CHAPTER 11

Flora and fauna

HELIDON TO CALVERT ENVIRONMENTAL IMPACT STATEMENT

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

Contents

Photographs

Figures

Tables

11. Flora and fauna

11.1 Summary

The ecology study area is situated within the South-East Queensland (SEQ) bioregion, which has experienced a long history of human disturbance as a result of agricultural practices, urban development and resource development. At a regional level, large tracts of remnant vegetation are typically fragmented, occurring in the areas that are less attractive to development (i.e. rocky ranges, sloping topography) and roadside vegetation, or as relatively small, isolated patches subject to edge-related impacts. The disturbance footprint travels through two catchment areas comprising Lockyer Creek (between Helidon and east of Laidley), and Bremer River (between Grandchester and Calvert), within the Brisbane River basin. A number of waterways occur within the Project disturbance footprint, including; Sandy Creek, Lockyer Creek, Laidley Creek and Western Creek. Two wetlands of high ecological significance are located at the eastern end of the disturbance footprint, adjacent to Western Creek.

The ecology study area provides suitable habitat for 26 matters of national environmental significance (MNES) (i.e. species listed under the (Cth) *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)), and seven non-MNES species listed under the provisions of the *Nature Conservation Act 1992* (Qld) (NC Act) (i.e. three plants and four animals) as well as potential habitat for 22 non-threatened, migratory species as listed under the EPBC Act. In addition, a number of endangered, of concern and least concern regional ecosystems (RE) are also present within the ecology study area that are protected under the *Vegetation Management Act 1999* (Qld) (VM Act). The ecology study area contains a suite of sensitive environmental receptors, including protected areas, high-value regrowth (HVR) vegetation, conservation significant flora and fauna species regionally significant species as well as bioregional corridors (local, regional and State significant). For the purposes of the impact assessment a sensitive environmental receptor is one that constitutes a non-threatened MNES or Matter of State Environmental Significance (MSES) (e.g. regulated vegetation, threatened species as listed under the provisions of the NC Act).

A total of 77 sensitive environmental receptors were identified within the ecology study area for the purposes of this assessment. These sensitive environmental receptors 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 nature of each unmitigated potential impact was considered in relation to the identified sensitive environmental receptors to derive an initial assessment of impact significance for the Project by assigning sensitivity and magnitude ratings. These ratings were then allocated a significance via a significance assessment matrix. The potential impacts on the sensitive environmental receptors were then assigned a major, high, moderate, low or negligible rating.

The proposed avoidance and mitigation measures for the Project were identified to reduce the significance of the potential impacts on the sensitive environmental receptors. After applying the mitigation hierarchy (i.e. avoid, minimise, mitigate), which included a range of mitigation measures and management plans, the impacts to the identified sensitive environmental receptors were generally reduced.

Following an initial impact assessment and the application of mitigation measures, each sensitive environmental receptor (where applicable) was analysed to determine if the Project would result in significant residual impact in accordance with the relevant Commonwealth or State significant impact guideline.

In accordance with the outcomes of the MNES significant impact guideline, there are **no significant impacts expected** for the following 22 non-threatened EPBC Act listed migratory species:

- Common Sandpiper (*Actitis hypoleucos*)
- Fork-tailed Swift (*Apus pacificus*)
- Sharp-tailed Sandpiper (*Calidris acuminata*)
- Pectoral Sandpiper (*Calidris melanotos*)
- Red-necked Stint (*Calidris ruficollis*)
- Oriental Dotterel (*Charadrius veredus*)
- Oriental Cuckoo (*Cuculus optatus*)
- Latham's Snipe (*Gallinago hardwickii*)
- Gull-billed Tern (*Gelochelidon nilotica*)
- Caspian Tern (*Hydroprogne caspia*)
- Black-tailed Godwit (*Limosa limosa*)
- Black-faced Monarch (*Monarcha melanopsis*)
- Yellow Wagtail (*Motacilla flava*)
- Satin Flycatcher (*Myiagra cyanoleuca*)
- Eastern Osprey (*Pandion haliaetus*)
- Red-necked Phalarope (*Phalaropus lobatus*)
- Glossy Ibis (*Plegadis falcinellus*)
- Pacific Golden Plover (*Pluvialis fulva*)
- Rufous Fantail (*Rhipidura rufifrons*)
- Spectacled Monarch (*Symposiachrus trivirgatus*)
- Common Greenshank (*Tringa nebularia*)
- Marsh Sandpiper (*Tringa stagnatilis).*

In accordance with the outcomes of the MNES significant impact guideline, it is anticipated that there **is potential** for the Project **to result in significant residual impacts** for the following 13 EPBC Act listed threatened species:

- **Flora**
  - Four-tailed Grevillea (*Grevillea quadricauda*)
  - Blunt-leaved Leionema (*Leionema obtusifolium*)
  - Lloyd's Olive (*Notelaea lloydii*)
  - A grass (*Paspalidium grandispiculatum*)
- **Fauna**
  - Spotted-tail Quoll (*Dasyurus maculatus maculatus*)
  - Collared Delma (*Delma torquata*)
  - Red Goshawk (*Erythrotriorchis radiatus*)
  - Swift Parrot (*Lathamus discolor*)
  - Brush-tailed Rock-wallaby (*Petrogale penicillata*)
  - Koala (*Phascolarctos cinereus*)
  - New Holland Mouse (*Pseudomys novaehollandiae*)
  - Grey-headed Flying-fox (*Pteropus poliocephalus*)
  - Australian Painted Snipe (*Rostratula australis*).

Assessment of prescribed MSES has been undertaken in accordance with the MSES significant impact criteria. Analysis indicates that the Project **is likely to result in significant residual impacts** to the following sensitive environmental receptors, with all remaining sensitive environmental receptors unlikely to be subject to a significant residual impact in accordance with the MSES guidelines:

- Regulated vegetation (Category B: other than grassland within a defined distance from the defining banks of a relevant watercourse or relevant drainage feature): 0.77 ha
- Essential Habitat (EH): 95.66 ha
- Protected wildlife habitat for the following species:
  - Bailey's Cypress Pine (*Callitris baileyi*): 28.40 ha
  - Swamp Tea-tree (*Melaleuca irbyana*): 128.78 ha
  - Glossy Black-cockatoo (*Calyptorhynchus lathami*): 45.11 ha
  - Powerful Owl (*Ninox strenua*): 28.63 ha.

The significance of the predicted cumulative impact as a result of the Project added to the seven other similar projects that occur within 50 km of the Project boundary are likely to be higher on the following sensitive environmental receptors:

- EPBC Act listed, threatened species:
  - Lloyd's Olive (*Notelaea lloydii*)—cumulative removal of 509.23 ha of which the Project contributes 26.32 per cent
  - A grass (*Paspalidium grandispiculatum*)—cumulative removal of 596.55 ha of which the Project contributes 14.18 per cent
  - White-throated Needletail (*Hirundapus caudacutus*)—cumulative removal of 11,620.85 ha of which the Project contributes 5.77 per cent
  - Grey Falcon (*Falco hypoleucos*)—cumulative removal of up to 9,185.74 ha of which the Project contributes 3.83 per cent
  - Swift Parrot (*Lathamus discolor*)— cumulative removal of up to 1,371.32 ha of which the Project contributes 7.20 per cent
  - Spotted-tail Quoll (*Dasyurus maculatus maculatus*)—cumulative removal of 1,213.77 ha of which the Project contributes 6.35 per cent
  - Koala (*Phascolarctos cinereus*)— cumulative removal of up to 3,821.32 ha of which the Project contributes 7.95 per cent
  - Grey-headed Flying-fox (*Pteropus poliocephalus*)—cumulative removal of 1,425.16 ha of which the Project contributes 6.98 per cent.
- EPBC Act listed, non-threatened migratory species:
  - Latham's Snipe (*Gallinago hardwickii*)—Project impact makes a 7.44 per cent contribution to the clearing of approximately 1,799.41 ha (sum of cumulative impact), which constitutes 1.29 per cent of the available habitat within the cumulative impact study area
  - Pectoral Sandpiper (*Calidris melanotos*), Red-necked Stint (*Calidris ruficollis*), Black-tailed Godwit (*Limosa limosa*), Yellow Wagtail (*Motacilla flava*), Red-necked Phalarope (*Phalarops lobatus*), Pacific Golden Plover (*Pluvialis fulva*), Common Greenshank (*Tringa nebularia*) and Marsh Sandpiper (*Tringa stagnatilis*)—Project impact makes a 5.70 per cent contribution to the clearing of approximately 1,413.32 ha (sum of cumulative impact), which constitutes 1.19 per cent of the available habitat within the cumulative impact study area

- Essential habitat—Project impact makes a 6.88 per cent contribution to the clearing of approximately 1,389.60 ha (sum of cumulative impact), which constitutes 0.46 per cent of the available habitat within the cumulative impact study area
- Category C Regulated vegetation (HVR)—Project impact makes a 7.29 per cent contribution to the clearing of approximately 922.04 ha (sum of cumulative impact), which constitutes 1.18 per cent of the available habitat within the cumulative impact study area.

The sensitive environmental receptors 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 on the identified MNES and MSES. 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. To mitigate the residual impacts to the sensitive environmental receptors identified above, environmental offsets will be required.

ARTC's Environmental Offsets Delivery Strategy—Qld (Strategy) is contained in Appendix I: Terrestrial and Aquatic Ecology Technical Report and Appendix J: Matters of National Environmental Significance Technical Report. This Strategy informs the development of offset delivery components including an Environmental Offsets 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.

11.2 Scope of chapter

This chapter provides a summary of MNES and MSES, vegetation communities and habitats, as well as weed and pest presence. Potential impacts to sensitive environmental attributes (i.e. prescribed environmental matter as defined in the Environmental Offsets Regulation 2014) (sensitive environmental receptors) resulting from construction, commissioning and reinstatement, and operation (where relevant) of the Project are also identified, with a suite of proposed mitigation measures to minimise environmental impacts resulting from the Project.

For the purpose of this chapter, the assessment of potential impacts was focused on the Project disturbance footprint and ecology study area presented in Figure 11.1.

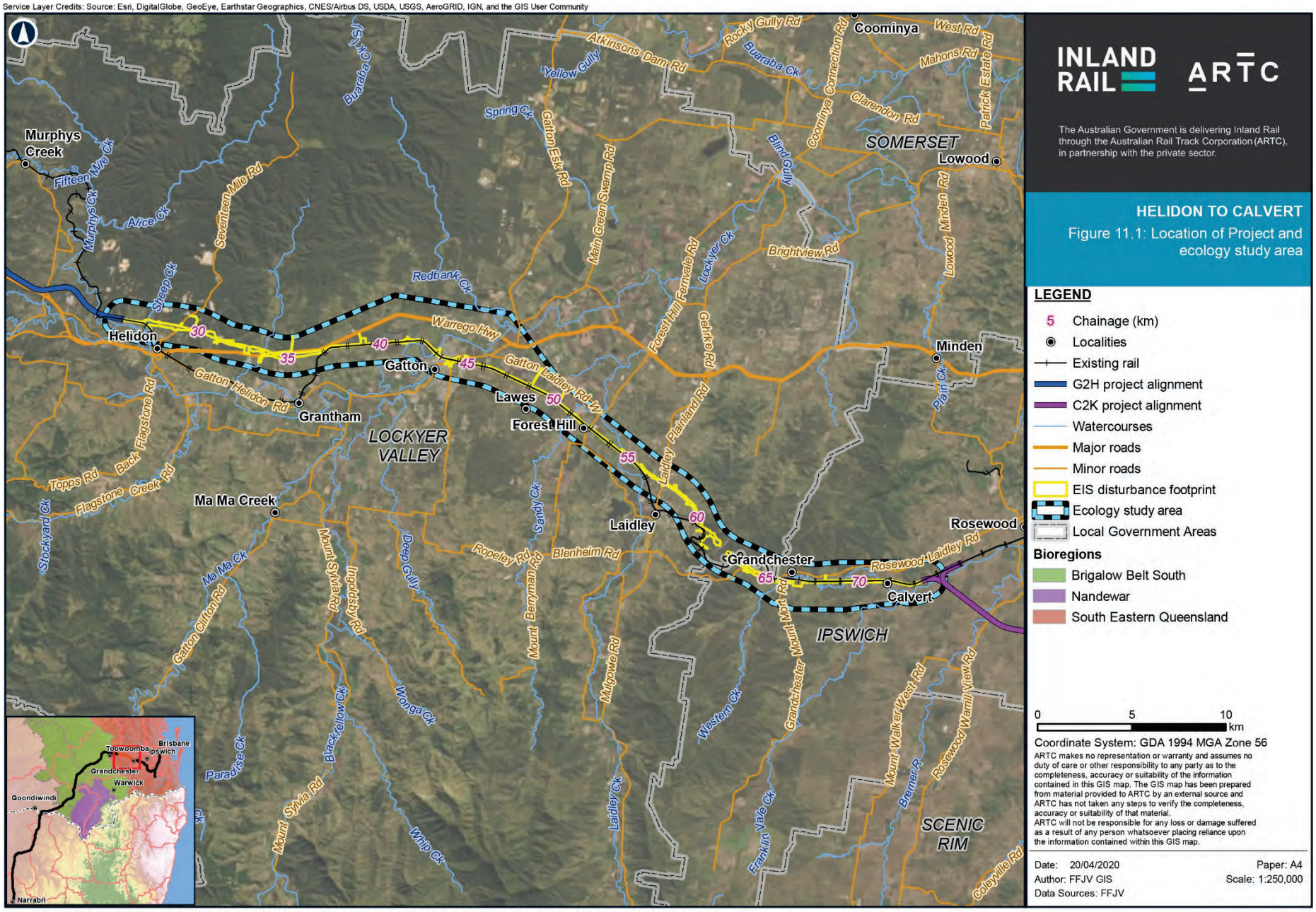
For the estimation of direct impacts, the Project disturbance footprint does not include the surface area associated with the rail tunnel where the Project alignment intersects a portion of the Little Liverpool Range as no surface disturbance is predicted.

An assessment of the potential impacts of the Project before, as well as after, the implementation of mitigation measures is provided, together with the significance of the anticipated impacts for each sensitive environmental receptor for the pre- and post-mitigation scenarios. Assessment of sensitive environmental receptors has been provided against the relevant government's significant impact assessment criteria to identify potential offset obligations.

Flora, fauna and habitat matters have been raised regularly by stakeholders and the community in discussions, meetings and correspondence with the Project team. The matters raised includes habitat for Koalas, the Regent Honeyeater, retention of *Melaleuca irbyana* trees and habitat connectivity across the corridor. The Project team also held a workshop about how to provide species record information or data collected by community members to the Queensland Government, so it can be recorded and recognised in the WildNet database, which was subsequently used as part of the EIS investigations. 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.

11.2.1 Ecology study area

The ecology study area adopts the EIS investigation corridor, an approximately 2 km wide study area, 1 km either side of the proposed rail alignment. The ecology study area 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. (refer Figure 11.1).



Map by: DTH/MEF/LCT/GN Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201906101333_Ecology_figures_and_calcs\330-EAP-201906101333_ARTC_Fig11.1_LocationOfProject_V3.mxd Date: 23/04/2020 12:29

11.3 Terms of Reference requirements

The Terms of Reference (ToR) describe the matters the proponent must address in the Environmental Impact Statement (EIS) for the Project. Specific sections of the ToR relating to MNES (Items 11.1 to 11.35), Flora and fauna (Items 11.96 to 11.103) and Biosecurity (Items 11.104 to 11.108) and how they are addressed in this EIS, are provided in Table 11.1.

A stand-alone document pertaining to MNES is provided as Appendix J: Matters of National Environmental Significance Technical Report in relation to Items 11.1 to 11.35 of the ToR. Appendix I: Terrestrial and Aquatic Ecology Technical Report provides the technical details associated with Items 11.96 to 11.108 of the ToR.

Compliance of the Environmental Impact Statement (EIS) against the full ToR is documented in Appendix B: Terms of Reference Compliance Table.

TABLE 11.1: TERMS OF REFERENCE—FLORA AND FAUNA

Terms of Reference requirement		Where addressed
MNES		
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.	Appendix J: Matters of National Environmental Significance Technical Report
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).	No response required
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.	No response required
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.	No response required
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.	No response required
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	No response required
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.	No response required
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.	No response required
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.	No response required

Terms of Reference requirement		Where addressed
Information requirements		
11.10	Consideration must be given to any relevant policy statements available from **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.	a) Appendix J: Matters of National Environmental Significance Technical Report, Sections 2.1 b) Appendix J: Matters of National Environmental Significance Technical Report, Sections 2.1 c) Appendix J: Matters of National Environmental Significance Technical Report, Sections 2.1, 3.2, 4 and Appendix B
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).	Sections 11.4 and 11.12 Appendix J: Matters of National Environmental Significance Technical Report, Sections 1, 3, 4, 5 and 6
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.	Appendix J: Matters of National Environmental Significance Technical Report
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.	Sections 11.8 and 11.13 Appendix J: Matters of National Environmental Significance Technical Report, Sections 5 and 7 Chapter 22: Cumulative impacts
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.	Sections 11.8, 11.9, 11.10 and 11.11 Appendix J: Matters of National Environmental Significance Technical Report, Sections 5, 9 and Appendix B
11.15	An estimate of the reliability of any predictions should be provided.	Appendix J: Matters of National Environmental Significance Technical Report, Section 3 and Appendix A
11.16	Any positive impacts of the Project should be identified and evaluated.	Appendix J: Matters of National Environmental Significance Technical Report, Section 1.9 Chapter 2: Project rationale Chapter 16: Social

Terms of Reference requirement		Where addressed
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 11.5 Appendix J: Matters of National Environmental Significance Technical Report, Sections 3.2 and 3.3
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.	Appendix J: Matters of National Environmental Significance Technical Report, Sections 1.6 Chapter 2: Project rationale
11.19	Short, medium and long-term advantages and disadvantages of the alternatives or options must be discussed.	Appendix J: Matters of National Environmental Significance Technical Report, Section 1.6 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.	Appendix J: Matters of National Environmental Significance Technical Report, Section 1.4 Chapter 1: Introduction Appendix F: Corporate Policies
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.	Appendix J: Matters of National Environmental Significance Technical Report, Sections 1.9 and 1.10 Chapter 2: Project rationale Chapter 5: Stakeholder engagement Chapter 16: Social 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 11.8.1 Appendix J: Matters of National Environmental Significance Technical Report, Sections 1.7 and 1.8 Chapter 6: Project description
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.	Appendix J: Matters of National Environmental Significance Technical Report, Sections 1.7 and 1.8 Chapter 6: Project description

Terms of Reference requirement		Where addressed
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.	Appendix J: Matters of National Environmental Significance Technical Report, Sections 4.2 and 5.1.3 Chapter 13: Surface water and hydrology Chapter 14: Groundwater Appendix L: Surface Water Quality Technical Report Appendix N: Groundwater Technical Report
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).	Section 11.6.2.3 Appendix J: Matters of National Environmental Significance Technical Report, Sections 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 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.	Sections 11.8, 11.11 and 11.12 Appendix J: Matters of National Environmental Significance Technical Report, Sections 5.1, 5.2, 5.3.3, 5.3.4 and 5.3.5 and Appendix B
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 11.9 Appendix J: Matters of National Environmental Significance Technical Report, Sections 5.2 and 5.3.2
11.28	The EIS should describe any offsets proposed to compensate for residual impacts.	Section 11.12 Appendix J: Matters of National Environmental Significance Technical Report, Section 5.4 and Appendix I

Terms of Reference requirement		Where addressed
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 species for the proposed action: 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 k) endangered, marine, migratory; l) Black-throated Finch (southern) (*Poephila cincta cincta*) – endangered; m) Australian Painted Snipe (*Rostratula australis*) – endangered, marine; n) Black-breasted Button-quail (*Turnix melanogaster*) – vulnerable; o) Mary River Cod (*Maccullochella mariensis*) – endangered; p) Pink Underwing Moth (*Phyllodes imperialis smithersi*) – endangered; q) Large-eared Pied Bat (*Chalinolobus dwyeri*) – vulnerable; r) Northern Quoll (*Dasyurus hallucatus*) – endangered; s) Spotted-tail Quoll (SE mainland population) (*Dasyurus maculatus*) – endangered; t) Greater Glider (*Petauroides Volans*) – vulnerable; u) Brush-tailed Rock-wallaby (*Petrogale penicillata*) – vulnerable; v) Koala (*Phascolarctos cinereus*) (combined population of Queensland, New South Wales and the Australian Capital Territory) – vulnerable; w) Long-nosed Potoroo (SE mainland) (*Potorous tridactylus tridactylus*) – vulnerable; x) New Holland Mouse (*Pseudomys novaehollandiae*) – vulnerable; y) Grey-headed flying-fox (*Pteropus poliocephalus*) – vulnerable; z) Five-clawed Worm-skink, Long-legged Worm-skink (*Anomalopus mackayi*) – vulnerable; aa) Marlborough blue (*Cycas ophiolitica*)– endangered; bb) Hairy-joint Grass (*Arthraxon hispidus*) – vulnerable; cc) A shrub (*Bertya ernestiana*) – vulnerable; dd) Three-leaved Bosistoa, Yellow Satinheart (*Bosistoa transversa*) – vulnerable; ee) Miniature Moss-orchid, Hoop Pine Orchid (*Bulbophyllum globuliforme*) – vulnerable; ff) Boonah Tuckeroo (*Cupaniopsis tomentella*) – vulnerable; gg) Bluegrass (*Dichanthium setosum*) – vulnerable; hh) Wandering Pepper-cress (*Lepidium peregrinum*) – endangered; ii) Macadamia nut, Queensland Nut Tree, (*Macadamia integrifolia*) – vulnerable; jj) Rough-shelled Bush Nut, Rough-leaved Queensland Nut (*Macadamia tetraphylla*) – vulnerable; kk) Cooneana Olive (*Notelaea ipsviciensis*) – critically endangered; ll) Lloyd's Olive (*Notelaea lloydii*) – vulnerable; mm) Lesser Swamp-orchid (*Phaius australis*) – endangered; nn) Mt Berryman Phebalium (*Phebalium distans*) – critically endangered; oo) Shiny-leaved Condoo, Black Plum, Wild Apple (*Planchonella eerwah*) – endangered; pp) Austral Cornflower, Native Thistle (*Rhaponticum australe*) – vulnerable; qq) Quassia (*Samadera bidwillii*) – vulnerable; rr) Brush sophora (*Sophora fraseri*) – vulnerable; ss) Austral Toadflax, Toadflax (*Thesium australe*) – vulnerable tt) Adorned Delma, Collared Delma (*Delma torquata*) – vulnerable; uu) Dunmall's Snake (*Furina dunmalli*) – vulnerable; vv) Three-toed Snake-tooth Skink (*Saiphos reticulatus*) – vulnerable.	Sections 11.8, 11.10 and 11.11 Appendix J: Matters of National Environmental Significance Technical Report, Sections 4.3, 4.4, 5.1 and 5.3

Terms of Reference requirement		Where addressed
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 11.10 and 11.11 Appendix J: Matters of National Environmental Significance Technical Report, Sections 5.3.4, 5.3.5 and Appendix B
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.	Sections 11.8, 11.10 and 11.11 Appendix J: Matters of National Environmental Significance Technical Report, Sections 4.3.1.2, 4.4.1.3, 5.1, 5.3.2 and 5.3.3
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.	Sections 11.10 and 11.11 Appendix J: Matters of National Environmental Significance Technical Report, Sections 5.3.3 and Appendix B
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.	Section 11.11 Appendix J: Matters of National Environmental Significance Technical Report, Sections 5.3.3, 5.3.4 and 5.3.5
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 11.12 Appendix J: Matters of National Environmental Significance Technical Report, Sections 5.4 and Appendix I
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; b) the principles of ecologically sustainable development and the precautionary principle; and c) the proposed avoidance, mitigation measures, and if relevant, offsets d) measures proposed to address any residual impacts.	Sections 11.5.6, 11.9, 11.12 and 11.13 Appendix J: Matters of National Environmental Significance Technical Report, Sections 1.11 and 8

Terms of Reference requirement		Where addressed
Flora and fauna		
Existing environment		
11.96	Identify and describe matters of State environmental significance (MSES), State and regionally significant biodiversity and natural environmental values of the terrestrial and aquatic ecology, including their seasonal variations, likely to be impacted by the project which have not been addressed in the section on MNES.	Sections 11.6 Appendix I: Terrestrial and Aquatic Ecology Technical Report, Section 4
11.97	Describe the likely impacts on the biodiversity and natural environmental values of affected areas arising from the construction and operation of the project. The assessment should include, but not be limited to, the following key elements:	-
	a) MSES, matters of local environmental significance, and designated State and regional biodiversity values and conservation corridors of conservation significance. Reference should be made to the Biodiversity Planning Assessment and BioCondition assessment tools where appropriate (refer to Appendix 1).	Sections 11.8, 11.10 and 11.11.3 Appendix I: Terrestrial and Aquatic Ecology Technical Report, Section 5.1, 5.3.1, 5.3.2 and 5.3.4
	b) terrestrial and aquatic ecosystems (including groundwater-dependent ecosystems) and their interaction and areas surrounding watercourses and wetlands	Sections 11.8 and 11.10 Appendix I: Terrestrial and Aquatic Ecology Technical Report, Section 5
	c) biological diversity including listed flora and fauna species and regional ecosystems, connectivity and essential habitat	Sections 11.8 and 11.10 Appendix I: Terrestrial and Aquatic Ecology Technical Report, Sections 5.1.2 and 5.3
	d) the existing integrity of ecological processes, including habitats of threatened, near-threatened or special least-concern species	Sections 11.8, 11.10 and 11.11 Appendix I: Terrestrial and Aquatic Ecology Technical Report, Sections 5.1.2 and 5.3
	e) the integrity of landscapes and places, including wilderness and similar natural places	Sections 11.8 and 11.10 Appendix I: Terrestrial and Aquatic Ecology Technical Report, Sections 5.1.2 and 5.3
	f) actions of the project that require an authority under the NC Act and Water Act (for example, riverine protection permits) and/or could be assessable development for the purposes of the VMA, Fisheries Act and PA	Section 11.8 Appendix I: Terrestrial and Aquatic Ecology Technical Report, Section 5 Chapter 3: Project approvals
	g) any exposure to contaminants or the bio-accumulation of contaminants	Section 11.8.2.11 Appendix I: Terrestrial and Aquatic Ecology Technical Report, Section 5.1.2.11
	h) impacts on native fauna due to proximity to the site and site impacts (e.g. lighting, noise, waste and fencing)	Sections 11.8.2.9 and 11.8.2.10 Appendix I: Terrestrial and Aquatic Ecology Technical Report, Sections 5.1.2.9 and 5.1.2.10
	i) impacts to movement of native fauna due to barrier effect of linear infrastructure	Section 11.8.2.8 Appendix I: Terrestrial and Aquatic Ecology Technical Report, Section 5.1.2.8
	j) impacts on vegetation category areas identified on the regulated vegetation management maps under Queensland's vegetation management framework.	Section 11.8, 11.10 and 11.11.3 Appendix I: Terrestrial and Aquatic Ecology Technical Report, Sections 5.1, 5.3.1, 5.3.2 and 5.3.4

Terms of Reference requirement		Where addressed
Mitigation measures		
11.98	Describe any proposed measures to avoid, minimise or mitigate potential impacts on natural values, and enhance these values. Assess how the nominated quantitative indicators and standards may be achieved for nature conservation management. In particular, address measures to protect or preserve any threatened or near-threatened species.	Section 11.9 Appendix I: Terrestrial and Aquatic Ecology Technical Report, Sections 5.2 Chapter 23: Draft Outline Environmental Management Plan
11.99	Assess the need for buffer zones and the retention, rehabilitation, planting or construction of movement corridors across the railway and propose measures that would avoid the need for waterway barriers or propose measures to mitigate the impacts of their construction and operation.	Section 11.9 Appendix I: Terrestrial and Aquatic Ecology Technical Report, Section 5.2
11.100	Describe how the achievement of the objectives would be monitored and audited, and how corrective actions would be managed	Section 11.9 Appendix I: Terrestrial and Aquatic Ecology Technical Report, Section 5.2
11.101	Where a significant residual impact will occur on a prescribed environmental matter as outlined in the Environmental Offsets Regulation 2014, the offset proposal(s) must be consistent with the requirements of Queensland's EO Act and the latest version of the Queensland Environmental Offsets Policy (refer to Appendix 1).	Section 11.12 Appendix I: Terrestrial and Aquatic Ecology Technical Report, Section 5.4
11.102	Assess the need and suitability and provide objective commitments to the provision of fauna passage between habitat fragmented by the rail corridor, of suitable design and location for affected species and their habitat.	Sections 11.9 Appendix I: Terrestrial and Aquatic Ecology Technical Report, Sections 4.4.7 and 5.2
11.103	Demonstrate that actions of the project avoid and minimise impacts of clearing of vegetation regulated through the VMA/PA and how any clearing maintains connectivity of the remaining mapped category B area in the landscape. Provide details on the exemptions/assessment pathway for any clearing of vegetation regulated through the VMA/PA	Section 11.9 Appendix I: Terrestrial and Aquatic Ecology Technical Report, Sections 2.1 and 5.2 to 5.4 Chapter 3: Project approvals
Biosecurity		
Existing environment		
11.104	Provide information on the current distribution of animal pests and weeds on the preferred alignment.	Section 11.6.2.4 and 11.6.3.2 Appendix I: Terrestrial and Aquatic Ecology Technical Report, Section 4.4.4
11.105	Surveys of animal pests and weeds should be undertaken in those areas identified during the desktop assessment as containing listed flora, fauna or ecological communities of national or state environmental significance (MNES or MSES defined by the EPBC and NC Acts respectively	Section 11.6.2.4 and 11.6.3.2 Appendix I: Terrestrial and Aquatic Ecology Technical Report, Sections 4.5.1.3 and 4.5.2.3
Impact assessment		
11.106	Describe the impact the project's construction and operation will have on the spread of pest animals and weed species along the preferred alignment and into adjoining properties	Sections 11.8.2.4 and 11.10 Appendix I: Terrestrial and Aquatic Ecology Technical Report, Sections 5.1.2.4, 5.3.2 and 5.3.4.1

Terms of Reference requirement		Where addressed
Mitigation measures		
11.107	Propose detailed measures to control and limit the spread of pests and weeds on the preferred alignment and adjacent areas and any relevant local government area Biosecurity Plans. This includes restricted matters listed in the Biosecurity Act and Biosecurity Regulation 2016 and designated pests under the Public Health Act 2005.	Section 11.9 Appendix I: Terrestrial and Aquatic Ecology Technical Report, Section 5.2 Chapter 23: Draft Outline Environmental Management Plan
11.108	All proposed measures must be in accordance with any relevant biosecurity surveillance or prevention program authorised under the Biosecurity Act and any requirements of the VMA/PA. Mitigation measures may be developed in consultation with relevant agencies and local government (e.g. baiting programs).	Section 11.9 Appendix I: Terrestrial and Aquatic Ecology Technical Report, Section 5.2 Chapter 23: Draft Outline Environmental Management Plan

11.4 Legislation, policies, standards and guidelines

This EIS has been prepared in accordance with State and Commonwealth regulatory context described within Chapter 3: Project approvals. The legislation, policies and guidelines relevant to the Project with respect to terrestrial and aquatic ecological values are presented in Table 11.2.

TABLE 11.2: LEGISLATION, POLICIES AND GUIDELINES RELEVANT TO THE ECOLOGICAL ASPECTS OF THE PROJECT

Legislation/policy	Legislative jurisdiction	Intent	Applicability
Commonwealth			
Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act)	Australia and its Territories. Specifically, projects that involve or have the potential to impact on nationally and internationally important flora, fauna, ecological communities and heritage places—defined under the EPBC 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 Australian Government Minister for the Environment and Department of Agriculture, Water and the Environment (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 the Environment and Energy (DotEE) (now DAWE) in February 2017 (EPBC, 2017/7883) The Minister for the Environment declared the Project a 'controlled action' on 17 March 2017. The controlling provisions for the controlled action are: ▸ Listed threatened species and communities. The EPBC Act controlled action will be assessed under the bilateral agreement with the Queensland Government.
EPBC Act Environmental Offsets Policy (2012) (EPBC Act Offsets Policy) (Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC), 2012)	Areas subject to the EPBC Act.	The EPBC Act Offset Policy was 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 DotEE. 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	The Project will implement a range of mitigation measures to avoid and minimise significant residual impacts on the MNES. 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 residual impacts on MNES identified in Appendix J: Matters of National Environmental Significance Technical Report.

Legislation/policy	Legislative jurisdiction	Intent	Applicability
EPBC Act Environmental Offsets Policy (2012) (EPBC Act Offsets Policy) (Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC), 2012) (continued)	Areas subject to the EPBC Act. (continued)	▸ Be in proportion to the level of statutory protection that applies to the protected matter ▸ 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, 2012). The Australian Government defines offsets as measures that compensate for the residual adverse impacts of an action on the environment (DSEWPaC, 2012).	
Matters of National Environmental Significance: Significant impact guidelines 1.1— *Environmental Protection and Biodiversity Conservation Act 1999* (Department of the Environment (DotE), 2013)	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 DotEE for a decision by the Australian Government Minister for Environment (the Minister) on whether assessment and approval is required under the EPBC Act. These guidelines outline 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 guidelines will facilitate the determination of a Significant residual impact to MNES. This has been undertaken in Appendix J: Matters of National Environmental Significance Technical Report (for the EPBC Act controlling provisions). Assessment has been undertaken in Section 11.11.1 for EPBC Act Project controlling provisions.

Legislation/policy	Legislative jurisdiction	Intent	Applicability
Draft Referral guidelines for 14 birds listed as migratory species under the EPBC Act (DAWE 2020a)	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 (the minister) on whether assessment and approval is required under the EPBC Act in relation to the 14 migratory birds. These guidelines outline 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 (non-threatened migratory species) against the guidelines will facilitate the determination of a significant residual impact to migratory birds relevant to this guideline. Assessment been undertaken in Section 11.11.2 for EPBC Act migratory 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. It is noted many threatened species do not have recovery plans currently in place.	Species recovery plans (State and Commonwealth) for the following MNES relevant to the Project have been considered as part of this assessment: ▸ Brush-tailed Rock-wallaby (*Petrogale penicillata*) ▸ Large-eared Pied Bat (*Chalinolobus dwyeri*) ▸ Spotted-tail Quoll (*Dasyurus maculatus maculatus*) ▸ Black-breasted Button-quail (*Turnix melanogaster*) ▸ Red Goshawk (*Erythrotriorchis radiatus*) ▸ Regent Honeyeater (*Anthochaera phrygia*) ▸ Swift Parrot (*Lathamus discolor*) Draft recovery plans awaiting adoption under the EPPBC Act and used 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*)

Legislation/policy	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 (*Vulpes vulpes*) ▸ Threat abatement plan for competition and land degradation by unmanaged goats.
State			
Planning Act 2016 (Qld) (Planning Act)	Queensland	The purpose of the Planning Act is to provide an efficient, effective, transparent, integrated, coordinated and accountable system of land use planning, development assessment and dispute resolution to facilitate the achievement of ecological sustainability. Together with a development assessment system, Chapter 1 of the Planning Act establishes a hierarchy of planning instruments that comprises: ▸ State planning policies (including temporary policies) ▸ Regional plans ▸ Planning schemes ▸ Temporary local planning instruments ▸ Planning scheme policies.	The Project may trigger the requirement to obtain approval for aspects of development that are assessable under Schedule 10 of the Planning Regulation 2017 (and integrated through other legislation as part of the Development Assessment Rules process) following completion of the EIS process.

Legislation/policy	Legislative jurisdiction	Intent	Applicability
Regional plans (Qld)	Queensland. Specifically, activities that are regulated through the Planning Act.	Regional plans are State planning instruments made under the Planning Act. Regional plans seek to provide strategic direction to achieve regional outcomes that align with the State interests in planning and development.	The Project is located within the South East Queensland (SEQ) Regional Planning area. The regional plan, known as *ShapingSEQ* (Department of Infrastructure, Local Government and Planning (DILGP, 2017a)) provides the regional framework for collaboration with the regions' 12 local governments for the management of growth, planning directions, economic competitiveness and high-quality living. *ShapingSEQ* identifies the need to plan strategically for the protection and enhancement of biodiversity values, koala habitat and landscape function and processes. Inland Rail has been identified in this plan.
State Planning Policy 2017 (SPP) (DILGP, 2017b)	Queensland	The SPP is a key component of the Queensland land use planning system which articulates the Queensland Government's 17 State interests in land use planning and development. The SPP is a statutory instrument and requires that the State interests be integrated into local government planning schemes. Some State interests in the SPP include assessment benchmarks that apply to certain types of development where a local government planning scheme does not appropriately integrate the relevant State interest. A number of the State interests set out in the SPP apply to the Project and to the Project impact areas.	The SPP is applicable to the Project across various aspects, including terrestrial and aquatic ecology which is represented by the *State interest guideline—biodiversity* (DILGP, 2017b). The biodiversity State interest requires development to be located in areas to avoid significant impacts to MNES, avoid and minimise impacts to MSES and matters of local environmental significance (MLES), maintaining or enhancing ecological processes and connectivity by avoiding fragmentation and conserve and enhance koala habitat extent and condition.

Legislation/policy	Legislative jurisdiction	Intent	Applicability
Environmental Protection Act 1994 (EP Act)	Queensland	The EP Act is the key legislative framework for environmental management and protection in Queensland. It regulates activities that will, or have the potential to, release contaminants into the environment which may cause environmental harm. These activities are defined as Environmentally Relevant Activities (ERA). ERAs include both prescribed ERAs and resource activities. The EP Act regulates the application of Environmental Authorities (EA) for ERAs and employs a number of mechanisms to achieve its objectives relating to biodiversity, including the Environmental Protection Regulation 2008 (Qld) (EP Reg). The EP Reg identifies prescribed ERAs that require an approval and provides the mechanism for levels of protection for Environmentally Sensitive Areas, which are defined in Schedule 12 of the EP Reg. The EP Act also regulates wetlands in wetland management areas under the subordinate Environmental Protection Policy (EPPs) including the Environmental Protection (Water and Wetland Biodiversity) Policy 2019. The EPP (Water and Wetland Biodiversity) establishes a process for identifying environmental values to be protected and states standards for water quality in support of those values.	The identification of any prescribed ERAs that will require an EA has been identified in Chapter 3: Project approvals of the EIS. Confirmation of these ERAs will be undertaken as part of the post-EIS approvals process. The EP Act also lists obligations and duties to prevent environmental harm, nuisances and contamination. ARTC will comply with the general environmental duty through the implementation of the environmental management plans for the construction and operation of the Project.

Legislation/policy	Legislative jurisdiction	Intent	Applicability
Nature Conservation Act 1992 (Qld) (NC Act)	Queensland	The NC Act provides for the conservation of nature through protection of all native plants, birds, reptiles, mammals and amphibians in Queensland (along with a limited range of invertebrates and freshwater fish). The NC Act is based on principles aimed at conserving biological diversity, ecologically sustainable use of wildlife, ecologically sustainable development and international criteria developed by the International Union for the Conservation of Nature for establishing and managing protected areas. The NC Act has 14 subordinate regulatory instruments in the form of regulations, conservation plans and notices. Of particular relevance to the Project are three instruments that regulate disturbance to flora, fauna and habitat, including: ▸ Nature Conservation (Animals) Regulation 2020, which prohibits the taking or destruction, without authorisation, of protected animals and lists all fauna species that are considered to be extinct in the wild, endangered, vulnerable, near threatened, least concern and special least concern wildlife (refer Chapter Glossary and Abbreviations for definitions of these terms). Also listed is international wildlife and prohibited wildlife. ▸ Nature Conservation (Plants) Regulation 2020, which prohibits the taking or destruction, without authorisation, of protected plants and lists all flora species that are considered to be extinct in the wild, endangered, vulnerable, near threatened, least concern and special least concern wildlife (refer Glossary and Abbreviations for definitions of these terms). Also listed is international wildlife and prohibited wildlife. ▸ Nature Conservation (Protected Plants) Conservation Plan 2000, which provides protection for protected flora species. Currently, all species of native Australian flora are listed as protected plants, including those species that are considered of least concern. The NC Act also includes provisions for protected areas such as national parks, nature refuges, and world heritage management areas.	The following permits and management plans may be required for the Project: ▸ Wildlife Movement Permits (Sections 88 and 97 of the NC Act)—for wildlife protected under the NC Act, and those found in certain areas covered by conservation plans created and implemented under the NC Act ▸ Clearing Permit (Protected Plants) (Section 89 of the NC Act) – for the clearing of vegetation contained within High risk areas identified on the Department of Environment and Science (DES) flora survey trigger map, or where protected plants have been identified in a Project survey within a proposed clearing area ▸ Rehabilitation Permit (spotter catcher endorsement) (Part 14 of the Nature Conservation (Animals) Regulation 2020) ▸ Damage Mitigation Permit (removal and relocation) ((Part 10 of the Nature Conservation (Animals) Regulation 2020) ▸ Species management plan must be submitted to the DES for approval for tampering with some animal breeding places (Section 33 of the Nature Conservation (Animals) Regulation 2020).
Nature Conservation (Koala) Conservation Plan 2017	Queensland	The Nature Conservation (Koala) Conservation Plan 2017 (Koala Plan) requires any clearing in certain areas to be undertaken sequentially, and in the presence of a suitably qualified koala spotter. The Koala Plan also prescribes three mapped koala districts (A, B and C) and includes requirements relating to the release of rehabilitation, sick or injured koalas.	The Project will require clearing within District A as identified in the Koala Plan. Clearing works in Koala habitat within District A require 'sequential clearing' and the presence of Koala spotters (Refer Section 11.6.4).

Legislation/policy	Legislative jurisdiction	Intent	Applicability
Biosecurity Act 2014 (Qld) (Biosecurity Act)	Queensland	The Biosecurity Act seeks to provide a framework for an effective biosecurity system for Queensland that helps to manage and minimise State biosecurity risks, as well as facilitate the response to biosecurity issues and events in a timely and effective way, so as to align with national and international obligations. The Act introduces the general biosecurity obligation on all persons to take all reasonable and practical measures to prevent or minimise biosecurity risks. Under the Biosecurity Act, red imported fire ants (*Solenopsis invicta*) are a Category 1 'restricted matter' and must be reported if found and all reasonable steps taken to minimise the risk of them spreading. The Act establishes a Fire Ant Biosecurity Zone. Restrictions on the movement of carriers of fire ant within and out of the zone will be prescribed and will include 'risk items' such as soil or anything that has soil attached and material that is a product or by-product of quarrying or mining. Movement of carriers by anyone of land within the zone will be prohibited unless the person has a Biosecurity Instrument Permit or under a prescribed exemption (which include implementing risk-mitigation activities).	The Project will potentially involve interaction with restricted matters and prohibited matters (potentially including pests, diseases or contaminants) and will therefore require compliance with the Biosecurity Act. The Biosecurity Management Plan will ensure that the potential spread of invasive species as a result of Project activities are minimised and managed appropriately. The Biosecurity Management Plan will consider operational impacts associated with movement of stock and produce on trains as a vector for spread of pest animals, plants and pathogens. The Project will traverse areas contained within Red Imported Fire Ant Biosecurity Zone 2; therefore, there will be restrictions around the movement of materials that could spread the red imported fire ant. The Biosecurity Management Plan will also consider Red imported fire ants (refer Section 11.9.2).
Agricultural Chemicals Distribution Control Act 1966 (ACDC Act)	Queensland	The ACDC Act and Agricultural Chemicals Distribution Control Regulation 1988 aim to control the distribution of agricultural chemicals from aircraft and from ground equipment. A herbicide, a category of agricultural chemical, is defined as any material used or intended to be used for destroying, or preventing the spread of weeds. Herbicides are registered by the Australian Pesticides and Veterinary Medicines Authority (APVMA). The misuse of herbicides has the potential to harm agriculture or livestock, the environment, trade, or human health, and the ACDC Act and Regulation are in place to ensure that commercial operators and their businesses distribute herbicides responsibly.	Large areas of the ecology study area have significant weed growth, particularly non-native grasses, which have been introduced as part of historic agricultural land use of the area (refer Chapter 11: Flora and Fauna). In addition, Project activities have the potential to increase the proliferation of weeds and pests. There is the requirement to appropriately manage weeds and pests as part of Project works. Any use of pesticides or herbicides to manage pests and weeds will need to be performed in accordance with the ACDC Act. Ground distribution of pesticides and herbicides may require both the operator of the equipment and the company or business employing or directing the operators to be licensed in accordance with the ACDC Act. For the purposes of the CEMP, the APVMA will regulate the lawful application of pesticides and herbicides for targeted pest and weed management activities.

Legislation/policy	Legislative jurisdiction	Intent	Applicability
Public Health Act 2005 (Public Health Act)	Queensland	The objective of the Public Health Act is to is to protect and promote the health of the Queensland public by: ▸ Preventing, controlling and reducing risks to public health ▸ Providing for the identification of, and response to, notifiable conditions ▸ Imposing obligations on persons and particular health care facilities involved in the provision of declared health services to minimise infection risks ▸ Providing for persons who have a major disturbance in mental capacity to be transported to a treatment or care place ▸ Protecting children who have been harmed or are at risk of harm when the children present at health service facilities ▸ Restricting the performance of cosmetic procedures on children ▸ Collecting and managing particular health information, and establishing mechanisms for health information held by a health agency to be accessed for appropriate research ▸ Inquiring into serious public health matters ▸ Responding to public health emergencies ▸ Providing for compliance with this Act to be monitored and enforced.	The Project will traverse areas that potentially contain designated pests as defined under the Public Health Act (e.g. Fire Ant Biosecurity Zones). Measures to control and minimise the spread of these pests is required. Control measures for designated pests is provided in Section 11.9.2.

Legislation/policy	Legislative jurisdiction	Intent	Applicability
Vegetation Management Act 1999 (Qld) (VM Act)	Queensland. Specifically, activities that are regulated through the Planning Act	The VM Act regulates the conservation and management of vegetation communities and clearing of vegetation identified as 'Regulated vegetation' identified as Category A, B, C and R. The VM Act provides a framework for identification, description, and mapping of remnant Regional Ecosystems (REs) certified by DES as Endangered, Of concern or Least concern. It also provides a framework for the identification, description and mapping of High Value Regrowth (HVR) vegetation as Endangered, Of concern or Least concern.	The clearing of vegetation regulated under the VM Act (e.g. Category B and C regulated vegetation) will occur as a result of the Project. Clearing of any relevant remnant or regulated regrowth vegetation will constitute operational works under Schedule 10 of the Planning Regulation that will require development approval, unless an exemption applies. Under Schedule 21, Part 1, Item 14 of the Planning Regulation, the following clearing work is exempt clearing work for which a development permit is not required: *(14) Clearing vegetation for the construction or maintenance of infrastructure stated in Schedule 5, if-* *a) the clearing is on a designated premises; or* *b) the infrastructure is government supported transport infrastructure* The Project is considered to be government supported infrastructure as per requirements of the Planning regulation. Vegetation clearing for the Project is considered to be eligible for exemption under Schedule 21 of the Planning Regulation given the Project is for transport infrastructure (rail transport infrastructure) that is government supported transport infrastructure (for a public use and funded partly by the Australian Government).

