act):
Swamp Tea-tree (Melaleuca irbyana) Forest of South-east Queensland TEC</td><td>Habitat loss from vegetation clearing/removal</td><td>2</td><td>3</td><td>1</td><td>3</td><td>9</td><td>Medium</td></tr>
<tr><td>Edge effects
Habitat fragmentation
Barrier effects
Reduction in connectivity of biodiversity corridors</td><td>1</td><td>2</td><td>1</td><td>3</td><td>7</td><td>Medium</td></tr>
<tr><td>Fauna species injury or mortality</td><td>1</td><td>1</td><td>1</td><td>3</td><td>6</td><td>Low</td></tr>
<tr><td>Dust and light and contaminant disturbance</td><td>1</td><td>1</td><td>1</td><td>3</td><td>6</td><td>Low</td></tr>
<tr><td>Increase in litter (waste)</td><td>1</td><td>1</td><td>1</td><td>3</td><td>6</td><td>Low</td></tr>
<tr><td>Reduction in biological viability of soil to support growth due to soil compaction</td><td>1</td><td>2</td><td>1</td><td>3</td><td>7</td><td>Medium</td></tr>
<tr><td>Displacement of species from invasion of weed and pest species</td><td>1</td><td>1</td><td>1</td><td>3</td><td>6</td><td>Low</td></tr>
<tr><td rowspan="7">Commonwealth significant ecological constraint (species listed under the EPBC Act):
Flora:
- Arthraxon hispidus (Hairy-joint grass)
- Lychnothamnus barbatus (a green algae)
- Notelaea lloydii (Lloyd's olive)
Fauna:
- Australasian bittern (Botaurus poiciloptilus)
- Curlew sandpiper (Calidris ferruginea)
- Large-eared pied bat (Chalinolobus dwyeri)
- Spotted-tailed quoll (Dasyurus maculatus maculatus)
- Collared delma (Delma torquata)
- Red goshawk (Erythrotriorchis radiatus)
- Painted honeyeater (Grantiella picta)
- Swift parrot (Lathamus discolor)
- Australian lungfish (Neoceratodus forsteri)</td><td>Habitat loss from vegetation clearing/removal</td><td>2</td><td>3</td><td>1</td><td>3</td><td>9</td><td>Medium</td></tr>
<tr><td>Edge effects
Habitat fragmentation
Barrier effects
Reduction in connectivity of biodiversity corridors</td><td>2</td><td>2</td><td>1</td><td>3</td><td>8</td><td>Medium</td></tr>
<tr><td>Fauna species injury or mortality</td><td>1</td><td>1</td><td>1</td><td>3</td><td>6</td><td>Low</td></tr>
<tr><td>Dust and light and contaminant disturbance</td><td>1</td><td>1</td><td>1</td><td>3</td><td>6</td><td>Low</td></tr>
<tr><td>Increase in litter (waste)</td><td>1</td><td>1</td><td>1</td><td>3</td><td>6</td><td>Low</td></tr>
<tr><td>Reduction in biological viability of soil to support growth due to soil compaction</td><td>1</td><td>2</td><td>1</td><td>3</td><td>7</td><td>Medium</td></tr>
<tr><td>Displacement of species from invasion of weed and pest species</td><td>1</td><td>1</td><td>1</td><td>3</td><td>6</td><td>Low</td></tr>
</table>

MNES(s)	Potential impacts[#]	Relevance factor of aspects				Sum of relevance factors	Impact significance
		Probability	Duration	Magnitude	Sensitivity		
▪ Southern greater glider (*Petauroides volans volans*) ▪ Brush-tailed rock wallaby (*Petrogale penicillata*) ▪ Koala (*Phascolarctos cinereus*) ▪ Long-nosed potoroo (*Potorous tridactylus tridactylus*) ▪ New Holland mouse (*Pseudomys novaehollandiae*) ▪ Grey-headed flying-fox (*Pteropus poliocephalus*) ▪ Australian painted snipe (*Rostratula australis*)							

Table notes:

1 Table 3.12 defines the consequences of the impact significance ratings, as follows:

- **Low** (sum of relevance factors = 1 to 5): Negative impacts need to be managed by standard environmental management practices. Special imposed conditions unlikely to be necessary. Monitoring to be part of general Project monitoring program.
- **Medium** (sum of relevance factors = 6 to 9): Mitigation measure likely to be necessary and specific management practices to be applied. Specific imposed conditions are likely. Targeted monitoring program required.
- **High** (sum of relevance factors = 10 to 12): Alternative actions would be considered and/or mitigation measures applied to demonstrate improvement. Specific imposed conditions are likely. Targeted monitoring program necessary.