Legislation/policy	Legislative jurisdiction	Intent	Applicability
Environmental Offsets Act 2014 (Qld) (Offsets Act)	Queensland	The Offsets Act and associated Environmental Offsets Regulation 2014 (Qld) seeks to 'counterbalance the significant residual impacts of particular activities on prescribed environmental matters through the use of environmental offsets'. Introduced on 1 July 2014, the Act is administered by DES, and establishes a new framework to regulate the delivery of offsets in Queensland, integrating the previous multiple sets of policies in a manner that provides an outcome-based approach and reducing duplication. Under the Offsets Act, an environmental offset is defined as 'an activity undertaken to counterbalance a significant residual impact of a prescribed activity on a prescribed environmental matter'. The Act defines the type of activities for which offsets may be imposed (i.e. 'prescribed activities') where these activities are determined to result in a 'Significant residual impact'. To achieve the purpose of the Offsets Act, the Queensland Environmental Offsets Policy (Version 1.1, December 2014) has been developed to provide further guidance on the requirements for the assessment of 'Significant residual impacts', and accepted methods for the delivery of offsets, where required.	The Project will be required to deliver environmental offsets in accordance with the Offsets Act. Environmental offsets for Significant residual impacts to a prescribed matter may be delivered through a proponent-driven offset (e.g. land-based offset), a financial offset calculated in accordance with the Financial Settlement Offset Calculation Methodology, or a combination of proponent driven and financial offsets. Information related to the provisions of offsets is provided in Section 11.1.
Queensland Environmental Offsets Policy Significant Residual Impact Guideline (*Nature Conservation Act 1992 Environmental Protection Act 1994 Marine Parks Act 2004*) (MSES Guidelines) (Department of State Development, Infrastructure and Planning (DSDIP), 2014a))	Queensland	The purpose of this guideline is to assist in deciding whether or not a prescribed activity will or is likely to have a significant residual impact on MSES. This guideline applies to any activity prescribed in the Environmental Offsets Regulation 2014 that requires an approval in relation to MSES, under any of the following: ▸ NC Act ▸ *Marine Parks Act 2004* ▸ EP Act.	The Project involves disturbance to features protected the EP Act and NC Act, and as such, assessment against the MSES guidelines is required to determine if a significant residual impact on an MSES occurs Section 11.11.3.

Legislation/policy	Legislative jurisdiction	Intent	Applicability
Water Act 2000 (Qld) (Water Act)	Queensland	The Water Act provides for the sustainable management of non-tidal waters and other resources, together with the establishment and operation of water authorities, and for other purposes. The Queensland Government maintains Watercourse Identification Mapping (WIM), which identifies defined watercourses under the Water Act, as well as drainage features (not regulated under the Water Act). Through the Planning Act, certain water-related development under the Water Act is assessable. In addition to the approvals triggered under Planning Act, the Water Act regulates the undertaking of works that involve the excavating or placing fill in a watercourse, lake or spring.	The Project involves works within defined mapped watercourses and the provisions of the Water Act may apply. Other unmapped waterways will be required to be verified during the detailed design phase to determine their status under the Water Act. The Project involves the removal of vegetation, excavation or placing fill in a waterway, lake or spring. ARTC is an approved entity for the purposes of the riverine protection permit exemption requirements. Where works are proposed within a watercourse, these activities will be in accordance with the riverine protection permit exemption requirements. A riverine protection permit will be required in instances where the exemption requirements cannot be achieved. ARTC or the construction contractor will obtain a water entitlement, water licences and/or development permits for watercourse diversion for the Project to enable the take of water for use during construction. Where works are proposed within a watercourse, these activities will be in accordance with the riverine protection permit exemption requirements. A riverine protection permit will be required in instances where the exemption requirements cannot be achieved.

Legislation/policy	Legislative jurisdiction	Intent	Applicability
Fisheries Act 1994 (Qld) (Fisheries Act)	Queensland	The Fisheries Act provides for the management, use, development and protection of fish habitats and resources, together with the management of aquaculture activities. Administered by the Department of Agriculture and Fisheries (DAF), the Fisheries Act applies to: ▸ Works in a declared Fish Habitat Area (FHA) ▸ Waterway barrier works resulting in the construction of instream structures inhibiting the free movement of fish along waterways. **Waterway Barrier Works:** Under the provisions of the Fisheries Act and Planning Act, a Development Permit for Operational Works involving Waterway Barrier Works is required for works that pose a barrier to fish passage (including permanent, partial and temporary barriers) within a waterway that is mapped by the Department of Agriculture and Fisheries (DAF) on the spatial data layer *Queensland waterways for waterway barrier works* unless: ▸ The works have a low impact to fisheries productivity and comply with DAF's requirements for 'works which are not waterway barrier works' which include (subject to specific design and construction requirements): ▸ New single or multi-span bridges ▸ Maintenance of existing bridge structures not subject to an existing permit ▸ Bank revetment ▸ Road resurfacing at waterway crossings ▸ Stormwater outlet construction. Works that occur within these waterways will be defined as waterway barrier works, unless the works comply with the *Accepted development requirements for operational work that is constructing or raising waterway barrier works* (DAF, 2018a)).	The Project transverses mapped waterways for waterway barrier works and therefore will likely trigger the requirement to obtain a Development Permit for Operational Works that is constructing or raising waterway barrier works, unless an exemption applies, or where works can be shown to comply with the accepted development requirements. The Project does not require: ▸ The removal, destruction or damage of marine plants ▸ Works involving aquaculture ▸ Work that is completely or partly within a declared FHA.

Legislation/policy	Legislative jurisdiction	Intent	Applicability
Queensland Environmental Offsets Policy (Qld) (QEOP)	Queensland	The QEOP aims to provide a framework for environmental offsets in Queensland, including principles and guidelines for using environmental offsets and guidance on when offsets should be used. The QEOP outlines seven principles that direct the way offsets must be used to contribute to environmentally sustainable development (ESD) as follows: ▸ Offsets will not replace or undermine existing environmental standards or regulatory requirements, or be used to allow development in areas otherwise prohibited through legislation or policy ▸ Impacts must first be avoided, then minimised, before considering the use of offsets for any remaining impact ▸ Offsets must achieve a conservation outcome that achieves an equivalent environmental outcome ▸ Offsets must provide environmental values as similar as possible to those being lost ▸ Offset provision must minimise the time-lag between the impact and delivery of the offset ▸ Offsets must provide additional protection to environmental values at risk, or additional management actions to improve environmental values ▸ Where legal security is required, offsets must be legally secured for the duration of the impact on the prescribed environmental matter.	The biodiversity offsets package that may be required for the Project will consider the QEOP (refer Section 11.1).
Back on Track species prioritisation framework (Department of Environment and Resource Management (DERM), 2010c)	-	The Back on Track species prioritisation framework is an initiative of the DES, based on the method of Marsh et al., (2007) that ranks species (regardless of their NC Act or EPBC Act classification) as critical, high, medium, or low priority for the State and for the Natural Resource Management (NRM) region. There is also a data deficient category according to three sets of criteria: probability of extinction, consequences of extinction and potential for successful recovery. Although it is not statutory, the Back on Track priority species provides a framework for biodiversity assessment and species prioritisation when determining ecological values.	Priority Back on Track species have been identified for each of the 14 NRM regions across Queensland. The Project is located in the SEQ NRM region. A total of 105 priority Back on Track species (56 flora species and 49 fauna species) are known to occur within the SEQ NRM region through the prioritisation framework (DERM, 2010c).

Legislation/policy	Legislative jurisdiction	Intent	Applicability
Biodiversity Planning Assessments (BPAs)		BPAs for each of Queensland's bioregions have been prepared based on the methodology outlined in the Biodiversity Assessment and Mapping Methodology (BAMM) (Department of Environment and Heritage Protection (DEHP), 2014b). The BPAs draw on the DES certified 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. The BPA assigns areas to one of three biodiversity significance levels, including: ▸ 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. Although it is not legislated, the BPA provides a framework for biodiversity assessment when determining environmental values. In addition to terrestrial BPAs, aquatic BPAs use and assess the conservation and ecological value of wetland systems based on a series of national and international criteria, including naturalness (aquatic and catchment), diversity and richness, threatened species/ecosystems, priority species/ecosystem, special features, connectivity and representativeness to provide aquatic conservation assessments for SEQ (DEHP, 2015).	The Project is located within the SEQ BPA area, (DEHP, 2016b). The following reports outline the BPAs conducted within the ecology study area: ▸ Biodiversity Planning Assessment for the SEQ Bioregion: Fauna Expert Panel Report (Version 4.1) (DEHP, 2016c) ▸ Biodiversity Planning Assessment for the SEQ Bioregion: Flora Expert Panel Report (Version 4.1) (DEHP, 2016d) ▸ Biodiversity Planning Assessment for the SEQ Bioregion: Landscape Expert Panel Report (Version 4.1) (DEHP, 2016e) The ecology study area is located within the Bremer and Logan Aquatic Conservation Assessment catchments (as part of the wider SEQ catchment) and outlined within the following report: ▸ Aquatic Conservation Assessment using AquaBAMM for the riverine and non-riverine wetland of SEQ (DEHP, 2015).

11.5 Methodology

11.5.1 Ecological values and receptors

A receptor is a feature, area or structure that may be affected by direct or indirect changes to the environment. Impact assessment associated with this chapter specifically focuses on sensitive environmental receptors that were identified through reviewing existing literature and previous studies relevant to the ecology study area and refined through field investigations and modelling where applicable. Sensitive environmental receptors include:

MNES

- EPBC Act listed TECs
- EPBC Act listed (including species listed under the NC Act) threatened species and their associated habitat
- EPBC Act listed migratory species and their associated habitat

MSES

- Protected areas (e.g. National Parks, Nature Refuges, Coordinated Conservation Areas, Conservation Parks and Resource Reserves)
  - NC Act listed threatened species and their associated habitat
  - NC Act listed Special Least Concern (SLC) species and their associated habitat
  - Regulated vegetations, including regional ecosystems and high value regrowth and
  - Wildlife habitat and essential habitat
  - High ecological significance wetlands and high ecological value waters
  - Strategic environmental areas (not present)
  - Fish habitat areas (not present)
  - Legally secured offsets included in the 'offsets register' (not present).

Other matters

- NC Act listed near-threatened and least concern species and their associated habitat Priority Back on Track flora and fauna species
- Significant wetlands (i.e. International, national and State)
- Connectivity areas
- State significant ecological constraints (i.e. BPA)
- Matters of Local environmental significance (MLES).

In instances where conservation significant species (i.e. species listed as threatened, near-threatened, migratory and SLC under the EPBC Act and/or the NC Act) did not have potential habitat within the ecology study area, these species were not subject to impact assessment. They were not considered to be sensitive environmental receptors for the purpose of the impact assessment process as the risk of impacts to these sensitive environmental receptors is considered low.

Further detail related to the identification of sensitive environmental receptors is provided within Appendix I: Terrestrial and Aquatic Ecology Technical Report and Appendix J: Matters of National Environmental Significance Technical Report.

11.5.2 Review of existing literature and previous studies

11.5.2.1 Overview

In addition to a review of publicly available databases, an analysis of existing ecological field data associated with the ecology study area was undertaken. A total of six ecological assessment reports were identified (refer Table 11.3), which presented ecological values of the ecology study area (i.e. located within the broader study area), including species diversity, abundance and seasonal distribution (Appendix I: Terrestrial and Aquatic Ecology Technical Report and Appendix J: Matters of National Environmental Significance Technical Report). In addition to the reports identified in Table 11.3, site-specific database queries as identified in Table 11.4 have been accessed to produce the predictive habitat mapping related to threatened flora and fauna (refer Section 11.5.3). This incorporates multi-seasonal datasets that span multiple years and adequately accounts for seasonal variation and detectability related to threatened species.

The findings of each of the studies (as outlined in Table 11.3), were incorporated into the current EIS documentation where applicable and were used to inform the terrestrial and aquatic ecological impact assessment in relation to sensitive environmental receptors associated with the Project.

TABLE 11.3: PROJECT-RELATED ASSESSMENTS AND REPORTS

Document title	Reference	Summary of significant findings related to sensitive environmental receptors
Southern Freight Rail Corridor Study (March 2010) (C2K Project study area adjacent to east of Project)	AECOM, 2010	Provides details on the Southern Freight Rail Corridor. This includes information related to: ▸ Confirmation of the presence of the Swamp Tea-tree (*Melaleuca irbyana*) Forest of SEQ threatened ecological community (TEC) located immediately east of MNES study area ▸ Observations of Koala (*Phascolarctos cinereus*) located immediately east of MNES study area—anecdotally known to occur throughout the study area from community consultation feedback.

Australian Rail Track Corporation/Transport—Land/southwest of Ipswich/Queensland/Inland Rail Helidon to Calvert Project (EPBC referral 2017/7883)	ARTC, 2017a	▸ Provides initial details on how the project is likely to impact upon MNES. This includes identification of potential habitat for 15 threatened species and five migratory species. Potential for significant residual impacts to Koala (*Phascolarctos cinereus*) predicted.
		▸ Observations of Koala (*Phascolarctos cinereus*) presence (scats)—eight distinct locations along the alignment
		▸ Identified the likely presence of the following migratory species:
		  ▸ Fork-tailed Swift (*Apus pacificus*)
		  ▸ Marsh Sandpiper (*Tringa stagnatilis*)

Initial Advice Statement: Inland Rail, Helidon to Calvert—15 February 2017.	ARTC, 2017b	▸ Provides initial details on how the project is likely to impact upon MNES and MSES. This includes identification of the potential presence of 15 threatened species.
Inland Rail—Gowrie to Kagaru **Geotechnical investigations. MNES assessment report—23 July 2018** **Biodiversity Management Plan—31 October 2018**	EMM Consulting Pty Ltd (EMM) 2018a,b	▸ Observations of Koala (*Phascolarctos cinereus*) presence throughout alignment (scats and scratches) ▸ Confirmation of the presence of Lloyd's Olive (*Notelaea lloydii*) near Laidley
Inland Rail—Gowrie to Kagaru **Geotechnical investigations. Protected plant survey reports (2018 and 2019)** **Preclearance survey reports (2018 and 2019)**	EMM 2018c,d; EMM 2019a,b	▸ No MNES observed
Inland Rail—Helidon to Calvert **Geotechnical investigations. Protected plant survey report—29 May 2019** **Preclearance survey report (30 July 2019)**	Eco Logical Australia (ELA) 2019a,b	▸ Identification of a single Swamp Tea-tree (*Melaleuca irbyana)*

11.5.2.3 Data source review

Prior to field investigations, a desktop analysis of publicly available, verified datasets was undertaken to identify terrestrial and aquatic ecological receptors potentially occurring within the ecology study area. Details of the relevant database sources, search dates, search area parameters and type of information considered for the desktop study are summarised in Table 11.4.

TABLE 11.4: DATABASE AND DOCUMENT REVIEW SUMMARY

Database/data source name	Database search date	Database search areas	Data type
Atlas of Living Australia (Atlas of Living Australia (AoLA), 2020)	29/03/2020	Ecology study area	Ongoing inspection of records of flora and fauna, including threatened species listed under the EPBC Act.
Flying Fox Monitoring Program (Queensland Government, 2020a)	24/03/2020	Ecology study area	Shows the location of flying-fox roosts in Queensland recorded by DES and include monitoring data of 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: (DEHP, 2016f)	04/03/2020	Ecology study area	Shows the general location of flying-fox roosts in Queensland recorded by DES and include continuously and periodically (seasonally or irregularly) used roosts. The exact location of roosts may vary within a small localised area.
Birds Australia (2019)	29/03/2019	Ecology study area	Records of avian fauna, including threatened and migratory species listed under the EPBC Act.
BPA mapping (Queensland Government, 2020b)	17/3/2020	Ecology study area	State, regional (MSES) and locally (MLES) significant biodiversity matters mapping. This mapping has been used to indicate the location of bioregional corridors (i.e. in the State, regional and local context). This mapping has also been used in the predictive modelling to identify core habitat areas (refer Section 11.5.3).
Back on Track species prioritisation framework (DERM, 2010c)	17/3/2020	SEQ NRM	The Back on Track species are categorised as critical, high, medium, or low priority for the State and for each NRM region in Queensland. There is also a 'data deficient' category according to three sets of criteria: probability of extinction, consequences of extinction and potential for successful recovery.
EPBC Act Protected Matters Search Tool (DAWE, 2020b)	17/03/2020	Ecology study area	Provides a 'predictive' account of MNES identified within a specific area. Includes MNES such as world heritage properties, national heritage places or wetlands of international importance and threatened/migratory species.
Groundwater Dependent Ecosystems Atlas (BoM, 2020)	17/3/2020	Ecology study area	Provides information related to 3 types of groundwater dependent ecosystems (GDEs): aquatic, terrestrial and subterranean.
Regulated Vegetation Management (RVM) Map (Queensland Government, 2020c)	04/03/2020	Ecology study area	Mapping of REs and HVR that provide habitat for TECs and threatened species under the EPBC Act.
Register of critical habitat (Australian Government, 2018b)	17/3/2020	Australian extent	Critical habitat listed under the EPBC Act.
Map of Referable Wetlands (Queensland Government, 2020d)	17/3/2020	Regional extent	Includes State significant wetlands, referable wetlands, important wetlands in the Great Barrier Reef catchments and wetland REs.

Database/data source name	Database search date	Database search areas	Data type
Wetland Info database (DES, 2020)	04/03/2020	Ecology study area	Provides interactive maps, species records, case studies and legislation associated with Queensland wetlands.
Fish Habitat Areas (Queensland Government, 2020e)	17/3/2020	Ecology study area	Boundaries of gazetted, declared fish habitat areas.
MSES Wildlife Habitat Map (Queensland Government, 2020f)	17/03/2020	Ecology study area	Modelled habitat for threatened species listed under the EPBC Act.
WildNet database (Queensland Government, 2020g) incorporating WildNet and Herbrecs datasets	17/03/2020	Ecology study area	Records of flora and vertebrate fauna including threatened species listed under the EPBC Act.
Queensland waterways for waterway barrier works (Queensland Government, 2020h)	17/3/2020	Ecology study area	Waterways where proposed waterway barrier works require assessment and approval under the Fisheries Act.
Watercourse Identification Mapping (Queensland Government, 2020i)	17/3/2020	Ecology study area	Known extent of watercourses and drainage features that are managed under the Water Act.
Queensland Springs Database (Queensland Government, 2020j)	04/03/2020	Regional extent	The dataset provides a comprehensive catalogue of permanently saturated springs that have fixed locations and any associated surface expression GDEs.
Matters of State Environmental Significance (Queensland Government, 2020k)	17/3/2020	Ecology study area	Location of MSES including: ▸ Protected areas ▸ Marine parks ▸ Management A and Management B declared FHAs ▸ Threatened and special least concern wildlife listed under the NC Act ▸ Regulated vegetation under the VM Act ▸ Wetlands in a wetland protection area or wetlands of high ecological significance ▸ Wetlands and watercourses in high ecological value waters as defined in the Environmental Protection (Water) Policy 2009 (EPP Water), Schedule 2 ▸ Legally secured offset areas.

11.5.3 Predictive habitat modelling

Following a review of government databases and existing ecological field data and investigations, predictive habitat modelling was developed for conservation significant flora and fauna species and communities identified as possibly occurring within the ecology study area. The predictive habitat modelling was used to identify and map areas considered to have potential to provide habitat for conservation-significant species (i.e. flora, fauna) based on their conservation listing advice, recovery programs, referral guidelines and peer-reviewed literature.

The predictive habitat modelling for each species used a range of existing, publicly available GIS datasets simultaneously to create a specific habitat layer for each of the species and communities identified as potentially occurring within the ecology study area. The habitat categories applied to MNES species were 'potential habitat', 'important habitat' and 'habitat critical to the survival of the species', whereas for species listed only under the provisions of the NC Act (i.e. MSES species), habitat categories consisted of 'general habitat', 'essential habitat' and 'core habitat' to align with significant impact assessment criteria as stipulated under the EPBC Act and the NC Act.

These habitat categories are defined Sections 11.5.3.2–11.5.3.6. Further information related to the specific assumptions used to model habitat for each individual species is provided in Appendix I: Terrestrial and Aquatic Ecology Technical Report and Appendix J: Matters of National Environmental Significance Technical Report.

11.5.3.1 General habitat

General 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 essential/core habitat (i.e. records of the species are considered anomalies as general microhabitat features are not considered to be present from a desktop perspective). General 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. General habitat may include areas of suboptimal habitat for a species.

11.5.3.2 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 from a desktop perspective). 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. Potential habitat may include areas of suboptimal habitat for species. Impacts to potential habitat are not considered to contribute to a significant impact on 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 has 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*.

11.5.3.3 Essential habitat (non-VM Act)

Essential habitat consists of areas containing resources that are considered essential for the maintenance of populations of the species (e.g. potential habitat for breeding, roosting, foraging, shelter) or areas that have been confirmed as containing suitable habitat as identified by a specimen-backed record or indirect evidence of the species (i.e. scat, trace, track, fur/feather, distinctive vocalisation or other site-based evidence). Essential habitat has been defined from known location-specific records (i.e. low location error information and from within the last 30 years), with a 1 kilometre (km) buffer or site-based observation of the species during site investigations.

In addition, if the 1 km buffer from the known record intersects an area identified as general habitat, the general habitat rating was elevated to essential habitat.

11.5.3.4 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 (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).

In addition, important habitat has been identified for migratory species under the Draft Referral Guideline for 14 birds listed as migratory species under the EPBC Act. Impacts to important habitat are considered to contribute towards significant residual impacts to an MNES.

11.5.3.5 Core habitat

Core habitat consists of essential habitat in which the species is known, and the habitat is recognised under relevant recovery plans or other relevant plans/policies/regulations. Where essential habitat intersects with areas identified as important within the relevant bioregion specific BPA, these areas have been elevated to the core habitat category.

11.5.3.6 Habitat critical to the survival of the species

Habitat critical to the survival of the species represents habitat with the greatest value for the particular MNES species. This habitat category identifies areas that align with 'habitat critical to the survival' of a listed threatened species is identified in an approved Recovery Plan for the relevant MNES species. However, in instances where there are no Recovery Plans for a specific species, 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. Impacts to habitat critical to the survival of the species are considered to contribute towards significant residual impacts to an MNES.

11.5.4 Field methodology

11.5.4.1 Terrestrial ecology

Following the formulation of the predictive habitat models, field-based assessments were used to validate modelled habitat. The validation process involved an assessment by experienced field ecologists including the ground-truthing of vegetation communities and abiotic factors, followed by a determination of habitat suitability for the relevant threatened species and/or communities. In addition, field-based investigations were undertaken to identify baseline conditions to inform the reference design stage of the Project and to inform constraints assessment process of the Project.

At each terrestrial sampling location, a vegetation survey, a fauna habitat assessment, active searches for cryptic fauna and opportunistic observations were undertaken as a minimum. Opportunistic site investigations associated with pre-clearance work for geotechnical investigations were used to supplement the desktop-based datasets and validate predictive, species-specific mapping. Surveys undertaken at opportunistic survey locations were in accordance with the methodology prescribed in the *Flora Survey Guidelines—Protected Plants* (DEHP, 2016g).

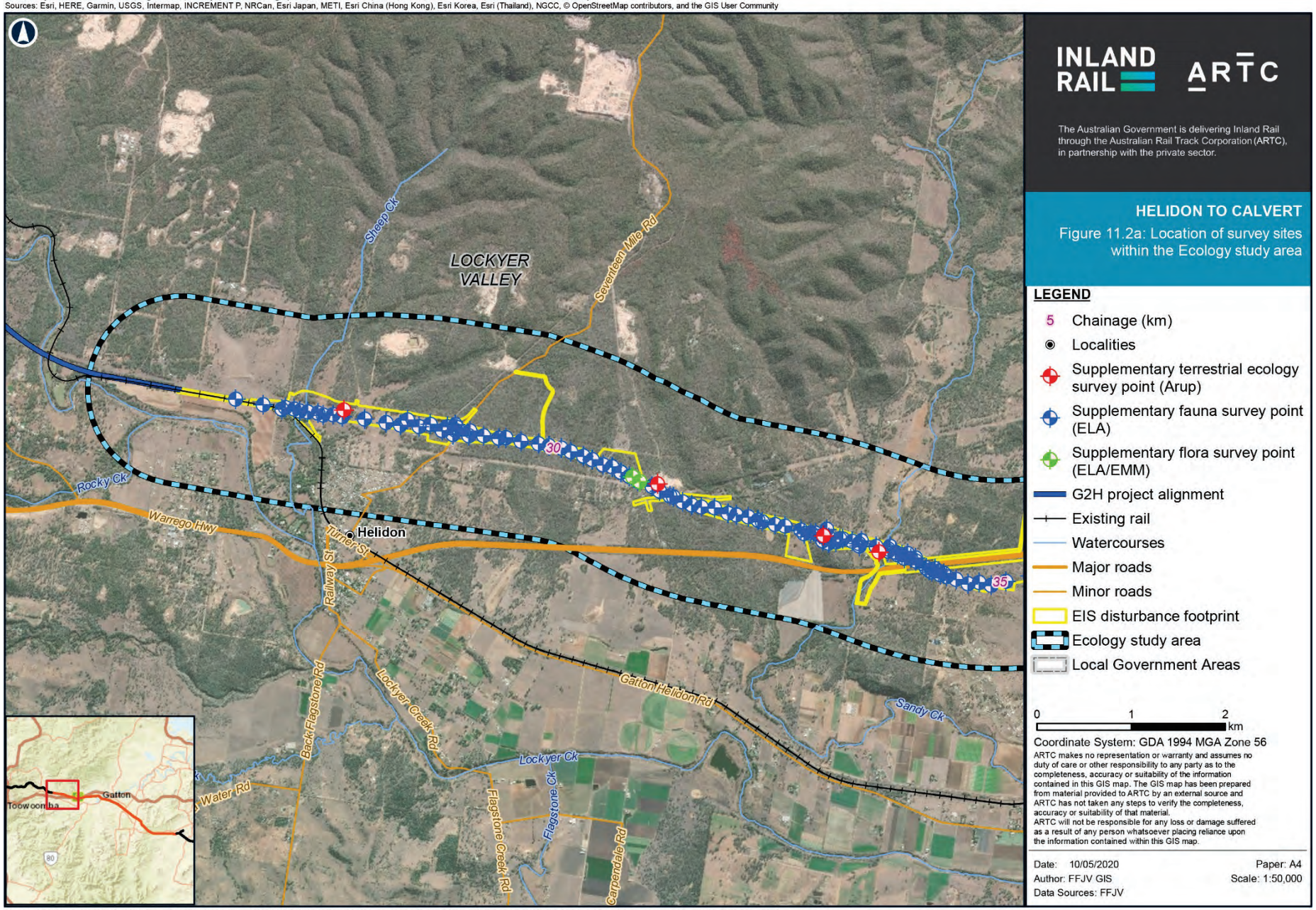
Field-based surveys associated with the Project EIS complemented historic and concurrent investigations conducted by Arup/SMEC (2016) as well as ELA and EMM (2018 and 2019) (refer Table 11.5 and Figure 11.2a and Figure 11.2e). Note that there is overlap in the location of surveys undertaken for programs presented in refer Table 11.5 and those undertaken as part of targeted investigations associated with the Project EIS. Data derived from surveys presented in Table 11.5 was incorporated into the current EIS documentation, where applicable.

Project EIS field investigations were undertaken over a nine-consecutive day period during spring, between 11 September 2017 and 19 September 2017 (refer Figure 11.3). Opportunistic site investigations associated with pre-clearance work for geotechnical investigations were used to supplement the desktop-based datasets and validate predictive, species-specific mapping. Surveys undertaken at opportunistic survey locations were in accordance with the methodology prescribed in the *Flora Survey Guidelines—Protected Plants* (DEHP, 2016g).

TABLE 11.5: 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
Initial ecological assessment to support EPBC referral 2017-7883	Arup/SMEC 2016	30 March to 1 April and 1 June 2016	Autumn, Winter (2016)	▸ Targeted Koala habitat searches—8 sites ▸ Protected plant surveys ▸ Fauna habitat assessments—16 sites
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 2019a, 2019b	16 May 2018–28 June 2018	Autumn, Winter (2018)	▸ Protected plant surveys within/adjacent to alignment (meander surveys—minimum 30 minutes) at 15 sites throughout 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 2018c, 2018d	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 137 sites throughout alignment

Study/investigation	Consultant (year)	Timing of investigations	Season	Methodologies and notes
Protected plant surveys associated with geotechnical investigations for the **H2C alignment**	ELA 2019a	December 2018 and February 2019	Summer/Autumn (2018/2019)	▸ Protected plant surveys within/adjacent to alignment (meander surveys – minimum 30 minutes) at 11 sites throughout alignment (covering 24.72 ha)
Pre-clearing surveys associated with geotechnical investigations for the **H2C alignment**	ELA 2019b	December 2018 and 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 269 sites and additional access tracks throughout the ecology study area


Service Layer Credits: Source: Esri, DigitalGlobe, 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, © OpenStreetMap contributors, and the GIS User Community
LOCKYER VALLEY
Sheep Ck
Seventeen Mile Rd
Rocky Ck
Warrego Hwy
Helidon
Turner St
Railway St
Back Flagstone Rd
Lockyer Creek Rd
Gatton Helidon Rd
Sandy Ck
Lockyer Ck
Flagstone Ck
Flagstone Creek Rd
Carpendale Rd
Water Rd
30
35
Toowoomba
Gatton
80
INLAND RAIL
ARTC
The Australian Government is delivering Inland Rail through the Australian Rail Track Corporation (ARTC), in partnership with the private sector.
HELIDON TO CALVERT
Figure 11.2a: Location of survey sites within the Ecology study area
LEGEND
5 Chainage (km)
Localities
Supplementary terrestrial ecology survey point (Arup)
Supplementary fauna survey point (ELA)
Supplementary flora survey point (ELA/EMM)
G2H project alignment
Existing rail
Watercourses
Major roads
Minor roads
EIS disturbance footprint
Ecology study area
Local Government Areas
0 1 2 km
Coordinate System: GDA 1994 MGA Zone 56
ARTC makes no representation or warranty and assumes no duty of care or other responsibility to any party as to the completeness, accuracy or suitability of the information contained in this GIS map. The GIS map has been prepared from material provided to ARTC by an external source and ARTC has not taken any steps to verify the completeness, accuracy or suitability of that material.
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Paper: A4
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Map by: DTH/MEF/LCT/GN/AD Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201906101333_Ecology_figures_and_calcs\330-EAP-201906101333_ARTC_Fig11.2_Location_historic_concurrent.mxd Date: 10/05/2020 12:26

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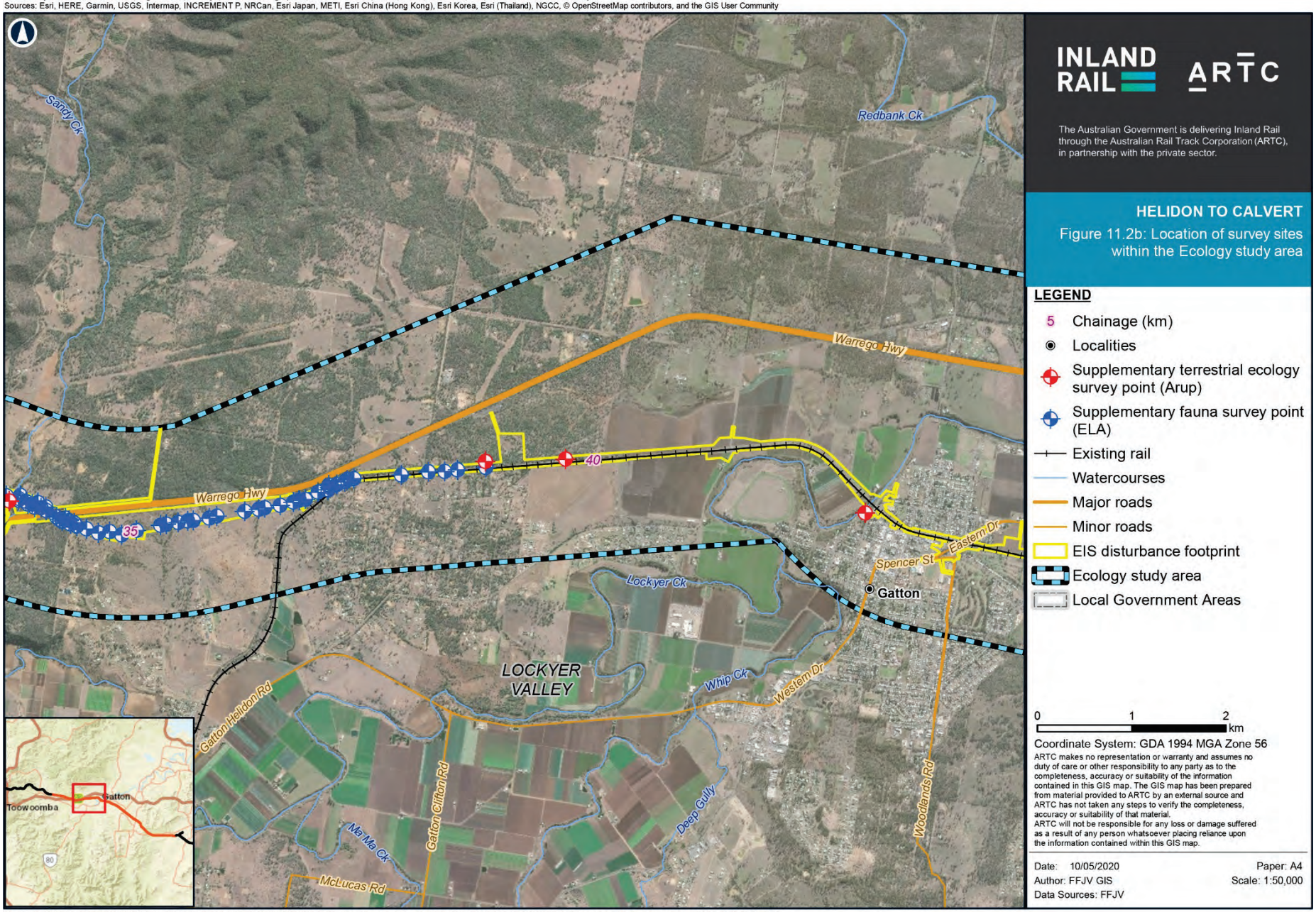

INLAND RAIL ARTC

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

HELIDON TO CALVERT

Figure 11.2b: Location of survey sites within the Ecology study area

LEGEND

- 5 Chainage (km)
- Localities
- Supplementary terrestrial ecology survey point (Arup)
- Supplementary fauna survey point (ELA)
- Existing rail
- Watercourses
- Major roads
- Minor roads
- EIS disturbance footprint
- Ecology study area
- Local Government Areas

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56

Date: 10/05/2020 Paper: A4
Author: FFJV GIS Scale: 1:50,000
Data Sources: FFJV

Map by: DTH/MEF/LCT/GN/AD Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201906101333_Ecology_figures_and_calcs\330-EAP-201906101333_ARTC_Fig11.2_Location_historic_concurrent.mxd Date: 10/05/2020 12:26

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Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, © OpenStreetMap contributors, and the GIS User Community

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HELIDON TO CALVERT

Figure 11.2c: Location of survey sites within the Ecology study area

LEGEND

- 5 Chainage (km)
- Localities
- Supplementary terrestrial ecology survey point (Arup)
- Supplementary fauna survey point (ELA)
- Existing rail
- Watercourses
- Major roads
- Minor roads
- EIS disturbance footprint
- Ecology study area
- Local Government Areas

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56

Date: 10/05/2020 Paper: A4
Author: FFJV GIS Scale: 1:50,000
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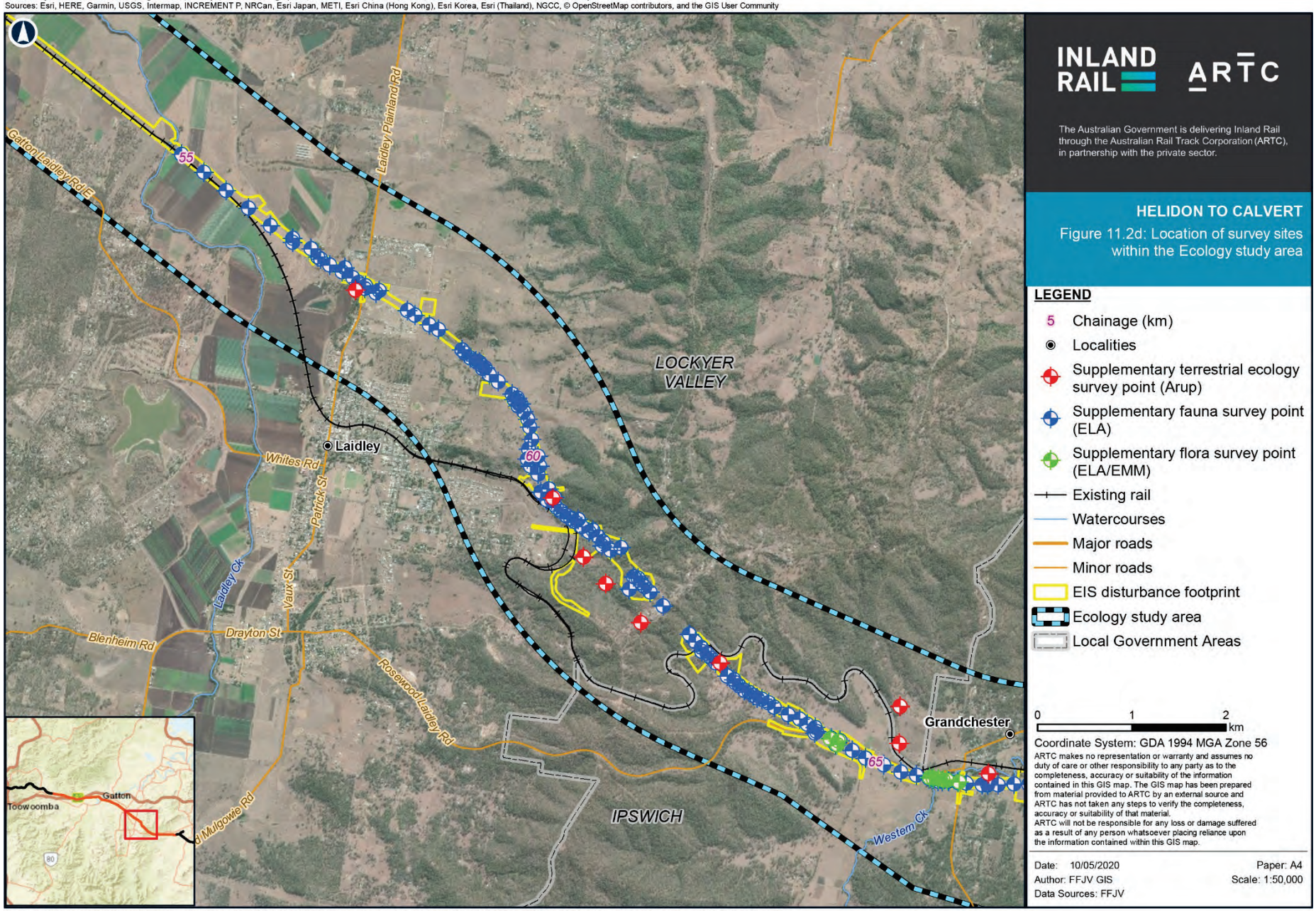
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Patrick St
Vaux St
Laidley Ck
Drayton St
Blenheim Rd
Rosewood Laidley Rd
Mulgowie Rd
IPSWICH
Western Ck
Grandchester
Toowoomba
Gatton
80
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Figure 11.2d: Location of survey sites within the Ecology study area
LEGEND
5 Chainage (km)
Localities
Supplementary terrestrial ecology survey point (Arup)
Supplementary fauna survey point (ELA)
Supplementary flora survey point (ELA/EMM)
Existing rail
Watercourses
Major roads
Minor roads
EIS disturbance footprint
Ecology study area
Local Government Areas
0 1 2 km
Coordinate System: GDA 1994 MGA Zone 56
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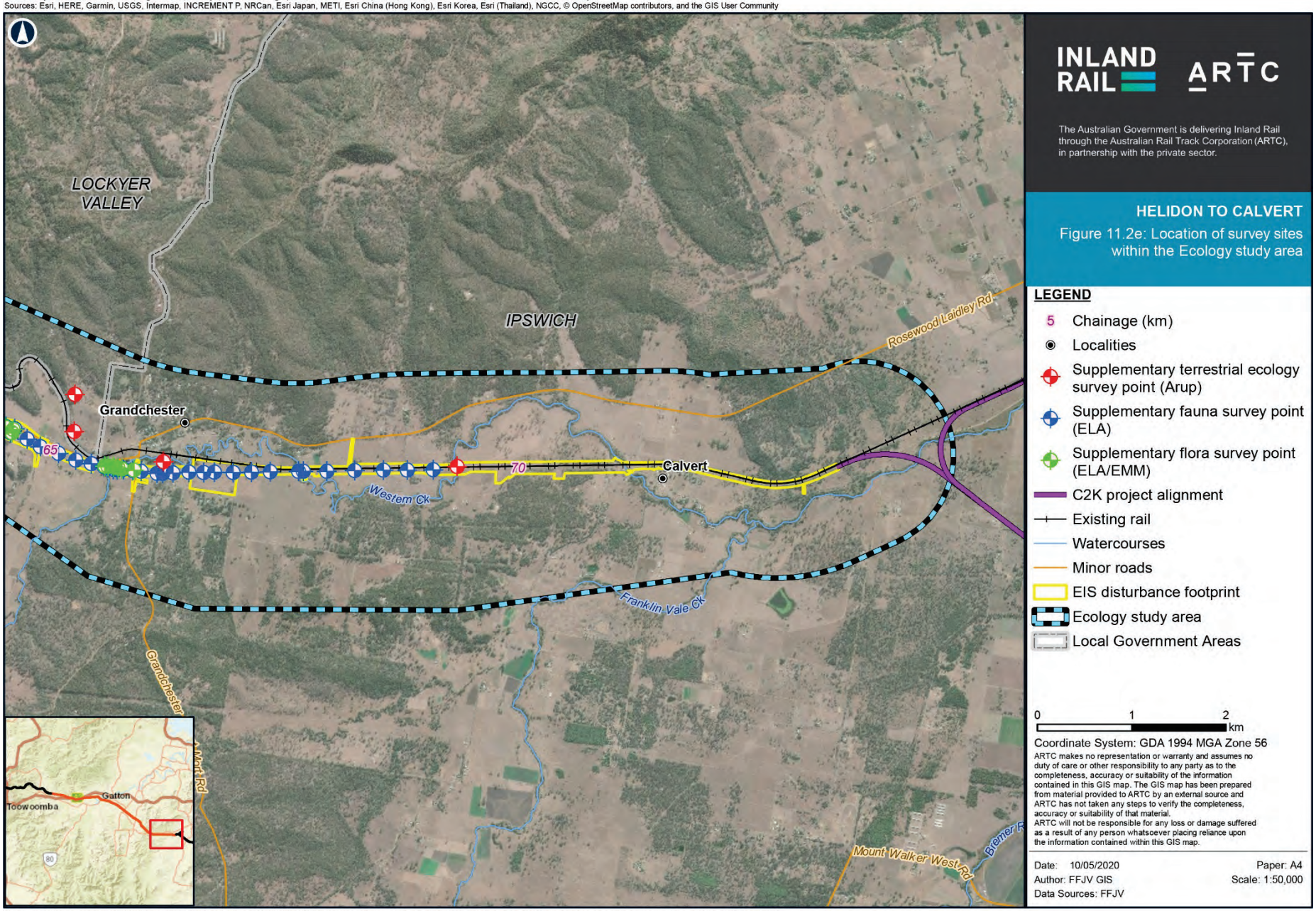

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Figure 11.2e: Location of survey sites within the Ecology study area

LEGEND

- 5 Chainage (km)
- Localities
- Supplementary terrestrial ecology survey point (Arup)
- Supplementary fauna survey point (ELA)
- Supplementary flora survey point (ELA/EMM)
- C2K project alignment
- Existing rail
- Watercourses
- Minor roads
- EIS disturbance footprint
- Ecology study area
- Local Government Areas

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56

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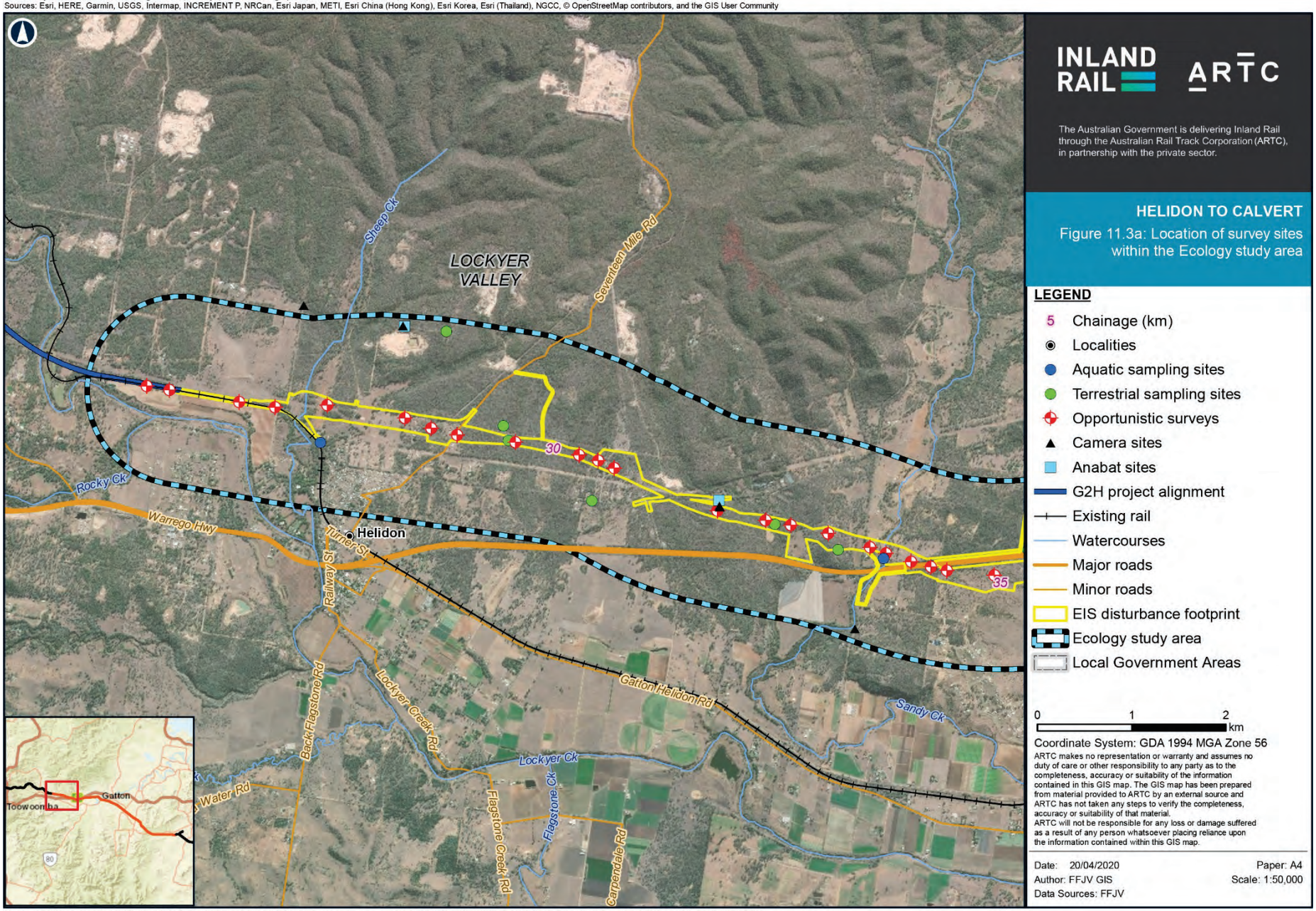

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Figure 11.3a: Location of survey sites within the Ecology study area

LEGEND

- 5 Chainage (km)
- Localities
- Aquatic sampling sites
- Terrestrial sampling sites
- Opportunistic surveys
- Camera sites
- Anabat sites
- G2H project alignment
- Existing rail
- Watercourses
- Major roads
- Minor roads
- EIS disturbance footprint
- Ecology study area
- Local Government Areas

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56

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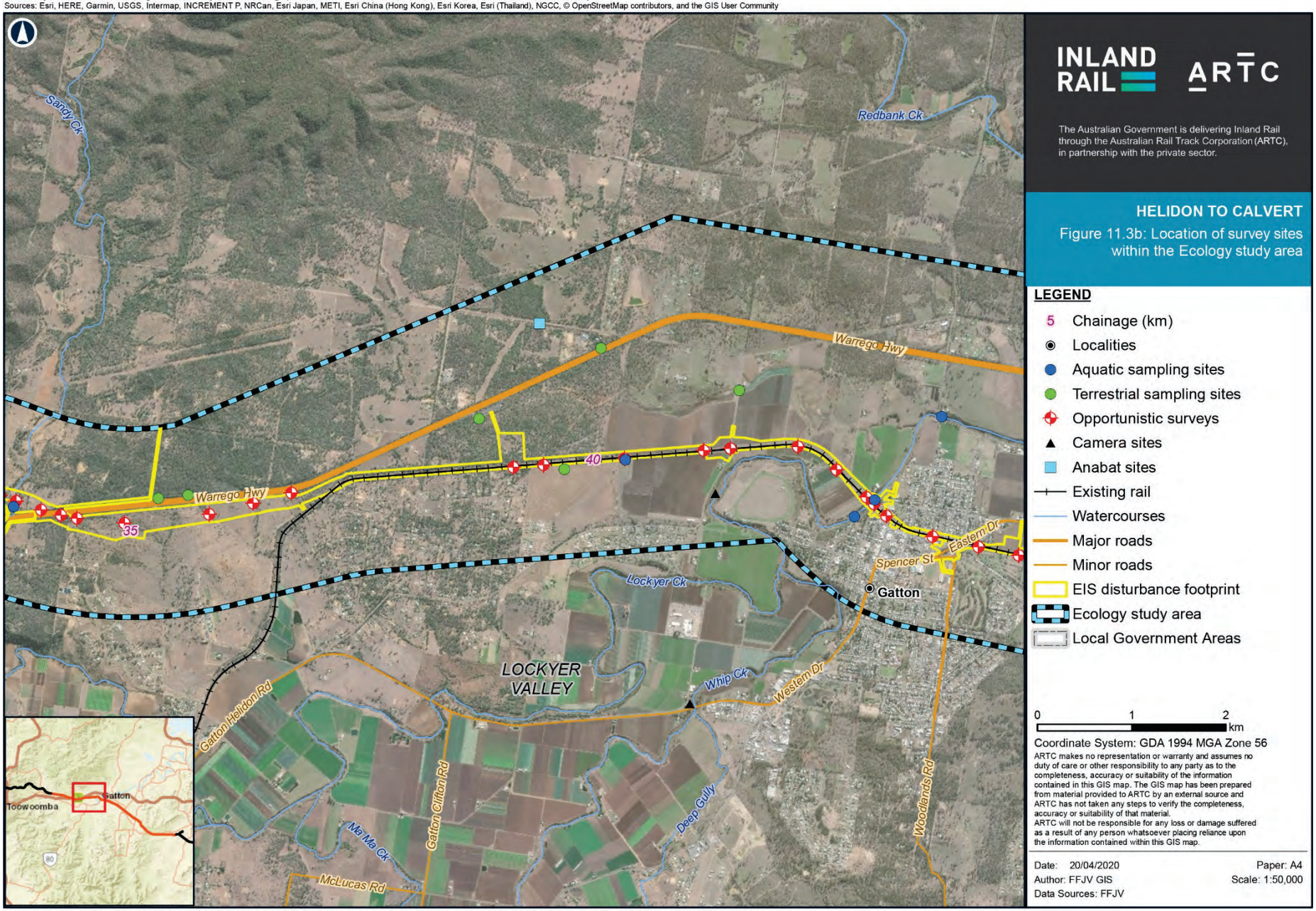

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Figure 11.3b: Location of survey sites within the Ecology study area

LEGEND

- 5 Chainage (km)
- Localities
- Aquatic sampling sites
- Terrestrial sampling sites
- Opportunistic surveys
- Camera sites
- Anabat sites
- Existing rail
- Watercourses
- Major roads
- Minor roads
- EIS disturbance footprint
- Ecology study area
- Local Government Areas

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56

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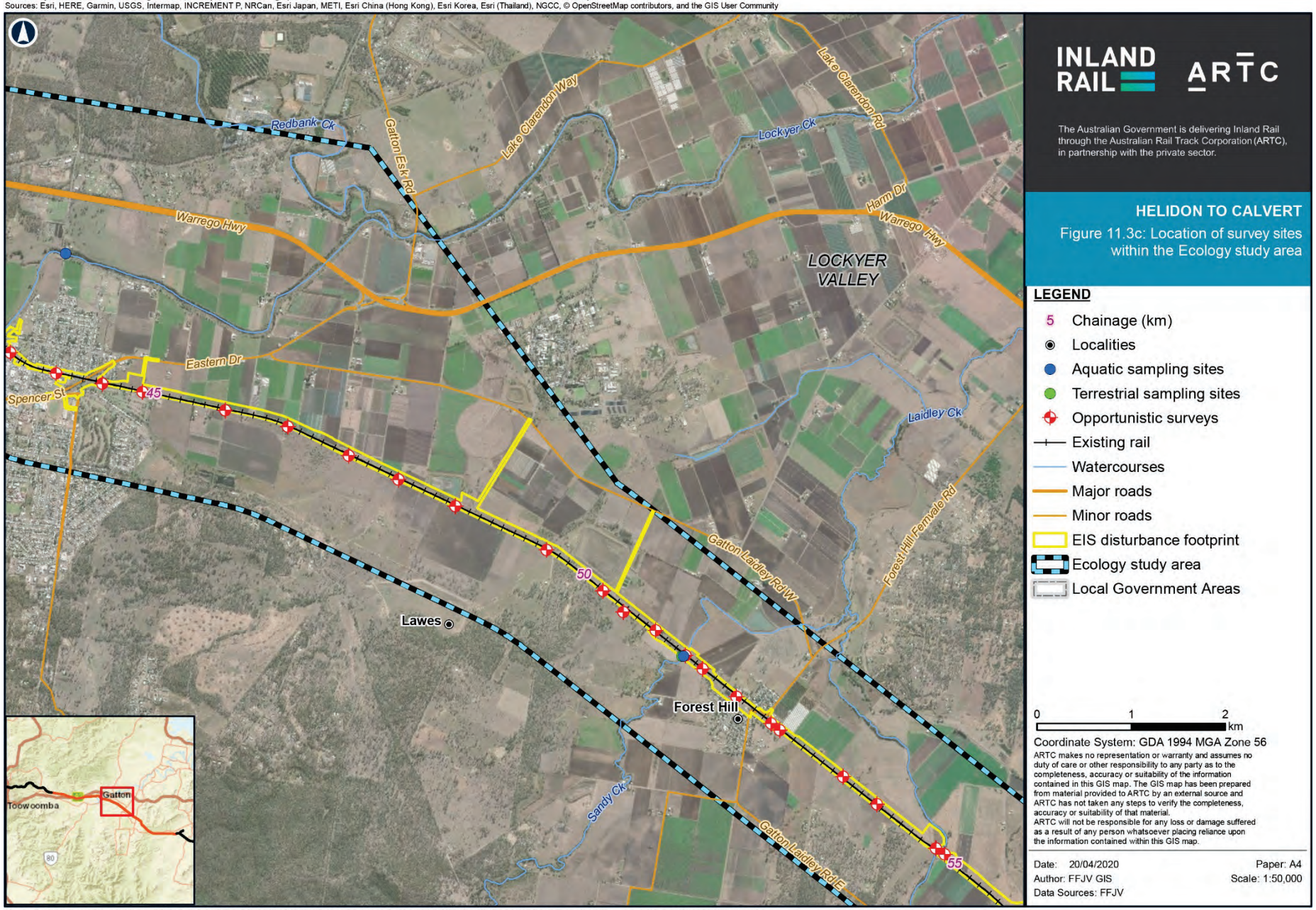

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Figure 11.3c: Location of survey sites within the Ecology study area

LEGEND

- 5 Chainage (km)
- Localities
- Aquatic sampling sites
- Terrestrial sampling sites
- Opportunistic surveys
- Existing rail
- Watercourses
- Major roads
- Minor roads
- EIS disturbance footprint
- Ecology study area
- Local Government Areas

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56

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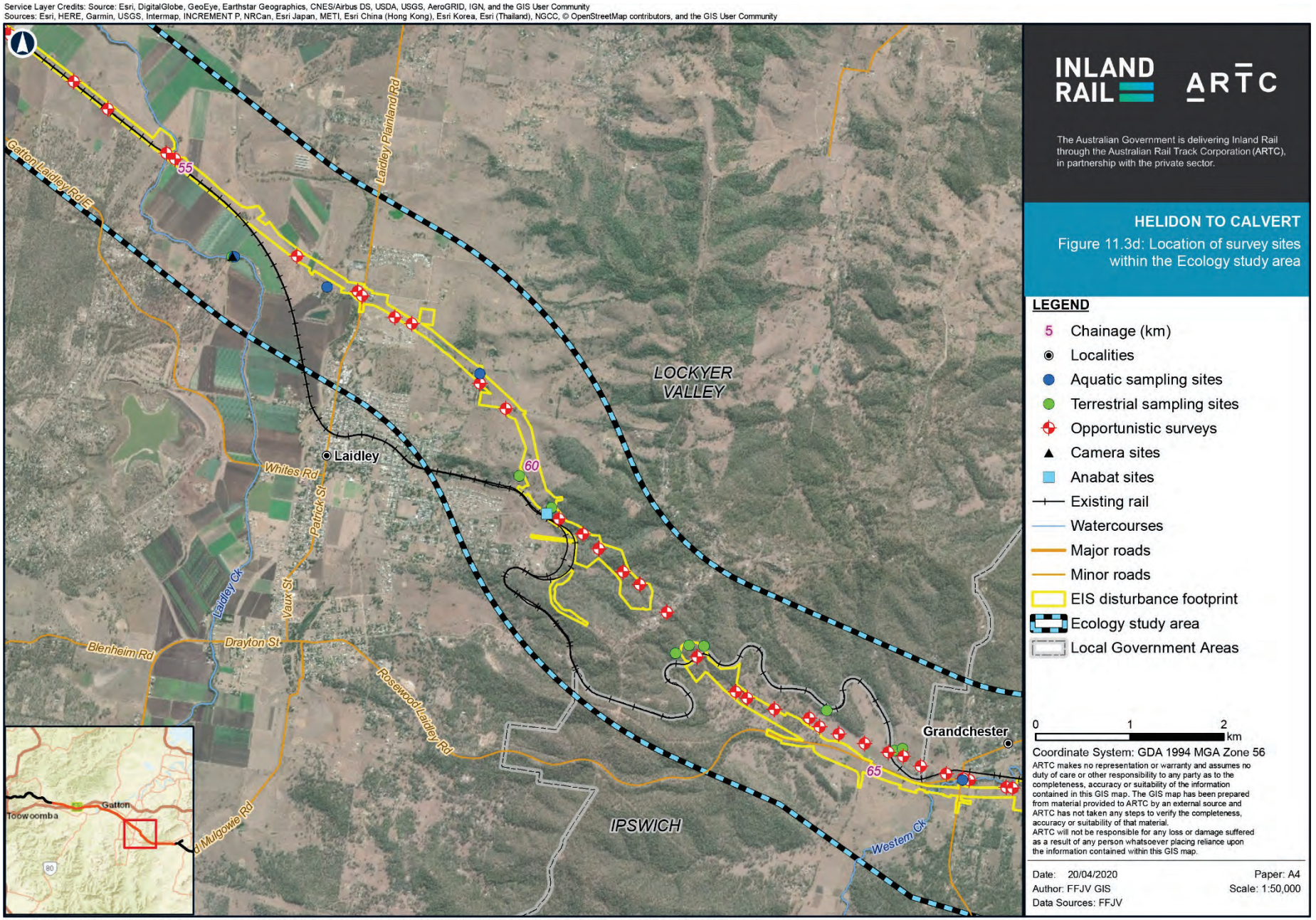

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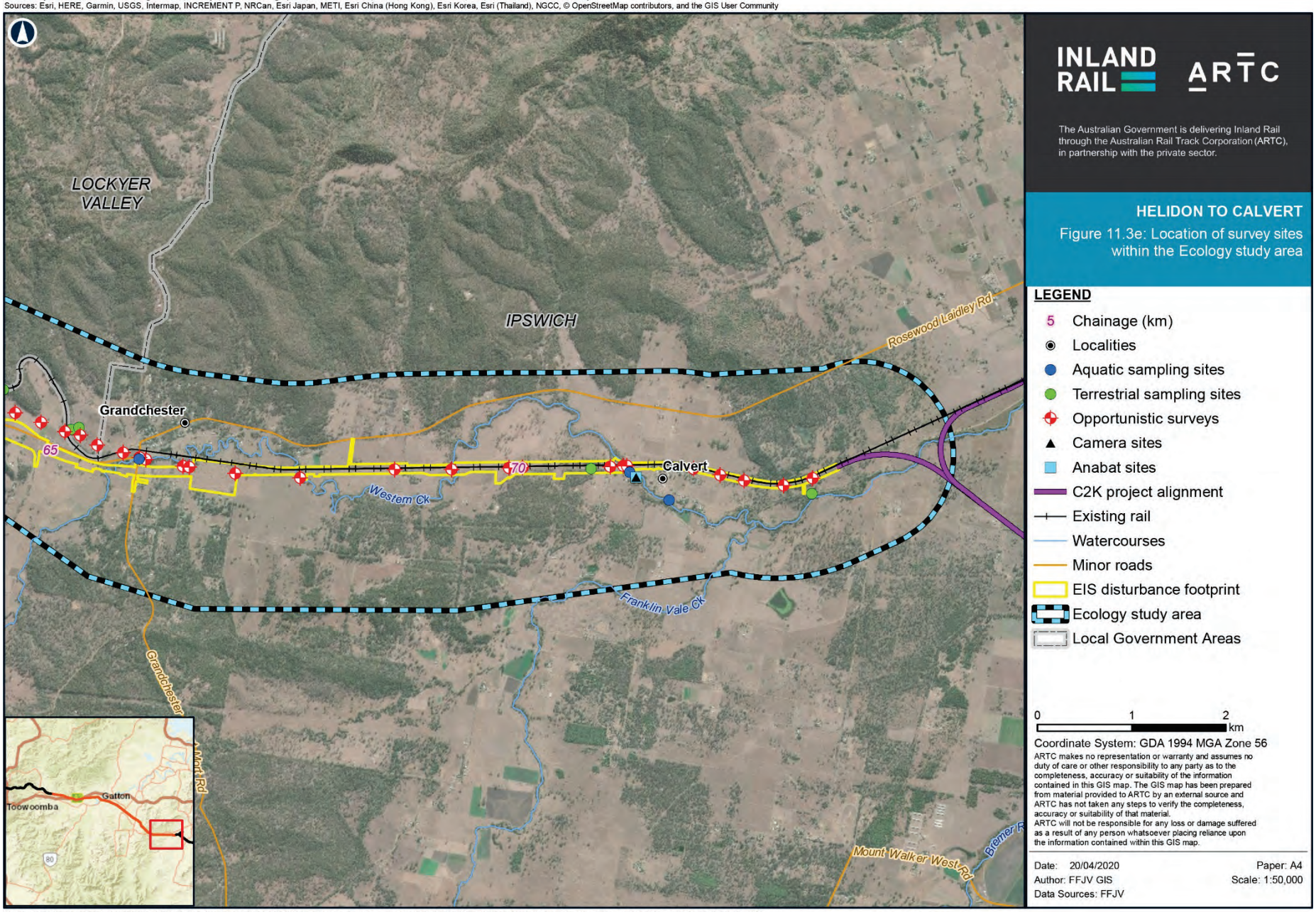

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A representative sampling approach was employed as part of the field sampling methodology. Sampling sites were specifically identified as containing features of interest. Specifically, the following features were used to target areas:

- 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 conservation significant species when viewed from aerial photography (i.e. Gilgai areas, wetlands and escarpments)
- Areas known or predicted to support conservation significant species
- Areas identified as containing or potentially containing EPBC Act listed TECs
- Waterways that will be potentially impacted by the Project
- Areas that have not been subject to previous ecological investigations.

At each location, a census of all flora, fauna, vegetation communities and habitat features (e.g. presences of hollows, leaf litter, surface rocks, soil banks, water and wetlands, and the availability of foraging resources such as flowers and fruit) was undertaken. Surveys were undertaken with reference to the following guidelines:

- Australian Government-published guidelines for threatened species where applicable (refer: **environment.gov.au/epbc/policy-statements**)
- *Methodology for survey and mapping of REs and vegetation communities in Queensland* (Neldner et al., 2017)
- *Terrestrial vertebrate fauna guidelines for Queensland* (Eyre et al., 2018)
- *Plants Flora Survey Guidelines—Protected*, NC Act (DEHP, 2016g).

Areas sampled as part of the field reconnaissance are presented in Figure 11.3a–e. Where field analysis identified sensitive environmental receptors or deviations from the predictive habitat modelling, this information was used to refine the relevant model to increase the accuracy and precision of the data to be used as part of the significance assessment associated with Project-related impacts on sensitive environmental receptors. Further details related to the field assessment methodologies is provided in Appendix I: Terrestrial and Aquatic Ecology Technical Report and Appendix J: Matters of National Environmental Significance Technical Report.

11.5.4.2 Aquatic ecology

The aquatic ecology field assessment described the environmental values of targeted drainage systems within the ecology study area. The AUSRIVAS Physical Assessment Protocol was used in the field assessment of the drainage systems. The physical habitat assessment was based on the AUSRIVAS bioassessment method which provides a protocol for the assessment of stream physical and geomorphological condition (DNRM, 2001).

As the aquatic ecology field assessment was used to determine potential habitat viability, the assessment was conducted on intersecting defined watercourses along the Project. The results were used to refine the aquatic receptors present within the ecology study area.

The AUSRIVAS Physical Assessment Protocol is a standardised rapid method for the collection of geomorphological, physical habitat and riparian data. It provides a repeatable and standard approach that allows for cumulative impacts associated with the Project to be assessed.

The key geomorphological, physical habitat and riparian data that was collected at each assessment site during October 2017, 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
- In-stream 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
- Water quality visual observations, including turbidity, water and sediment oils, water and sediment odours, algae and moss cover.

Qualitative water quality observations were supported by collection of water samples for quantitative assessments as part of the Project surface water quality investigations (refer Chapter 13: Surface water and hydrology, Chapter 14: Groundwater and Appendix I: Terrestrial and Aquatic Ecology Technical Report).

The habitat value of each aquatic ecology assessment site was assessed to describe the aquatic fauna assemblages that were considered likely to use the area. 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 baited traps and dip netting, specifically targeting vertebrate species such as fish and turtles as appropriate. Adequate habitat assessment and field data was collected to inform a likelihood of occurrence assessment for threatened aquatic species within the ecology study area.

During the aquatic ecology field investigations, data was collected with respect to any aquatic invasive species and other disturbances present within or affecting the aquatic environments.

Further details related to the field assessment methodologies is provided in Appendix I: Terrestrial and Aquatic Ecology Technical Report.

11.5.5 Impact assessment methodology

The terrestrial and aquatic impact assessment of the Project uses a significance-based impact assessment framework to identify and assess Project-related impacts in relation to sensitive environmental receptors. Several stages were involved in the assessment of Project impacts to sensitive environmental receptors, which included identifying sensitive environmental receptors, defining their 'sensitivity' rating, identifying potential impacts resulting from the Project and identification of the 'magnitude' of impacts to the sensitive environmental receptor (i.e. extent of area impact).

For the purpose of impact assessment, terrestrial and aquatic ecology sensitive environmental receptors were assessed both quantitatively and qualitatively. A significant impact depends on the 'sensitivity' of a sensitive environmental receptor, the quality of the environment that is impacted, and on the 'magnitude' of the potential impacts. Determination of the 'sensitivity' or vulnerability of the sensitive environmental receptor and the 'magnitude' of the potential impacts facilitate the assessment of the significance of potential ecological impacts.

The use of predictive habitat models facilitated the quantification of potential impacts to which initial mitigation measures were then applied. Reassessment of Project-related impacts accounting for the implementation of Project mitigation measures then identified instances where potentially significant impacts as a result of the Project to sensitive environmental receptors may occur.

Where potentially significant impacts following Project mitigation measures were identified, these sensitive environmental receptors were then subject to significant impact assessment using the relevant significant impact guidelines to inform potential offset requirements.

For MNES, the significant impact criteria is outlined in the *Matters of National Environmental Significance Significant impact guidelines 1.1* (*Environment Protection and Biodiversity Conservation Act 1999*) (DotE, 2013); *EPBC Act Referral Guidelines for the vulnerable koala (combined populations of Queensland, New South Wales and the Australian Capital Territory)* (DotE, 2014), and the *Draft referral guidelines for 14 birds listed as migratory species under the EPBC Act* (DAWE, 2020a).

For MSES, the significant impact criteria are outlined in the *Queensland Environmental Offsets Policy Significant Residual Impact Guidelines* (DSDIP, 2014b).

Further details related to the impact assessment is provided in Appendix I: Terrestrial and Aquatic Ecology Technical Report and Appendix J: Matters of National Environmental Significance Technical Report.

11.5.6 Stakeholder engagement

Flora, fauna and habitat matters have been raised regularly by stakeholders and the community in discussions, meetings and correspondence with the Project team. These include:

- Habitat for Koalas (*Phascolarctos cinereus*)
- Retention of Swamp Tea-tree (*Melaleuca irbyana*)
- Habitat connectivity across the corridor.

The Project team also held a workshop on how to provide species record information or data collected by community members to the Queensland Government, so it can be recorded and recognised in the Wildlife Online database. This data was subsequently used as part of the EIS investigations. 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.

11.5.7 Precautionary principle

The assessment methodology incorporates the precautionary principle, which 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.

Ecological assessments have responded to this requirement 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 then, 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
- 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 ecology 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 ecology study area.

Where impacts cannot be avoided (e.g. clearing of remnant vegetation or habitat for a threatened species), mitigation and management measures will be implemented. Where required, biodiversity offsets will be secured. A draft Environmental Offset Strategy for the Project has been prepared in consultation with the Queensland Government and Australian Government and is included in Appendix I: Terrestrial and Aquatic Ecology Technical Report and Appendix J: Matters of National Environmental Significance Technical Report.

11.5.8 Cumulative impact assessment

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 used in the cumulative impact assessment and the methodology applied in undertaking the assessment for flora and fauna (encompassing both MSES and MNES).

11.5.8.1 Project selection

Projects for inclusion in the cumulative impact assessment are all those within the Project region meeting the following criteria:

a) 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 (IAS) is publicly available

b) Are currently being assessed under Part 1 of the Chapter 3 of the Qld EP Act as per DES website

c) 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

d) Could potentially compound residual impacts that the Project may have on environmental or social values.

Table 11.6 shows 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 11.4. The projects listed in Table 11.6 include infrastructure development projects located in proximity (i.e. within a 50 km radius) to the Project. It is important to note that projects that fall into the following categories have been excluded from the cumulative impact assessment:

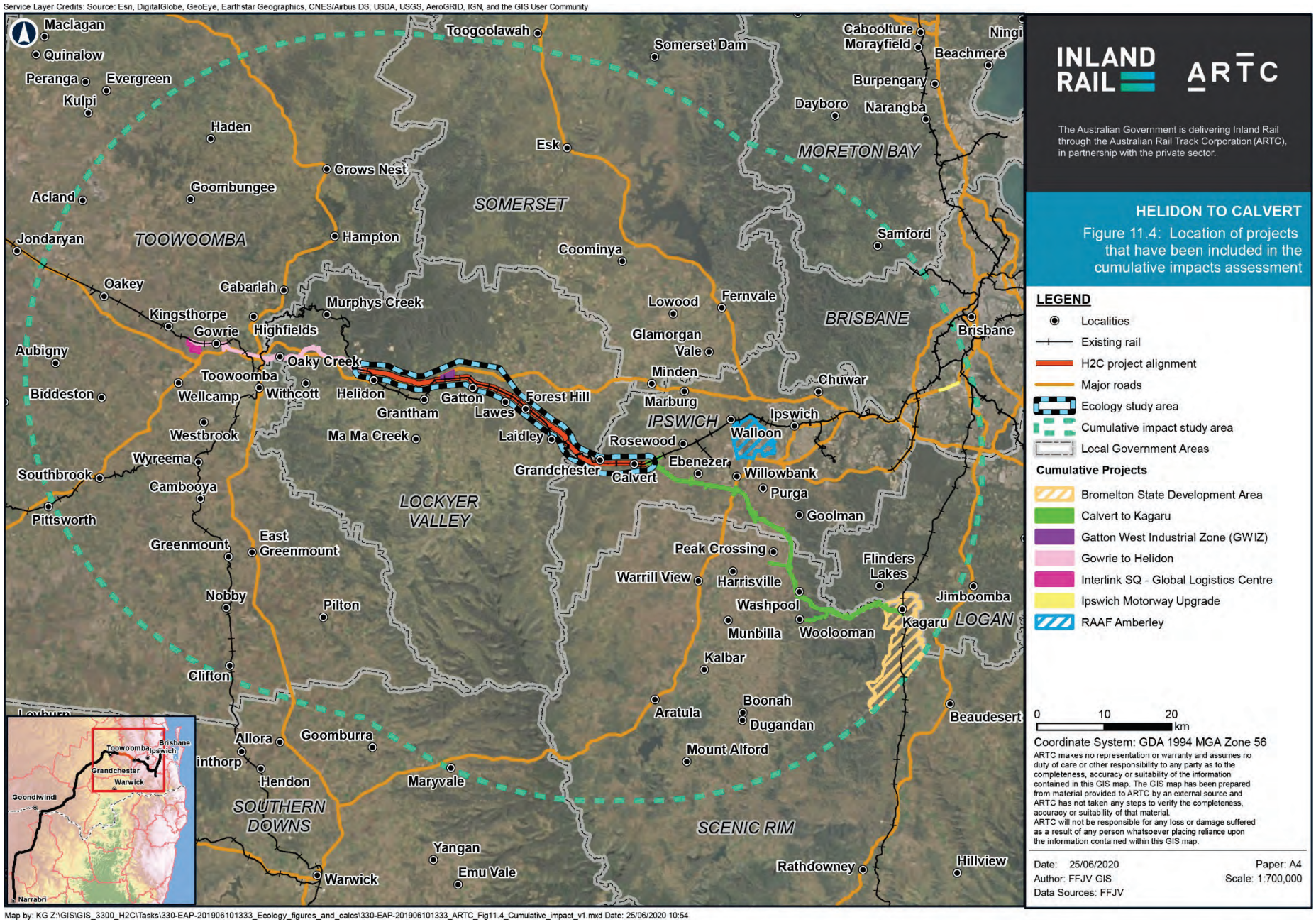
- Existing or historic projects within the Project cumulative impact area that are considered to constitute part of the baseline environment
- Projects that have not been developed to the point that their environmental assessment process has been made public.

TABLE 11.6: PROJECTS INCLUDED IN THE CUMULATIVE ASSESSMENT

Project (and proponent)	Location	Description	Source	Project status	Construction dates and jobs	Operation years and jobs	Selection criteria	Relationship to the proposal
Gowrie to Helidon (ARTC)	Rail alignment from Gowrie to Helidon	26 km single-track dual-gauge freight railway as part of Inland Rail	eisdocs.dsdip.qld.gov.au/Inland%20Rail%20Gowrie%20to%20Helidon/IAS/inlandrail-G2H-final-ias.pdf	ARTC currently preparing EIS Declared a 'controlled action' by DotEE—17/03/2017	2021– 2026 Jobs: Peak of 596 FTE, average of 264 FTE	>50 years Jobs: 20	a), b) & c)	Overlap of construction with H2C and G2H.
Calvert to Kagaru (ARTC)	Rail alignment from Calvert to Kagaru	53 km single-track dual-gauge freight railway as part of Inland Rail	eisdocs.dsdip.qld.gov.au/Inland%20Rail%20Calvert%20to%20Kagaru/IAS/initial-advice-statement.pdf	ARTC currently preparing EIS Declared a 'controlled action' by DotEE—21/06/2017	2021–2026 Jobs: Peak of 620 FTE, average of 271 FTE	>50 years Jobs: 20	a), b) & c)	Overlap of construction for H2C and C2K.
Bromelton State Development Area (SDA) (Queensland Government)	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.	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) & d)	Ongoing development at the Bromelton SDA could require deconfliction of construction resources. There may also be an increase of heavy vehicles using the surrounding highways during both construction and operation.
Ipswich Motorway Upgrade Rocklea to Darra (Stage 1 and remaining sections) (Department of Transport and Main Roads)	Western Brisbane	Addressing congestion and extensive delays in the Ipswich Motorway corridor by a range of road upgrades along 7km of Ipswich Motorway between Rocklea and Darra	infrastructureaustralia.gov.au/map/ipswich-motorway-upgrade-rocklea-darra-remaining-sections	Project listed on QLD Infrastructure Initiative List – Proponent to complete business case development (Stage 3 of Infrastructure Australia's Assessment Framework)	2016/17 to 2020-2021 Jobs: TBA	TBA Jobs: TBA	c)	Construction periods may overlap resulting in conflict in demand for construction resources and traffic volumes on highways.

Project (and proponent)	Location	Description	Source	Project status	Construction dates and jobs	Operation years and jobs	Selection criteria	Relationship to the proposal
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	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 increase in road traffic with heavy vehicles and further increase as the H2C construction occurs
Gatton West Industrial Zone (GWIZ) (Lockyer Valley Regional Council)	3 km north west Gatton	Industrial development including a transport and logistics hub on the Warrego Highway	lockyervalley.qld.gov.au/our-region/economic -and-regional-development/Documents/Economic%20and%20Development/Lockyer%20Economic%20Development%20Plan%202018%20-2023.pdf	N/A	2019 – 2024 Jobs: 13.5 FTE	- Jobs: Approximately 37	c)	May increase road traffic. Need for rail resources.
InterLinkSQ (InterLinkSQ)	13 km west of Toowoomba	200 ha of new transport, logistics and business hubs. Located on the narrow-gauge regional rail network and interstate network. Located at the junction of the Gore, Warrego and New England Highways.	interlinksq.com.au	N/A	2017 – 2037	Jobs 1,500	c)	Ongoing development could require deconfliction of construction resources. There may also be an increase of heavy vehicles using the surrounding highways

Table notes:
TBA—unavailable or yet to be advised.
Selection criteria based on the criteria outlined in Section 11.5.8.1.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Peranga
Evergreen
Kulpi
Haden
Toogoolawah
Somerset Dam
Caboolture
Morayfield
Beachmere
Ningi
Burpengary
Dayboro
Narangba
Esk
MORETON BAY
Crows Nest
Goombungee
Acland
SOMERSET
Jondaryan
TOOWOOMBA
Hampton
Coominya
Samford
Oakey
Cabarlah
Murphys Creek
Kingsthorpe
Gowrie
Highfields
Lowood
Fernvale
BRISBANE
Brisbane
Glamorgan Vale
Aubigny
Oaky Creek
Toowoomba
Minden
Chuwar
Biddeston
Wellcamp
Withcott
Helidon
Gatton
Forest Hill
Grantham
Lawes
Marburg
Ipswich
IPSWICH
Westbrook
Ma Ma Creek
Laidley
Walloon
Rosewood
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Grandchester
Calvert
Willowbank
Cambooya
Purga
LOCKYER VALLEY
Pittsworth
Goolman
East Greenmount
Greenmount
Peak Crossing
Flinders Lakes
Warrill View
Harrisville
Nobby
Pilton
Washpool
Jimboomba
Kagaru
LOGAN
Munbilla
Woolooman
Clifton
Kalbar
Aratula
Boonah
Dugandan
Beaudesert
Allora
Goomburra
Mount Alford
Inthorp
Hendon
Maryvale
SOUTHERN DOWNS
SCENIC RIM
Yangan
Emu Vale
Warwick
Rathdowney
Hillview
Toowoomba
Brisbane
Ipswich
Grandchester
Warwick
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HELIDON TO CALVERT
Figure 11.4: Location of projects that have been included in the cumulative impacts assessment
LEGEND
Localities
Existing rail
H2C project alignment
Major roads
Ecology study area
Cumulative impact study area
Local Government Areas
Cumulative Projects
Bromelton State Development Area
Calvert to Kagaru
Gatton West Industrial Zone (GWIZ)
Gowrie to Helidon
Interlink SQ - Global Logistics Centre
Ipswich Motorway Upgrade
RAAF Amberley
0 10 20 km
Coordinate System: GDA 1994 MGA Zone 56
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Date: 25/06/2020
Author: FFJV GIS
Data Sources: FFJV
Paper: A4
Scale: 1:700,000
Map by: KG Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201906101333_Ecology_figures_and_calcs\330-EAP-201906101333_ARTC_Fig11.4_Cumulative_impact_v1.mxd Date: 25/06/2020 10:54

11.5.8.2 Approach

Each of the technical chapters within the EIS has undertaken a cumulative impact assessment for the relevant environmental aspect of the Project. The approach used to identify and assess potential cumulative impacts of this Project provided within this chapter and the associated technical reports (refer Appendix I: Terrestrial and Aquatic Ecology technical report and Appendix J: Matters of National Environmental Significance Technical Report) is summarised below:

- A review of the potential impacts identified within the EIS assessments covers the environment at the time of issuing of the EIS ToR as the baseline, prior impacts from past land use have not been considered
- A register of assessable projects has been collated with timelines to demonstrate the temporal relationship between projects. This 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:
    - For this Project, the Gowrie to Helidon and the Calvert to Kagaru Inland Rail projects have been considered
- Identification and mapping of the assessable projects and the area of interest of the aspect being considered:
  - Current operational projects and commercial or agricultural operations that are in the areas of influence around the Project are already accounted for in the corresponding technical baseline studies (e.g. air, noise, social, economic)
- 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:
  - Assessment method has been quantitative in nature (if/as possible), with qualitative assessment also undertaken
  - For quantitative assessment—the significance of impact is assessed in comparison to the same criteria or guidelines adopted by the relevant technical assessments
  - For qualitative impacts—the probability, duration, and magnitude/intensity of the impacts is considered as well as the sensitivity and value of the receiving environment conditions
  - An assessment matrix method (further detailed within Section 11.5.8.3) has been used to determine the significance of cumulative impacts with respect to beneficial or 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.

11.5.8.3 Assessment matrix

Following the identification of each potential cumulative impact, a relevance factor score of low, medium and high has been determined in consideration of the impacts, in accordance with the assessment matrix given in Table 11.7.

The significance of the impact has been determined by using professional judgement to select the most appropriate relevance factor for each aspect in Table 11.7 and summing the relevance factors. The sum of the relevance factors determines the impact significance and consequence which are summarised in Table 11.8. 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 11.7: ASSESSMENT MATRIX

	Relevance factor		
Aspect	**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 11.8: 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 approval 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 approval 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 approval conditions required. Targeted monitoring program necessary, where appropriate.

11.6 Description of existing conditions

11.6.1 Regional and local context

The Project is located within the western extent of the Moreton Basin subregion, one of the 12 subregions of the SEQ bioregion. The SEQ bioregion has a sub-tropical climate with warm and wet summers and mild winters. The region contains the most urbanised areas in Queensland and is subject to a range of land uses including grazing, agriculture, residential and industrial urban areas, and rural residential. The bioregion also comprises extensive areas set aside for conservation including the Gondwana Rainforests of Australia World Heritage Area located over 25 km south of the Project.

Within the wider area, low-lying alluvial river and creek flats have been extensively cleared and remnant patches of open forest woodlands on floodplains are typically confined to constrained gullies with limited access and creek channels. These fringing woodlands are typically comprised of Blue Gum (*Eucalyptus tereticornis*), River She-oak (*Casuarina cunninghamiana*) and Paperbark (*Melaleuca spp.*), with Grey Box (*E. moluccana*) and Red Ironbark (*E. fibrosa subsp. fibrosa*) sometimes present in more elevated areas of the floodplain.

Undulating landscapes and foothills such as in the Helidon Hills and Little Liverpool Range areas are dominated by open eucalypt forests on sedimentary rocks, typically comprised of Brown Bloodwood (*Corymbia trachyphloia subsp. trachyphloia*), Spotted Gum (*Corymbia citriodora subsp. variegata*), Narrow-leaved Ironbark (*E. crebra*), Red Ironbark (*E. fibrosa subsp. fibrosa).* Within elevated parts of the Great Dividing Range, there are remnant pockets of Narrow-leaved Ironbark woodland, which contains Narrow-leaved ironbark (*E. crebra*) and Blue Gum (*Eucalyptus tereticornis*), Moreton Bay Ash (*Corymbia tessellaris*), Smooth-barked Apple (*Angophora costata.*), Silver-leaved Ironbark (*E. melanophloia*).

The western section of the Project passes to the north of the township of Helidon intersecting the lower slopes of the Helidon Hills. The area to the north encompasses a rugged landscape dominated by sandstone formations with extensive tracts of remnant vegetation and several sandstone quarries. A large portion of this area is protected under State legislation including Lockyer National Park, Lockyer Resources Reserve and Lockyer State Forest. The area comprises habitat for a number of threatened fauna species ((including Brush-tailed Rock-wallaby (*Petrogale penicillata*), Powerful Owl (*Ninox strenua*), Glossy Black-cockatoo (*Calyptorhynchus lathami*) and Collared Delma (*Delma torquata*)) and several threatened plants with a restricted range such as Four-tailed Grevillea (*Grevillea quadricauda*), Helidon Ironbark (*Eucalyptus taurina*) and Blunt-leaved Leionema (*Leionema obtusifolium*). The Project itself passes through a mosaic of cleared grazing lands, rural residential properties and remnant and regrowth vegetation as far east as the Warrego Highway.

The Project crosses to the south of the Warrego Highway and heads east to Gatton, the largest town in the Lockyer Valley. Here, the landscape becomes progressively more degraded and dominated by grazing, rural residential properties and irrigated agriculture. Scattered patches of remnant and regrowth vegetation occur largely to the north and outside of the Project. Large trees occur as scattered paddock trees and along the existing West Moreton System rail corridor, which the Project follows for much of this section. The Project crosses Lockyer Creek before entering Gatton itself. Creek line vegetation is highly degraded along the creek with little native tree cover in the vicinity of the crossing point.

From Gatton east to Forest Hill and to Laidley, the Project is co-located with the existing West Moreton System rail corridor, with the landscape relatively flat and highly modified being dominated by irrigated agriculture and grazing lands. There are scattered patches of remnant and regrowth vegetation in the landscape, largely to the south of the Project. No mapped vegetation communities occur within this section of the Project, with large trees only occurring as scattered paddock trees, part of residential gardens and as a thin strip along Laidley Creek. There is limited connectivity across or along the existing rail corridor with the exception of Laidley Creek.

The area of the Little Liverpool Range to the north and east of the Project (between Laidley and Grandchester) is part of a volcanic shield system of Tertiary age, which includes Main Range to the south. The peak elevation of the land intersected by the Project is reached as the Project intersects Little Liverpool Range at an approximate elevation of 240 m. While the slopes of the range in this area remain vegetated with a mixture of remnant and regrowth vegetation, rural housing occupies the ridge line where the proposed Little Liverpool Range tunnel is to be constructed.

The landscape within the Grandchester–Calvert area (east of the Little Liverpool Range) is characterised by very high levels of anthropogenic disturbance in the vicinity of Western Creek with most extant remnant and regrowth vegetation located on higher ground outside the Project. This presents a highly fragmented environment dominated primarily by pasture grasses, isolated trees and areas of woody regrowth. While much of the area is subject to grazing and other agricultural practices, Western Creek retains a thin but relatively continuous strip of riparian vegetation and has a limited potential to act as local fauna movement conduit.

The majority of the Project is located in the Lockyer Creek catchment, which extends east to Laidley where the Little Liverpool Range forms the boundary of the catchment. The western portion of the Project (from Helidon to Gatton) runs roughly parallel to the creek and the Project intersects Lockyer Creek on the northwest edge of Gatton township. The Project intersects a number of waterways within the catchment including Laidley Creek and Sandy Creek and their associated floodplains west of the Little Liverpool Range. To the west of the Little Liverpool Range (Grandchester to Calvert) the Project is located within the upper reach of Western Creek, which is within the Bremer River catchment. The Project crosses Western Creek in four locations. There are no large dams located upstream of the Project. There are a number of smaller dams in the area including Lake Dyer near Laidley.

Both catchments are considered to be in poor health, with freshwater health continuing to decline, being in very poor condition due to a decrease across most indicators, particularly water quality, fish and macroinvertebrate community health (Health Land and Water, 2019a). Site investigations indicate that watercourses that intersect the Project corridor are in relatively very poor condition. Laidley Creek in particular was considered to be in very poor condition and noted as being dry for the first time since sampling at this site had begun (Health Land and Water, 2019a).

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 ecology study area and are sufficiently displaced from the Project areas that downstream impacts will be negligible. For example, the Project is located over 65 km west of Moreton Bay, a wetland of international importance (Ramsar wetland).

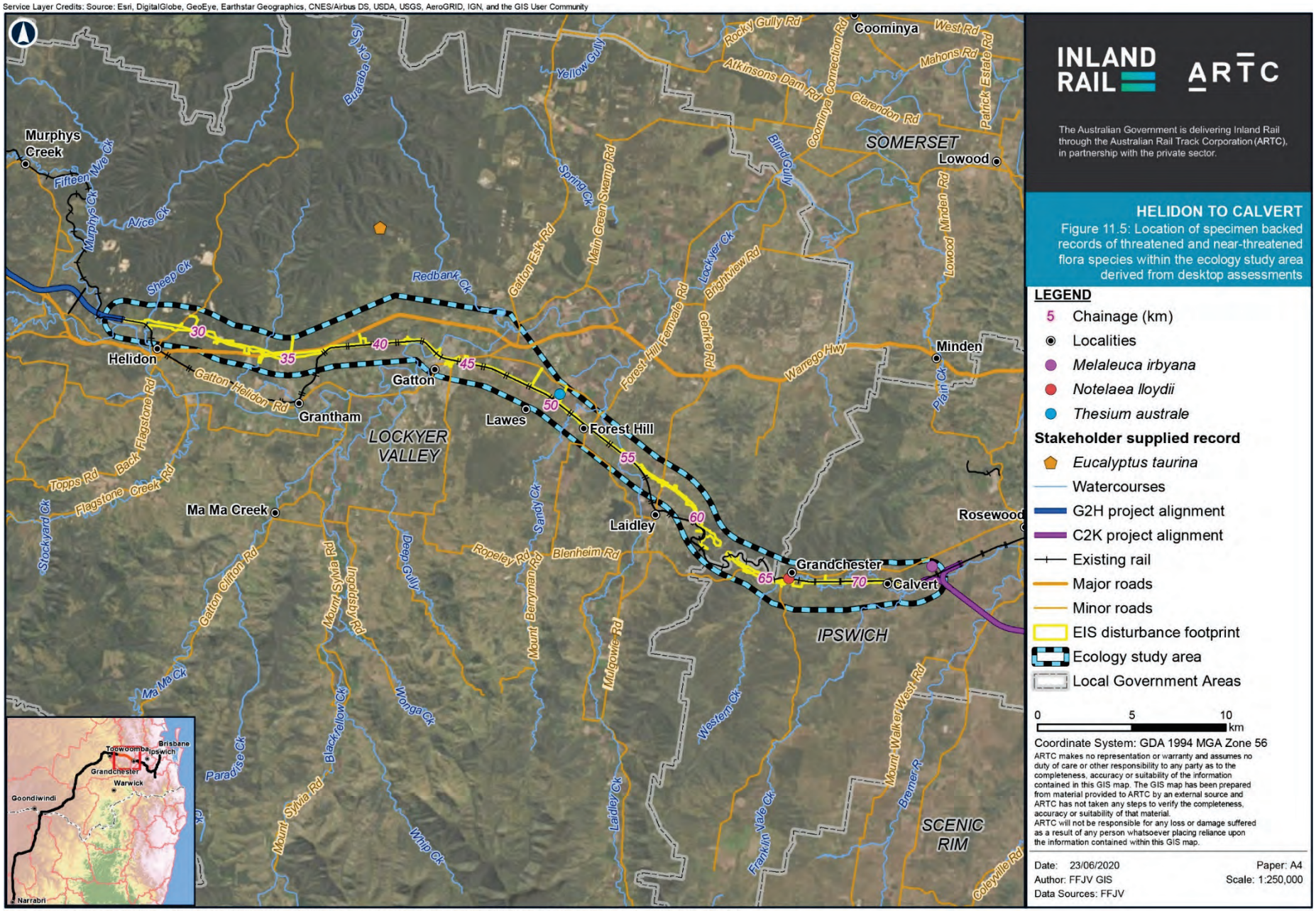
11.6.2 Flora and ecological communities

A total of 21 threatened or near-threatened flora species as listed under the EPBC Act and/or the NC Act are predicted to occur within the ecology study area. In addition, six Back on Track priority flora species have potential to occur within the ecology study area. The location of threatened or near-threatened flora species derived from specimen-backed records (e.g. Herbrecs and Atlas of Living Australia) within the ecology study area, is provided in Figure 11.5.

A total of 421 plant species were identified within the ecology study area during the Project EIS field assessment (i.e. during targeted surveys and opportunistic surveys), including 287 native species (68.2 per cent) and 134 non-native species (31.8 per cent). Both terrestrial and aquatic flora species were identified. With the exception of Swamp tea-tree (*Melaleuca irbyana*) (listed as a High Priority Back on Track species in addition to Endangered under the NC Act) no Back on Track priority flora species were observed within the ecology study area.

A comprehensive list of flora species recorded within the ecology study area is available in Appendix I: Terrestrial and Aquatic Ecology Technical Report and Appendix J: Matters of National Environmental Significance Technical Report.

Non-native species were typically more abundant and diverse in areas of high anthropogenic disturbance when compared to those areas characterised by an intact canopy of native species such as remnant vegetation/ intact bushland. However, encroachment of non-native species, particularly those spread by birds (e.g. *Lantana camara* and *Lantana montividensis*) 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 ecology study area.


Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
INLAND RAIL
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The Australian Government is delivering Inland Rail through the Australian Rail Track Corporation (ARTC), in partnership with the private sector.
HELIDON TO CALVERT
Figure 11.5: Location of specimen backed records of threatened and near-threatened flora species within the ecology study area derived from desktop assessments
LEGEND
5 Chainage (km)
Localities
Melaleuca irbyana
Notelaea lloydii
Thesium australe
Stakeholder supplied record
Eucalyptus taurina
Watercourses
G2H project alignment
C2K project alignment
Existing rail
Major roads
Minor roads
EIS disturbance footprint
Ecology study area
Local Government Areas
0 5 10 km
Coordinate System: GDA 1994 MGA Zone 56
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Date: 23/06/2020
Author: FFJV GIS
Data Sources: FFJV
Paper: A4
Scale: 1:250,000
Murphys Creek
Helidon
Grantham
Gatton
Lawes
Forest Hill
Laidley
Ma Ma Creek
Minden
Lowood
SOMERSET
LOCKYER VALLEY
IPSWICH
SCENIC RIM
Grandchester
Calvert
Rosewood
Coominya
Toowoomba
Brisbane
Ipswich
Warwick
Goondiwindi
Narrabri
Map by: DTH/MEF/LCT/AD/KG Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201906101333_Ecology_figures_and_calcs\330-EAP-201906101333_ARTC_Fig11.5_DesktopFlora_v4.mxd Date: 23/06/2020 15:58

11.6.2.1 Conservation-significant flora

Two specimens of Lloyd's Olive (*Notelaea lloydii*) (listed as vulnerable under the EPBC Act and the NC Act) were recorded within the Project disturbance footprint during preliminary pre-clearance ecology surveys and protected plant surveys (ELA, 2019b). The specimens were found at the same location to the east of Laidley in a road reserve (refer Figure 11.6). The habitat comprised regrowth woodland on sedimentary soils (refer Photograph 11.1). A search of the surrounding area did not identify additional specimens, though there have been a number of other records of this species within the Little Liverpool Range area, beyond the ecology study area boundary.