8 Conclusion

In May 2017, the Project was submitted as an EPBC Act referral to the DotEE (EPBC 2017/7944). On 21 June 2017, the Minister for the Environment determined that the Project is a 'controlled action' action' to be assessed under the bilateral agreement between the State of Queensland and the Commonwealth. The controlling provision for the Project is listed threatened species and communities.

This MNES Assessment Report has been prepared in accordance with Sections 11.1 to 11.35 of the *Terms of Reference for an environmental impact statement: Inland Rail Calvert to Kagaru Project* issued on 8 December 2017 by the Queensland Coordinator-General. It has been prepared as a "stand-alone" document that assesses potential impacts on listed threatened species and communities under the EPBC Act during construction, operation and decommissioning of the Project. This technical report has been prepared for the purpose of supporting the Primary approvals for the Project.

The MNES study area contains one confirmed TEC and suitable habitat for threatened species as listed under the provisions of the EPBC Act.

Twenty-five MNES were identified as potentially present within the MNES study area for the purposes of this assessment. These consisted of a single TEC and threatened flora and fauna species. These MNES were grouped into high, moderate and low sensitivity categories based on factors including conservation status, exposure to threatening processes, resilience and representation in the broader landscape.

The construction, operation and decommissioning of the Project has the potential to impact on MNES including but not necessarily limited to:

- Habitat loss and degradation from vegetation clearing/removal
- Fauna species injury or mortality
- Reduction in biological viability of soil to support growth due to soil compaction
- Displacement of flora and fauna species from invasion of weed and pest species
- Reduction in the connectivity of biodiversity corridors
- Edge effects
- Habitat fragmentation
- Barrier effects
- Noise, dust, and light
- Increase in litter (waste)
- Aquatic habitat degradation
- Erosion and sedimentation.

In order to determine the significance of potential impacts of the Project upon the identified MNES, sensitivity categories were applied to each of the MNES. The sensitivity of the MNES was grouped into three distinct categories: high, moderate and low. These groupings were based on factors including, but not limited to, legislative status, resilience and representation in the broader landscape. In addition to sensitivity, the magnitude of each potential impact was assigned based on the extent, duration and resultant change to the MNES. The magnitude of impact was grouped into five categories: major, high, moderate, low and negligible. Both the sensitivity of a MNES and the magnitude of the potential impact were used to determine the significance of a potential impact.

The proposed mitigation measures for the Project were considered in order to reduce the initial magnitude and ultimately the significance of the potential impacts upon the listed threatened species and communities. Project mitigation measures included (but were not limited to):

- Reducing the disturbance footprint as far as reasonably practical
- Development and implementation of a Flora and Fauna Sub-plan as a component of the CEMP
- Development and implementation of a Soil Management Plan, including erosion and sedimentation controls, as a component of the CEMP
- Identification and implementation of fauna movement features to reduce barrier effects associated with the Project and enable fauna passage
- Development and implementation of a Reinstatement and Rehabilitation Plan and a Landscape and Rehabilitation Management Plan
- Development and implementation of the whole-of-Project Draft Outline EMP.

Following the implementation of a range of mitigation measures and management plans including, but not limited to, avoidance, minimisation and mitigation, the magnitude of residual impacts to the listed threatened species and communities were predicted to be generally reduced, followed by a subsequent reduction in the significance of the impact. However, one potential impact (i.e. habitat loss from vegetation clearing/removal upon most of the terrestrial MNES) was not predicted to significantly reduce in magnitude of impact following the implementation of Project mitigation measures, resulting in a residual impact to each of the MNES.