PHOTOGRAPH 11.1: LLOYD'S OLIVE—LAIDLEY AREA (2018)

In addition to Lloyd's Olive, a single specimen of Swamp Tea-tree (*Melaleuca irbyana*) (listed as endangered under the NC Act) was identified within a cleared area, immediately to the south of Rosewood Laidley Road, within Lot 112 on CH31344 during preliminary pre-clearance ecology surveys (ELA, 2019b) (refer Figure 11.6)

Eleven special least concern (SLC) flora species listed under the provisions of the NC Act were observed throughout the ecology study area. While these species are relatively common, they were most abundant in areas containing in-tact remnant vegetation. Threatened and special least concern flora species identified within the ecology study area are presented in Table 11.9.

TABLE 11.9: THREATENED AND SPECIAL LEAST CONCERN FLORA SPECIES OBSERVED WITHIN THE ECOLOGY STUDY AREA

Family	Species name	Common name	EPBC Act status	NC Act status
Campanulaceae	*Lobelia purpurascens*	White Root	-	SLC
Campanulaceae	*Wahlenbergia glabra*	Native Bluebell	-	SLC
Campanulaceae	*Wahlenbergia gracilis*	Sprawling Bluebell	-	SLC
Campanulaceae	*Wahlenbergia stricta*	Small Bluebell	-	SLC
Myrtacae	*Melaleuca irbyana*	Swamp Tea-tree	-	V
Oleaceae	*Notelaea lloydii*	Lloyd's Olive	V	V
Orchidaceae	*Cymbidium canaliculatum*	Black Orchid	-	SLC
Polypodiaceae	*Platycerium bifurcatum*	Elkhorn Fern	-	SLC
Potamogetonaceae	*Potamogeton crispus*	Curly-leafed Pondweed	-	SLC
Potamogetonaceae	*Potamogeton ochreatus*	Blunt Pondweed	-	SLC
Sterculiaceae	*Brachychiton acerifolius*	Flame Tree	-	SLC
Sterculiaceae	*Brachychiton discolor*	Lacebark Tree	-	SLC
Sterculiaceae	*Brachychiton populneus*	Kurrajong	-	SLC

Table notes:
- = Species not listed SLC = Special least concern V = Vulnerable E = Endangered

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

- Four-tailed Grevillea (*Grevillea quadricauda*)
- A grass (*Paspalidium grandispiculatum)*
- Bayley's Cypress Pine (*Callitris baileyi*).

Potential habitat for threatened flora species is largely associated with remnant vegetation associated with Helidon Hills area (north of Helidon) and the Little Liverpool Range (between Laidley and Grandchester). Further information related to threatened species and their associated habitat is contained within Appendix F of Appendix I: Terrestrial and Aquatic Ecology Technical Report and Appendix F of Appendix J: Matters of National Environmental Significance Technical Report of the EIS.

11.6.2.2 Vegetation communities

Desktop analysis indicates that the ecology study area is predominantly mapped as non-remnant (~76%) with Category B (i.e. remnant vegetation) and C (high-value regrowth) regulated vegetation also present as indicated on the regulated vegetation map (Queensland Government, 2020c). Table 11.10 summarises the extent of Category B and Category C areas of regulated vegetation within the ecology study area and the Project disturbance footprint, noting the ecology study area does not contain vegetation mapped as Category R (Figure 11.7a and Figure 11.7b). In addition to this, the following regulated vegetation intersects watercourses or wetlands:

- Category B—Remnant vegetation: 63.45 ha (ecology study area); 0.77 ha (Project disturbance footprint)
- Category C—High-value regrowth: 30.71 ha (ecology study area); 1.52 ha (Project disturbance footprint).

The regulated vegetation is mapped as endangered, of concern or least concern under the VM Act and comprises 17 REs. A list of the REs and their extent within the ecology study area is provided in Table 11.11, noting that only eight REs are present in the Project disturbance footprint of which half are mapped as high-value regrowth only. Ground-truthing in accordance with Neldner et al., (2017) has been undertaken to verify and delineate this mapping, where possible. For further information related to regulated vegetation, refer Appendix I: Terrestrial and Aquatic Ecology Technical Report.

TABLE 11.10: EXTENT OF CATEGORIES B, C, R AND X AREAS OF REGULATED VEGETATION THAT ARE ENDANGERED OR OF CONCERN REGIONAL ECOSYSTEMS WITHIN THE ECOLOGY STUDY AREA

	Extent (ha)	
Regulated vegetation category	**Ecology study area**	**Project disturbance footprint**
Category R—Remnant vegetation	0.00	0.00
Category B—Remnant vegetation	1703.32	32.26
Category C—High value regrowth	1093.72	66.39
Category X—Non-remnant	9057.47	535.93

Table notes:
Category R is regrowth vegetation regulated under the VMA Act that is within 50 metres of a watercourse located in the Burdekin, Burnett–Mary, Eastern Cape York, Fitzroy, Mackay–Whitsunday or Wet Tropics catchments
Category B is remnant vegetation regulated under the VMA shown on the regulated vegetation management map
Category C is high value regrowth vegetation regulated under the VMA shown on the regulated vegetation management map
Category X is non-remnant vegetation generally not regulated under the VMA

TABLE 11.11: DESCRIPTIONS OF REGIONAL ECOSYSTEMS (CATEGORY B AND CATEGORY C REGULATED VEGETATION) WITHIN THE ECOLOGY STUDY AREA

Regional ecosystems (REs)	Management status		Description (REDD Version 11)	Category B Extent (ha)		Category C Extent (ha)	
	VM Act	Biodiversity status		Within ecology study area	Project disturbance footprint	Within ecology study area	Project disturbance footprint
12.3.2	OC	OC	*Eucalyptus grandis* +/- *E. microcorys*, *Lophostemon confertus* tall open forest with vine forest understorey ('wet sclerophyll'). Patches of *Eucalyptus pilularis* sometimes present especially in vicinity of sedimentary rocks (e.g. around Palmwoods). Fringing streams and in narrow gullies in high rainfall areas.	0.03	0.00	0.00	0.00
12.3.3	E	E	*Eucalyptus tereticornis* woodland. *Eucalyptus crebra* and *E. moluccana* are sometimes present and may be relatively abundant in places, especially on edges of plains and higher-level alluvium. Other species that may be present as scattered individuals or clumps include *Angophora subvelutina* or *A. floribunda, Corymbia clarksoniana, C. intermedia, C. tessellaris, Lophostemon suaveolens* and *E. melanophloia*. Occurs on Quaternary alluvial plains, terraces and fans where rainfall is usually less than 1,000 mm/year.	85.72	1.62	117.86	8.16
12.3.3d	E	E	*Eucalyptus moluccana* woodland. Other frequently occurring species include *Eucalyptus tereticornis*, *E. crebra*, *E. siderophloia*, *Corymbia citriodora* subsp. *variegata*, *Angophora leiocarpa* and *C. intermedia*. Occurs on margins of Quaternary alluvial plains often adjacent sedimentary geologies. May also occur on stranded Pleistocene river terraces. Floodplain (other than floodplain wetlands).	2.08	0.00	12.34	0.00
12.3.7	LC	OC	Narrow fringing woodland of *Eucalyptus tereticornis*, *Casuarina cunninghamiana* subsp. *cunninghamiana* +/- *Melaleuca viminalis*. Other species associated with this RE include *Melaleuca bracteata*, *M. trichostachya*, *M. linariifolia*. North of Brisbane *Waterhousea floribunda* commonly occurs and may at times dominate this RE. *Melaleuca fluviatilis* occurs in this RE in the north of the bioregion. *Lomandra hystrix* often present in stream beds. Occurs on fringing levees and banks of rivers and drainage lines of alluvial plains throughout the region	131.15	2.24	18.66	1.31
12.3.8	OC	OC	Swamps with characteristic species including *Cyperus* spp., *Schoenoplectus* spp., *Philydrum lanuginosum*, *Eleocharis* spp., *Leersia hexandra*, *Cycnogeton procerus*, *Nymphaea* spp., *Nymphoides indica*, *Persicaria* spp., *Phragmites australis*, *Typha* spp. and a wide range of sedges grasses or forbs. Emergent *Melaleuca* spp. may sometimes occur. Occurs in freshwater swamps associated with floodplains.	7.99	0.00	0.95	0.00

Regional ecosystems (REs)	Management status		Description (REDD Version 11)	Category B Extent (ha)		Category C Extent (ha)	
	VM Act	Biodiversity status		Within ecology study area	Project disturbance footprint	Within ecology study area	Project disturbance footprint
12.3.10a	E	E	*Acacia harpophylla* open forest to woodland. Occurs on Quaternary alluvial plains where minor areas of cracking clay soils prevail.	0.00	0.00	0.58	0.00
12.3.18	E	E	*Melaleuca irbyana* low open forest or thicket. Emergent *Eucalyptus moluccana*, *E. crebra*, *E. tereticornis* or *Corymbia citriodora* subsp. variegata may be present. Occurs on Quaternary alluvial plains where drainage of soils is impeded.	4.59	0.00	1.18	0.00
12.3.19	E	E	*Eucalyptus moluccana* and/or *Eucalyptus tereticornis* and *E. crebra* open forest to woodland, with a sparse to mid-dense understorey of *Melaleuca irbyana*. Occurs on margins of Quaternary alluvial plains	7.79	0.00	2.75	0.00
12.9–10.2	LC	NC	*Corymbia citriodora* subsp. variegata open forest or woodland usually with *Eucalyptus crebra*. Other species such as *Eucalyptus tereticornis*, *E. moluccana*, *E. acmenoides* and *E. siderophloia* may be present in scattered patches or in low densities. Understorey can be grassy or shrubby. Shrubby understorey of *Lophostemon confertus* (Whipstick form) often present in northern parts of bioregion. Occurs on Cainozoic and Mesozoic sediments.	1154.95	27.32	547.88	34.64
12.9–10.3	OC	OC	*Eucalyptus moluccana* open forest. Other canopy species include *Eucalyptus siderophloia* or *E. crebra*, *E. tereticornis* and *Corymbia citriodora* subsp. *variegata*. Understorey generally sparse but can become shrubby in absence of fire. Occurs on Cainozoic and Mesozoic sediments, especially shales. Prefers lower slopes	13.90	0.00	29.91	2.86
12.9–10.5	LC	NC	Shrubby woodland complex. More widely distributed and abundant species include *Corymbia trachyphloia* subsp. *trachyphloia*, *C. citriodora* subsp. *variegata*, *Eucalyptus crebra*, *E. fibrosa* subsp. *fibrosa,* E. *major*, *Angophora leiocarpa*, *E. helidonica*. Understorey of sclerophyllous shrubs. Localised occurrences of *Eucalyptus baileyana*, *E. pilularis*, *Corymbia henryi*, *E. dura*, *E. decorticans* (extreme west of bioregion), *E. taurina*, *Angophora woodsiana*, *Lysicarpus angustifolius* and *Lophostemon confertus*. Tends to shrubland or monospecific woodland of species such as *Eucalyptus dura* on shallow lithosols. Occurs on quartzose sandstone scarps and crests.	9.93	0.00	27.21	2.86

Regional ecosystems (REs)	Management status		Description (REDD Version 11)	Category B Extent (ha)		Category C Extent (ha)	
	VM Act	Biodiversity status		Within ecology study area	Project disturbance footprint	Within ecology study area	Project disturbance footprint
12.9–10.5a	LC	NC	*Eucalyptus helidonica*, *Corymbia citriodora* subsp. *variegata* open forest +/- *C. trachyphloia* subsp. *trachyphloia*, *Eucalyptus fibrosa* subsp. *fibrosa*, *E. taurina*, *E. dura*, *E. baileyana*, *C. gummifera*, *Angophora woodsiana* and *Lysicarpus angustifolius*. Occurs on quartzose sandstone scarps and crests.	153.10	0.00	36.45	0.00
12.9–10.6	E	E	*Acacia harpophylla* open forest +/- *Casuarina cristata* and vine thicket species. Occurs on Cainozoic and Mesozoic sediments, especially fine-grained rocks.	0.00	0.00	4.53	0.00
12.9–10.7	OC	OC	*Eucalyptus crebra* +/- *E. tereticornis*, *Corymbia tessellaris*, *Angophora leiocarpa*, *E. melanophloia* woodland. Occurs on Cainozoic and Mesozoic sediments.	114.32	1.08	212.64	9.53
12.9–10.17a	LC	NC	*Lophostemon confertus* or *Lophostemon. suaveolens* dominated open forest usually with emergent Eucalyptus and/or Corymbia species. Occurs in gullies and southern slopes on Cainozoic and Mesozoic sediments	0.00	0.00	18.38	0.19
12.9–10.19	LC	NC	*Eucalyptus fibrosa* subsp. *fibrosa* woodland +/- *Corymbia citriodora* subsp. *variegata*, *E. acmenoides* or *E. portuensis*, *Angophora leiocarpa*, *E. major*. Understorey often sparse. Localised occurrences of *Eucalyptus sideroxylon*. Occurs on Cainozoic and Mesozoic sediments.	12.96	0.00	61.92	6.84
12.9–10.27	E	E	*Corymbia citriodora* subsp. *variegata*, *Eucalyptus crebra* and/or *E. moluccana*, *E. tereticornis* open forest with a sparse to mid-dense understorey of *Melaleuca irbyana*. Occurs on lower slopes and elevated flats with impeded drainage on Mesozoic sediments.	4.79	0.00	0.48	0.00
Non-remnant	-	-	Not applicable	9,057.47	535.93	-	-

Table notes:
LC = Least concern NC = No concern at present OC = Of concern E = Endangered BD = Biodiversity ha = hectare mm/yr= millimetres per year

11.6.2.3 Threatened ecological communities (EPBC Act)

Two threatened ecological communities under the EPBC Act are known from the ecological study area Critically Endangered (Swamp Tea-tree (*Melaleuca irbyana*) Forest of SEQ) and the Endangered Brigalow (*Acacia harpophylla* dominant and co-dominant) ecological community.

Queensland RE and HVR mapping indicates that polygons of remnant and HVR RE 12.3.18 (analogous to the Swamp tea-tree TEC) and heterogeneous polygons of HVR including RE 12.9-10.6 (analogous to the Brigalow TEC) occur within the ecology study area. The location and extent of mapped TECs within the ecology study area is presented in Figure 11.6.

The estimated extent of Swamp Tea-tree TEC identified covers 5.77 ha in two discrete patches located south of Calvert (eastern extent of Project) comprising 4.59 ha of remnant vegetation and 1.18 ha of HVR. The nearest of the two patches to the Project is 530 m south of the Project disturbance footprint (refer Figure 11.8), with the Project generally located to the north-west and south of the TECs known area of occupancy.

The estimated extent of Brigalow TEC comprises 4.53 ha of HVR with the nearest occurrence located approximately 30 m to the south of the Project disturbance footprint (Ch 54 to Ch55) with the proposed rail alignment to the north of the existing West Moreton System (refer Figure 11-8).

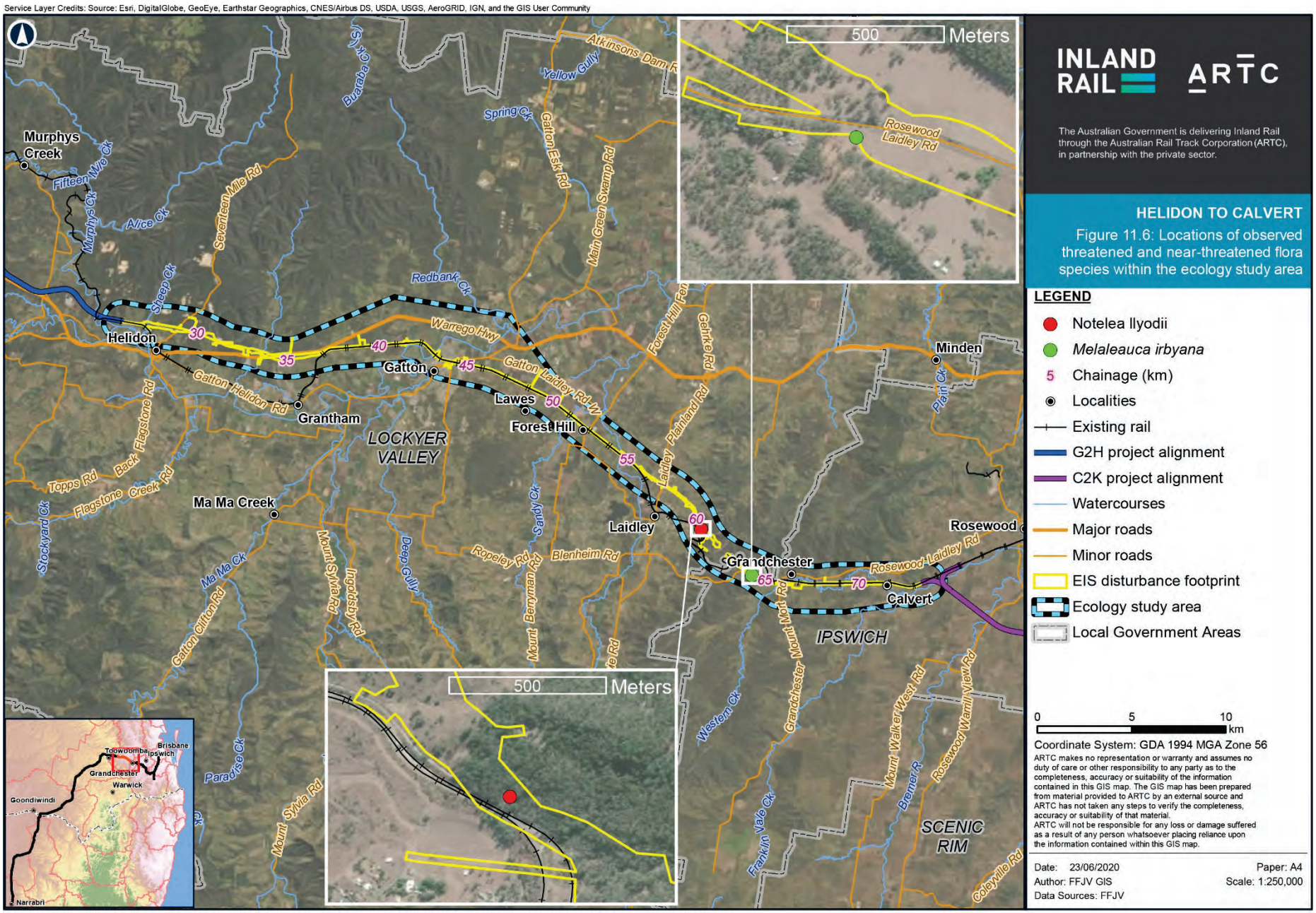
Further, these communities were not encountered during field assessments (e.g. protected plant surveys) with only a solitary record of *Melaleuca irbyana* noted from the Project disturbance footprint, while *Acacia harpophylla* was also recorded. As such these TEC's do not occur within the Project disturbance footprint.

Further surveys are currently in progress to identify the accuracy of the vegetation mapping and the extent to which the TEC actually occurs within the vicinity of the Project boundary.

11.6.2.4 Introduced flora

In total, 134 non-native flora species were identified during the Project EIS field investigations (refer Appendix I: Terrestrial and Aquatic Ecology Technical Report).

Of the 134 non-native flora species, 18 restricted matters flora species (under the Biosecurity Act) were identified from the ecology study area (refer Table 11.12). The categories shown in Table 11.12 identify the type of restricted matter (under the Biosecurity Act); Categories 3 to 7 relate to restricted matter that is in a person's possession, under their control, and is also about not feeding restricted matters. Each category identifies types of restricted matter and specific management strategies associated with these types.



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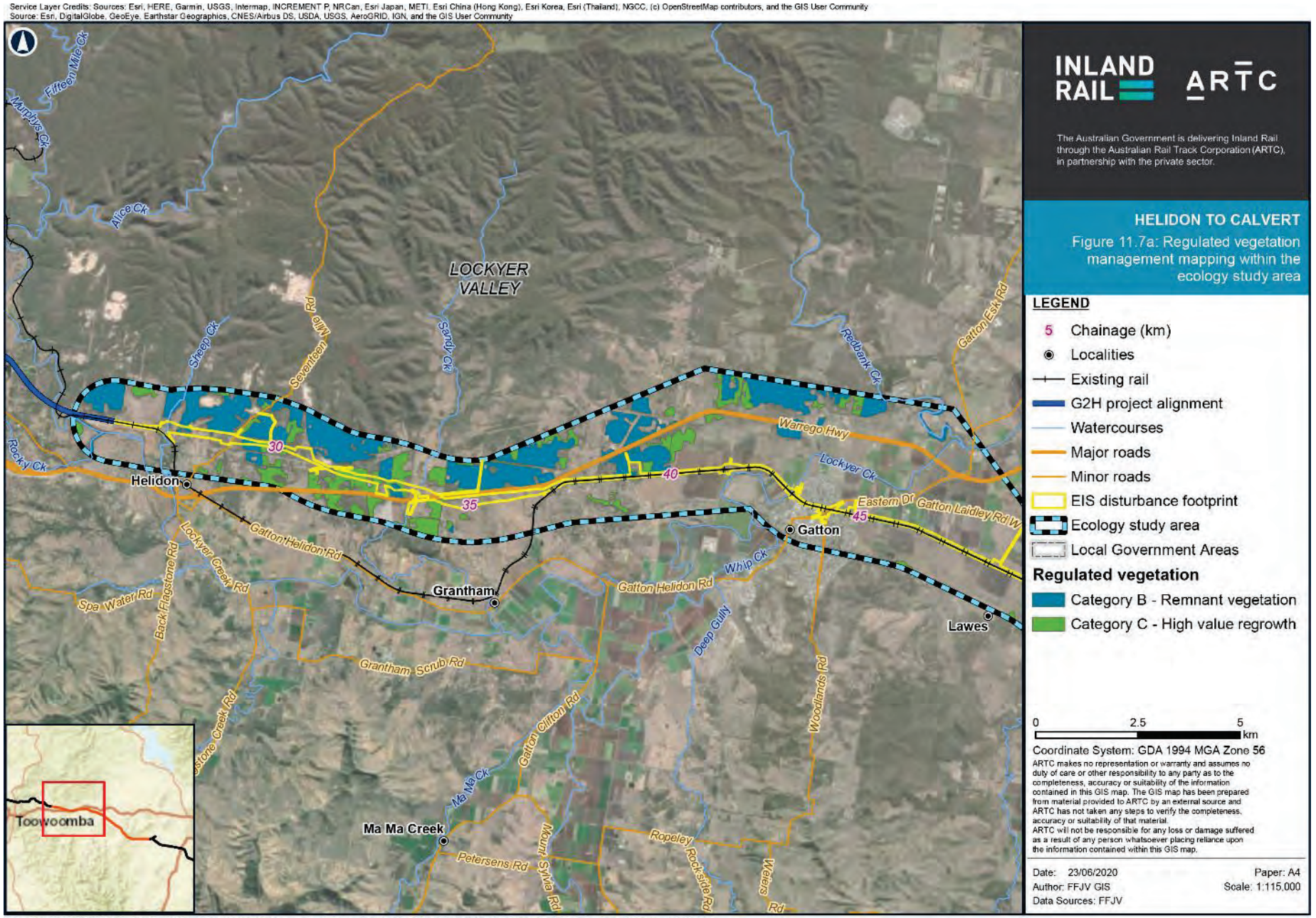
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LOCKYER VALLEY
Helidon
Grantham
Gatton
Lawes
Ma Ma Creek
Toowoomba
Fifteen Mile Ck
Murphys Ck
Alice Ck
Sheep Ck
Seventeen Mile Rd
Sandy Ck
Redbank Ck
Gatton Esk Rd
Warrego Hwy
Lockyer Ck
Rocky Ck
Eastern Dr
Gatton Laidley Rd W
Gatton Helidon Rd
Lockyer Creek Rd
Spa Water Rd
Back Flagstone Rd
Whip Ck
Deep Gully
Grantham Scrub Rd
Woodlands Rd
Gatton Clifton Rd
Ma Ma Ck
Mount Sylvia Rd
Petersens Rd
Ropeley Rockside Rd
Waters Rd
30
35
40
45
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Figure 11.7a: Regulated vegetation management mapping within the ecology study area
LEGEND
5 Chainage (km)
Localities
Existing rail
G2H project alignment
Watercourses
Major roads
Minor roads
EIS disturbance footprint
Ecology study area
Local Government Areas
Regulated vegetation
Category B - Remnant vegetation
Category C - High value regrowth
0 2.5 5 km
Coordinate System: GDA 1994 MGA Zone 56
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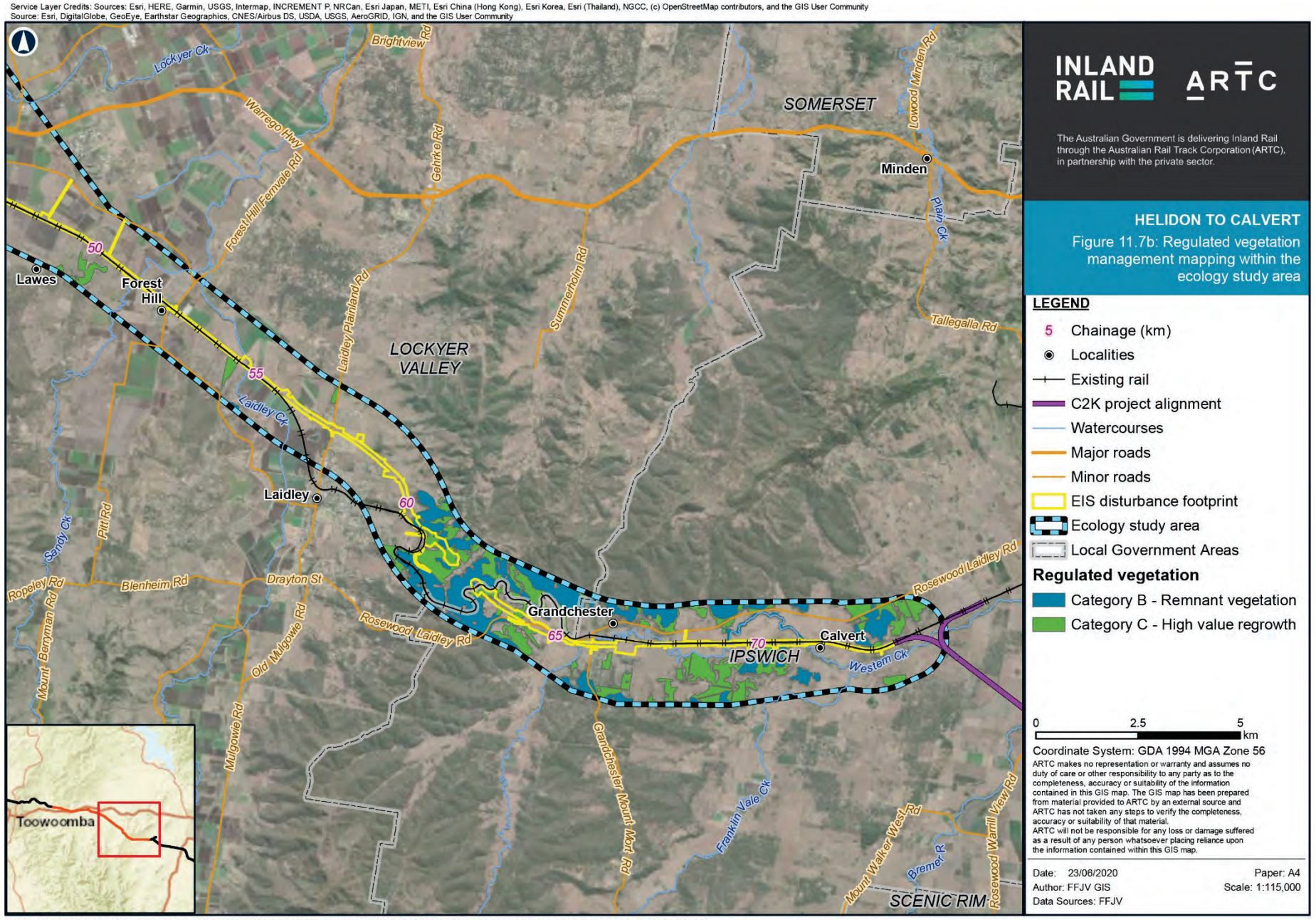
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Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Lockyer Ck
Brightview Rd
Warrego Hwy
Forest Hill Fernvale Rd
Gehrke Rd
SOMERSET
Lowood Minden Rd
Minden
Plain Ck
Lawes
Forest Hill
50
55
60
65
70
Laidley Plainland Rd
Summerholm Rd
LOCKYER VALLEY
Tallegalla Rd
Laidley Ck
Laidley
Sandy Ck
Pitt Rd
Ropeley Rd
Blenheim Rd
Drayton St
Rosewood Laidley Rd
Grandchester
Calvert
IPSWICH
Western Ck
Mount Berryman Rd
Old Mulgowie Rd
Mulgowie Rd
Grandchester Mount Mort Rd
Franklin Vale Ck
Mount Walker West Rd
Bremer R
Rosewood Warrill View Rd
SCENIC RIM
Toowoomba
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Figure 11.7b: Regulated vegetation management mapping within the ecology study area
LEGEND
5 Chainage (km)
Localities
Existing rail
C2K project alignment
Watercourses
Major roads
Minor roads
EIS disturbance footprint
Ecology study area
Local Government Areas
Regulated vegetation
Category B - Remnant vegetation
Category C - High value regrowth
0 2.5 5 km
Coordinate System: GDA 1994 MGA Zone 56
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Data Sources: FFJV
Map by: GN/KG Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201906101333_Ecology_figures_and_calcs\330-EAP-201906101333_ARTC_Fig11.7_RegulatedVegetation_v1.mxd Date: 23/06/2020 16:08

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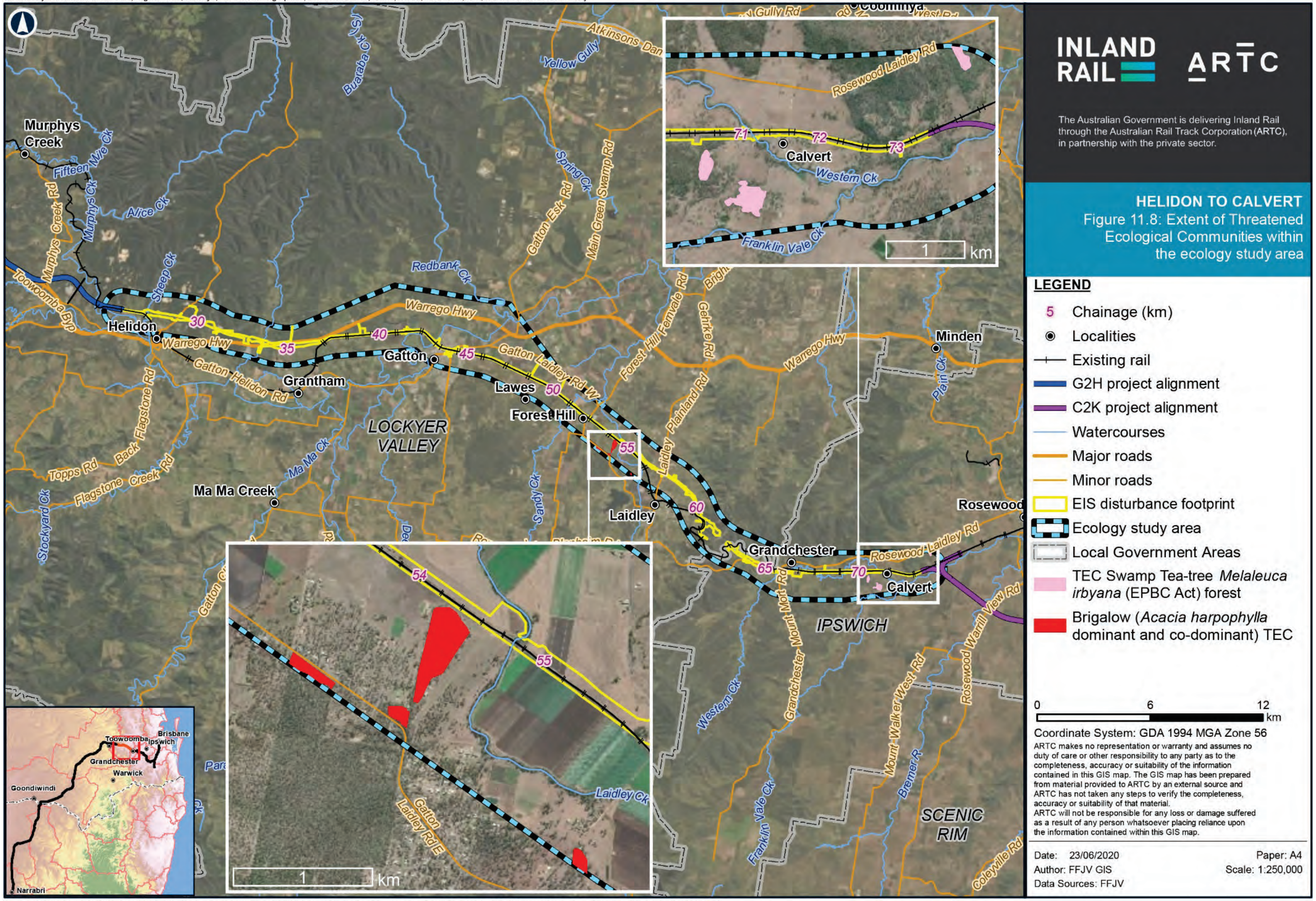

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Figure 11.8: Extent of Threatened Ecological Communities within the ecology study area

Map by: DTH/MEF/LCT/AD/GN/KG Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201906101333_Ecology_figures_and_calcs\330-EAP-201906101333_ARTC_Fig11.8_TEC_v5.mxd Date: 23/06/2020 15:58

TABLE 11.12: RESTRICTED MATTERS IDENTIFIED WITHIN THE ECOLOGY STUDY AREA

Family name	Species name	Common name	Schedule 2 of the Biosecurity Act	Weeds of National Significance	Relative abundance within the ecology study area	Typical areas of occurrence within the ecology study area
Anacardiaceae	*Schinus terebinthifolius*	Broadleaved Peppertree	Category 3	No	Occasional to common	Riparian forest and bushland
Apocynaceae	*Cryptostegia grandiflora*	Rubber Vine	Category 3	No	Uncommon	Drainage lines and riparian areas
Asparagaceae	*Asparagus aethiopicus*	Asparagus Fern	Category 3	Yes	Common	Bushland
Asparagaceae	*Asparagus asparagoides*	Bridal Creeper	Category 2,3,4,5	Yes	Uncommon	Bushland
Asparagaceae	*Asparagus plumosus*	Climbing Asparagus Fern	Category 3	Yes	Common	Drainage lines and riparian areas
Asteraceae	*Ambrosia artemisiifolia*	Annual ragweed	Category 3	No	Common	Bushland, agricultural areas and road reserves
Asteraceae	*Baccharis halimifolia*	Groundsel Bush	Category 3	Yes	Common	Agricultural areas and road reserves
Asteraceae	*Senecio madagascariensis*	Fireweed	Category 3	Yes	Very common	Agricultural areas and road reserves
Basellaceae	*Anredera cordifolia*	Madeira Vine	Category 3	Yes	Common	Drainage lines and riparian areas
Bignoniaceae	*Tecoma stans var. stans*	Yellow Bells	Category 3	No	Common	Bushland
Cactaceae	*Opuntia stricta*	Common Pest Pear	Category 3	Yes	Common	Bushland and agricultural areas
Cactaceae	*Opuntia tomentosa*	Velvety Tree Pear	Category 3	Yes	Very common	Bushland and agricultural areas
Crassulaceae	*Bryophyllum delagoense*	Mother-of-millions	Category 3	Yes	Very common	Bushland and agricultural areas
Lauraceae	*Cinnamomum camphora*	Camphor Laurel	Category 3	No	Common	Riparian forest and bushland
Oleaceae	*Ligustrum lucidum*	Broad-leaved Privet	Category 3	No	Common	Drainage lines and riparian areas
Ulmaceae	*Celtis sinensis*	Chinese Celtis	Category 3	No	Very common	Drainage lines and riparian areas
Verbenaceae	*Lantana camara*	Lantana	Category 3	Yes	Very common	All areas
Verbenaceae	*Lantana montevidensis*	Creeping Lantana	Category 3	No	Common	Bushland and agricultural areas

Table notes: Each restriction category number identifies an obligation or an offence provision that applies to biosecurity matter assigned that category number.
These categories are identified below:
Biosecurity category 2: A person must report the invasive plant within 24 hours to ph. 13 25 23 and take all reasonable and practical steps to minimise the risk of the plant spreading until advised by an authorised officer.
Biosecurity category 3: A person must not distribute the invasive plant either by sale or gift, release it into the environment.
Biosecurity category 4: A person must not move the invasive plant.
Biosecurity category 5: A person must not keep the invasive plant.

11.6.3 Fauna

A total of 34 threatened or near-threatened fauna species identified under the EPBC Act and/or NC Act are predicted to occur within the ecology study area. In addition, 22 non-threatened migratory species as listed under the EPBC Act, two SLC mammals (i.e. Short-beaked Echidna (*Tachyglossus aculeatus)* and Platypus (*Ornithorhynchus anatinus*) and four Back on Track priority fauna species are also predicted to occur within the ecology study area. The location of specimen-backed records for threatened, near-threatened and migratory fauna species, derived from database sources (e.g. Birds Australia, WildNet and Atlas of Living Australia) that are known from the ecology study area is provided in Figure 11.9a to Figure 11.9b.

The Project EIS field investigations identified a total of 168 fauna species (refer Appendix E of Appendix I: Terrestrial and Aquatic Ecology Technical Report), including 156 native species (92.9 per cent) and 12 non-native species (7.1 per cent) from within the ecology study area. Recorded species consisted of 120 (71.43 per cent) birds, 32 (19.05 per cent) mammals (16 of which are microbat species), 12 (7.14 per cent) reptiles, four (2.38 per cent) amphibians. Given the fragmented nature of bushland areas within the ecology study area, their fragile 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.

A comprehensive list of fauna species recorded within the ecology study area is available in Appendix I: Terrestrial and Aquatic Ecology Technical Report and Appendix J: Matters of National Environmental Significance Technical Report.

11.6.3.1 Conservation significant fauna

The threatened species identified from the ecology study area, consist of the following:

- Grey-headed Flying fox (*Pteropus poliocephalus*) was observed outside of the ecology study area within the vicinity of a known flying-fox camp in the Gatton area
- Signs of Koala (*Phascolarctos cinereus*) presence (scratches and scats) have been observed at several locations along the Project alignment during EIS surveys and surveys by Arup/SMEC (2016). Along the Project alignment these records are located between Helidon and Gatton and Laidley to Calvert. In particular, records are concentrated around forested areas in the Little Liverpool Range and the Helidon Hills
- Grey Falcon (*Falco hypoleucos*) identified within vegetation along Lockyer Creek at Gatton.

In addition to the species identified above, two non-threatened migratory species listed under the EPBC Act were observed within the ecology study area. These species consisted of:

- Black-faced Monarch (*Monarcha melanopsis*) identified within vegetation along Laidley Creek
- Spectacled Monarch (*Symposiachrus trivirgatus*) identified within vegetation along Laidley Creek.

The location of the observed threatened, near-threatened and migratory fauna species within the ecology study area is provided in Figure 11.10a to Figure 11.10e.

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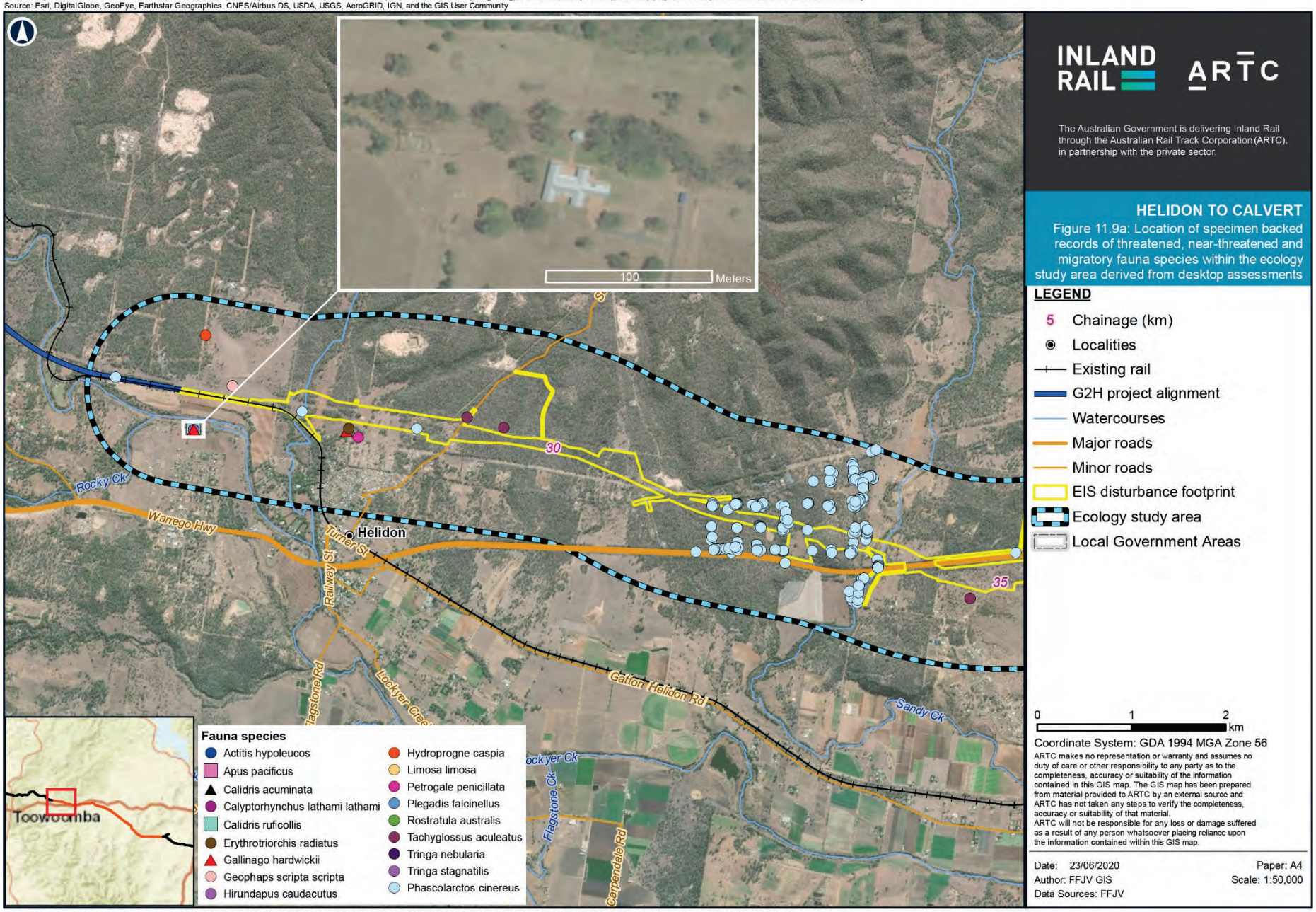

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Figure 11.9a: Location of specimen backed records of threatened, near-threatened and migratory fauna species within the ecology study area derived from desktop assessments

LEGEND

- 5 Chainage (km)
- Localities
- Existing rail
- G2H project alignment
- Watercourses
- Major roads
- Minor roads
- EIS disturbance footprint
- Ecology study area
- Local Government Areas

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56

Date: 23/06/2020
Author: FFJV GIS
Data Sources: FFJV

Paper: A4
Scale: 1:50,000

Map by: DTH/MEF/LCT/AD/GN/KG Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201906101333_Ecology_figures_and_calcs\330-EAP-201906101333_ARTC_Fig11.9_SignificantFauna_v6_pageA.mxd Date: 23/06/2020 15:55

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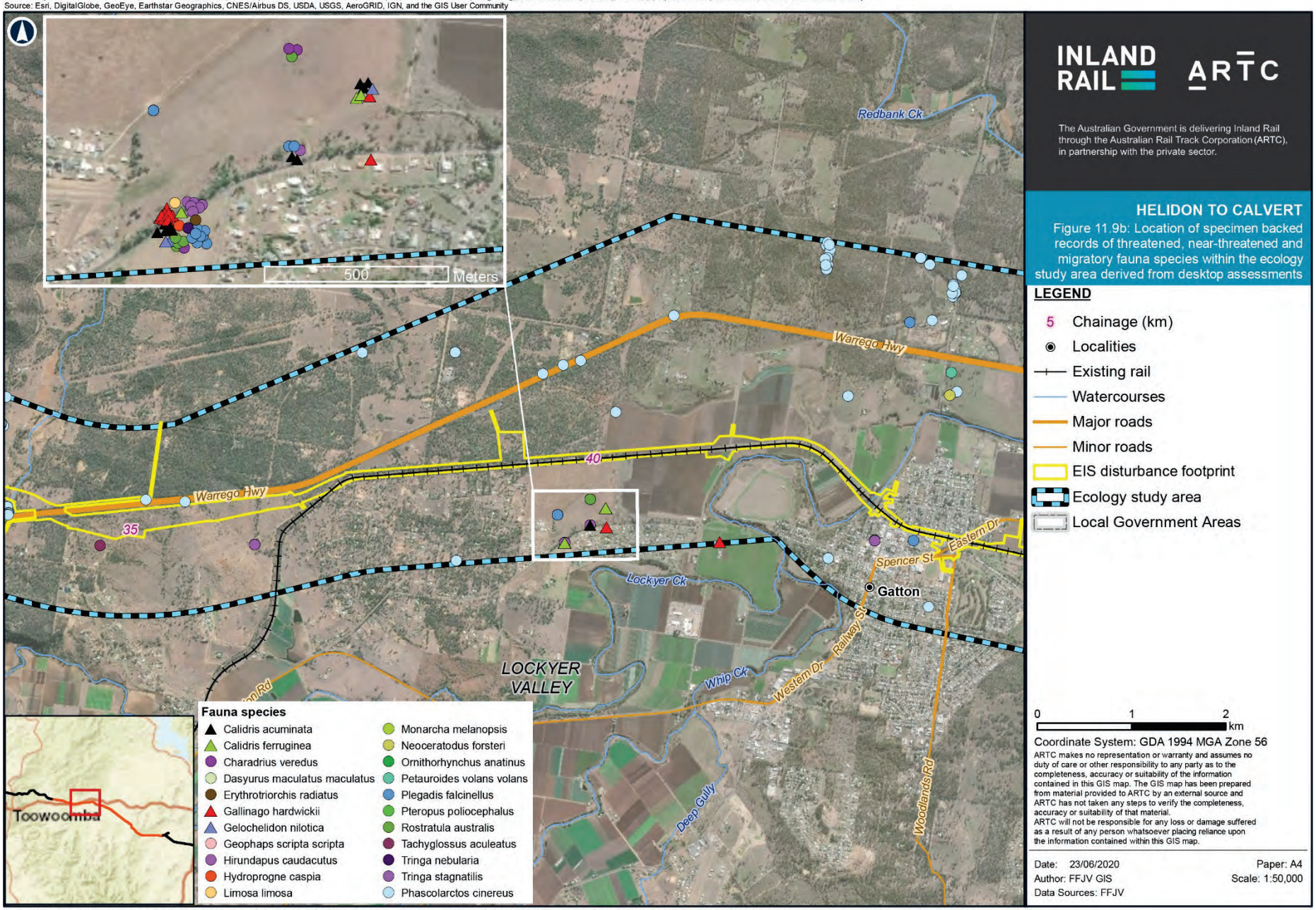

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Figure 11.9b: Location of specimen backed records of threatened, near-threatened and migratory fauna species within the ecology study area derived from desktop assessments

LEGEND

- 5 Chainage (km)
- Localities
- Existing rail
- Watercourses
- Major roads
- Minor roads
- EIS disturbance footprint
- Ecology study area
- Local Government Areas

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56

Date: 23/06/2020
Author: FFJV GIS
Data Sources: FFJV

Paper: A4
Scale: 1:50,000

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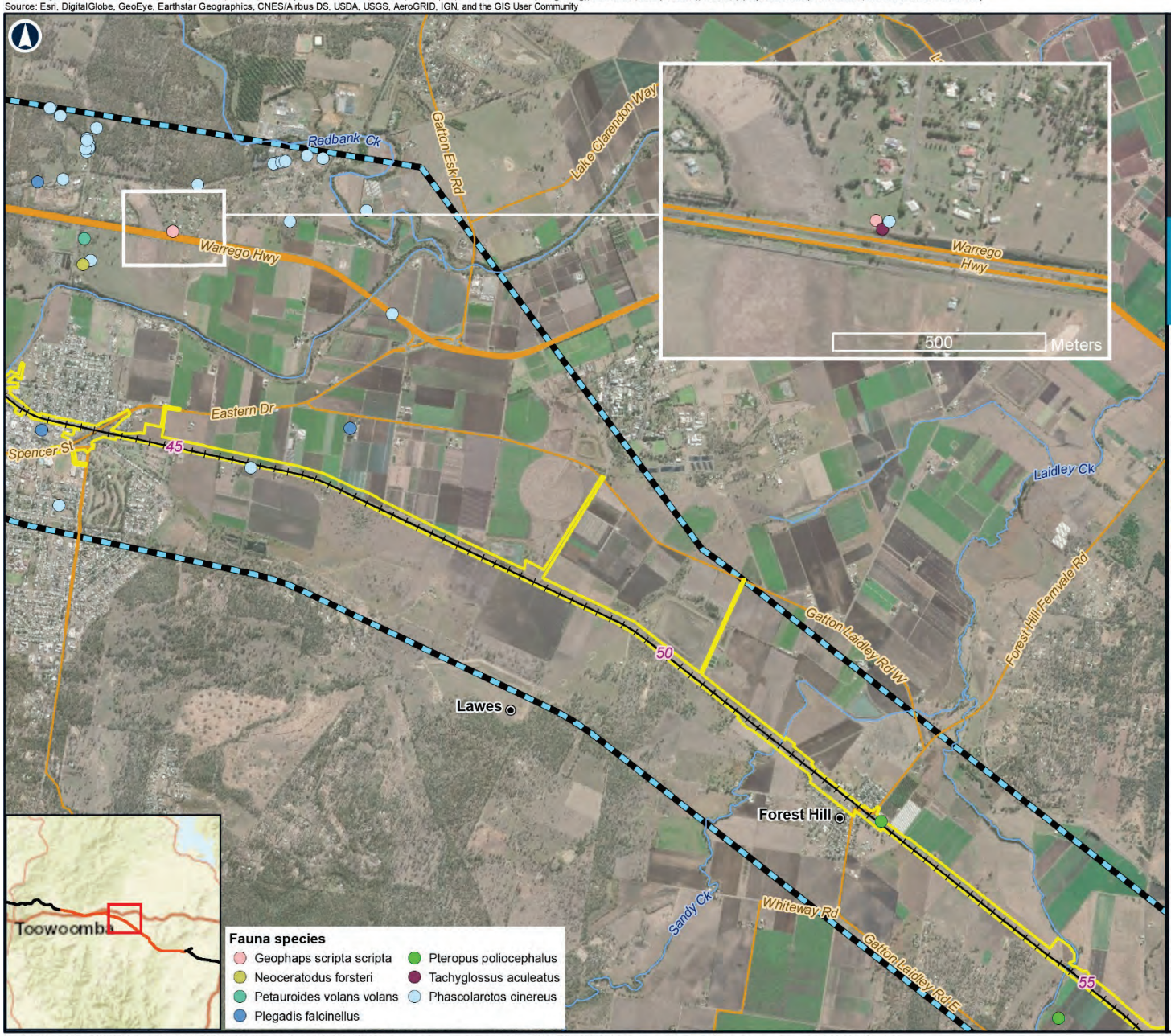

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Figure 11.9c: Location of specimen backed records of threatened, near-threatened and migratory fauna species within the ecology study area derived from desktop assessments

LEGEND

- 5 Chainage (km)
- Localities
- Existing rail
- Watercourses
- Major roads
- Minor roads
- EIS disturbance footprint
- Ecology study area
- Local Government Areas

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56

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Data Sources: FFJV

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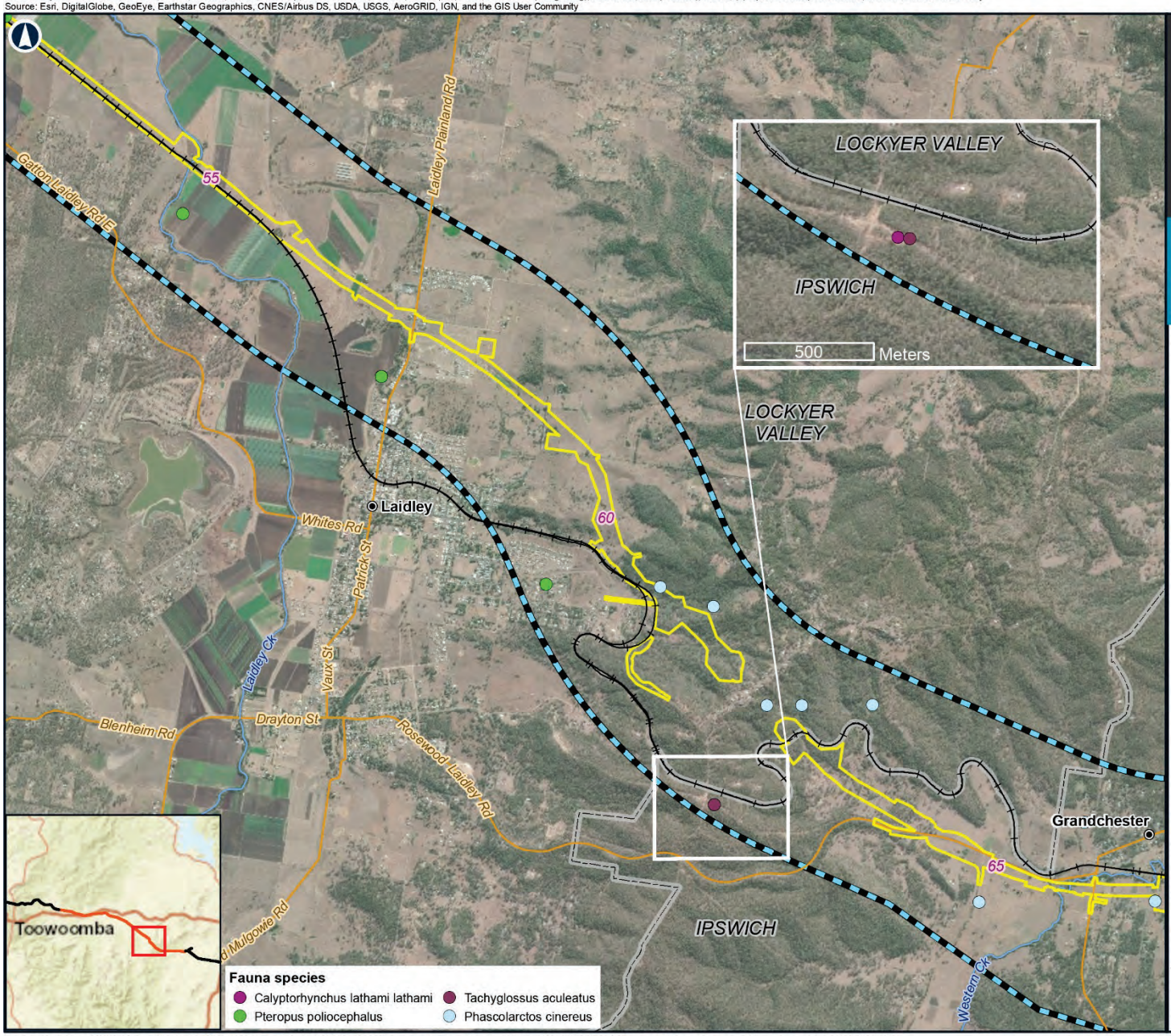

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Figure 11.9d: Location of specimen backed records of threatened, near-threatened and migratory fauna species within the ecology study area derived from desktop assessments

LEGEND

- 5 Chainage (km)
- Localities
- Existing rail
- Watercourses
- Minor roads
- EIS disturbance footprint
- Ecology study area
- Local Government Areas

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56

Date: 23/06/2020
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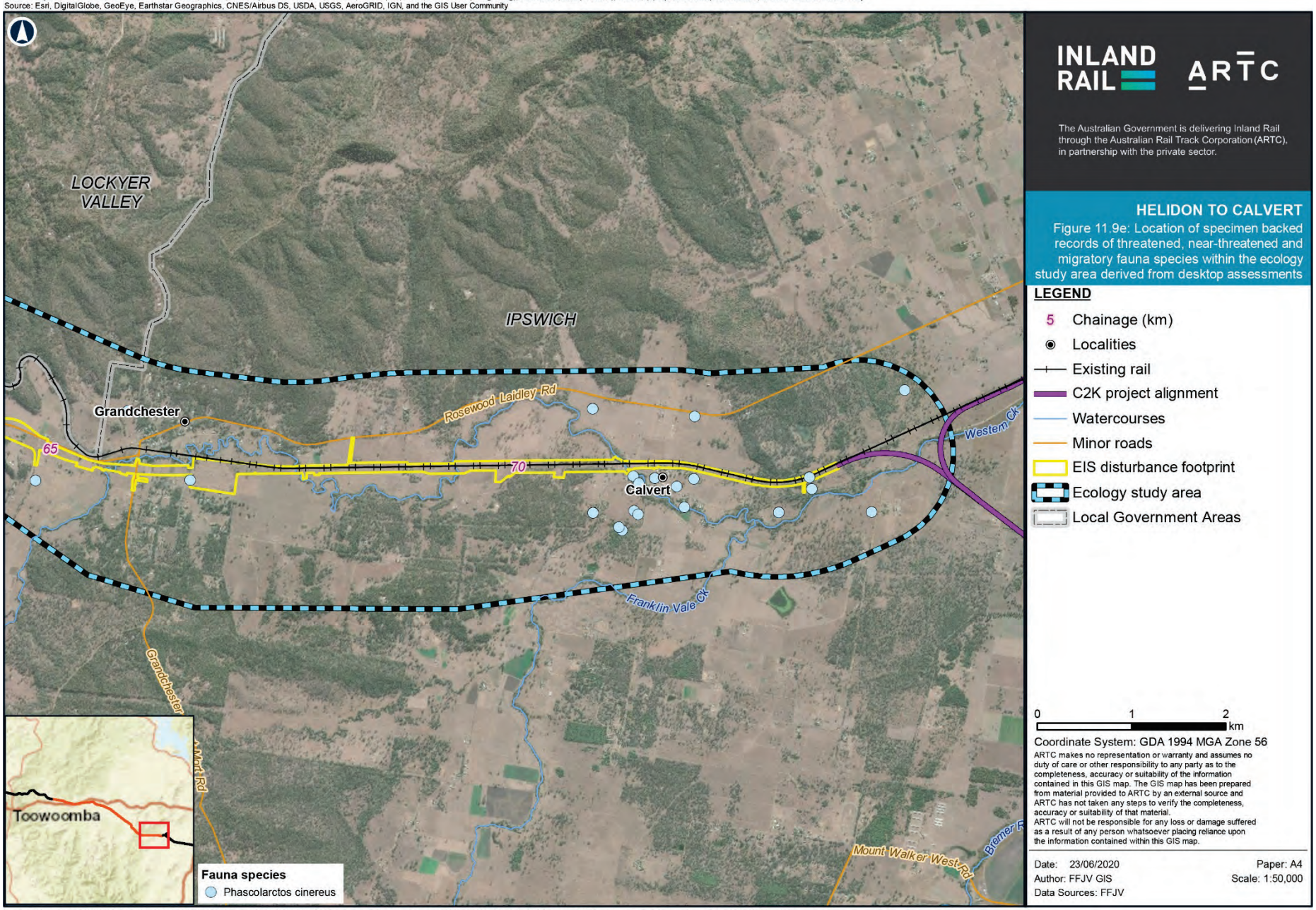

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Figure 11.9e: Location of specimen backed records of threatened, near-threatened and migratory fauna species within the ecology study area derived from desktop assessments

LEGEND

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

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56

Date: 23/06/2020
Author: FFJV GIS
Data Sources: FFJV

Paper: A4
Scale: 1:50,000

Map by: DTH/MEF/LCT/AD/GN/KG Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201906101333_Ecology_figures_and_calcs\330-EAP-201906101333_ARTC_Fig11.9_SignificantFauna_v6_pageE.mxd Date: 23/06/2020 15:55

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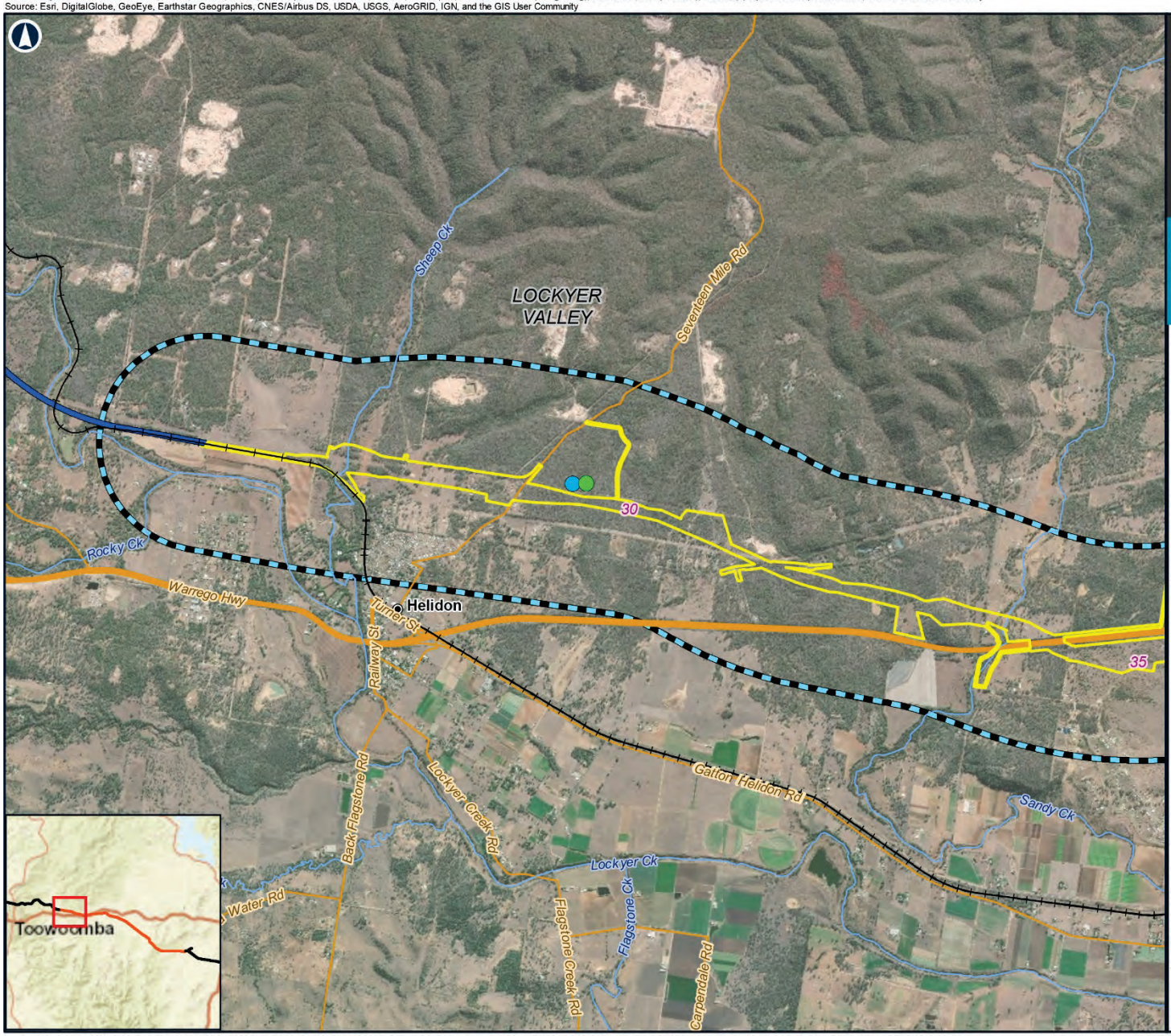

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Figure 11.10a: Locations of observed threatened, near-threatened and migratory fauna species within the ecology study area

LEGEND

- 5 Chainage (km)
- Localities
- Existing rail
- G2H project alignment
- Watercourses
- Major roads
- Minor roads
- EIS disturbance footprint
- Ecology study area
- Local Government Areas

Fauna observations

- Koala (*Phascolarctos cinereus*)
- Black-faced monarch (*Monarcha melanopsis*)

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56

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Author: FFJV GIS
Data Sources: FFJV

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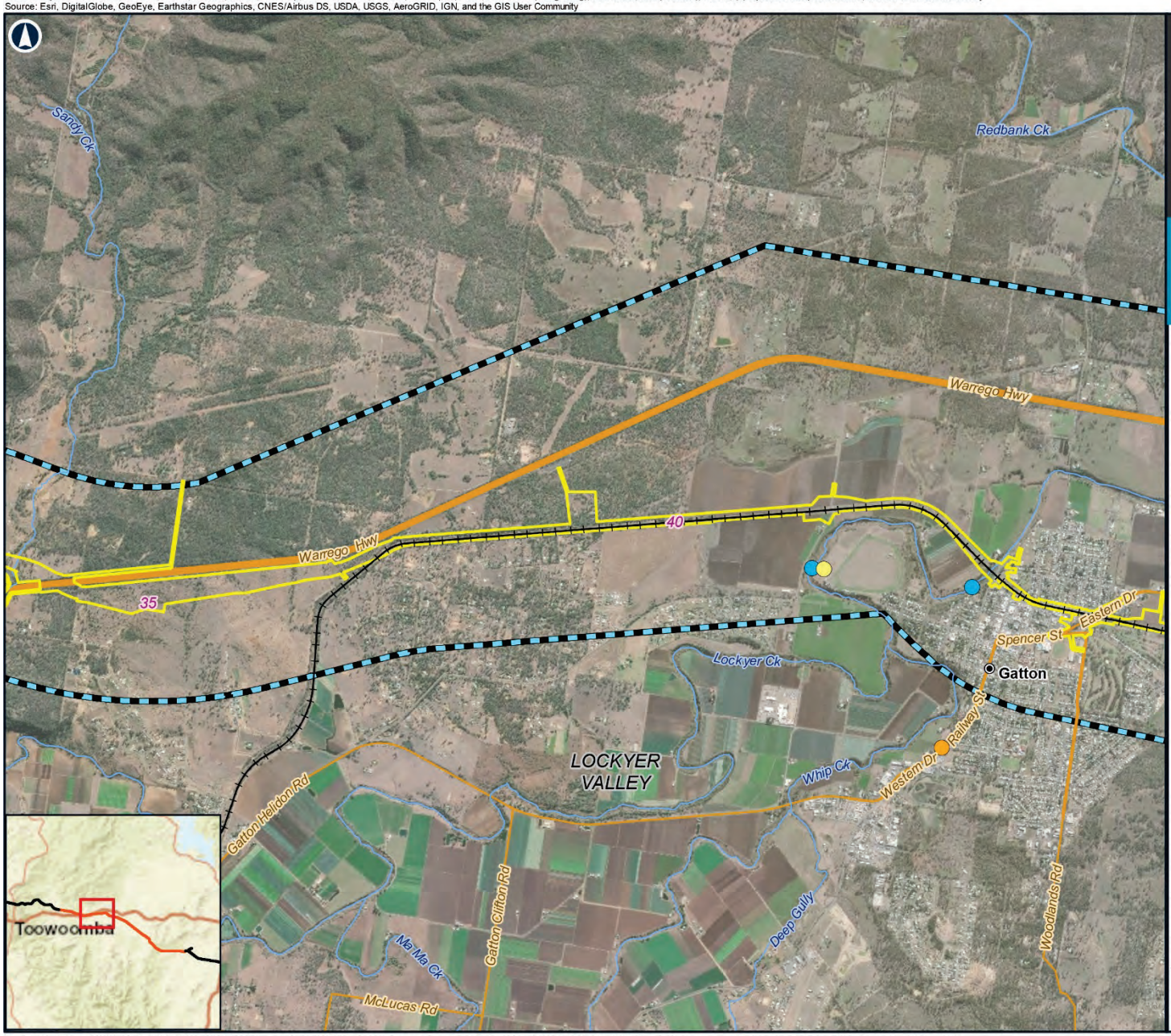

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Figure 11.10b: Locations of observed threatened, near-threatened and migratory fauna species within the ecology study area

LEGEND

- 5 Chainage (km)
- Localities
- Existing rail
- Watercourses
- Major roads
- Minor roads
- EIS disturbance footprint
- Ecology study area
- Local Government Areas

Fauna observations

- Grey falcon (*Falco hypoleucos*)
- Black-faced monarch (*Monarcha melanopsis*)
- Grey-headed flying fox (*Pteropus poliocephalus*)

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56

Date: 23/06/2020
Author: FFJV GIS
Data Sources: FFJV

Paper: A4
Scale: 1:50,000

Map by: DTH/MEF/LCT/AD/GN/KG Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201906101333_Ecology_figures_and_calcs\330-EAP-201906101333_ARTC_Fig11.10_ConservationSignificantFaunaSpecies_v5.mxd Date: 23/06/2020 15:47

Service Layer Credits: 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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Figure 11.10c: Locations of observed threatened, near-threatened and migratory fauna species within the ecology study area

LEGEND

- 5 Chainage (km)
- Localities
- Existing rail
- Watercourses
- Major roads
- Minor roads
- EIS disturbance footprint
- Ecology study area
- Local Government Areas

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56

Date: 23/06/2020
Author: FFJV GIS
Data Sources: FFJV

Paper: A4
Scale: 1:50,000

Map by: DTH/MEF/LCT/AD/GN/KG Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201906101333_Ecology_figures_and_calcs\330-EAP-201906101333_ARTC_Fig11.10_ConservationSignificantFaunaSpecies_v5.mxd Date: 23/06/2020 15:47

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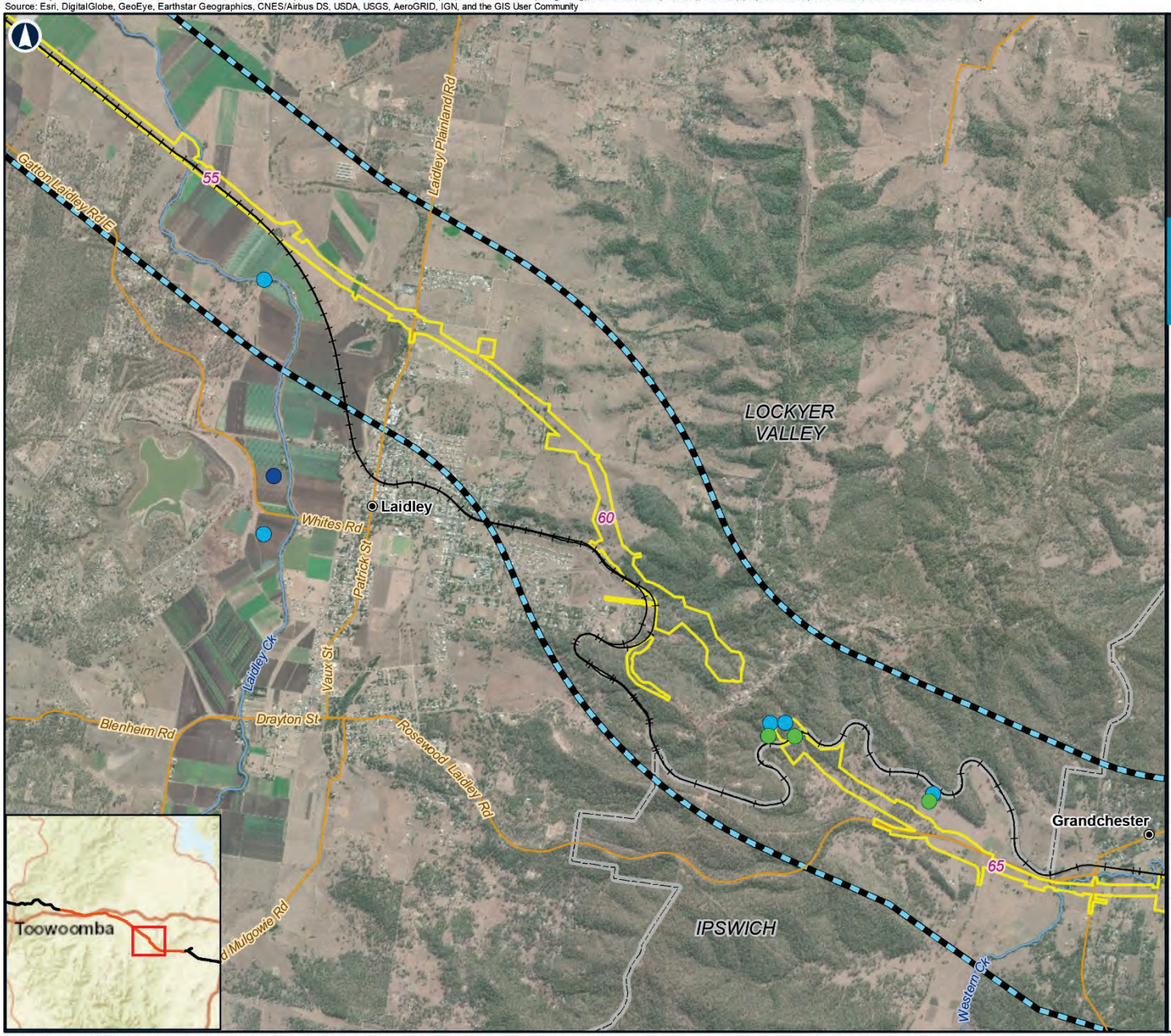

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Figure 11.10d: Locations of observed threatened, near-threatened and migratory fauna species within the ecology study area

LEGEND

- 5 Chainage (km)
- Localities
- Existing rail
- Watercourses
- Minor roads
- EIS disturbance footprint
- Ecology study area
- Local Government

Fauna observations

- Koala (*Phascolarctos cinereus*)
- Black-faced monarch (*Monarcha melanopsis*)
- Spectacled monarch (*Symposiachrus trivirgatus*)

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56

Date: 23/06/2020
Author: FFJV GIS
Data Sources: FFJV

Paper: A4
Scale: 1:50,000

Map by: DTH/MEF/LCT/AD/GN/KG Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201906101333_Ecology_figures_and_calcs\330-EAP-201906101333_ARTC_Fig11.10_ConservationSignificantFaunaSpecies_v5.mxd Date: 23/06/2020 15:47

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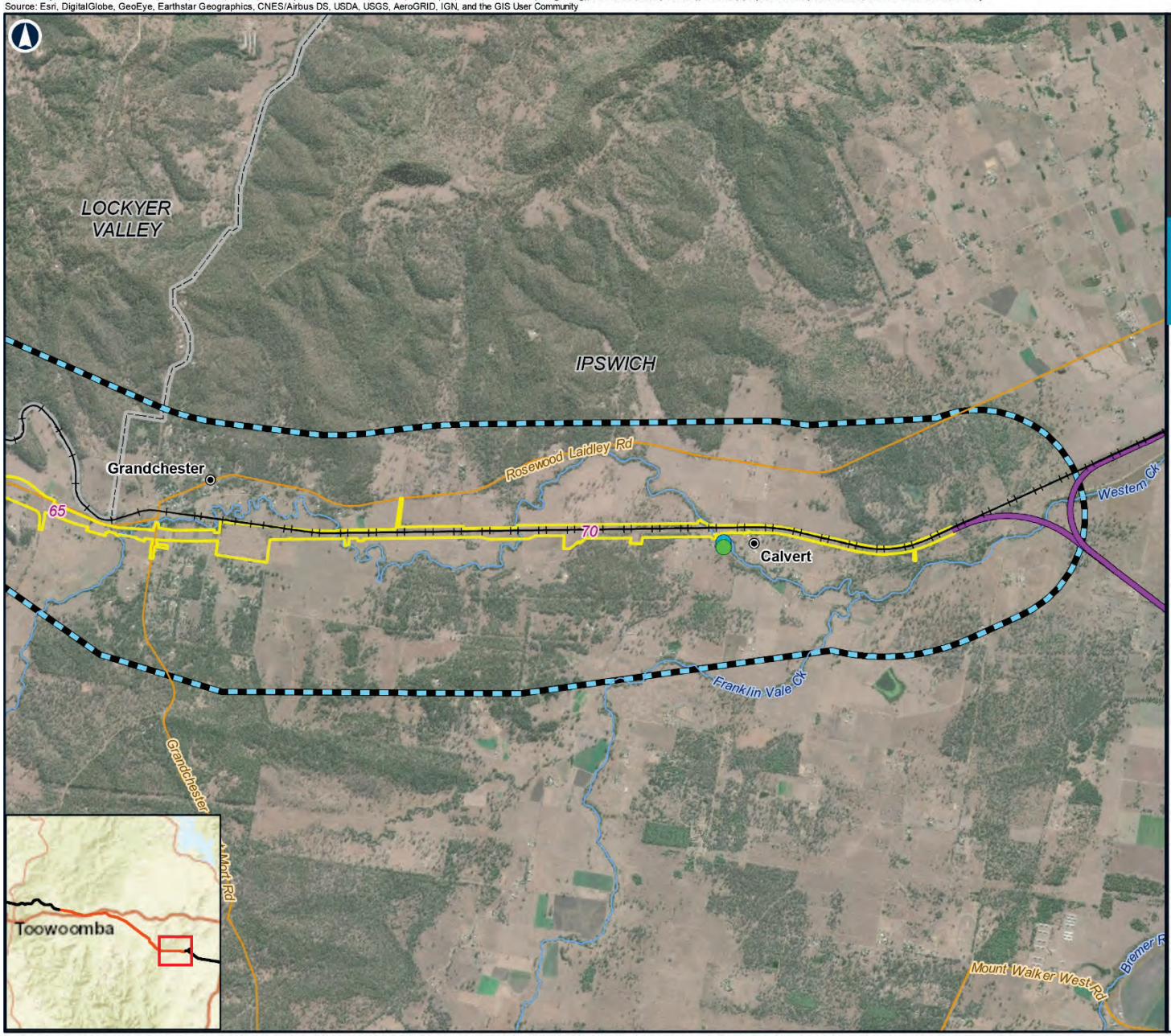

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Figure 11.10e: Locations of observed threatened, near-threatened and migratory fauna species within the ecology study area

LEGEND

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

Fauna observations

- Koala (*Phascolarctos cinereus*)
- Black-faced monarch (*Monarcha melanopsis*)

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56

Date: 23/06/2020
Author: FFJV GIS
Data Sources: FFJV

Paper: A4
Scale: 1:50,000

Map by: DTH/MEF/LCT/AD/GN/KG Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201906101333_Ecology_figures_and_calcs\330-EAP-201906101333_ARTC_Fig11.10_ConservationSignificantFaunaSpecies_v5.mxd Date: 23/06/2020 15:47

11.6.3.2 Introduced fauna

Twelve non-native fauna species, including five declared as restricted matters (invasive animals) under the Biosecurity Act, were identified within ecology study area during Project EIS field investigations (refer Table 11.13). These species were widespread across the entire ecology study area.

TABLE 11.13: RESTRICTED MATTER FAUNA SPECIES IDENTIFIED WITHIN THE ECOLOGY STUDY AREA

Family name	Species name	Common name	Schedule 2 of the Biosecurity Act	Relative abundance within the ecology study area
Bovidae	*Capra hircus*	Feral Goat	Category: 3,4,6	Uncommon
Canidae	*Canis lupis familiaris*	Wild dog	Category: 3,4,6	Common
Felidae	*Felis catus*	Unowned Cat	Category: 3,4,6	Common
Leporidae	*Oryctolagus cuniculus*	European rabbit	Category: 3,4,5,6	Common
Poeciliidae	*Gambusia holbrooki*	Eastern mosquito fish	Category: 3	Very common

Table notes:
Each restriction category number identifies an obligation or an offence provision that applies to biosecurity matter assigned that category number. These categories are identified below:
Biosecurity category 3: A person must not distribute the invasive plant either by sale or gift, release it into the environment.
Biosecurity category 4: A person must not move the invasive plant.
Biosecurity category 5: A person must not keep the invasive plant.
Biosecurity category 6: Includes certain invasive animals such as foxes, rabbits, wild dogs, feral deer and noxious fish such as carp, gambusia and tilapia. A person must not feed this category of restricted matter.

The Project overlaps the Fire Ant Biosecurity Zone 1 east of where the alignment ties in with the West Moreton System south of the Warrego Highway. All movement of soil to outside the Fire Ant Biosecurity Zones requires a biosecurity instrument permit, which includes the Project disturbance footprint to the west.

11.6.4 Wildlife mapping and Koala mapping and Biodiversity Planning Assessment mapping

11.6.4.1 Threatened species habitat mapping

Habitat for threatened flora and fauna (including some SLC animals) as listed under the provisions of the NC Act (Qld) are defined as MSES under the Queensland SPP 2017 (DILGP, 2017b). This habitat includes areas listed as 'essential habitat' for threatened species as mapped under the VM Act.

A review of government datasets identified the following areas mapped as Essential habitat (VM Act):

- Lockyer National Park, north of Helidon
- Lockyer Creek
- Land north east of Placid Hills
- Gatton National Park, south east of Gatton
- Little Liverpool Range.

Mapped MSES wildlife habitat and Essential habitat (VM Act) mapping occurring within the Project disturbance footprint is shown in Figure 11.11a and Figure11.11b and quantified in Table 11.14. Much of this habitat has been mapped for the Koala (*Phascolarctos cinereus*). Further details related to the Koala is provided within Appendix J: Matters of National Environmental Significance Technical Report and Section 11.1.1.1.

TABLE 11.14: MATTERS OF STATE ENVIRONMENTAL SIGNIFICANCE WILDLIFE HABITAT PRESENT WITHIN THE ECOLOGY STUDY AREA

	Extent (ha)	
Identified wildlife habitat	Ecology study area	Project disturbance footprint
MSES wildlife mapping	2940.06	19.84
Essential habitat (VM Act)	2679.75	95.66

11.6.4.2 Koala habitat mapping

The ecology study area is wholly contained within Koala district A which is defined as South East Queensland under the Planning Regulation 2017 (Qld). As defined by the *Nature Conservation (Koala) Conservation Plan 2017*, which categorises areas into four distinct categories: Koala Priority Areas, Koala Habitat Areas, Koala Habitat Restoration Areas, Locally Refined Koala Habitat Areas.

- Koala Priority Areas are large, connected areas where a focus will be on habitat protection, habitat restoration and threat mitigation to safeguard Koala populations in South East Queensland. The Little Liverpool Range and the forested areas to the north-west of Helidon mapped as Koala Priority Areas. Koala Priority Areas constitute the second largest habitat category within the ecology study area and the Project disturbance footprint
- Koala Habitat Areas (core) represent the best quality Koala habitat, based on modelling of biophysical measures (such as climate), suitable vegetation (for both food and shelter), and Koala sighting records. Koala Habitat Areas relevant to the Project include remnant vegetation to the north of the Warrego Highway and Little Liverpool Range, while between the Warrego Highway and Little Liverpool Range these areas are to the south of the Project. This mapping also generally aligns with the essential habitat mapping for Koalas.
- Koala Habitat Restoration Areas is land that could be restored and established as Koala habitat. These areas feature low threats or constraints, and high conservation opportunities. The majority of the ecology study area east of Gatton is mapped as Koala Habitat Restoration Areas, including areas within the Koala Priority Area. This mapping includes areas substantially cleared for agriculture, along with Lockyer and Laidley creeks. Koala restoration areas (i.e. Koala Habitat Restoration Area - Koala Priority Area and Koala Habitat Restoration Areas) constitute the largest habitat category within the ecology study area and the Project disturbance footprint
- Koala habitat areas (locally refined) are currently protected in South East Queensland and include areas of remnant (uncleared) or high-value regrowth vegetation previously protected by local governments. None of these areas occur within the ecology study area. These areas are absent from the ecology study area and the Project disturbance footprint.

The extent of these areas is shown in Figure 11.12a and Figure 11.12e and defined in Table 11.15.

TABLE 11.15: EXTENT OF KOALA MAPPING WITHIN THE ECOLOGY STUDY AREA

	Extent (ha)	
Habitat category	**Ecology study area**	**Project disturbance footprint**
Koala Priority Areas	4,407.30	193.49
Koala Habitat Areas	2,649.01	95.62
Koala Habitat Restoration Area—Koala Priority Area	1,638.38	119.50
Koala Habitat Restoration Areas	3,962.79	161.07
Locally Refined Koala Habitat Areas	0.00	0.00

11.6.4.3 Biodiversity Planning Assessment mapping

The BPA classifies areas according to their significance based on the presence of endangered, vulnerable and near threatened (EVNT) taxa. It excludes highly mobile fauna taxa. The ecology study area includes areas of State and regional habitat values for EVNT taxa. The extent of this habitat within the ecology study area is provided in Table 11.16 and shown in Figure 11.13a.

TABLE 11.16: THE EXTENT OF BIODIVERSITY PLANNING ASSESSMENT HABITAT VALUES WITHIN THE ECOLOGY STUDY AREA

	Extent (ha)	
Habitat values	**Ecology study area**	**Project disturbance footprint**
Local or other values	277.44	10.65
Regional	667.14	9.10
State	635.09	9.61
State Habitat for EVNT taxa	155.12	2.90

Areas identified under the BPA as corridors qualify either because they are existing vegetated corridors important for contiguity including regrowth or cleared areas that could serve this purpose if revegetated. Some examples of corridors include riparian habitats, transport corridors and 'stepping stones'.

The ecology study area is traversed by terrestrial and riparian ecological corridors. The location of these corridors is provided in Figure 11.13a and Figure11.13b and quantified in Table 11.17.

TABLE 11.17: THE EXTENT OF BIODIVERSITY PLANNING ASSESSMENT TERRESTRIAL AND RIPARIAN ECOLOGICAL CORRIDORS WITHIN THE ECOLOGY STUDY AREA

	Extent (ha)	
Corridor type	**Ecology study area**	**Project disturbance footprint**
Regional terrestrial	1,805.81	140.81
State riparian	720.47	22.52
State riparian/terrestrial	2.54	0.00

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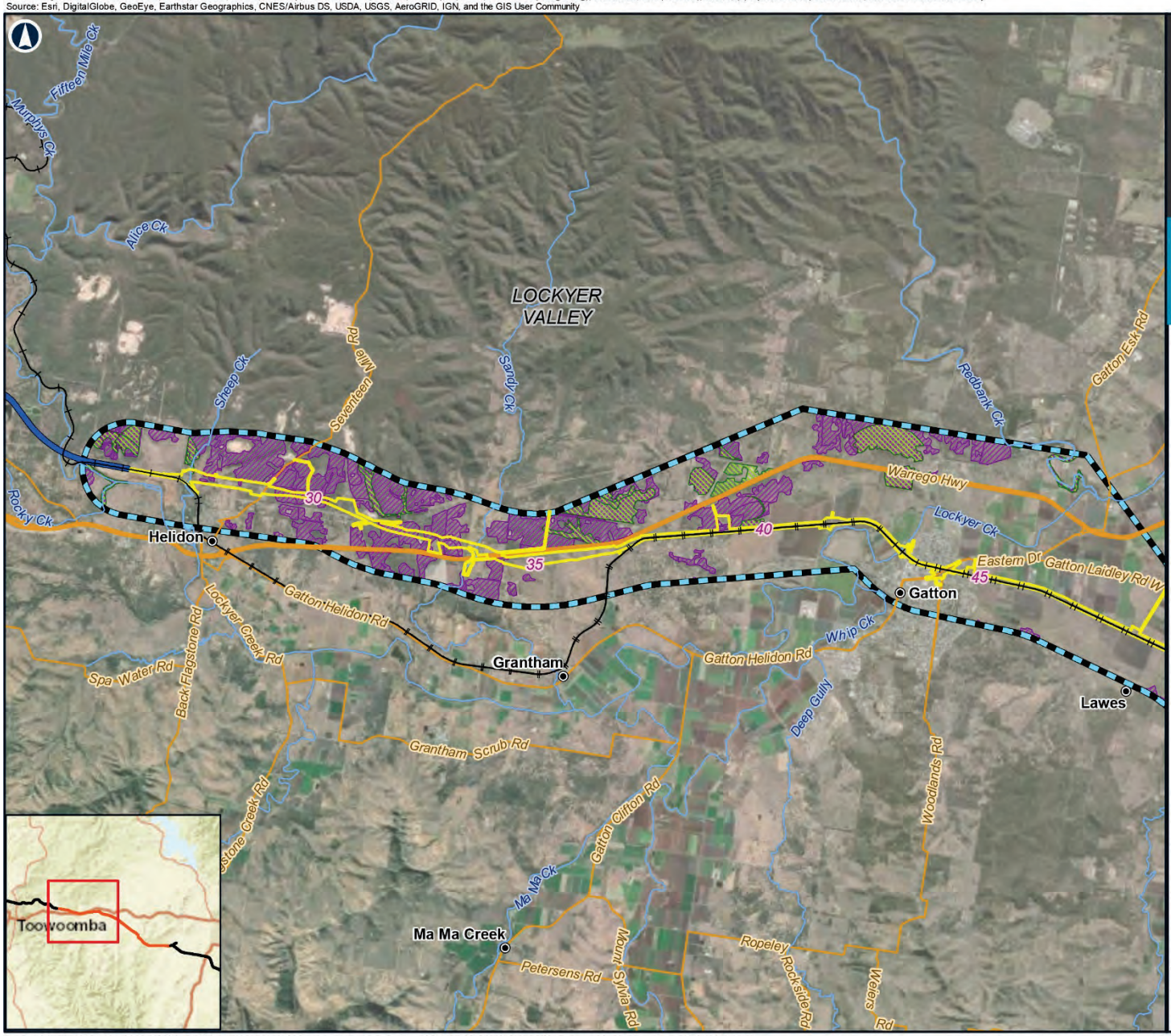

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Figure 11.11a: Matters of state environmental significance (MSES) wildlife habitat and essential habitat mapping

LEGEND

- 5 Chainage (km)
- Localities
- Existing rail
- G2H project alignment
- Watercourses
- Major roads
- Minor roads
- EIS disturbance footprint
- Ecology study area
- Local Government Areas
- Essential habitat
- MSES wildlife habitat

0 2.5 5 km

Coordinate System: GDA 1994 MGA Zone 56

Date: 23/06/2020
Author: FFJV GIS
Data Sources: FFJV

Paper: A4
Scale: 1:115,000

Map by: GN/KG Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201906101333_Ecology_figures_and_calcs\330-EAP-201906101333_ARTC_Fig11.11_MSES_v1.mxd Date: 23/06/2020 15:41

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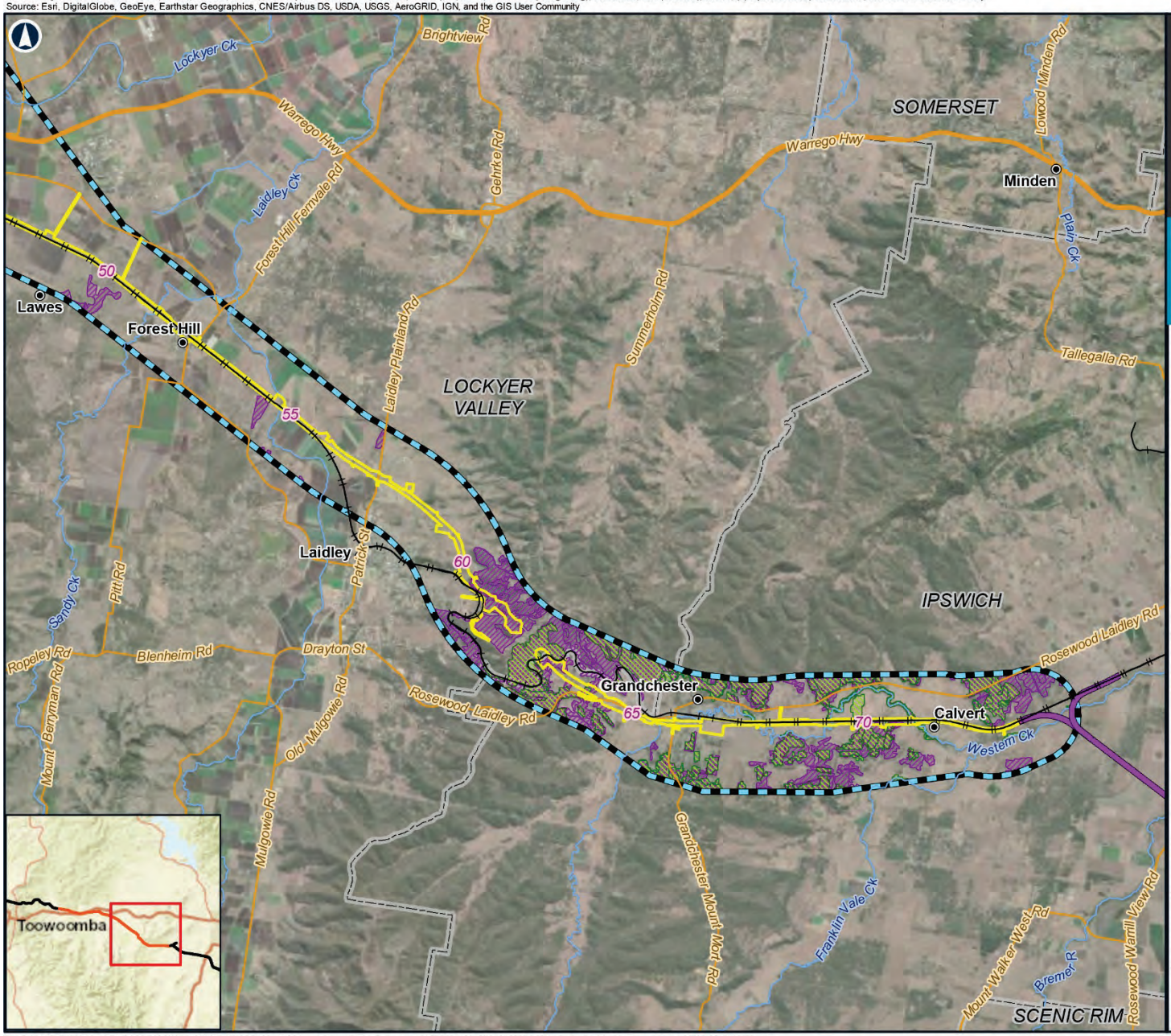

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Figure 11.11b: Matters of state environmental significance (MSES) wildlife habitat and essential habitat mapping

LEGEND

- 5 Chainage (km)
- Localities
- Existing rail
- C2K project alignment
- Watercourses
- Major roads
- Minor roads
- EIS disturbance footprint
- Ecology study area
- Local Government Areas
- Essential habitat
- MSES wildlife habitat