As a result of the modelling approach, it is predicted that the significant residual impacts are likely to occur to the following listed threatened species and communities:

- Threatened Ecological Community
  - Swamp tea-tree (*Melaleuca irbyana*) Forest of South-east Queensland – total likely impact of up to 30.45 ha
- Flora
  - *Notelaea lloydii* (Lloyd's olive) – total likely impact of 26.77 ha to *Habitat critical to the survival of the species*
- Fauna
  - Collared delma (*Delma torquata*) - total likely impact of 9.56 ha to *Important habitat*
  - Koala (*Phascolarctos cinereus*) - total likely impact of 124.31 ha to *Habitat critical to the survival of the species* and potential population fragmentation

There are also a number of threatened fauna species of which there is uncertainty as to whether they occur in the area, or if impacts of the Project may be considered as residual impacts. The assessment has followed a conservative approach and there is also potential to have significant residual impacts to the following fauna species:

- Fauna
  - Spotted-tail quoll (*Dasyurus maculatus maculatus*) - total potential impact of 6.92 ha to *Habitat critical to the survival of the species*
  - Red goshawk (*Erythrotriorchis radiatus*) - total potential impact of 77.25 ha to *Habitat critical to the survival of the species*
  - Swift parrot (*Lathamus discolor*) - total potential impact of 11.74 ha to *Habitat critical to the survival of the species*
  - Brush-tailed rock-wallaby (*Petrogale penicillata*) – potential population fragmentation impact (no predicted direct impact to suitable habitat)
  - Grey-headed flying-fox (*Pteropus poliocephalus*) – total potential impact of 71.44 ha to *Habitat critical to the survival of the species*

- Australian painted snipe (*Rostratula australis*) – total potential impact of 34.55 ha to *Habitat critical to the survival of the species*

The primary reason for these significant residual impacts is the potential loss of habitat as a result of the Project, along with barrier effects and habitat fragmentation. During the detailed design phase, the expected extent of the clearing will be minimised, along with the implementation of design solutions to mitigate barrier effects (e.g. fauna fencing and fauna passageways which will facilitate the movement of wildlife across the alignment).

Predicted cumulative impacts within 50 km of the Project may potentially include habitat loss from vegetation clearing/removal, fauna species injury or mortality, reduction in biological viability of soil to support growth due to soil compaction, displacement of flora and fauna species due to invasion of weeds and pest species, reduction in connectivity of biodiversity corridors, edge effects, habitat fragmentation, barrier effects, noise, dust, and light impacts and increase in litter (waste) and aquatic habitat degradation. However, the significance of the predicted cumulative impact as a result of the Project and other similar projects that occur within 50 km of the Project boundary are likely to be higher on the following ecological MNES:

- EPBC Act listed TEC (i.e. Swamp Tea-tree (*Melaleuca irbyana*) Forest of South-east Queensland)
- EPBC Act listed threatened flora and fauna species (e.g. Lloyd's olive (*Notelaea lloydii*), Red goshawk (*Erythrotriorchis radiatus*), Koala (*Phascolarctos cinereus*), Grey-headed flying-fox (*Pteropus poliocephalus*).

The MNES identified through the EIS will be subject to further investigations and surveys during the detailed design phase to more accurately determine the magnitude of the significant residual impacts upon the listed threatened species and communities. The specific mitigation measures will then be applied to ensure that the significance ratings of any potential impacts are classified as low as is reasonably practicable. As part of this ARTC is committed to implementing ongoing monitoring of the effectiveness of the measures with contingency (under an adaptive management framework) to change/improve management strategies where deleterious impacts to the identified environmental values are observed, or are not minimised, as per the objectives of the proposed mitigation measures.

Significant residual impacts will be offset through the development and implementation of an Environmental Offset Delivery Plan and associated Offset Area Management Plans.

There is the potential for some Project activities (e.g. vegetation clearing) to have a cumulative, irreversible and/or permanent impact upon some ecological MNES, even after the implementation of all Project mitigation measures. In these cases, the compensation for the residual impact will need to occur. An Environmental Offset Delivery Plan and Offset Area Management Plans for the Project will be prepared in consultation with the relevant State and Commonwealth agencies and will comply with the relevant offsets policies. Strategic offsets will be provided in accordance with Commonwealth and State based policies.

8.1 Post primary approval

ARTC will work with relevant stakeholders and agencies to implement the measures outlined above, along with the relevant imposed conditions to further reduce the impacts on MNES following the issuing of primary Project approvals.

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