0 2.5 5 km

Coordinate System: GDA 1994 MGA Zone 56

Date: 23/06/2020
Author: FFJV GIS
Data Sources: FFJV

Paper: A4
Scale: 1:115,000

Map by: GN/KG Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201906101333_Ecology_figures_and_calcs\330-EAP-201906101333_ARTC_Fig11.11_MSES_v1.mxd Date: 23/06/2020 15:41

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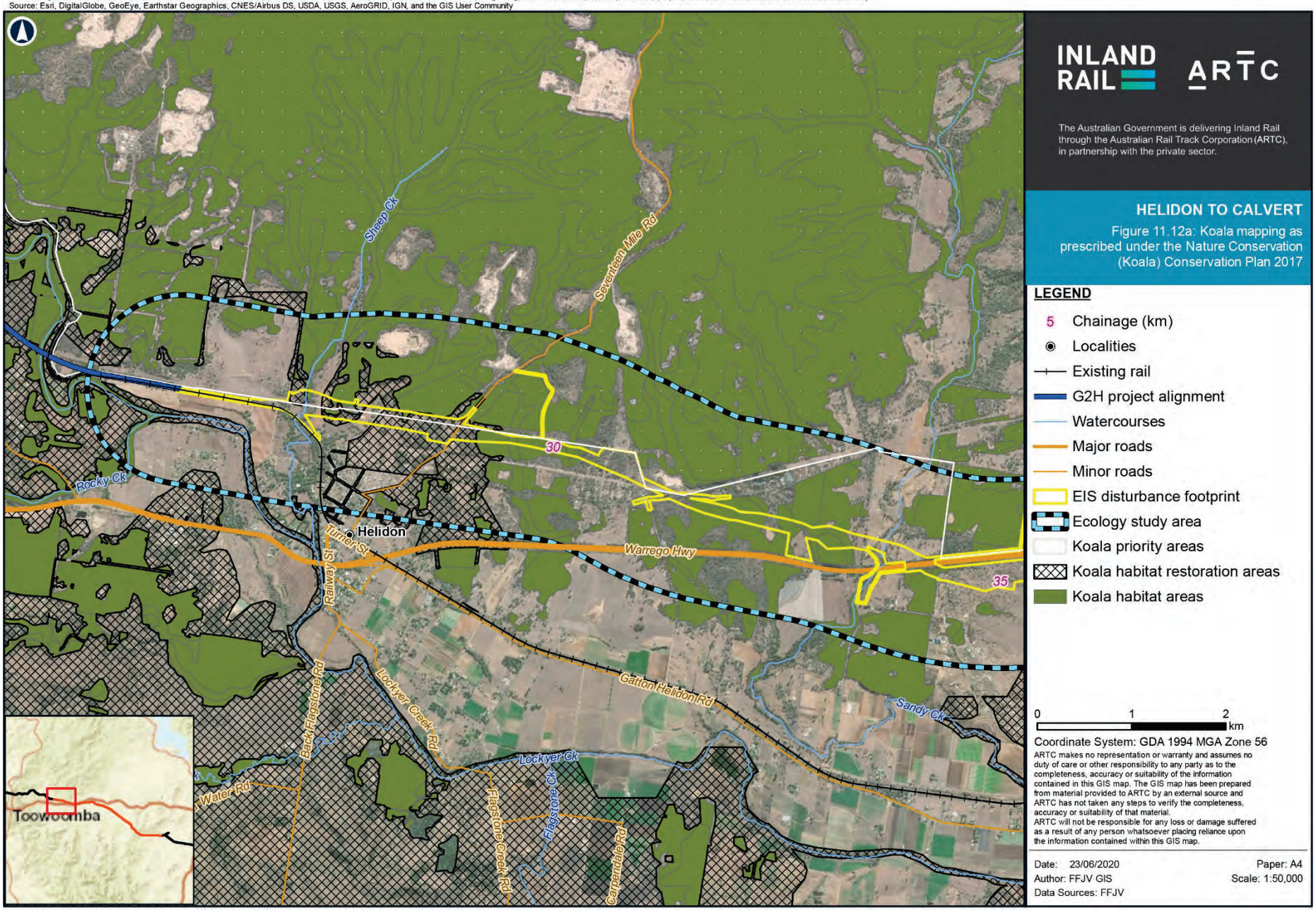

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Figure 11.12a: Koala mapping as prescribed under the Nature Conservation (Koala) Conservation Plan 2017

LEGEND

- 5 Chainage (km)
- Localities
- Existing rail
- G2H project alignment
- Watercourses
- Major roads
- Minor roads
- EIS disturbance footprint
- Ecology study area
- Koala priority areas
- Koala habitat restoration areas
- Koala habitat areas

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56

Date: 23/06/2020
Author: FFJV GIS
Data Sources: FFJV

Paper: A4
Scale: 1:50,000

Map by: GN/KG Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201906101333_Ecology_figures_and_calcs\330-EAP-201906101333_ARTC_Fig11.12_Koala_map_v1.mxd Date: 23/06/2020 15:42

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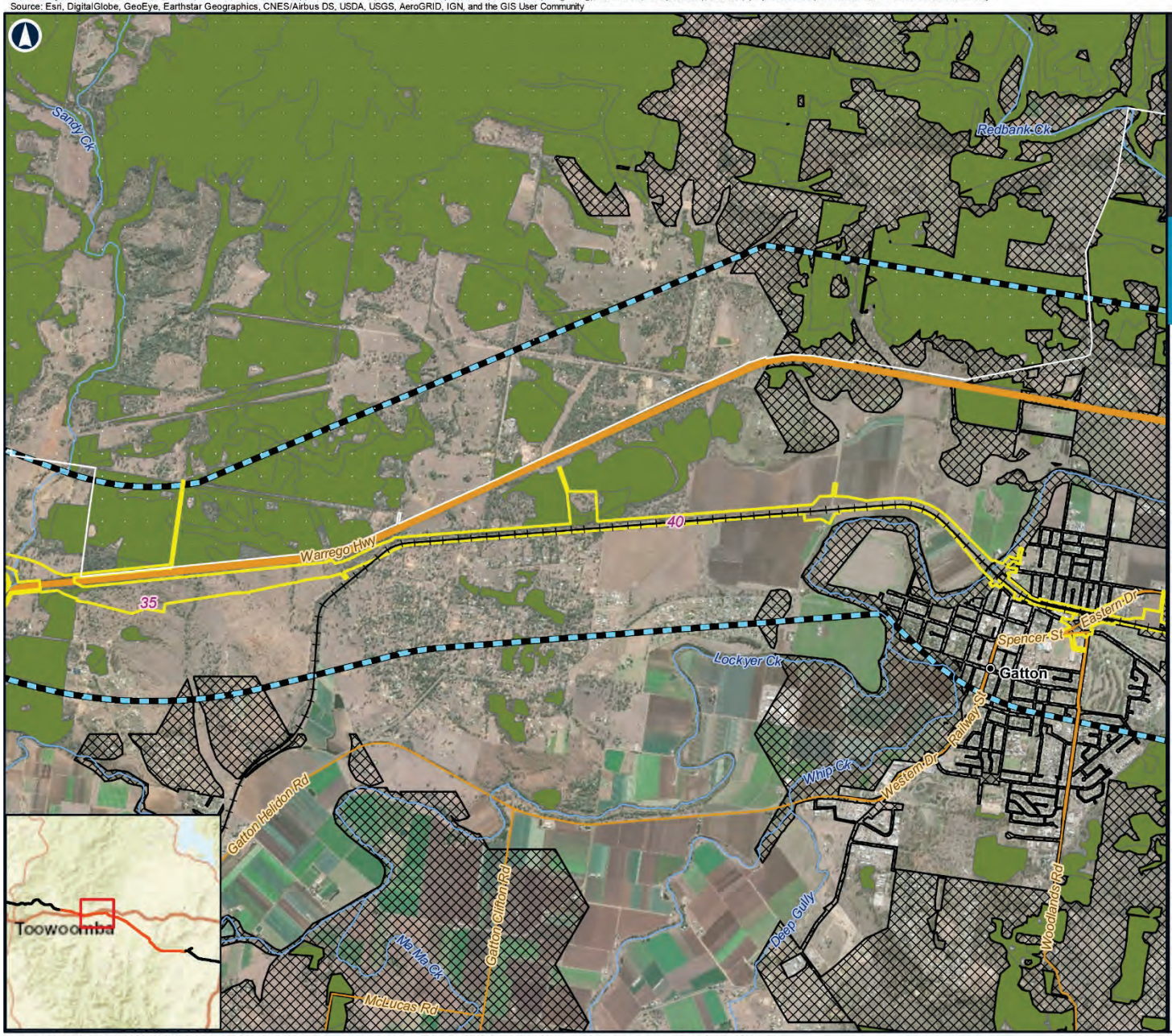

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Figure 11.12b: Koala mapping as prescribed under the Nature Conservation (Koala) Conservation Plan 2017

LEGEND

- 5 Chainage (km)
- Localities
- Existing rail
- Watercourses
- Major roads
- Minor roads
- EIS disturbance footprint
- Ecology study area
- Koala priority areas
- Koala habitat restoration areas
- Koala habitat areas

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56

Date: 23/06/2020
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Data Sources: FFJV

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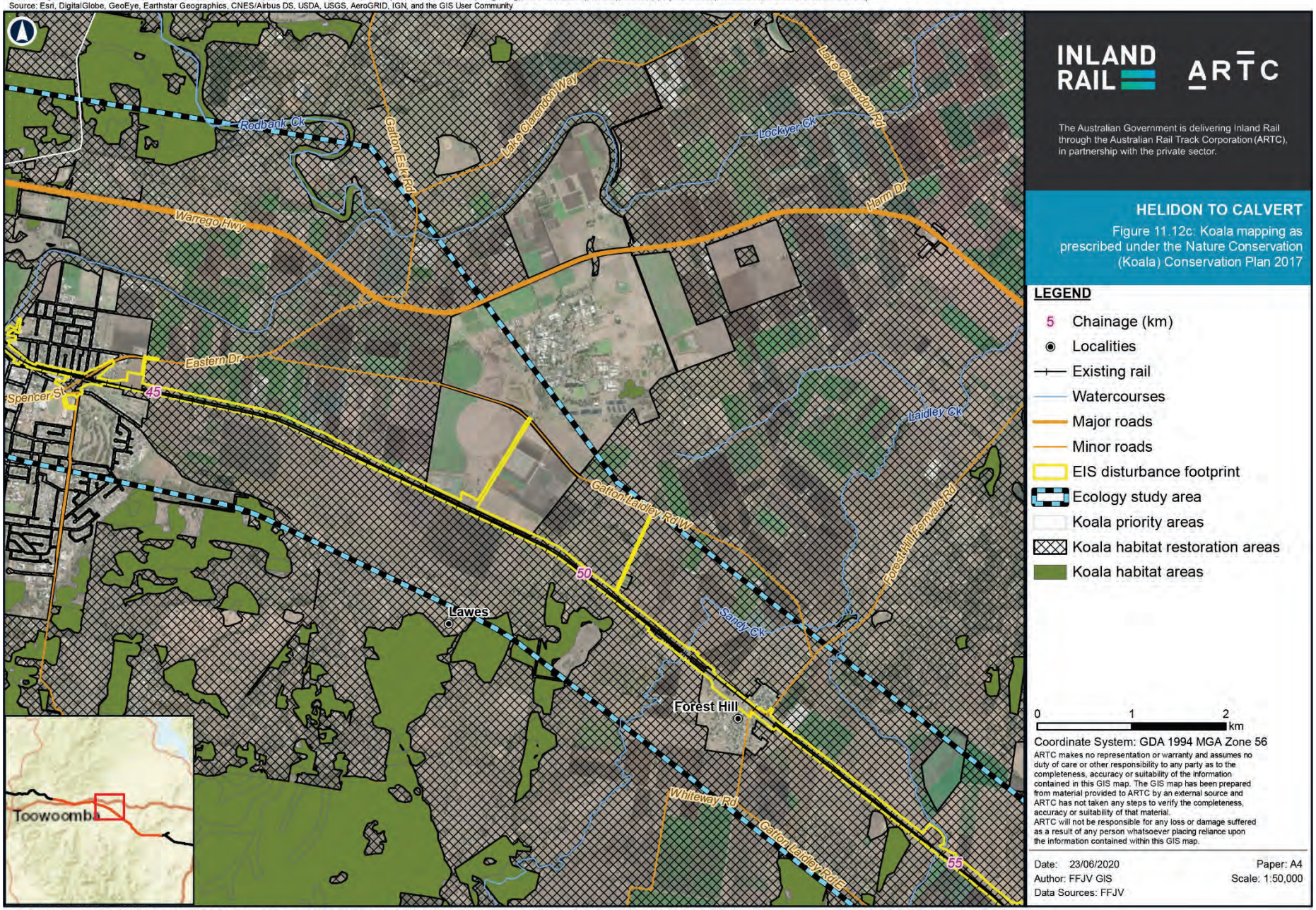

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Figure 11.12c: Koala mapping as prescribed under the Nature Conservation (Koala) Conservation Plan 2017

LEGEND

- 5 Chainage (km)
- Localities
- Existing rail
- Watercourses
- Major roads
- Minor roads
- EIS disturbance footprint
- Ecology study area
- Koala priority areas
- Koala habitat restoration areas
- Koala habitat areas

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56

Date: 23/06/2020
Author: FFJV GIS
Data Sources: FFJV

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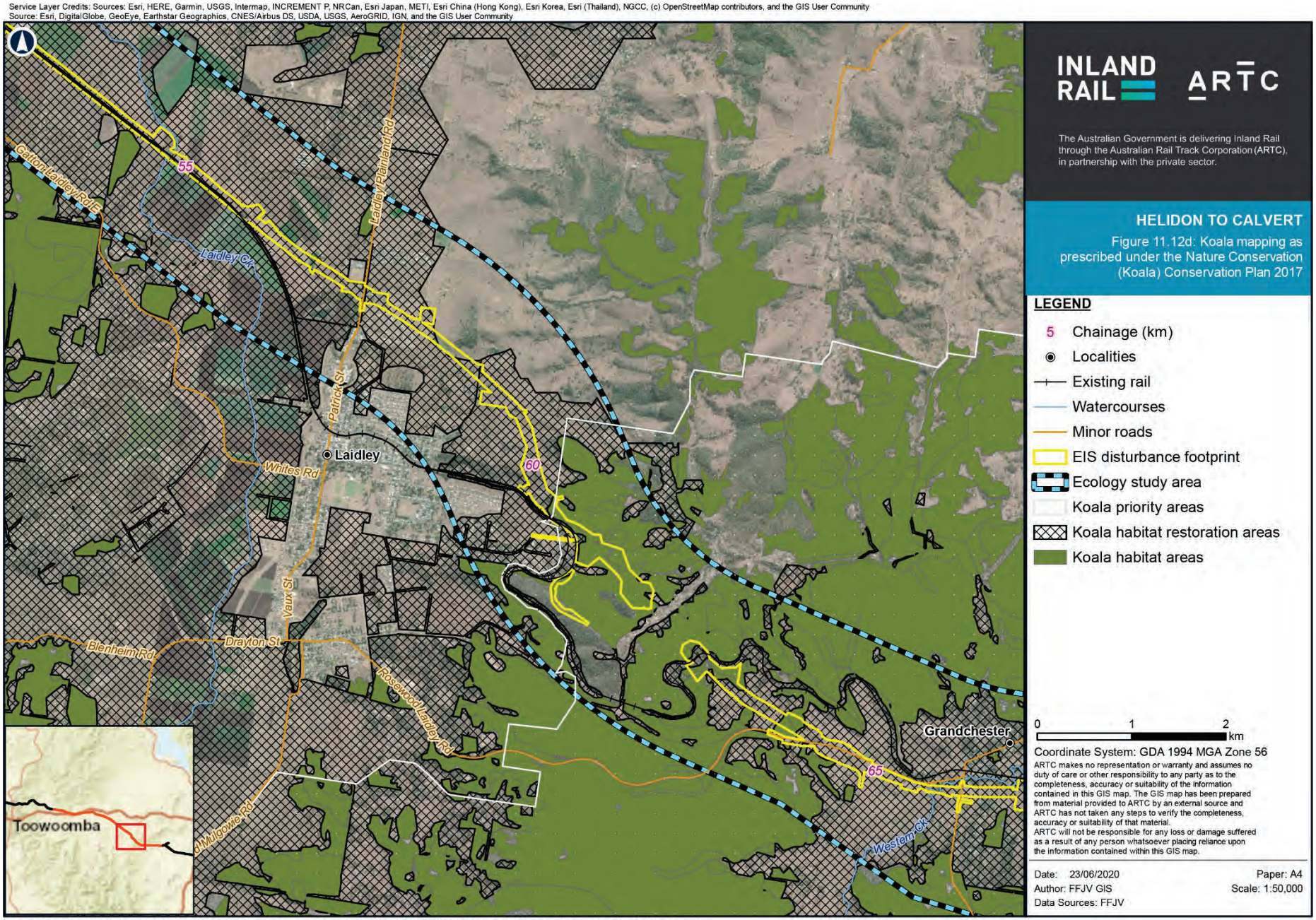

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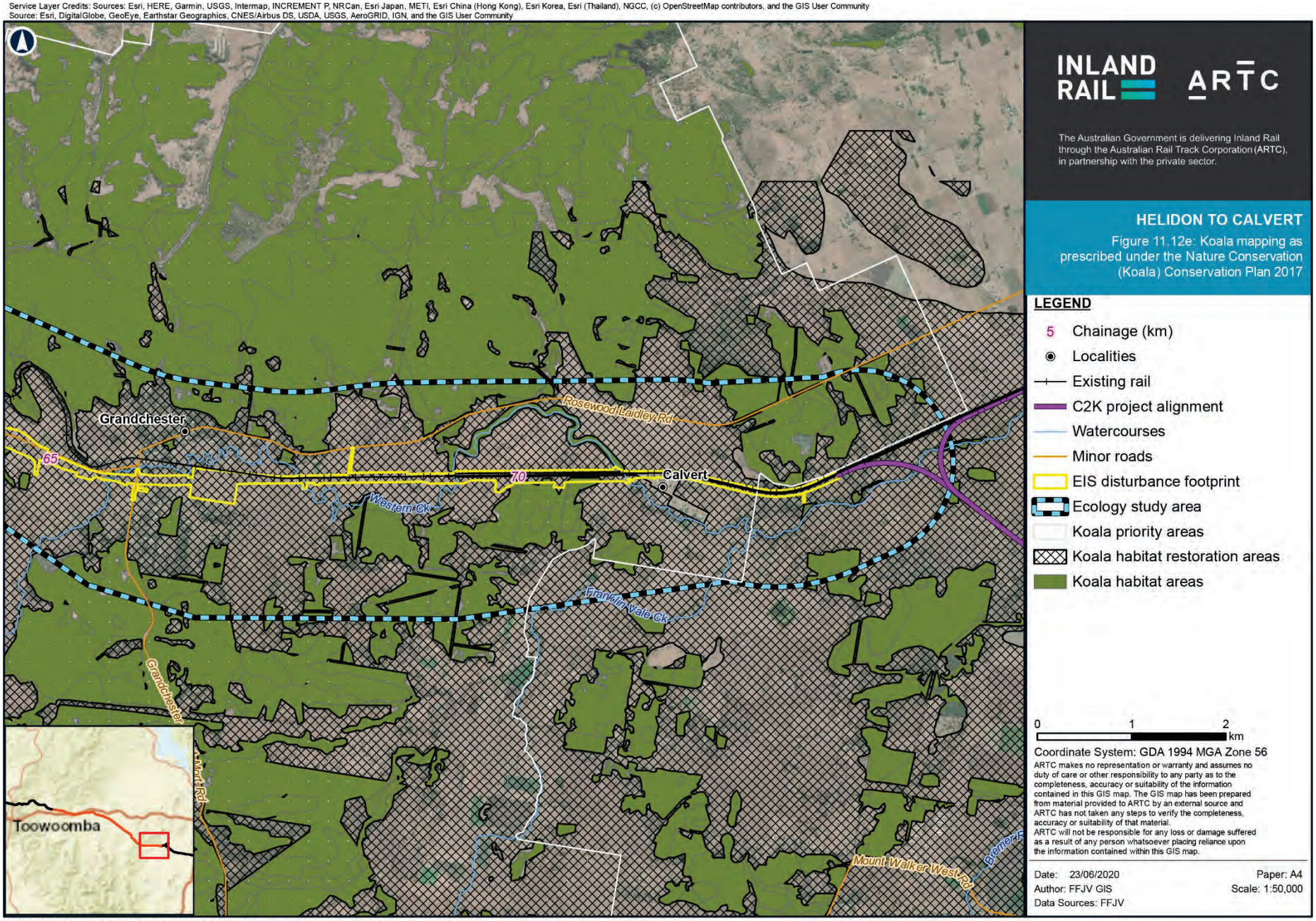
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Grandchester
Calvert
Rosewood-Laidley Rd
Western Ck
Franklin Vale Ck
Grandchester
Mount Walker West Rd
65
70
Toowoomba
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Figure 11.12e: Koala mapping as prescribed under the Nature Conservation (Koala) Conservation Plan 2017
LEGEND
5 Chainage (km)
Localities
Existing rail
C2K project alignment
Watercourses
Minor roads
EIS disturbance footprint
Ecology study area
Koala priority areas
Koala habitat restoration areas
Koala habitat areas
0 1 2 km
Coordinate System: GDA 1994 MGA Zone 56
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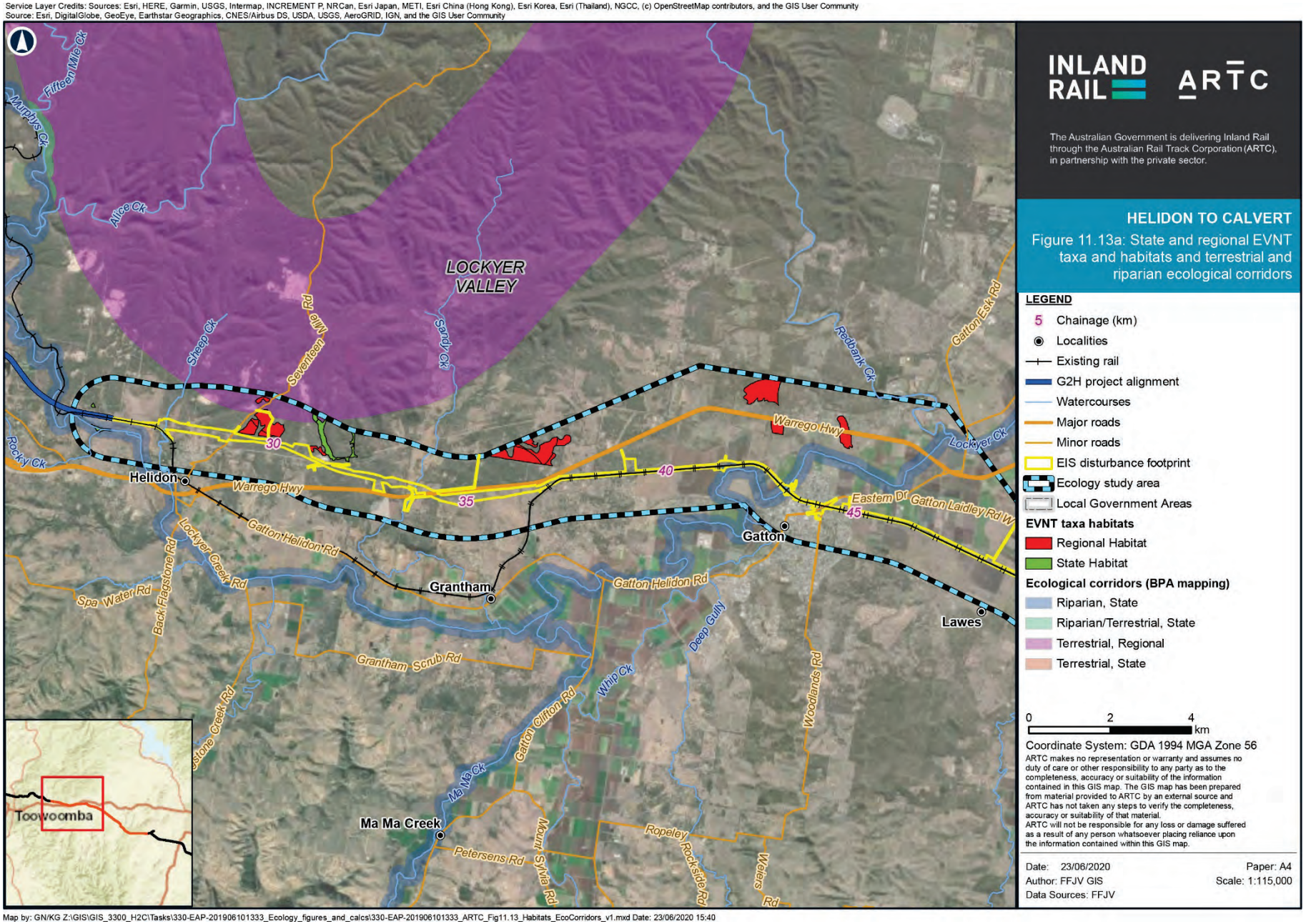
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LOCKYER VALLEY
Helidon
Grantham
Gatton
Lawes
Ma Ma Creek
Toowoomba
Warrego Hwy
Gatton Helidon Rd
Grantham Scrub Rd
Petersens Rd
Gatton Clifton Rd
Eastern Dr
Gatton Laidley Rd
Lockyer Creek Rd
Back Flagstone Rd
Spa Water Rd
Mount View Rd
Ropeley Rockside Rd
Woodlands Rd
Deep Gully
Whip Ck
Ma Ma Ck
Fifteen Mile Ck
Murphys Ck
Alice Ck
Sheep Ck
Seventeen Mile Rd
Sandy Ck
Redbank Ck
Gatton Esk Rd
Lockyer Ck
Rocky Ck
30
35
40
45
INLAND RAIL
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HELIDON TO CALVERT
Figure 11.13a: State and regional EVNT taxa and habitats and terrestrial and riparian ecological corridors
LEGEND
5 Chainage (km)
Localities
Existing rail
G2H project alignment
Watercourses
Major roads
Minor roads
EIS disturbance footprint
Ecology study area
Local Government Areas
EVNT taxa habitats
Regional Habitat
State Habitat
Ecological corridors (BPA mapping)
Riparian, State
Riparian/Terrestrial, State
Terrestrial, Regional
Terrestrial, State
0 2 4 km
Coordinate System: GDA 1994 MGA Zone 56
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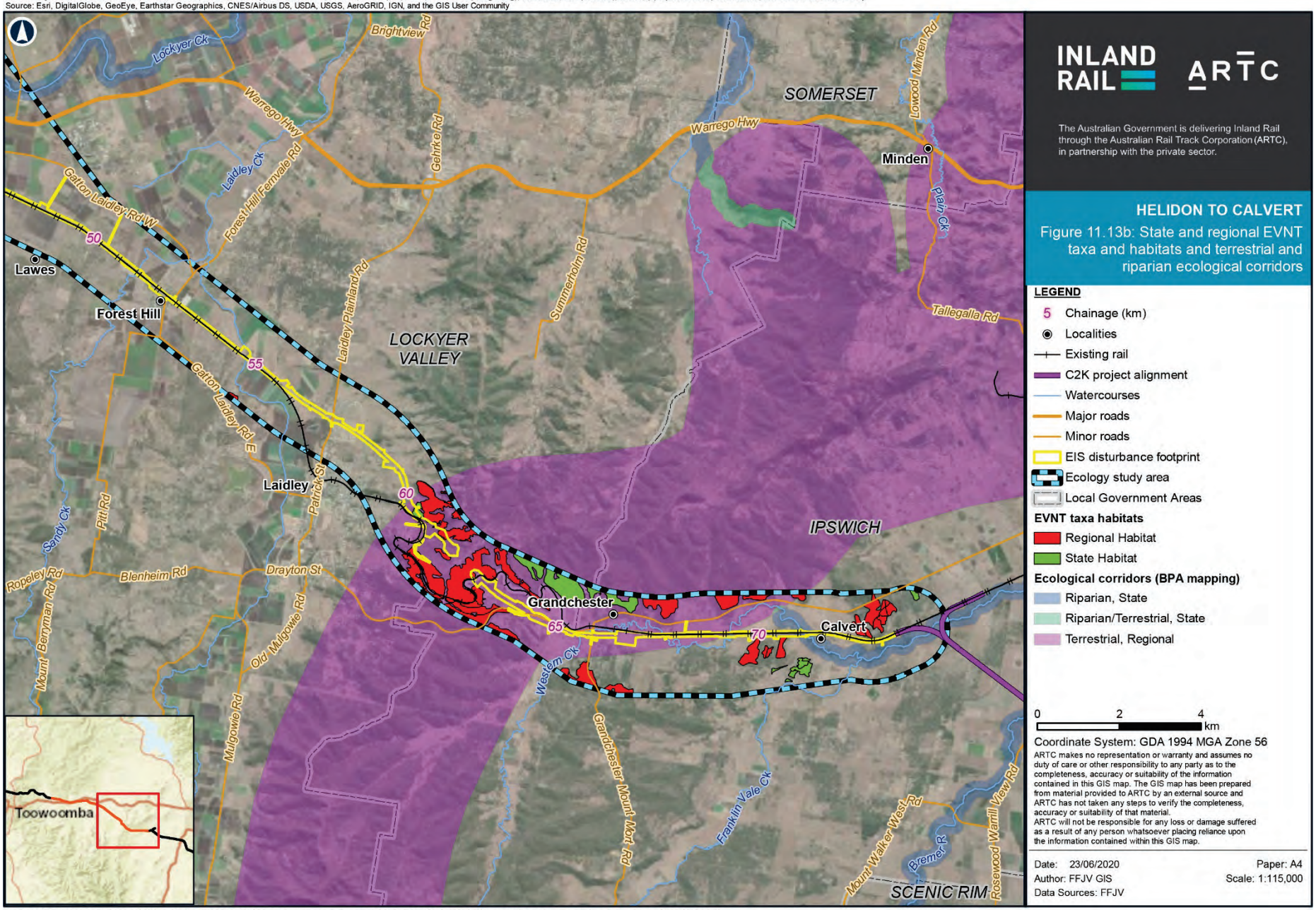
Author: FFJV GIS
Data Sources: FFJV
Paper: A4
Scale: 1:115,000
Map by: GN/KG Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201906101333_Ecology_figures_and_calcs\330-EAP-201906101333_ARTC_Fig11.13_Habitats_EcoCorridors_v1.mxd Date: 23/06/2020 15:40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Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Lockyer Ck
Brightview Rd
Warrego Hwy
Gehrke Rd
Laidley Ck
Forest Hill Fernvale Rd
Gatton Laidley Rd W
50
Lawes
Forest Hill
Laidley Plainland Rd
LOCKYER VALLEY
Summerholm Rd
SOMERSET
Lowood Minden Rd
Minden
Plain Ck
Tallegalla Rd
55
Gatton Laidley Rd E
Laidley
Patrick St
60
Sandy Ck
Pitt Rd
Ropeley Rd
Blenheim Rd
Drayton St
Mount Berryman Rd
Old Mulgowie Rd
Mulgowie Rd
IPSWICH
Grandchester
65
70
Calvert
Western Ck
Grandchester Mount Mort Rd
Franklin Vale Ck
Mount Walker West Rd
Bremer R
Rosewood Warrill View Rd
SCENIC RIM
Toowoomba
INLAND RAIL
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HELIDON TO CALVERT
Figure 11.13b: State and regional EVNT taxa and habitats and terrestrial and riparian ecological corridors
LEGEND
5 Chainage (km)
Localities
Existing rail
C2K project alignment
Watercourses
Major roads
Minor roads
EIS disturbance footprint
Ecology study area
Local Government Areas
EVNT taxa habitats
Regional Habitat
State Habitat
Ecological corridors (BPA mapping)
Riparian, State
Riparian/Terrestrial, State
Terrestrial, Regional
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km
Coordinate System: GDA 1994 MGA Zone 56
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Date: 23/06/2020
Paper: A4
Author: FFJV GIS
Scale: 1:115,000
Data Sources: FFJV
Map by: GN/KG Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201906101333_Ecology_figures_and_calcs\330-EAP-201906101333_ARTC_Fig11.13_Habitats_EcoCorridors_v1.mxd Date: 23/06/2020 15:40

11.6.5 Predicted habitat for conservation significant species and ecological communities

Predicted habitat mapping for threatened and near-threatened, migratory and SLC species indicates that potential habitat exists for 10 flora (species list listed under the EPBC Act the NC Act, and three species listed under the NC Act) and 21 fauna species (15 species list listed under the EPBC Act and the NC Act, four species under listed under the EPBC Act and two species listed under the NC Act)occurs within the ecology study area (refer Table 11.18, Table 11.19 and Table 11.20). Areas of habitat for these species are provided in Table 11.18, Table 11.19 and Table 11.20 and maps provided in Appendix I: Terrestrial and Aquatic Ecology Technical Report and Appendix J: Matters of National Environmental Significance Technical Report.

It is noted that for Table 11.18, the habitat category criteria is defined in Section 11.5.3, with potential habitat specifically defined in section 11.5.3.2. While these areas may not meet state or commonwealth defined habitat (i.e. essential or critical) it has been included in the impact assessment as part of the precautionary approach.

TABLE 11.18: PREDICTED HABITAT FOR THREATENED (EPBC ACT) FLORA AND FAUNA SPECIES WITHIN THE ECOLOGY STUDY AREA

				Predicted habitat within the ecology study area (ha)* (11,866.54 ha)				Predicted habitat within the Project disturbance footprint (ha)* (634.58 ha)			
Species name	**Common name**	**NC Act status**	**EPBC Act status**	**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	V	**1.16**	1.16	0.00	0.00	**0.00**	0.00	0.00	0.00
Dichanthium setosum	Bluegrass	LC	V	**0.00**	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00
Grevillea quadricauda	Four-tailed Grevillea	V	V	**476.49**	476.49	0.00	0.00	**26.06**	26.06	0.00	0.00
Leionema obtusifolium	Blunt-leaved Leionema	V	V	**888.11**	888.11	0.00	0.00	**29.26**	29.26	0.00	0.00
Lepidium peregrinum	Wandering Pepper-cress	LC	E	**0.00**	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00
Notelaea lloydii	Lloyd's Olive	V	V	**2,593.56**	2,417.14	0.00	176.42	**134.03**	112.77	0.00	21.26
Paspalidium grandispiculatum	a grass	V	V	**2,359.53**	2,359.53	0.00	0.00	**84.58**	84.58	0.00	0.00
Phebalium distans	Mt Berryman Phebalium	E	CE	**0.00**	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00
Sophora fraseri	Brush Sophora	V	V	**414.52**	414.52	0.00	0.00	**39.98**	39.98	0.00	0.00
Thesium australe	Austral Toadflax	V	V	**653.22**	653.22	0.00	0.00	**94.77**	94.77	0.00	0.00
Fauna (threatened)											
Anthochaera phrygia	Regent Honeyeater	E	CE	**2,259.21**	2,259.21	0.00	0.00	**84.58**	84.58	0.00	0.00
Botaurus poiciloptilus	Australasian Bittern	LC	E	**446.51**	415.42	0.00	31.09	**15.43**	15.43	0.00	0.00
Calidris ferruginea	Curlew Sandpiper	E	CE, M	**818.13**	812.98	0.00	5.15	**15.43**	15.43	0.00	0.00
Erythrotriorchis radiatus	Red Goshawk	E	V	**2,426.17**	1,380.34	0.00	955.83	**88.82**	71.08	0.00	17.74

				Predicted habitat within the ecology study area (ha)* (11,866.54 ha)				Predicted habitat within the Project disturbance footprint (ha)* (634.58 ha)			
Species name	**Common name**	**NC Act status**	**EPBC Act status**	**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**
Falco hypoleucos	Grey Falcon	V	V	**6,425.19**	6,425.19	0.00	0.00	**351.97**	351.97	0.00	0.00
Grantiella picta	Painted Honeyeater	V	V	**683.72**	681.05	0.00	2.67	**13.34**	13.34	0.00	0.00
Hirundapus caudacutus	White-throated Needletail^	SLC	M, V	**11,866.54**	9,057.47	2,809.07	0.00	**634.58**	535.12	99.46	0.00
Lathamus discolor	Swift Parrot	E	CE	**2,773.66**	2,411.00	0	362.66	**98.67**	85.33	0	13.34
Rostratula australis	Australian Painted Snipe	V	E	**790.96**	344.45	0.00	446.51	**33.38**	17.95	0.00	15.43
Turnix melanogaster	Black-breasted Button-quail	V	V	**0.09**	0.00	0.00	0.09	**0.00**	0.00	0.00	0.00
Dasyurus maculatus	Spotted-tail Quoll (Southern subspecies)	V	E	**2,126.47**	1,807.43	0.00	319.04	**77.07**	75.48	0.00	1.59
Petrogale penicillata	Brush-tailed Rock-wallaby	V	V	**297.73**	235.89	0.00	61.84	**41.25**	36.37	0.00	4.88
Pseudomys novaehollandiae	New Holland Mouse	V	V	**2,401.31**	2,400.63	0.00	0.68	**88.12**	88.12	0.00	0.00
Phascolarctos cinereus	Koala	V	V	**6,467.86**	3,782.28	0.00	2,685.58	**303.95**	205.29	0.00	98.66
Potorous tridactylus	Long-nosed Potoroo	V	V	**2,253.93**	2,253.93	0.00	0.00	**84.58**	84.58	0.00	0.00
Petauroides volans	Greater Glider	V	V	**1,527.84**	1,527.84	0.00	0.68	**30.64**	30.64	0.00	0.00
Pteropus poliocephalus	Grey-headed Flying-fox	LC	V	**2,812.21**	26.30	0.00	2,785.91	**99.46**	0.00	0.00	99.46
Anomalopus mackayi	Five-clawed Worm-skink	E	V	**0.00**	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00
Delma torquata	Collared Delma	V	V	**2,326.15**	0.00	2,326.15	0.00	**85.33**	0.00	85.33	0.00
Furina dunmalli	Dunmall's Snake	V	V	**0.00**	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00
Neoceratodus forsteri	Australian Lungfish	-	V	**462.87**	338.88	0.00	123.99	**2.24**	0.28	0.00	1.96

Table notes:
CE = Critically endangered E = Endangered V = Vulnerable M = Migratory LC = Least concern - = Not listed
^ = Aerial species, all 'air-space' above the Project is considered habitat. However, these areas will not be impacted 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 ecology study area, impact assessment has not occurred although their habitat requirements and ecology has been considered through the modelling process.

TABLE 11.19: PREDICTED HABITAT FOR EPBC ACT LISTED MIGRATORY SPECIES WITHIN THE ECOLOGY STUDY AREA

				Predicted habitat within the ecology study area (ha)* (11,866.54 ha)			Predicted habitat within the Project disturbance footprint (ha)* (634.58 ha)		
Species name	**Common name**	**NC Act status**	**EPBC Act status**	**Total habitat**	**Potential habitat**	**Important habitat**	**Total habitat**	**Potential habitat**	**Important habitat**
EPBC Act migratory species									
Actitis hypoleucos	Common Sandpiper	SLC	M	**1,741.55**	446.51	1,295.04	**80.58**	15.43	65.15
Apus pacificus	Fork-tailed Swift	SLC	M	**11,866.54**	9,057.47	2,809.07	**634.58**	535.12	99.46
Calidris acuminata	Sharp-tailed Sandpiper	SLC	M	**2,020.07**	757.71	1,262.36	**92.00**	26.85	65.15
Calidris melanotos	Pectoral Sandpiper	SLC	M	**1,741.55**	446.51	1,295.04	**80.58**	15.43	65.15
Calidris ruficollis	Red-necked Stint	SLC	M	**1,741.55**	446.51	1,295.04	**80.58**	15.43	65.15
Charadrius veredus	Oriental Dotterel	SLC	M	**1,967.38**	694.62	1,272.75	**98.40**	33.25	65.15
Cuculus optatus	Oriental Cuckoo	SLC	M	**95.41**	74.45	20.95	**0.52**	0.08	0.43
Gallinago hardwickii	Latham's Snipe	SLC	M	**2,579.12**	1,359.30	1,219.82	**133.88**	68.73	65.15
Gelochelidon nilotica	Gull-billed Tern	SLC	M	**502.98**	460.49	42.49	**15.43**	15.43	0.00
Hydroprogne caspia	Caspian Tern	SLC	M	**708.09**	661.19	46.89	**20.51**	20.51	0.00
Limosa	Black-tailed Godwit	SLC	M	**1,741.55**	446.51	1,295.04	**80.58**	15.43	65.15
Monarcha melanopsis	Black-faced Monarch	SLC	M	**275.52**	254.56	20.95	**6.07**	5.64	0.43
Motacilla flava	Yellow Wagtail	SLC	M	**1,741.55**	446.51	1,295.04	**80.58**	15.43	65.15
Myiagra cyanoleuca	Satin Flycatcher	SLC	M	**61.42**	40.47	20.95	**0.52**	0.08	0.43
Pandion haliaetus	Eastern Osprey	SLC	M	**446.51**	404.02	42.49	**15.43**	15.43	0.00
Phalaropus lobatus	Red-necked Phalarope	SLC	M	**1,741.55**	446.51	1,295.04	**80.58**	15.43	65.15
Plegadis falcinellus	Glossy Ibis	SLC	M	**4,224.33**	3,300.63	923.71	**184.68**	126.73	57.95
Pluvialis fulva	Pacific Golden Plover	SLC	M	**1,741.55**	446.51	1,295.04	**80.58**	15.43	65.15
Rhipidura rufifrons	Rufous Fantail	SLC	M	**61.42**	40.47	20.95	**0.52**	0.08	0.43
Symposiachrus trivirgatus	Spectacled Monarch	SLC	M	**61.42**	40.47	20.95	**0.52**	0.08	0.43
Tringa nebularia	Common Greenshank	SLC	M	**1,741.55**	446.51	1,295.04	**80.58**	15.43	65.15
Tringa stagnatilis	Marsh Sandpiper	SLC	M	**2,027.97**	765.61	1,262.36	**92.22**	27.07	65.15

Table notes:
M = Migratory SLC = Special Least Concern
* = No value (i.e. 0) represents areas where habitat modelling has indicated that no predicted habitat has been identified within a particular area. For these species, impact assessment has not occurred although their habitat requirements and ecology has been considered through the modelling process.

TABLE 11.20: PREDICTED HABITAT FOR NC ACT THREATENED, NEAR-THREATENED AND SPECIAL LEAST CONCERN FLORA AND FAUNA SPECIES (EXCLUDING MNES) WITHIN THE ECOLOGY STUDY AREA

			Predicted habitat within the ecology study area (ha)* (11,866.54 ha)				Predicted habitat within the Project disturbance footprint (ha)* (634.58 ha)			
Species name	**Common name**	**NC Act status**	**Total habitat**	**General**	**Essential**	**Core**	**Total habitat**	**General**	**Essential**	**Core**
NC Act conservation significant flora										
Callitris baileyi	Bailey's Cypress Pine	NT	1,399.47	1,399.47	0.00	0.00	28.40	28.40	0.00	0.00
Eucalyptus taurina	Helidon Ironbark	V	3.18	3.18	0.00	0.00	0.00	0.00	0.00	0.00
Melaleuca irbyana	Swamp Tea-tree	E	3,122.61	2,914.01	208.6	0.00	128.78	124.35	4.43	0.00
NC Act conservation significant fauna										
Calyptorhynchus lathami	Glossy Black-cockatoo	V	700.46	700.46	0.00	0.00	45.11	45.11	0.00	0.00
Hemiaspis damelii	Grey Snake	E	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ninox strenua	Powerful Owl	V	343.50	343.50	0.00	0.00	28.63	28.63	0.00	0.00
NC Act special least concern animals										
Ornithorhynchus anatinus	Platypus	SLC	1,217.28	1,217.28	0.00	0.00	47.77	47.77	0.00	0.00
Tachyglossus aculeatus	Short-beaked Echidna	SLC	2,486.69	2,486.69	0.00	0.00	75.71	75.71	0.00	0.00

Table notes:

E = Endangered V = Vulnerable NT = Near threatened SLC = Special Least Concern

* = No value (i.e. 0) represents areas where habitat modelling has indicated that no predicted habitat has been identified within a particular area. For these species, impact assessment has not occurred although their habitat requirements and ecology has been considered through the modelling process.

11.6.6 Terrestrial flora and fauna species habitat

Nine broad fauna habitat types have been identified within the ecology 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 ecology study area.

Discrete areas of remnant vegetation are scattered across the ecology study area; however, most of the area is characterised by non-remnant vegetation, particularly cleared agricultural areas, which provide grassland habitat to fauna species. Grassland is the dominant land cover in the ecology study area and other land cover types in order of decreasing extent include crops, forest/woodland, urban and quarry.

The majority of remnant and non-remnant native vegetation is clustered around the eastern and western extremities of the ecology study area (i.e. Helidon and Calvert), in areas of higher elevation (e.g. Little Liverpool Range). The central portion of the ecology study area (i.e. Gatton–Forest Hill) is extensively cleared and subject to high-intensity irrigated horticulture. Non-remnant linear vegetation along roadsides, the existing West Moreton System rail corridor and drainage lines, regrowth vegetation and isolated paddock trees form a variegated landscape mosaic in an otherwise fragmented environment. Drainage lines, waterways and wetlands are also important features in regards for the provision of habitat for MNES and are present within the ecology study area.

Each broad habitat type is discussed in further detail below and spatially represented in Figure 11.14a to Figure 11.14e. An analysis of the quantity of fauna habitat contained within the ecology study area and within the Project disturbance footprint is presented in Table 11.19.

TABLE 11.21: EXTENT OF TERRESTRIAL FLORA AND FAUNA HABITAT TYPES LOCATED WITHIN THE ECOLOGY STUDY AREA

Fauna habitat type (refer Figure 11.14a)	Analogous Regional Ecosystems	Extent (ha)	
		Ecology study area	Project disturbance footprint
Mature eucalypt open forest and woodland	12.9-10.2, 12.9-10.3, 12.9-10.7, 12.9-10.17a, 12.9-10.19, 12.9-10.27, 12.3.2, 12.3.3, 12.3.3d and 12.3.19	1,529.81	29.63
Mature eucalypt riparian woodland	12.3.7	87.33	1.87
Acacia harpophylla—*Casuarina cristata* open forest subdominant community	12.9-10.6 and 12.3.10a (Category B and C)	6.11	0.00
Regrowth eucalypt communities	High value regrowth (Category C)	879.76	49.03
Melaleuca irbyana low open forest	12.3.18	5.77	0.00
Riparian zones/waterways	N/A	521.81	19.79
Wetlands	12.3.8 (also includes areas mapped as wetlands HES wetlands)	22.77	0.00
Grassland	N/A	6,986.46	490.70
Cultivated land	N/A	1,826.72	43.56
Total area of habitat		**11,866.54**	**634.56**

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

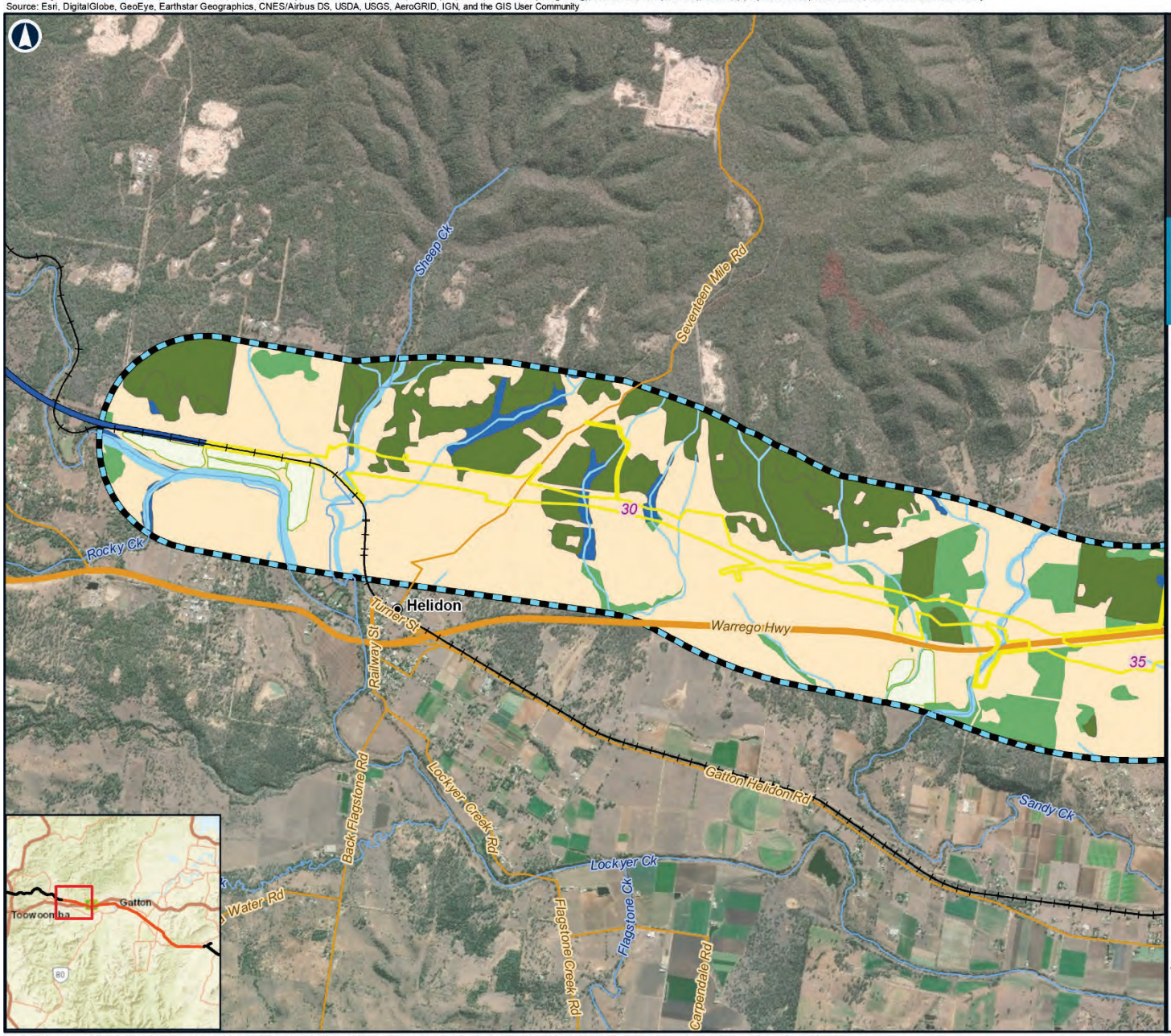

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Figure 11.14a: Location of fauna habitat contained within the ecology study area

LEGEND

- 5 Chainage (km)
- Localities
- Existing rail
- G2H project alignment
- Watercourses
- Major roads
- Minor roads
- EIS disturbance footprint
- Ecology study area
- 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

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56

Date: 23/06/2020 Paper: A4
Author: FFJV GIS Scale: 1:50,000
Data Sources: FFJV

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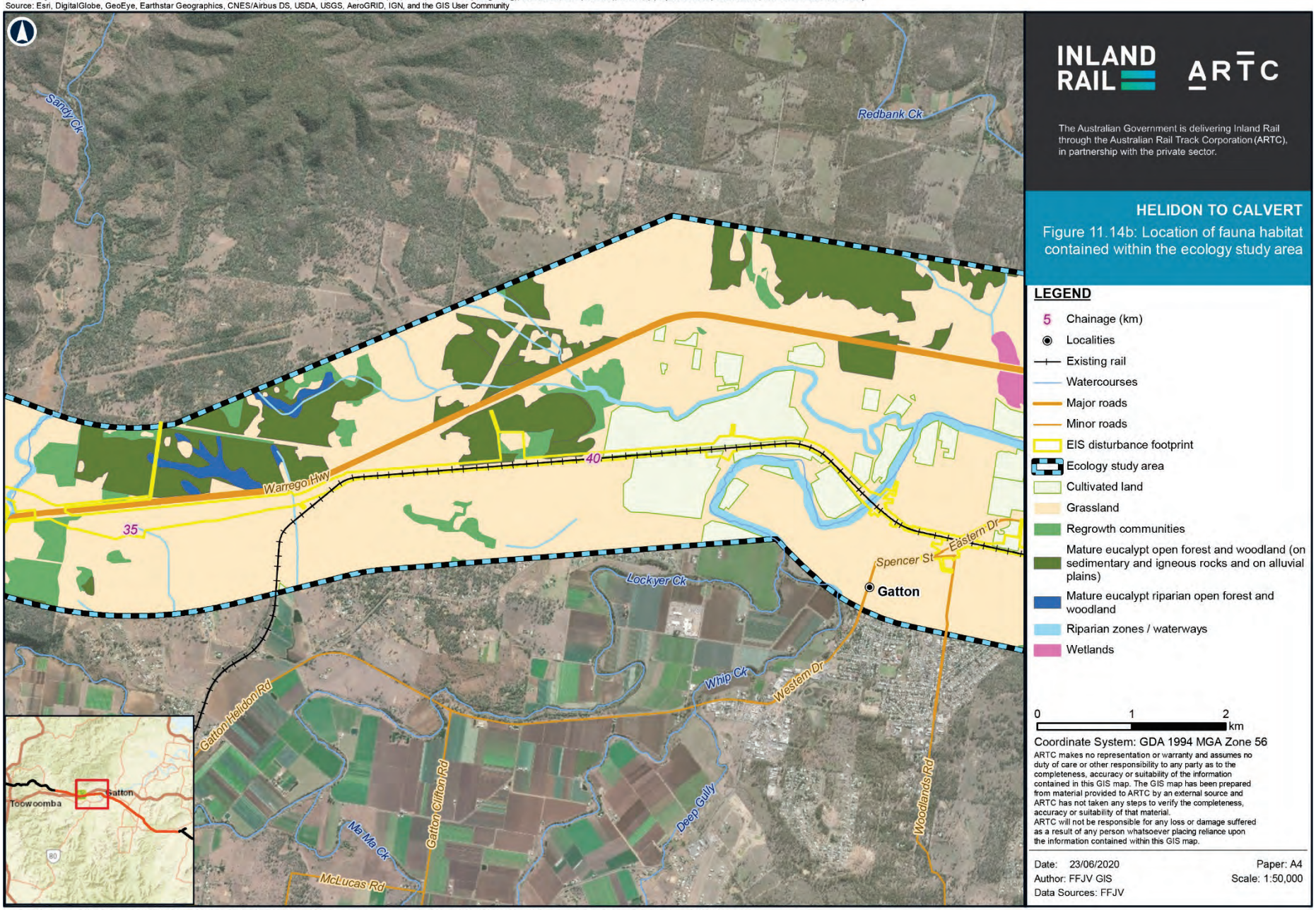
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Sandy Ck
Redbank Ck
Warrego Hwy
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Spencer St
Eastern Dr
Lockyer Ck
Gatton
Whip Ck
Western Dr
Gatton Helidon Rd
Gatton Clifton Rd
Deep Gully
Woodlands Rd
Ma Ma Ck
McLucas Rd
Toowoomba
Gatton
80
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HELIDON TO CALVERT
Figure 11.14b: Location of fauna habitat contained within the ecology study area
LEGEND
5 Chainage (km)
Localities
Existing rail
Watercourses
Major roads
Minor roads
EIS disturbance footprint
Ecology study area
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
0 1 2 km
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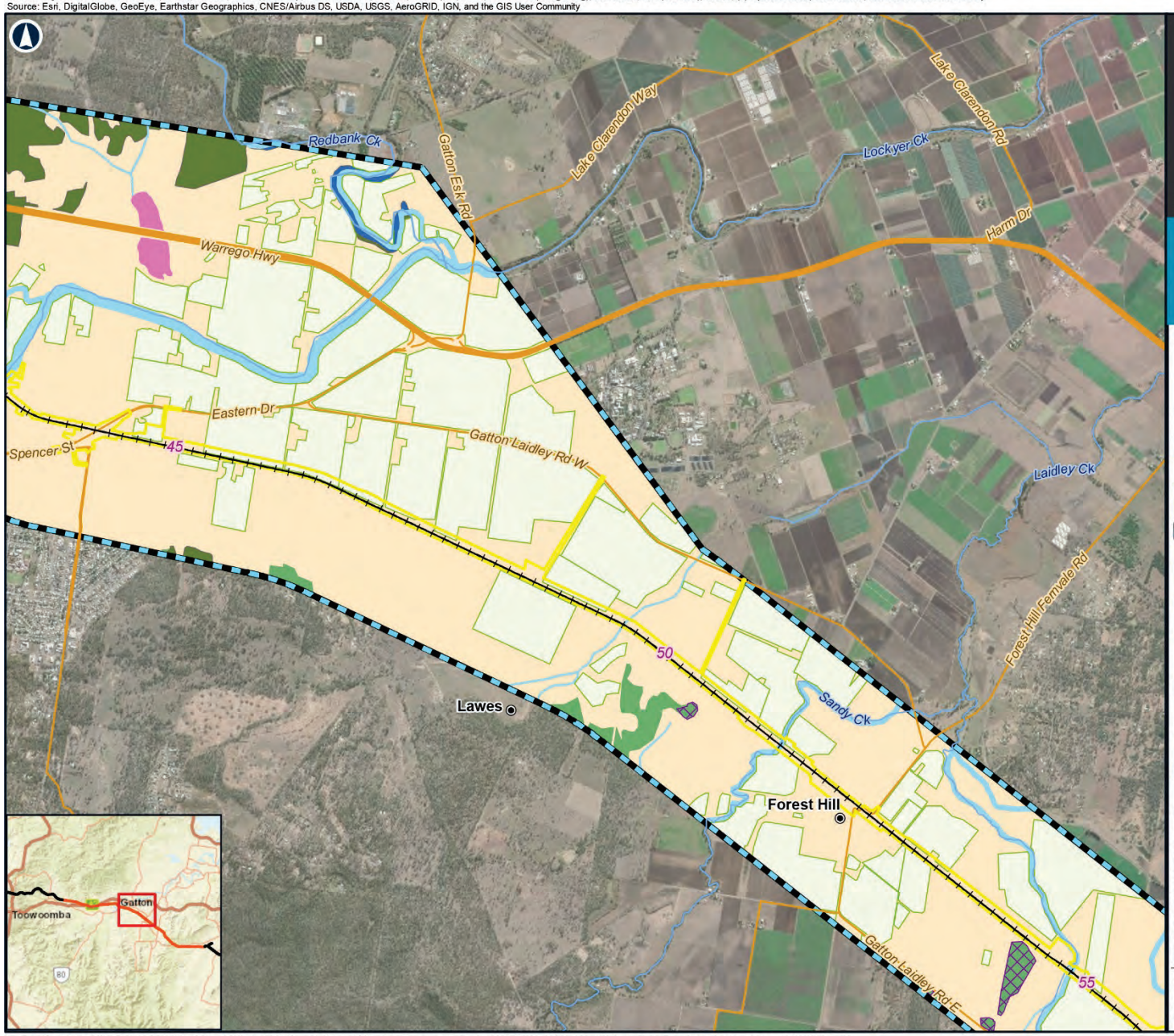

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Figure 11.14c: Location of fauna habitat contained within the ecology study area

LEGEND

- 5 Chainage (km)
- Localities
- Existing rail
- Watercourses
- Major roads
- Minor roads
- EIS disturbance footprint
- Ecology study area
- 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
- *Acacia harpophylla-Casuarina cristata* open forest sub-dominant community

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56

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Data Sources: FFJV

Paper: A4
Scale: 1:50,000

Map by: DTH/MEF/LCT/GN/KG Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201906101333_Ecology_figures_and_calcs\330-EAP-201906101333_ARTC_Fig11.14_FaunaHabitats_v7.mxd Date: 23/06/2020 15:45

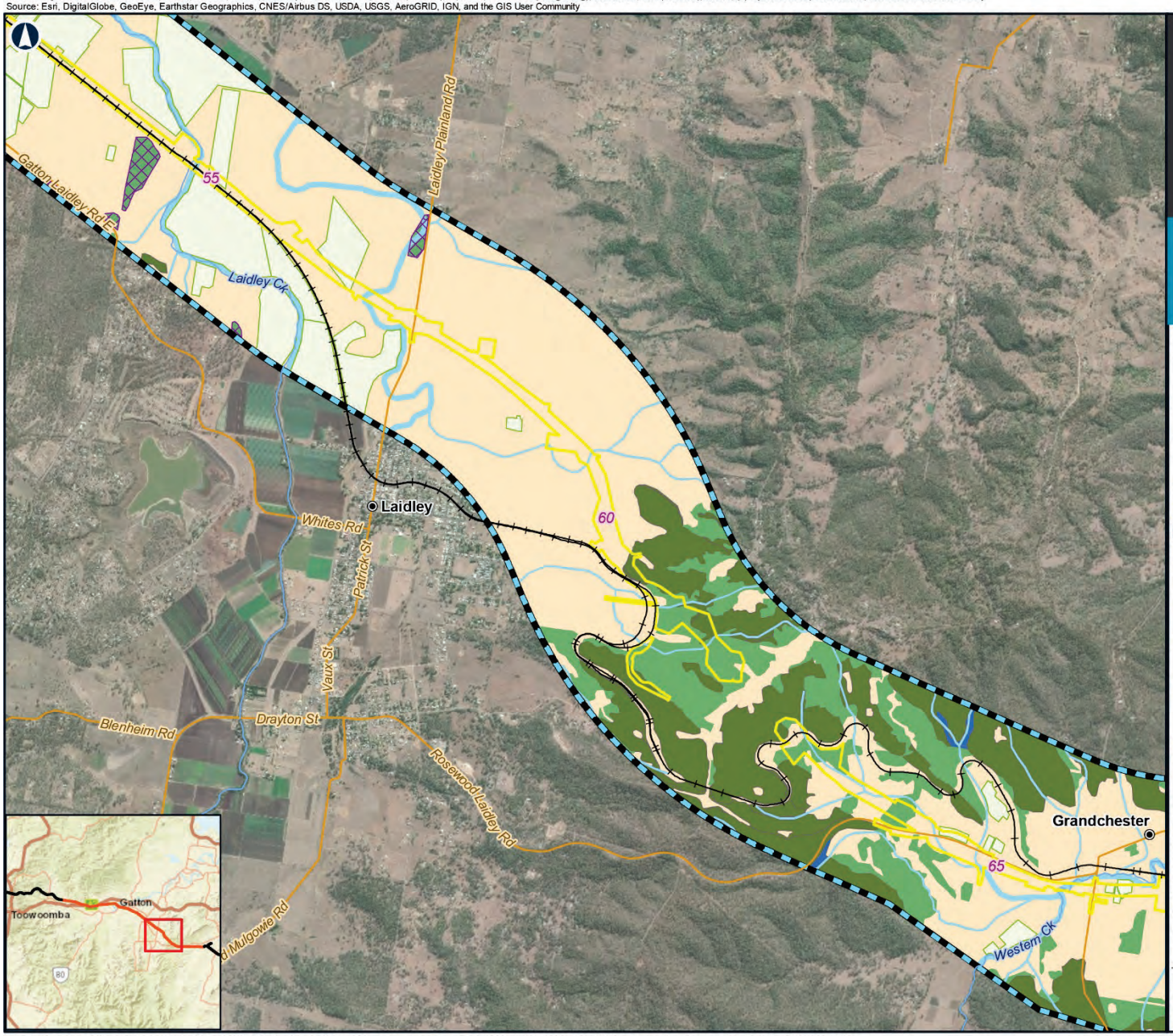

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Figure 11.14d: Location of fauna habitat contained within the ecology study area

LEGEND

- 5 Chainage (km)
- Localities
- Existing rail
- Watercourses
- Major roads
- Minor roads
- EIS disturbance footprint
- Ecology study area
- 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
- *Acacia harpophylla-Casuarina cristata* open forest sub-dominant community

0 1 2 km

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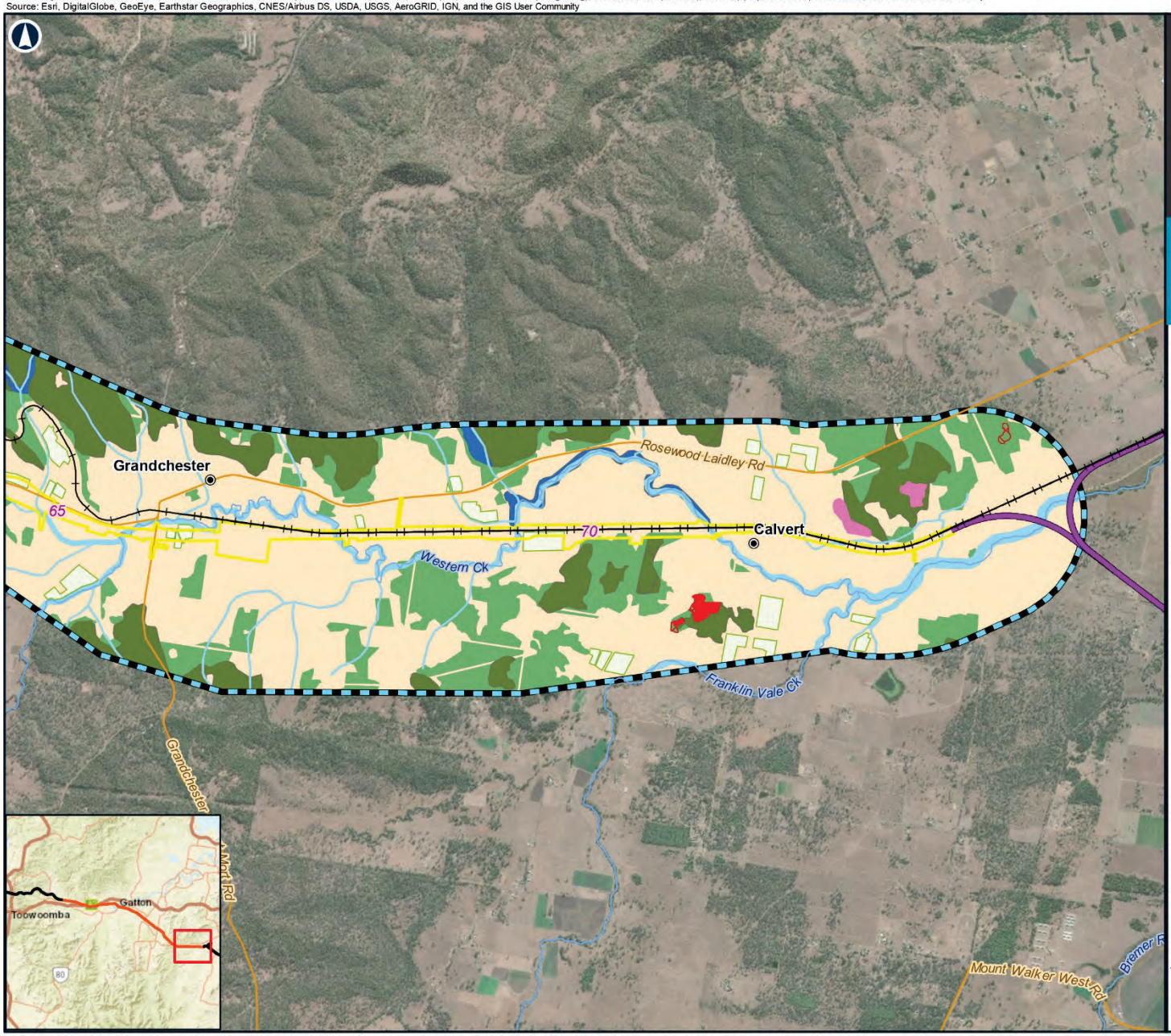

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Figure 11.14e: Location of fauna habitat contained within the ecology study area

LEGEND

- 5 Chainage (km)
- Localities
- Existing rail
- C2K project alignment
- Watercourses
- Minor roads
- EIS disturbance footprint
- Ecology study area
- 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
- Melaleuca low open woodland
- Riparian zones / waterways
- Wetlands
- Regrowth Melaleuca low open woodland

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56

Date: 23/06/2020 Paper: A4
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Data Sources: FFJV

Map by: DTH/MEF/LCT/GN/KG Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201906101333_Ecology_figures_and_calcs\330-EAP-201906101333_ARTC_Fig11.14_FaunaHabitats_v7.mxd Date: 23/06/2020 15:45

11.6.6.1 Mature eucalypt open forest and woodland

On sedimentary rocks

This habitat is dominant in the Helidon Hills west to the Warrego Highway in the western portion of the ecology study area and the elevated areas associated with the Little Liverpool Range in the east. Areas of remnant, mature eucalypt open forest and woodland within the ecology study area are represented by REs 12.9-10.2, 12.9-10.3, 12.9-10.7 and 12.9-10.19. These communities are dominated by Spotted Gum (*Corymbia citriodora*), Narrow-leaved Ironbark (*Eucalyptus crebra*), Queensland Blue Gum (*Eucalyptus tereticornis*), Moreton Bay Ash (*Corymbia tessellaris*), Silver-leaved Ironbark (*Eucalyptus melanophloia*), Broad-leaved Ironbark (*Eucalyptus fibrosa*), Gum-topped Box (*Eucalyptus moluccana*) and *Angophora* spp. Many of these species provide foraging habitat for Koala (*Phascolarctos cinereus*), although Queensland Blue Gum is particularly preferred. Spotted Gum dominates the woodland in the Little Liverpool Range due to the poor soils in this area (refer Photograph 11.2), while woodlands in the Helidon Hills were more diverse.

The condition and structure of these habitats varies greatly across the ecology study area, ranging from a simplified structure with sparse shrub and/or ground strata reflective of past land use and current management practices (e.g. 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 camara* and *montevidensis),* and *Opuntia* species were noted as commonly occurring in this habitat with dense infestations of *Lantana camara* observed in some areas. Important microhabitat refugia provided by this habitat type includes tree hollows, hollow logs and termitaria (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 Microchiropteran bats, gliders, possums, birds (including parrots, cockatoos and owls), arboreal snakes and monitors. 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 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. Canopy arthropods are relatively abundant in eucalypt forest and woodlands and provide a valuable foraging resource to birds and mammals. Eucalypt forests and woodlands also provide an important source of nectar, potential for threatened species such as Regent Honeyeater (*Anthochaera phrygia*), Swift Parrot (*Lathamus discolor*) and Grey-headed Flying-fox (*Pteropus poliocephalus*). Red Goshawk (*Erythrotriorchis radiatus*) may occur where there are extensive woodlands supporting an abundance of birds.

Rocky areas of mature eucalypt open forest and woodland within the Helidon Hills may provide suitable habitat values for threatened fauna species such as Collared Delma (*Delma torquata*), Spotted-tail Quoll (*Dasyurus maculatus maculatus*), Greater Glider (*Petauroides volans*), and Brush-tailed Rock wallaby (*Petrogale penicillata*) (refer Photograph 11.3). Long-nosed Potoroo (*Potorous tridactylus tridactylus*) may occur where a dense understorey and ground layer is present. Suitable habitat for Collared Delma and Greater Glider were also identified in the Little Liverpool Range.

PHOTOGRAPH 11.2: SPOTTED GUM DOMINATED WOODLAND IN LITTLE LIVERPOOL RANGE (2017)

PHOTOGRAPH 11.3: ROCKY HABITAT IN HELIDON HILLS AREA (2017)

On alluvial plains

Areas of mature eucalypt open forest and woodland on alluvial plains within the ecology study area include areas dominated by Queensland Blue Gum (*Eucalyptus tereticornis*) and Gum-topped Box (*Eucalyptus moluccana*). Areas of remnant eucalypt open forest and woodland (on alluvial plains) within the ecology study area are represented by RE 12.3.3 and 12.3.19. This habitat type exists on floodplains and creek flats within the ecology study area and generally exhibits low structural complexity, particularly at lower strata levels. Ground cover is typically low due to the impacts of livestock use, and the understorey is also generally very sparse with an open canopy of large Queensland Blue Gum (refer Photograph 11.4). However, mature eucalypt trees on alluvial plains are known to provide important habitat, such as food and shelter (in the form of large tree hollows) (refer Photograph 11.5), for a range of fauna species, including birds, mammals, and reptiles. MNES fauna species that may occur in mature eucalypt open forests and woodland include Regent Honeyeater (*Anthochaera phrygia*), Swift Parrot (*Lathamus discolor*), Greater Glider (*Petauroides volans*), Koala (*Phascolarctos cinereus*), Grey-headed Flying-fox (*Pteropus poliocephalus*).

Furthermore, during heavy rainfall periods this habitat type may flood temporarily, effectively becoming a wetland habitat (riverine 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. MNES fauna species that may occasionally use flooded eucalypt open forest and woodland on alluvial plains include Australian Painted Snipe (*Rostratula australis*) where suitable cover may occur.

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

PHOTOGRAPH 11.4: DEGRADED FLOODPLAIN WOODLAND IN GATTON AREA (2017)

PHOTOGRAPH 11.5: EXAMPLE OF LARGE HABITAT TREE (QUEENSLAND BLUEGUM) IN ECOLOGY STUDY AREA (2017)

11.6.6.2 Mature eucalypt riparian woodland

Eucalypt riparian open forest and woodlands within the ecology 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*). Areas of remnant *Eucalypt* riparian open forest and woodland within the ecology study area are represented by RE 12.3.7. This habitat type occurs exclusively along the edge of rivers, creeks and vegetated drainage lines within the ecology study area. Mature eucalypt riparian open forest and woodlands within the ecology study area is generally in poor condition having been heavily impacted by adjacent land use. In most areas, this habitat has been subject to clearing with few large trees present and substantial weed invasion (such as Laidley Creek and the mid-reaches of Lockyer Creek). Western Creek retains a narrow line of riparian vegetation along its length within the ecology study area (refer Photograph 11.6), as does the upper reaches of Lockyer Creek (in the Helidon area).

A range of fauna, including birds, mammals, and reptiles, may use 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, although as noted, this connectivity is generally impaired within the ecology study area. MNES fauna species that may occur in mature eucalypt riparian open forests and woodland include Regent Honeyeater (*Anthochaera phrygia*), Red Goshawk (*Erythrotriorchis radiatus*) where it occurs within extensive tracts of remnant vegetation, Swift Parrot (*Lathamus discolor*) and Koala (*Phascolarctos cinereus*). Greater Glider (*Petauroides volans*) may occur where riparian woodland remains adjacent to tracts of floodplain woodland.

PHOTOGRAPH 11.6: WESTERN CREEK IN GRANDCHESTER AREA (2017)

PHOTOGRAPH 11.7: REGROWTH *ACACIA* WOODLAND WITH *LANTANA CAMARA* DOMINANT UNDERSTOREY (2017)

11.6.6.3 *Acacia harpophylla-Casuarina cristata* open forest to woodland

Acacia harpophylla-Casuarina cristata open forest on sedimentary rocks within the ecology study area is represented by mapped patches of mixed regrowth partially comprising RE 12.9-10.6. This habitat type is dominated by Brigalow (*Acacia harpophylla*) and/or Belah (*Casuarina cristata*), with a semi-evergreen vine thicket understorey. A prominent low tree or tall shrub layer may be present including species such as *Geijera parviflora* and *Eremophila mitchellii.* Vine thicket species potentially present include *Carissa ovata, Owenia acidula, Croton insularis, Denhamia oleaster* and *Notelaea microcarpa*. This habitat type typically occurs on cracking clays that are usually black or grey to brown or reddish-brown in colour and occurs in the Lockyer Valley and Boonah areas. RE 12.9-10.6 is considered to meet the conservation listing advice criteria for the Brigalow (*Acacia harpophylla* dominant and co-dominant) TEC.

Brigalow open forest/woodland on alluvial plains within the impact assessment area is represented by RE 11.3.10a. This habitat type is dominated by *Acacia harpophylla* forming a fairly continuous canopy with *Eucalyptus* spp. including *E. populnea and E. tereticornis* sometimes scattered through the canopy or occurring as emergents. This community occurs on Quaternary alluvial plains in the Lockyer Valley where small areas of cracking clay soils occur. This community does not meet the conservation listing advice criteria for the Brigalow TEC.

In the region both communities have been heavily impacted by land use activities associated with agriculture and cattle grazing. Within the ecology study area these communities may provide habitat for MNES species including Painted Honeyeater (*Grantiella picta*) and Dunmall's Snake (*Furina dunmalli*). The areas where these communities are mapped are outside the Project disturbance footprint and have not been surveyed and confirmed as present.

Regrowth eucalypt communities

Areas of regrowth vegetation, largely represented by the Department of Resources' (formerly Department of Natural Resources, Mine and Energy) High-Value Regrowth (HVR) vegetation mapping, are present throughout the ecology study area. A total of 1,105.75 ha of HVR is mapped within the ecology study area. The patches of regrowth vegetation within the ecology study area are generally in poor condition, suffering from extensive weed invasion (refer Photograph 11.7) and disturbance from cattle grazing practices. Areas of regrowth habitat may provide foraging and perching habitat value for transitional fauna species and suitable microhabitats, including cracking clay soils for reptile species in floodplain areas. Transitional fauna species include migratory terrestrial bird species, moving between habitats.

***Melaleuca irbyana* low open woodland**

Melaleuca low open woodland within the ecology study area includes small areas of low open woodland and tall shrubland dominated by *Melaleuca irbyana* (Swamp Tea-tree). Areas of remnant *Melaleuca* low open woodland within the ecology study area are represented by RE 12.3.18 on alluvial plains and are represented by three small patches in the western extent of the Project alignment. 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. RE 12.3.18 is considered to meet the conservation listing advice for Swamp Tea-tree (*Melaleuca irbyana*) Forest of SEQ TEC.

This habitat type may provide foraging and nesting habitat for a limited range of bird and mammal 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. Where Queensland Blue Gum (*Eucalyptus tereticornis*) is present, *M. irbyana* low open forest may provide abundant seasonal nectar resources. Threatened fauna species that may use *Melaleuca* low open woodland within the ecology study area includes Painted Honeyeater (*Grantiella picta*) and Grey-headed Flying fox (*Pteropus poliocephalus*).

11.6.6.4 Riparian zones/waterways

Riparian zones are an interface between terrestrial and aquatic ecosystems and also play a vital role 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, some aquatic organisms may have the potential to 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 general, riparian zones within the ecology study area are in poor condition with little taller vegetation present and heavy weed infestation in the shrub and ground layers. Where present, riparian forests dominated by Queensland Blue Gum (*Eucalyptus tereticornis*) provide seasonal nectar resources for birds and flying-foxes and mature specimens have large tree hollows suitable as shelter nesting sites for arboreal mammals and some bird species (particularly parrots). 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 near large permanent waterholes, specifically Australian Lungfish (*Neoceratodus forsteri*). Australian Lungfish is known to occur in Lockyer Creek. Riparian vegetation at the Project alignment crossing at this point is heavily degraded with few overstorey trees present (refer Photograph 11.8).

Within the ecology 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. Lockyer Creek was noted as retaining a large pool at the Project crossing area during Project assessments despite dry conditions occurring at the time (refer Photograph 11.8). Mapping of risk to waterways from waterway barrier works currently indicates that eight major risk and two high risk waterways intersect the Project alignment. 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 ecology study area. Further information regarding riverine habitat values is provided in Appendix I: Terrestrial and Aquatic Ecology Technical Report.

PHOTOGRAPH 11.8: LOCKYER CREEK AT ALIGNMENT CROSSING POINT (2017)

PHOTOGRAPH 11.9: LAKE DYER (BILL GUNN DAM) NEAR LAIDLEY (2017). NOTE: THIS IS OUTSIDE OF THE ECOLOGY STUDY AREA

11.6.6.5 Wetlands

Wetland habitats within the ecology study area include dams and reservoirs (lacustrine), wetlands associated with the floodplains of major watercourses (riverine), and vegetated swamps (palustrine). It is noted no wetlands are mapped as occurring within the Project disturbance footprint. Artificially created wetlands (i.e. farm and public dams (refer Photograph 11.9)), which are abundant across agricultural landscapes, are included as they potentially provide suitable wetland alternatives for vertebrate fauna. Artificial wetlands include typically small farm dams and much larger turkey-nest dams 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, and Queensland Blue Gum (*Eucalyptus tereticornis*). All of the aquatic ecology monitoring sites at non-riverine wetlands had Aquascores (under ACA AquaBAMM assessment (DEHP, 2015)) of high to very high indicating good conditions across the ecology study area.

Palustrine wetlands within the ecology study area typically occur on alluvial floodplains and are dominated by *Poaceae* (grasses), *Restionaceae* (rushes) and *Cyperaceae* (sedges). Areas of remnant Palustrine wetland within the ecology study area are represented by RE 12.3.8, although none occur within the Project disturbance footprint.

Wetland habitats within the ecology study area are considered to provide suitable habitat for a variety of fish, amphibian, reptile (including turtles) and bird species. Larger palustrine-wetlands potentially provide important refuge habitat for many bird species, including dispersive species. Fauna species that may use wetland habitats within the ecology 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 that farm dams are less likely to provide these habitat elements and floodplain wetlands are highly ephemeral. At the time of the EIS field surveys the study area had undergone an extended dry period with no water available on floodplain wetlands. Curlew Sandpiper (*Calidris ferruginea*) may occasionally occur on larger dams with shallow muddy areas (such as Lake Dyer near Laidley).

Of the 22.77 ha of HES wetland that occurs within the ecology study area, none lies within the Project disturbance footprint and these wetlands will not be directly impacted from activities associated with the Project. Two high-ecological significance (HES) wetlands are located at the eastern end of the ecology study area, associated with the local hydrological catchment of Western Creek (Ch 72.40 km).

Other wetland values within the ecology study area are represented through aquatic conservation assessment modelling. The catchment aquatic conservation assessment indicates a skew towards higher value riverine wetlands throughout both the Lockyer Creek and Bremer River (including Western Creek in the ecology study area) catchments, indicating the presence of sensitive wetlands throughout both catchments. Noting this, aquatic assessment within the ecology study area indicated areas of very low value (i.e. portions of Lockyer Creek catchment) and medium value (i.e. Lockyer Creek, Laidley Creek and Western Creek) (DEHP, 2015). No springs mapped on the Queensland wetland mapping layer (DES, 2020a) were identified within the ecology study area.

11.6.6.6 Grassland

Grassland habitats within the ecology 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), 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 Rat-tail Grass (*Sporobolus creber*), Forest Bluegrass (*Bothriochloa bladhii*), Blue grass (*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*), Forest bluegrass (*Bothriochloa bladhii*), Blue Grass, Digitaria (*Digitaria divaricatissima*), and Pitted Blue Grass (*Bothriochloa decipiens*). However, exotic pasture grasses sometimes occur, such as Rhodes grass (*Chloris gayana*).

Non-native and native derived grasslands are considered as one fauna habitat due to similarities in structure and floristics. Grassland within the ecology study area is typically located on alluvial floodplains and creek flats. These grassland habitats are commonly used for agricultural purposes including livestock grazing and fodder harvesting and are often in poor condition. Better grassland habitat condition may be found in road and rail reserves, which are not impacted by grazing (refer Photograph 11.10).

Grassland within the ecology study area provides 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.

PHOTOGRAPH 11.10: GRASSLANDS IN ROAD/RAIL RESERVE IN LAIDLEY AREA (2017)

PHOTOGRAPH 11.11: CULTIVATED LANDS NEAR LAIDLEY (2017)

11.6.6.7 Cultivated land

Cultivated land within the ecology study area is extensive and includes irrigated and dryland crops, stubble fields and fallow fields. Common crops include winter cereals, vegetables and legumes (refer Photograph 11.11). The availability of soil cracks and other microhabitat refugia is greatly reduced by soil cultivation. Cultivated land typically Catchment area overview

The Project alignment travels through two discrete hydrological catchments. The Lockyer Creek catchment, between Helidon and Laidley in the west and the Bremer River catchment between Grandchester and Calvert as the Project alignment moves east.

The Lockyer Creek catchment is located west of Brisbane and east of Toowoomba, within the local government areas (LGAs) of Lockyer Valley, Somerset, Ipswich and Toowoomba. The catchment covers an area of approximately 3,000 square kilometres (km^2) with the main Lockyer Creek surrounded by several sub-catchments (DES, 2015b). The Lockyer Creek catchment experiences high rainfall in the south and parts of the north. The rest of the catchment has moderate to low rainfall. However due to the steep slopes in the upper reaches of the catchment, many streams can experience high flows despite the relatively low rainfall (DES, 2015b).

The Bremer River catchment is situated west of Brisbane within the LGAs of Ipswich and Scenic Rim and expands to an area of approximately 2,030 km^2 with the main Bremer River channel surrounded by smaller sub-catchments (DES, 2016b). Rainfall in the catchment is considered higher along its steeper sections which are situated to the south and east whilst the remainder of the catchment experiences average rainfall of under 1,000 mm/yr. The catchment supports a diverse range of land uses including agriculture, grazing and urban areas as well as featuring steep slopes (DES, 2016b).

11.6.7 Springs and groundwater dependent ecosystems

GDEs are ecosystems that require access to groundwater on a permanent or periodic basis to meet all or some of their water requirements to maintain their communities of plants and animals, ecological processes and ecosystem services.

The GDE Atlas (BoM, 2020) identifies three types of ecosystems:

- Aquatic ecosystems that rely on the surface expression of groundwater—this includes surface water ecosystems that may have a groundwater component (i.e. rivers, wetlands, springs)
- Terrestrial ecosystems that rely on the subsurface presence of groundwater—this includes all vegetation ecosystems
- Subterranean ecosystems—this includes cave and aquifer ecosystems.

As the assessment using the GDE Atlas is modelled at a large scale (i.e. typically at the 1:100,000 or 1:50,000 scale), the identification of potential GDEs in the Atlas therefore does not confirm that a particular ecosystem is groundwater dependent. The Atlas has identified several potential aquatic and terrestrial groundwater-dependent systems including wetland systems and watercourses.

A review of refined-scale potential GDE mapping (DES, 2020a) has been undertaken and the following GDEs aquifer categories have the potential to occur within the ecology study area:

- Unconsolidated sedimentary aquifers
- Consolidated sedimentary aquifers
- Metamorphic rock aquifers.

There are no springs known to occur within the ecology study area based on government data sources and ground truthing. However, terrestrial GDEs and surface areas GDEs are present within the ecology study area. The area encompassed by terrestrial GDEs and surface area GDEs is quantified in Table 11.22.

TABLE 11.22: EXTENT OF SPRINGS, GROUNDWATER-DEPENDENT ECOSYSTEMS AND SURFACE AREAS WITHIN THE ECOLOGY STUDY AREA

	Extent (ha)	
Feature	**Ecology study area**	**Project disturbance footprint**
Springs	0.00	0.00
Terrestrial GDEs	415.43	8.09
Surface areas GDEs	20.53	0.00
Total	**435.96**	**8.09**

Table notes:
Terrestrial ecosystems rely on the subsurface presence of groundwater—this includes all vegetation ecosystems.
Aquatic ecosystems that rely on the surface expression of groundwater—this includes surface water ecosystems that may have a groundwater component, such as rivers, wetlands and springs. Marine and estuarine ecosystems can also be groundwater dependent.

As no ground-truthing of these particular environments were undertaken, it has been assumed for the purposes of the EIS, that the modelled extent of the aquatic and terrestrial GDEs are accepted as true presence, and thus form a potentially sensitive environmental receptor.

11.6.8 Aquatic habitat

A review of the DAF *Queensland Waterways for Waterway Barrier Works* mapping was undertaken, identifying a total of 26 waterways for waterway barrier works (including bridge and culvert infrastructure) which cross the Project alignment which are intersected 29 times by the Project which are made up of 15 culvert crossings and 14 bridge crossings. Of the 26 waterways, several of the waterways are crossed by the Project alignment several times (refer Table 11.23)

These waterways are classified as follows:

- Low risk of impact (Category 1)—9 waterways mapped as 'low' intercept the Project alignment
- Moderate risk of impact (Category 2)—7 waterways mapped as 'moderate' intercept the Project alignment
- High risk of impact (Category 3)—2 waterways mapped as 'high' intercept the Project alignment
- Major risk of impact (Category 4)— 8 waterways mapped as 'major' intercept the Project alignment.

The level of risk relating to each waterway will be considered by the detailed design team responsible for the design of infrastructure such as culverts, bridges and other potential barriers (e.g. temporary impoundments). At this stage of Project design, access roads are considered to be proximal to currently identified waterways intersecting the Project alignment. Designs will need to be in accordance with the DAF factsheet 'What is not a waterway barrier work?', or accepted development requirements for operational work that is constructing or raising waterway barrier works (DAF, 2018a), or under a relevant development approval.

Of the 26 waterways potentially requiring barrier works, eight are expected to require development approval, as they are exceeding the risk of impact of self-assessable works. However, as all of the eight waterway barrier works are associated with bridge infrastructure crossings of major waterways, assessment of the disruption to fish passage would be assessed as part of approval of infrastructure.

Table 11.23 identifies the waterways which cross the Project alignment and the relevant waterway impact risk category.

TABLE 11.23: WATERWAYS FOR WATERWAY BARRIER WORKS THAT CROSS THE PROPOSED PROJECT ALIGNMENT

Waterway impact risk (DAF)	Waterway (approximate chainage (Ch))
Major (Category 4)	▸ Sandy Creek (Grantham) (Ch 33.60 km) ▸ Lockyer Creek (Ch 43.20 km) ▸ Sandy Creek (Forest Hill) (Ch 1.40 km) ▸ Laidley Creek (Ch 54.80 km) ▸ Western Creek (Ch 65.70 km) ▸ Western Creek (Ch 67.60 km) ▸ Western Creek (Ch 69.30 km) ▸ Western Creek (Ch 71.10 km)
High (Category 3)	▸ Un-named tributary of Lockyer Creek (Ch 27.40 km) ▸ Un-named tributary of Laidley Creek (Ch 56.80 km)
Moderate (Category 2)	▸ Un-named tributary of Lockyer Creek (Ch 28.10 km) ▸ Un-named tributary of Sandy Creek (Grantham) (Ch 32.80 km) ▸ Un-named tributary of Sandy Creek (Grantham) (Ch 33.40 km) ▸ Un-named tributary of Sandy Creek (Forest Hill) (Ch 49.50 km) ▸ Un-named tributary of Laidley Creek (Ch 59.40 km) ▸ Un-named tributary of Western Creek (Ch 64.40 km) ▸ Un-named tributary of Western Creek (Ch 64.80 km)
Low (Category 1)	▸ Un-named tributary of Lockyer Creek (Ch 27.10 km) ▸ Un-named tributary of Lockyer Creek (Ch 29.60 km) ▸ Un-named tributary of Lockyer Creek (Ch 30.20 km, Ch 30.50 km) ▸ Un-named tributary of Sandy Creek (Grantham) (Ch 35.10 km) ▸ Un-named tributary of Lockyer Creek (Ch 36.80 km) ▸ Un-named tributary of Laidley Creek (Ch 61.60 km) ▸ Un-named tributary of Western Creek (Ch 63.00 km) ▸ Un-named tributary of Western Creek (Ch 63.60 km) ▸ Un-named tributary of Western Creek (Ch 73.30 km)

Based on the AUSRIVAS assessment, the watercourses within the ecology study area are generally in fair to good condition (refer Table 11.24). This is generally in line with the AquaBAMM modelling, which assesses the conservation and ecological value of waterways and wetlands on a series of criteria, including naturalness (aquatic and catchment), diversity and richness, threatened species and ecosystems, priority species/ecosystems, special features, connectivity and representativeness (DEHP, 2015).

The ecological site values were recorded across a 100 m assessment reach and have been summarised for each survey location in Table 11.24. The habitat assessment scores noted that most of the aquatic habitat across the ecology study area was typically fair to good. Typically, the un-named tributaries demonstrated lower physical habitat site condition scores, while higher physical habitat site condition scores were noted from Western Creek and Laidley Creek. According to AquaBAMM, the majority of the watercourses within the catchment have a 'medium' AquaBAMM score, including monitoring sites associated with Lockyer Creek, Sandy Creek (Grantham), Sandy Creek (Forest Hill), Laidley Creek and Western Creek (i.e. sites 2A, 3A, 4A, 7A, 9A, 10A, 11A, 12A, 13A, 14A, 17A, 18A))—this indicates that the regional wetland analysis does not fully align with the current existing environment, specifically the smaller tributaries.

Further information related to water quality and catchment health is provided in Chapter 13: Surface water and hydrology.

TABLE 11.24: AQUATIC HABITAT ASSESSMENT SCORE SUMMARY

Location (Watercourse)	Relation of site to alignment waterway crossing	Habitat assessment score	Category
H2C 1A (Sandy Creek)	Alignment waterway crossing	55%	Good
H2C 2A (Un-named tributary: Lockyer Creek)	Alignment waterway crossing	33.5%	Fair
H2C 3A (Lockyer Creek)	Upstream of alignment	52%	Good
H2C 4A (Lockyer Creek)	Alignment waterway crossing	47%	Fair
H2C 5A (Sandy Creek)	Alignment waterway crossing	40.5%	Fair
H2C 7A (Un-named Tributary: Lockyer Creek)	Alignment waterway crossing	44%	Fair
H2C 8A (Un-named tributary: Laidley Creek)	Alignment waterway crossing	33.5%	Fair
H2C 9A (Western Creek)	Alignment waterway crossing	52.5%	Good
H2C 10A (Western Creek)	Alignment waterway crossing	51%	Good
H2C 11A (Lockyer Creek)	Downstream of alignment	41.5%	Fair
H2C 12A (Lockyer Creek)	Downstream of alignment	43%	Fair
H2C 13A (Laidley Creek)	Downstream of alignment	49%	Fair
H2C 14A (Laidley Creek)	Upstream of alignment	51%	Fair
H2C 15A (Un-named tributary: Lockyer Creek)	Downstream of alignment	43.5%	Fair
H2C 16A (Sandy Creek)	Upstream of alignment	44.5%	Fair
H2C 17A (Laidley Creek)	Upstream of alignment	60%	Good
H2C 18A (Western Creek)	Downstream of alignment	58.5%	Good

Photographic records and water quality information was taken at each aquatic ecology survey site and these are provided in Appendix L: Surface Water Quality Technical Report and Appendix I: Terrestrial and Aquatic Ecology Technical Report.

Wetland habitats within the ecology study area include dams and reservoirs (lacustrine), wetlands associated with the floodplains of major watercourses (riverine) and vegetated swamps (Palustrine). Riverine wetlands associated with floodplains are ephemeral and typically vegetated by a mixture of native and non-native grasses and grass-like plants and *Eucalyptus tereticornis* (Queensland Blue Gum). Palustrine wetlands within the ecology study area typically occur on alluvial floodplains and are dominated by grasses (Poaceae), rushes (Restionaceae) and sedges (Cyperaceae).

Several high-ecological significance (HES) wetlands (under EPP (Water and Wetland Biodiversity)) are present within the ecology study area, upgradient of the Project. Two HES wetlands are located at the eastern end of the ecology study area, proximal to Western Creek (Ch 72.40 km and Ch 73.20 km) and are located approximately 100 m upgradient of the Project alignment. Another high ecological significance wetland is associated with Sheep Stations Creek a tributary of Lockyer Creek (Ch 27.40 km) upstream of the Project. However, this creek along with Wrights Creek are also mapped as high ecological value waters (wetland and watercourse), which drain south across the Project alignment into Lockyer Creek. The forest area to the north-west of Helidon is also mapped as a high ecological value water area under EPP (Water and Wetland Biodiversity).

Aquatic habitats within the ecology study area are considered to provide suitable habitat for a variety of fish, of which five species were identified, consisting of:

- Goldfish (*Carassius auratus*)[1]
- Eel-tailed Catfish (*Tandanus tandanus*)
- Striped Gudgeon (*Gobiomorphus australis*)
- Mosquitofish (*Gambusia holbrooki*)[1]
- Spangled Perch (*Leiopotherapon unicolour*)

1. Non-native species

In addition, habitat for a range of amphibians, reptiles (including turtles) and birds is also present. Larger Palustrine wetlands potentially provide important refuge habitat for many bird species, including migratory and dispersive species. Conservation significant species that may use wetland habitats within the ecology study area include the Australasian Bittern (*Botaurus poiciloptilus*), Curlew Sandpiper (*Calidris ferruginea*), and Australian Painted Snipe (*Rostratula australis*).

No springs were observed during field assessments associated with surface water or identified from the Groundwater Dependent Ecosystems Atlas (BoM, 2020) within the ecology study area. Noting this, several first order streams intersect the Project alignment and may be associated with natural springs.

11.7 Matters specific to MNES

11.7.1 Matters identified within the ecology study area

The following MNES were identified within or in close proximity to the ecology study area:

- Threatened species listed under the EPBC Act and their associated habitat (refer Section 11.6.2.1, Section 11.6.3.1)
- TEC listed under the EPBC Act (refer Section 11.6.2.3)
- Habitat for non-threatened EPBC Act listed migratory[2] species and their associated habitat (refer Section 11.6.3, Section 11.6.5)
- Groundwater-dependent ecosystems.[3] [4]

Appendix J: Matters of National Environmental Significance Technical Report assessed impacts on MNES.

11.7.2 Matters not within the ecology study area

The following MNES were not identified within or in close proximity to the ecology study area:

- World Heritage Areas
- National Heritage Areas
- Commonwealth Marine Areas
- Great Barrier Reef Marine Park
- Nuclear actions
- Springs and groundwater-dependent ecosystems (water resources) associated with coal seam gas development and large coal mining development.

11.8 Potential impacts

11.8.1 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 in Table 11.25.

2. EPBC Act listed migratory species are not a controlling provision of the Project and have been included for completeness. Further detail is provided in Appendix J: Terrestrial and Aquatic Ecology Technical Report.
3. These water resources will not be subject to impacts associated with coal seam gas development and large coal mining development and as such, they do not constitute an MNES for the purposes of this EIS.
4. Potential impacts to GDEs are likely to result from potential draw-down as a consequence of 'cut an fill activities' located proximate to the GDE. These impacts are considered to be minor–negligible and are therefore not discussed further in this document.

TABLE 11.25: DESCRIPTION OF PROJECT-RELATED ACTIVITIES ASSOCIATED WITH CONSTRUCTION, COMMISSIONING AND REINSTATEMENT, OPERATION, AND DECOMMISSIONING PHASES

Phase	Infrastructure activity	Description of activities	Duration of disturbance*
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	Permanent
	Structures	Construction of bridges over main waterways	Medium term
		Road/rail bridge construction	Medium term
Construction (continued)	Civil works	Cutting construction	Medium term
		Embankment construction using cut to fill from Project alignment from external 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
	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 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

Phase	Infrastructure activity	Description of activities	Duration of disturbance*
Commissioning and reinstatement	Demobilisation/de commissioning	Establish permanent fencing	Temporary
		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 Project rail corridor	Permanent
Decommissioning	Lines decommissioned	Increased vehicle movement within Project rail corridor	Short term

Table note:
*Duration of disturbance timeframes:
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
Long term/long lasting—From 11 to 21 years
Permanent—More than 21 years

11.8.2 Potential impacts to terrestrial and aquatic ecology

Potential impacts to terrestrial and aquatic ecological receptors associated with the four phases of the Project have been summarised into 12 broad categories, including:

- 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.

Potential impacts identified above are discussed in the following sections.

11.8.2.1 Habitat loss and degradation from vegetation clearing/removal

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). Vegetation clearing, and habitat loss are likely to occur during the construction phase activities.

The Project disturbance footprint encompasses a total area of 634.58 ha. Under current Queensland Government (Department of Resources) vegetation mapping this includes 32.26 ha of remnant vegetation and 66.39 ha of regrowth vegetation (HVR). The remaining 535.93 ha (84.5 per cent of the Project disturbance footprint) has been largely heavily modified (clearing for agriculture/cattle grazing).

Habitat loss and degradation has the potential to impact on all sensitive environmental receptors (including their associated habitats) identified in this assessment.

Of the sensitive environmental receptors identified, the greatest amount of essential/important/critical habitat is to be removed (refer Section 11.6.5) for the following species:

- Lloyd's Olive (*Notelaea lloydii*)—21.26 ha of critical habitat
- Swamp Tea-tree (*Melaleuca irbyana*)—4.43 ha of essential habitat
- Swift Parrot (*Lathamus discolor*)—13.34 ha of critical habitat
- Koala (*Phascolarctos cinereus*)—98.66 ha of critical habitat
- New Holland Mouse (*Pseudomys novaehollandiae*)—4.88 ha of critical habitat
- Grey-headed Flying-fox (*Pteropus poliocephalus*)—99.46 ha of critical habitat
- Collared Delma (*Delma torquata*)—85.33 ha of important habitat
- White-throated Needletail (*Hirundapus caudacutus*) and Fork-tailed Swift (*Apus pacificus*)—99.46 ha of important habitat
- Latham's Snipe (*Gallinago hardwickii*)—65.15 ha of important habitat
- Common Sandpiper (*Actitis hypoleucos*), Pectoral Sandpiper (*Calidris melanotos*), Red-necked Stint (*Calidris ruficollis*), Black-tailed Godwit (*Limosa*), Eastern Osprey (*Pandion haliaetus*), Glossy Ibis (*Plegadis falcinellus*) and Common Greenshank (*Tringa nebularia*)— 65.15 ha of important habitat.

For aerial foraging bird species (White-throated Needletail and Fork-tailed Swift) that do not require forested areas to occur; these areas are represented over the entire Project disturbance footprint. Given the species occurs transiently across a broad swathe of eastern Australia, the impact from the Project is considered negligible at worst and impacts on this species are not considered further.

For the threatened flora species, it should be noted that only one specimen of Lloyd's Olive (*Notelaea lloydii*) *and Melaleuca irbyana* will be cleared as a result of this Project. Additional, protected plants surveys will be undertaken to further verify and delineate known threatened flora populations and support the required secondary approvals.

While 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 is likely to result in permanent impacts to threatened biodiversity values.

Settlement and subsidence may also result in the loss or degradation of habitat. The construction and operation of the tunnel is not expected to result in any settlement and/or subsidence above the tunnel which is discussed further in Section 11.8.2.13.

11.8.2.2 Fauna species injury or mortality

Physical trauma to fauna is a direct impact applicable to all fauna species, that has the potential to reduce local population size and has the potential to create 'source/sink' dynamics, 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 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 (*Phascolarctos cinereus*) (e.g. Koala, Grey-headed Flying fox and Glossy Black-cockatoo) and is less pronounces in 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 area (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*), 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 sensitive environmental receptors, including threatened and migratory fauna species listed under the provisions of the EPBC Act and NC 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, mammal species and aquatic species), or those that are nocturnal and nest or roost in tree 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. 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. .some) that are tolerant of disturbance and/or those species that can use 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. 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 species, which ascend to the ground to disperse such as Koala (*Phascolarctos cinereus*).

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

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 (Ayers 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 in the absence of woodland or forest habitat such as mammals, amphibians, and reptiles.

Aquatic fauna may be injured or killed during construction within waterways, such as the construction of culverts and bridges and associated temporary impoundments required during construction. Species most susceptible to death or injury include smaller and/or sessile species such as freshwater invertebrates. Species such as Australian Lungfish are less likely to be at risk to direct mortality where appropriate mitigation measures are applied (i.e. pre-disturbance relocation activities prior to creating temporary impoundments).

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.

11.8.2.3 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 consistency 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 threatened flora such as Hairy-joint Grass (*Arthraxon hispidus*), Four-tailed Grevillea (*Grevillea quadricauda*), Lloyd's Olive (*Notelaea lloydii*) and *Paspalidium grandispiculatum* (a grass) and Bailey's Cypress Pine (*Callitris baileyi*). 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 that 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 2004). This will act directly on recruitment processes and may impact on a species/community's ability to re-colonise 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 on 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.

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

Weed and pest species have the potential to impact terrestrial and aquatic biodiversity as native species can become displaced through predation and competition. In addition, weeds may result in impacts to the health and integrity of regional ecosystems 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 specific sensitive environmental receptors. This reduction in habitat 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 has the potential to occur during all phases of the Project; 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 sensitive environmental receptors. These potential impacts are likely to be long-term and affect all Sensitive environmental receptors in the Project disturbance footprint, including affecting the quality and integrity of TECs, remnant vegetation, habitat for threatened species, wetlands and waterways.

Non-native species comprise over 30 per cent of the flora species recorded in the ecology study area (refer Appendix I: Terrestrial and Aquatic Ecology Technical Report. Of these non-native species, 13 flora species (as well as 6 pest fauna species) were restricted matters, listed under the provisions of the Biosecurity Act. Weed species such as *Lantana camara* are noted as a potential threat to a number of Sensitive environmental receptors (e.g. Four-tailed Grevillea (*Grevillea quadricauda)* and Lloyd's Olive (*Notelaea lloydii)*) and were identified as common throughout the ecology study area, particularly in regrowth areas and along waterways. Without appropriate management strategies, the Project activities have the potential to disperse weeds into areas of remnant vegetation where weed species are currently limited or are 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 species of sensitive environmental receptors by supplying an abundant food source, which would otherwise be unavailable (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 ecology 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.

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.

Large areas of the ecology 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 in-tact remnant vegetation that currently has low weed diversity and abundance.

Unmitigated Project activities have the potential to disperse pest (fauna) species from the ecology 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 present in the area including feral cats and dogs. Therefore, unmitigated potential impacts of the displacement of native species through the invasion of non-native species may be temporary or irreversible.

11.8.2.5 Reduction in the connectivity of biodiversity corridors

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 species such as Spotted-tail Quoll (*Dasyurus maculatus maculatus*) and Koala (*Phascolarctos cinereus*).

The Queensland corridor mapping for SEQ (Version 4.1, 2016) depicts regional corridors within the ecology study area along the Little Liverpool Range, which portrays vegetation that is significant for the spread and movement of flora and fauna, including those listed under the EPBC Act and NC Act. Connectivity is present north and south of the ecology study area in the range and is evident in areas associated with steep topography.

Most of the Project disturbance footprint exists in a very fragmented environment. However, functional connectivity across the ecology study area is retained somewhat through local linkages of remnant and regrowth vegetation, associated with roadside and riparian corridors linking larger patches of vegetation on private land. These linkages may provide landscape permeability for mobile species such as birds and bats.

The potential impacts of linear infrastructure traversing this biodiversity corridor includes 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 on biodiversity corridors resulting from the Project is the proliferation of weeds and pest species, as mentioned previously.

Nevertheless, the Project includes a tunnel section where it intersects the Little Liverpool Range allowing fauna movement above the corridor. It is also noted there is an existing rail line (West Moreton System rail corridor) and the Rosewood Laidley Road intersecting the range to the south of the Project disturbance footprint. Given the highly disturbed nature of the landscape surrounding the Project the unmitigated potential impacts to biodiversity corridors resulting from the Project are likely to be relatively minor.

11.8.2.6 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 ecology study area, the Project largely avoids patches of vegetation that are small, irregularly shaped, and fragmented, and as such are already subject to considerable edge effects. The Project will impact some larger habitat patches with low edge to area ratios, in the Helidon area and the Little Liverpool Range. Project activities (vegetation clearing, temporary and permanent) may create edge effects resulting in habitat degradation and a reduction of the habitat available for a range of species.

Edge effects have the potential to impact the range of flora and fauna species identified as potentially occurring in the ecology study area, especially on the species with specific micro-habitat requirements that are less tolerant to disturbance (e.g. some ground-dwelling reptiles and mammals, smaller birds and some plants). Conversely, some threatened flora species appear to respond positively to edge effects, particularly ground disturbance, and colonise these edge areas reasonably quickly (e.g. *Paspalidium grandispiculatum* and *Thesium australe*).

It is anticipated that threatened species and wetland/waterway habitat (including habitat for Spotted-tail Quoll (*Dasyurus maculatus maculatus*), Collared Delma (*Delma torquata*), Greater Glider (*Petauroides volans*) and New Holland Mouse (*Pseudomys novaehollandiae*) may be impacted greatest 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 and irreversible.

11.8.2.7 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. This effect will largely impact habitat associated with the area between Helidon and Gatton, and the Little Liverpool Range (i.e. greenfield sections of the Project). Outside of these areas the Project is co-located with the existing West Moreton System avoiding further fragmentation, though it is noted that the width of existing barrier will increase which will impact on some species behavior.

Habitat fragmentation has been identified as important threatening process to several threatened species including the Spotted-tail Quoll (*Dasyurus maculatus maculatus*) and Koala (*Phascolarctos cinereus*). This is due to the importance of connectivity, dispersal opportunities and habitat quality for 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, given the capacity of the species to disperse widely across the landscape (e.g. Koala (*Phascolarctos cinereus*) and vagile species such as birds and bats). Species-specific assessments in accordance with the MNES and MSES significant impact guidelines (incorporating a discussion of habitat fragmentation) are within Appendix I: Terrestrial and Aquatic Ecology Technical report (Sections 5.3.3 and 5.3.4) and Appendix J: Matters of National Environmental Significance Technical Report (Section 5.3.3, 5.3.4 and 5.3.5).

Linear project activities may, however, result in some small-scale localised fragmentation that 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.

The unmitigated potential impacts of habitat fragmentation resulting from the Project are long term and irreversible.

11.8.2.8 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 species such as the Australian Lungfish (*Neoceratodus forsteri*)). As noted in the previous section (fragmentation) this is only considered a potential impact in the Helidon and Little Liverpool Range (excluding the tunnel) due to the highly modified nature of much of the landscape and that the Project is co-located with the existing West Moreton System rail corridor for approximately 24 km.

Species most vulnerable to barrier effects include uncommon species, smaller ground-dwelling species, and relatively sessile species with smaller home ranges. Threatened species most vulnerable to barrier effects include the Collared Delma (*Delma torquata*), Southern Greater Glider (*Petauroides 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). This impact may affect threatened species such as Collared Delma (*Delma torquata*) and the New Holland Mouse (*Pseudomys novaehollandiae*). Mobile 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, given the capacity of the species to disperse widely across the landscape (including heavily disturbed areas) and use Project infrastructure (such as culverts) (e.g. Koala (*Phascolarctos cinereus*).

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 is 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, in most cases, to be short term and temporary (i.e. in instances where fauna passage measures are provided) but may in some cases be long term and irreversible.

11.8.2.9 Noise, dust, and light impacts

Noise, dust, and light are direct impacts that have the potential to occur as a result from the Project activities during all phases and may also have cumulative effects. Understanding of the impacts of noise on fauna is limited. There are no current State Government or Australian Government policies or guidelines that recommend noise and vibration 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 decrease in aquatic health on 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 from increased light) or indirect impacts related to altered foraging and habituation in areas exposed to increased lighting. Light impacts associated with construction will be temporary in nature; however, operational lighting impacts will be long term and localised (e.g. infrastructure) or transient in nature (i.e. vehicle movement). While light spill may impact negatively on many species, it may positively impact on species such as microbats by attracting nocturnally flying insects on which this species feeds.

Sensitive environmental receptors affected from these potential impacts include all threatened flora (impact associated with dust) and terrestrial fauna species (impact associated with noise and vibration) listed under the provisions of the EPBC Act. The Swamp Tea-tree (*Melaleuca irbyana*) Forest of SEQ TEC is likely to 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), although it is noted the nearest occurrence of this TEC is located approximately 100 m from the Project disturbance footprint. These types of impacts are likely to be short in duration and localised. These types of impacts are likely to be short-term in duration and localised.

11.8.2.10 Increase in litter (waste)

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).

Sensitive environmental receptors 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 in duration due to the varying times of decomposition; however, it is likely to be localised and manageable.

11.8.2.11 Aquatic habitat degradation

Activities related to the construction and operation of the Project are likely to impacts to water quality, thereby degrading habitats for aquatic fauna and flora. Erosion and sedimentation (refer Section 11.8.2.12), contamination and an increase in litter (refer Section 11.8.2.10) 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.

Physical habitat modification due to hydrological regime change may degrade current habitat morphological features including substrate composition, channel form and bank stability which may reduce aquatic ecological values. Further loss of ecological services may occur from a removal of riparian vegetation required for both watercourse and drainage feature infrastructure (within construction and operation phases), which may compound physical habitat modification from any changes to hydrological regimes. It is noted most waterways intersected by the Project are already subject to significant habitat modification due to adjacent land use.

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 may also affect terrestrial habitats. This in turn 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 11.8.2.8).

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 or bio-accumulation within ecosystems. There is the potential to increase exposure of sensitive environmental receptors to contaminants or bio-accumulation of contaminants. Refer Chapter 9: Land Resources and Chapter 13: Surface Water and Hydrology for discussion on contaminants on land and in aquatic environments.

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 the watercourse thereby impacting on structural aspects that support breeding and foraging requirements of aquatic species.

Aquatic habitat degradation is considered a 'high ranking' threatening process contributing to Australian Lungfish (*Neoceratodus forsteri*) population declines (DotEE, 2017) 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 as well 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 (Lockyer Creek) 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) at sites localised to construction works although this is only expected to be temporary in nature.

11.8.2.12 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 course sandy sediment tends to accumulate in areas of slow-flow and may smother bottom-dwelling organisms and their habitats.

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 to ruin this critical refuge habitat.

In addition to the secondary impact of erosion and sedimentation on aquatic habitats, the primary impact of erosion on terrestrial habitat has potential to occur in relation to Project activities. As indicated above, these impacts 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 a localised direct impact on terrestrial habitats. These impacts are principally associated with a loss of substrate stability around vegetation and may result in a loss of vegetation quality and cover.

11.8.2.13 Tunnelling impacts–Little Liverpool Range

The construction and operation of the proposed tunnel through the Little Liverpool 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. The tunnel is proposed to be 850 m long with an excavated cross-section of approximately 142 m^2 (internal space dimensions are driven by ventilation requirements).

The tunnel intersects the Koukandowie Formation (part of the Marburg Subgroup), which is a sedimentary rock comprising cross bedded sandstone and shale layers of weak to medium strength (refer Chapter 9: Land resources for further detail). Aboveground subsidence may result from both the tunnelling process itself or as a result of settlement caused by subsequent groundwater drawdown processes caused by the tunnel. Impacts to native vegetation from potential subsidence will be localised and are therefore difficult to predict beforehand. Potential impacts on remnant vegetation may include the following: trees may become destabilised by surface movement causing tree falls and slumping; surface or tension cracking may sever or damage vegetation root systems causing tree death; ground fracturing and surface cracking may cause localised changes to soil hydrology with follow-on adverse impacts to surface vegetation.

Geotechnical survey works within the tunnel area have so far been limited (refer Golder, 2019). Nevertheless, initial interpretation of results indicate the potential for settlement and therefore damage to vegetation communities due to subsidence from the tunnel appears to be low. Ongoing geotechnical investigations will assess the potential for settlement/subsidence and will inform the final design of the tunnel.

Groundwater monitoring in the Little Liverpool Range area indicates groundwater levels range from 13 metres below ground level (mbgl) (east of the east portal of the tunnel), 15 m mbgl (west of the west portal) and up to 82 mbgl along the ridgeline (at Ch 62.2) (Golder, 2020). The vegetation in the range at the tunnel area comprises eucalypt open forest 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. Indeed, the depth to groundwater in the higher elevations of the range preclude vegetation accessing this water source.

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 [Groundwater Dependent Ecosystems (GDEs)]. Mapping of GDEs (from the BoM GDE Atlas (BoM, 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 north side of the east portal of the tunnel. It is noted the mapped GDEs have not been confirmed as present. Vegetation in these areas includes Queensland Blue Gum (*E. tereticornis*), which may access groundwater. Preliminary predictive numerical modelling of the drained tunnel through the Little Liverpool Range was carried out to estimate potential groundwater drawdown impacts (Golder, 2020). Drawdown is assumed to be ongoing and long-term. Under the base case scenario (estimated typical groundwater levels and no structural features) drawdown impacts were limited in magnitude and lateral extent, and no potential GDEs were within the predicted 1 m drawdown extent and no unacceptable adverse impacts would be anticipated (refer Chapter 14: Groundwater for further information).

Potential ground-borne vibration and associated ground-borne noise due to tunnel construction works 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 Chapter 15: Noise and Vibration for further information). The assessment considered the closest 70 sensitive (human) receivers to the tunnel as properties beyond this distance were not expected to experience vibration levels that could trigger the assessment criteria. It is noted there are no guidelines regarding potential impacts to fauna. Vibration levels are predicted to be above the lower guideline limit for dwellings during non-standard working criteria (0.3 mm/s) at approximately 10 properties along the top of the range above the tunnel. Nevertheless, it is noted there are no guidelines regarding potential impacts of ground vibration to fauna. Vibration impacts are very likely to be similar to those described for noise. In addition, vibration impacts will be restricted to the construction period. As such, any potential impact on fauna is likely to be minor at worst and temporary.

11.9 Impact mitigation

This section outlines both the terrestrial and aquatic ecological 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 design mitigation measures and then reassessed to determine residual risk after the inclusion of the proposed mitigation measures.

11.9.1 Design considerations

The mitigation measures presented in

Table 11.26 have been incorporated into the Project design. These design measures have been identified through collaborative development of the design and consideration of environmental constraints and issues. These design measures are proposed to minimise the environmental impacts of the project on flora and fauna and therefore contribute to a lowering of the initial impact risk rating for each potential impact.

TABLE 11.26: INITIAL MITIGATION MEASURES THROUGH DESIGN RESPONSE

Aspect	Initial design measures

Flora and fauna	▸ The Project is partially located within the existing West Moreton System rail corridor, as well as within the protected Gowrie to Grandchester future State transport corridor. As noted previously, the Gowrie to Grandchester future State transport corridor was assessed in 2003, with detailed analysis of potential environmental impacts. The Project design has been developed to use the existing West Moreton System rail corridor 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 Lockyer Resources Reserve, Lockyer State Forest or Lockyer National Park.
	▸ Clearing of vegetation will be restricted to the minimum required to enable the safe 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
	  ▸ In-stream habitats.
	▸ Eighteen new bridge structures over watercourses are to be constructed to minimise disturbance of aquatic habitats during operations. In addition, the existing QR rail bridge across Lockyer Creek will also be upgraded.
	▸ The Project has been developed to minimise impacts to watercourses, riparian vegetation and in-stream flora and habitats by adopting a crossing structure hierarchy where bridges are preferred to culverts to maintain connectivity for species such as Australian Lungfish (*Neoceratodus forsteri*) and riparian fauna conduits that are important to these 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 threatened flora and fauna species has been avoided, wherever possible.
	▸ Fauna crossing opportunities for species such as Koala (*Phascolarctos cinereus*), have been co-located with waterway crossing structures to maintain habitat connectivity across the rail corridor (refer Figure 11.15). Where possible, these structures align with regionally significant fauna movement corridors or areas of important fauna habitat. Crossing one (Ch 29.7 km) is at natural ground level north-west of Helidon and represents a likely choice for fauna to cross with minimal guidance. Crossings two and three (Ch 32.6 km and Ch 65.7 km) are located with bridge crossings south of the Helidon Hills area and east of Grandchester respectively (refer EIS Chapter 6: Project description (refer Figure 6.4)). The three locations have been assessed as providing movement opportunities for the greatest number of species. Opportunities to incorporate fauna infrastructure at other potential crossing points (such as large culverts) will be considered during the detailed design process.
	▸ Avoidance of natural movement corridors will maintain connectivity for species such as the Brush-tailed rock-wallaby, Koala and Greater Glider, which have potential habitat with the broader region. For example, the Little Liverpool Range tunnel (850 m long) occurs where the Project crosses a higher point in the mapped regional corridor in the Little Liverpool Range. Fauna will be able to use the unimpacted section of the range over the tunnel as a movement corridor, with impacts from the tunnel's construction and operation not anticipated (e.g. subsidence and settlement) or are likely to be negligible (e.g. ground-borne noise).
	▸ Where feasible works will be staged outside of animal breeding periods where threatened species have been identified during targeted pre-construction surveys, although it is acknowledged this will be restricted by proposed construction timeframes.

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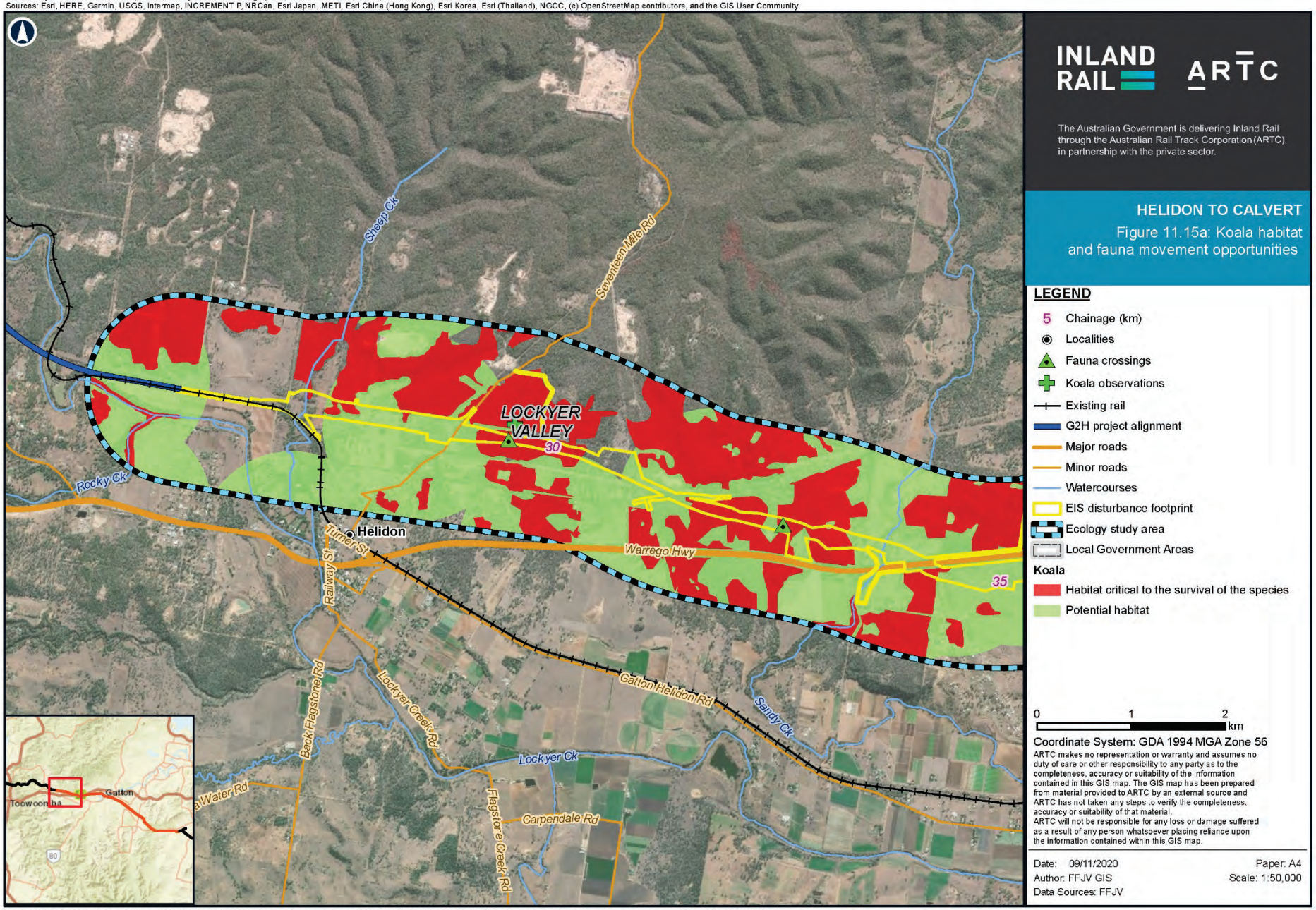

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HELIDON TO CALVERT

Figure 11.15a: Koala habitat and fauna movement opportunities

LEGEND

- 5 Chainage (km)
- Localities
- Fauna crossings
- Koala observations
- Existing rail
- G2H project alignment
- Major roads
- Minor roads
- Watercourses
- EIS disturbance footprint
- Ecology study area
- Local Government Areas

Koala

- Habitat critical to the survival of the species
- Potential habitat

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56

Date: 09/11/2020
Author: FFJV GIS
Data Sources: FFJV

Paper: A4
Scale: 1:50,000

Map by: MF Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201906101333_Ecology_figures_and_calcs\330-EAP-201906101333_ARTC_Fig11.15_Koala_habitat_fauna_movement_opps .mxd Date: 9/11/2020 10:02

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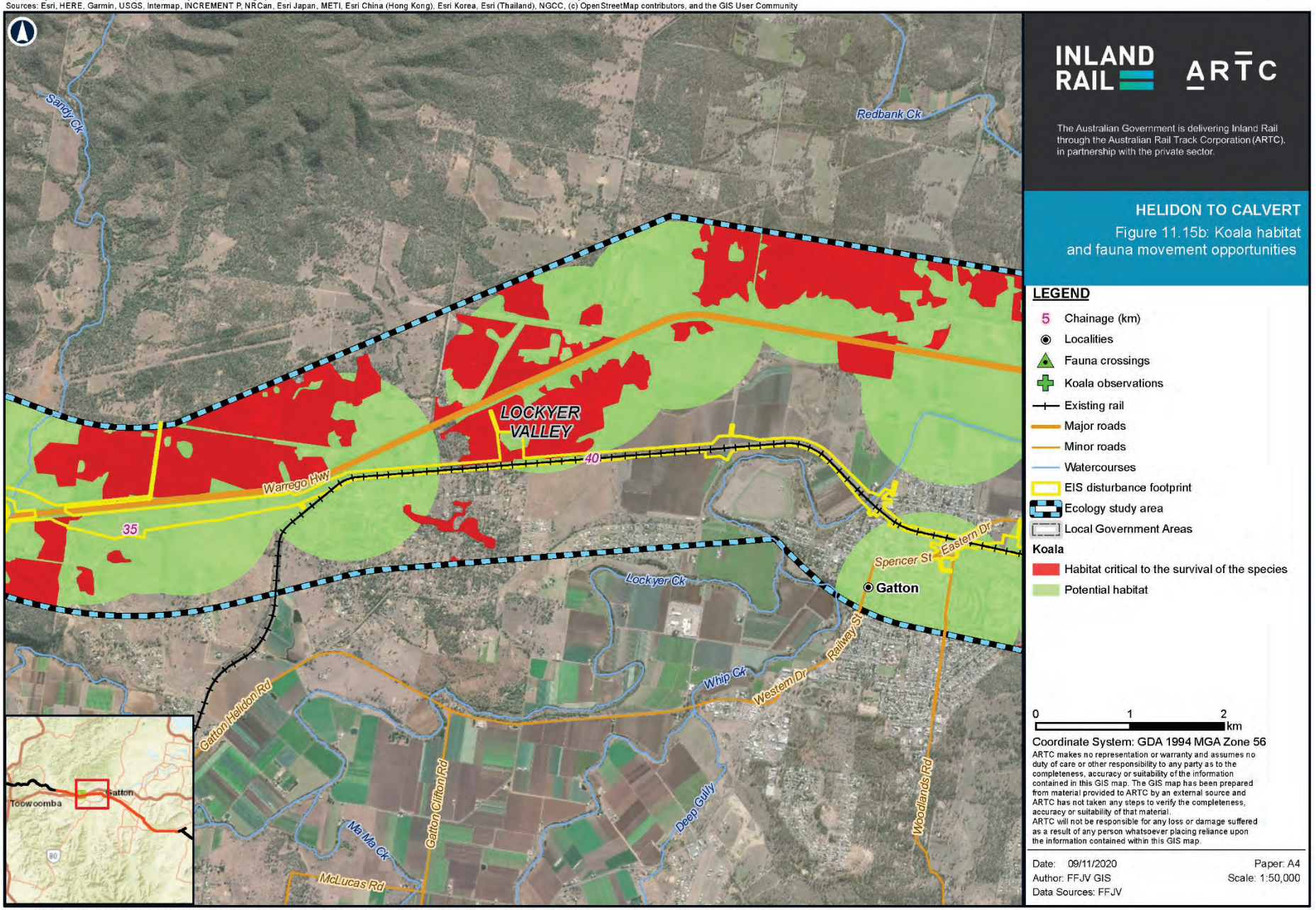

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HELIDON TO CALVERT

Figure 11.15b: Koala habitat and fauna movement opportunities

LEGEND

- 5 Chainage (km)
- Localities
- Fauna crossings
- Koala observations
- Existing rail
- Major roads
- Minor roads
- Watercourses
- EIS disturbance footprint
- Ecology study area
- Local Government Areas

Koala

- Habitat critical to the survival of the species
- Potential habitat

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56

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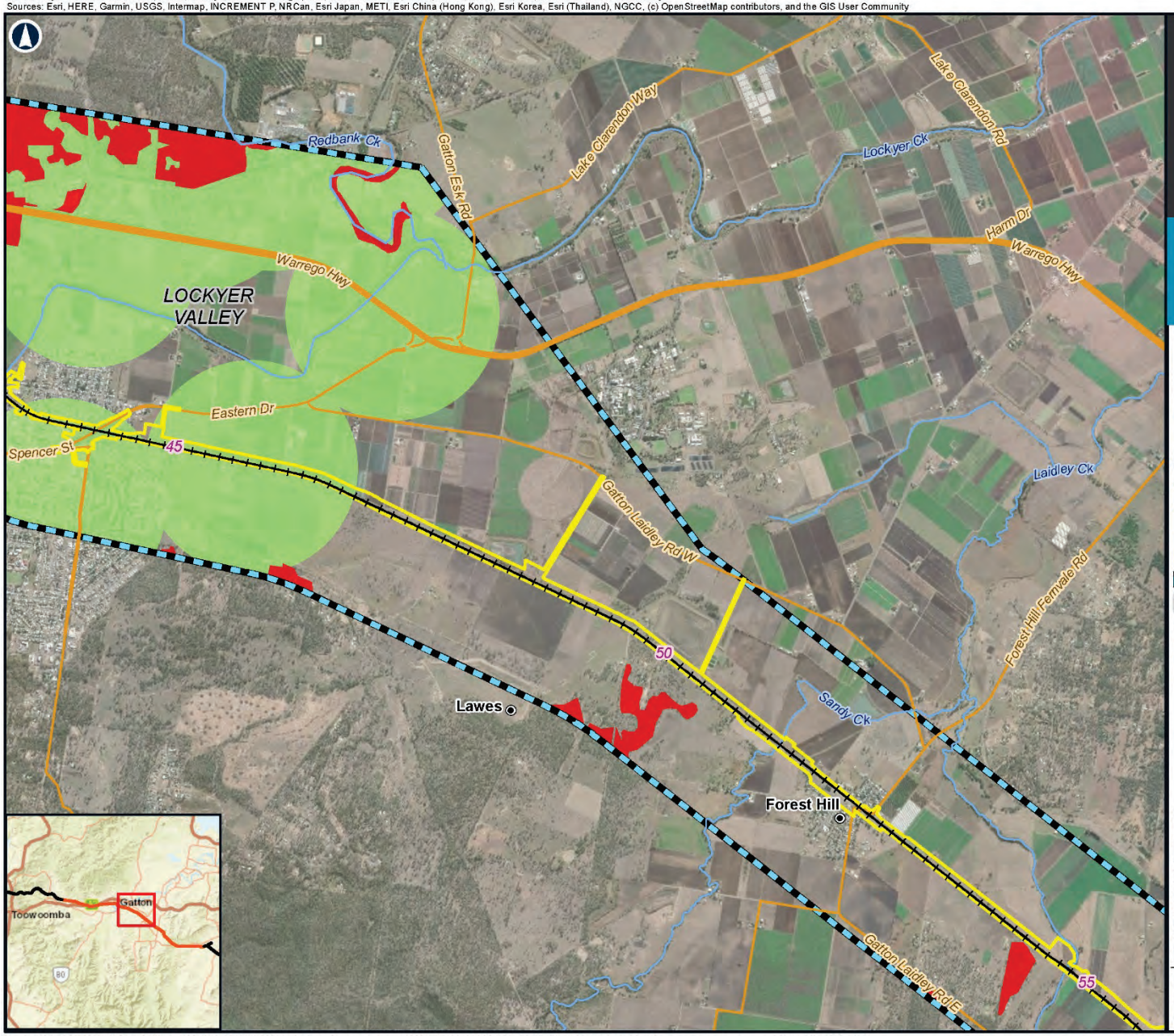

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HELIDON TO CALVERT

Figure 11.15c: Koala habitat and fauna movement opportunities

LEGEND

- 5 Chainage (km)
- Localities
- Fauna crossings
- Koala observations
- Existing rail
- Major roads
- Minor roads
- Watercourses
- EIS disturbance footprint
- Ecology study area
- Local Government Areas

Koala

- Habitat critical to the survival of the species
- Potential habitat

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56

Date: 09/11/2020 Paper: A4
Author: FFJV GIS Scale: 1:50,000
Data Sources: FFJV

Map by: MF Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201906101333_Ecology_figures_and_calcs\330-EAP-201906101333_ARTC_Fig11.15_Koala_habitat_fauna_movement_opps .mxd Date: 9/11/2020 10:02

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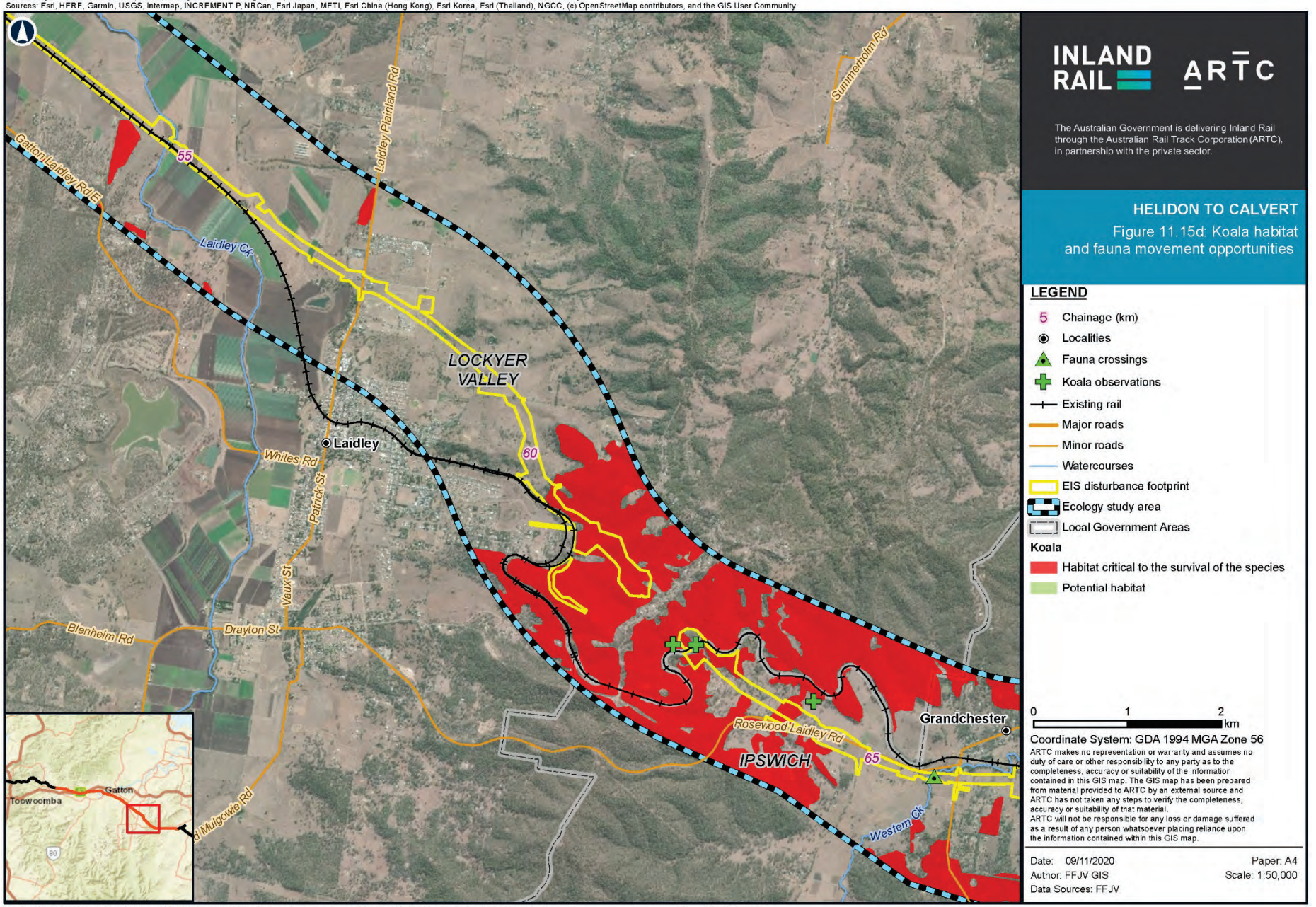

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Figure 11.15d: Koala habitat and fauna movement opportunities

LEGEND

- 5 Chainage (km)
- Localities
- Fauna crossings
- Koala observations
- Existing rail
- Major roads
- Minor roads
- Watercourses
- EIS disturbance footprint
- Ecology study area
- Local Government Areas

Koala

- Habitat critical to the survival of the species
- Potential habitat

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56

Date: 09/11/2020
Author: FFJV GIS
Data Sources: FFJV

Paper: A4
Scale: 1:50,000

Map by: MF Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201906101333_Ecology_figures_and_calcs\330-EAP-201906101333_ARTC_Fig11.15_Koala_habitat_fauna_movement_opps .mxd Date: 9/11/2020 10:02

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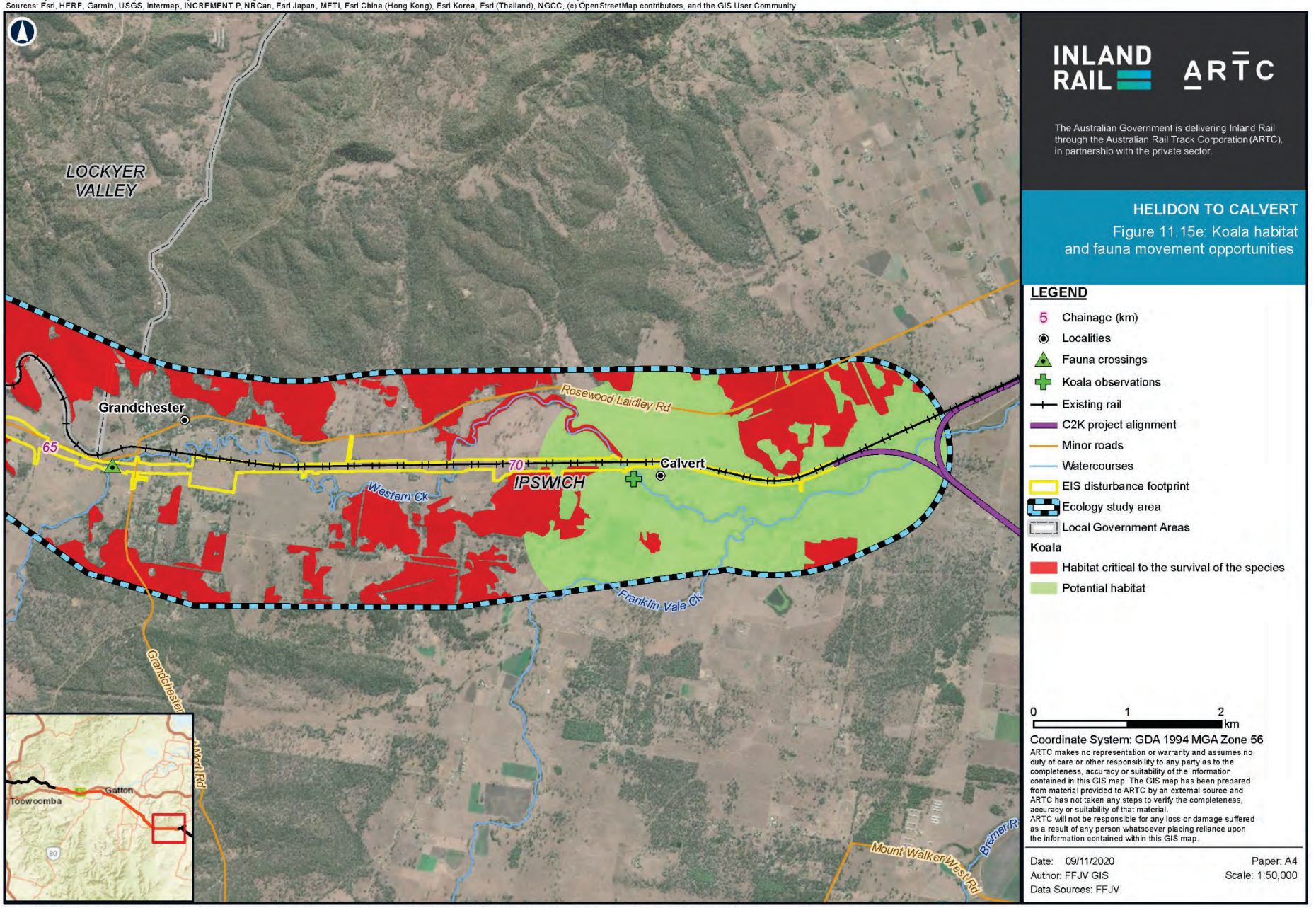

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The Australian Government is delivering Inland Rail through the Australian Rail Track Corporation (ARTC), in partnership with the private sector.

HELIDON TO CALVERT

Figure 11.15e: Koala habitat and fauna movement opportunities

LEGEND

- 5 Chainage (km)
- Localities
- Fauna crossings
- Koala observations
- Existing rail
- C2K project alignment
- Minor roads
- Watercourses
- EIS disturbance footprint
- Ecology study area
- Local Government Areas

Koala

- Habitat critical to the survival of the species
- Potential habitat

0 1 2 km

Coordinate System: GDA 1994 MGA Zone 56

Date: 09/11/2020
Author: FFJV GIS
Data Sources: FFJV

Paper: A4
Scale: 1:50,000

Map by: MF Z:\GIS\GIS_3300_H2C\Tasks\330-EAP-201906101333_Ecology_figures_and_calcs\330-EAP-201906101333_ARTC_Fig11.15_Koala_habitat_fauna_movement_opps .mxd Date: 9/11/2020 10:02

11.9.2 Proposed mitigation measures

Table 11.27. presents mitigation measures that are proposed for implementation in future phases of Project delivery. These proposed mitigation measures have been identified to address Project-specific issues and opportunities, address legislative requirements and accepted government plans, policy and practice. Information related to government threat abatement plans and recovery plans has been incorporated into the identified mitigation measures wherever applicable.

A summary of threat abatement plans and recovery plans applicable to the identified MNES is provided in Appendix I: Terrestrial and Aquatic Ecology Technical Report and Appendix J: Matters of National Environmental Significant Technical Report.

Table 11.27 identifies the relevant Project phase, the aspect to be managed, and the proposed mitigation measure, which is then factored into the initial impact assessment (refer Table 11.33 and Table 11.34).

Initial significance ratings of Low, Moderate, High and Major (refer Table 11.35) constitute a potential significant impact to sensitive environmental receptors and where applicable, were subsequently re-assessed against the MNES/MSES significant impact guidelines to confirm the significance assessment (refer Section 12.1).

ARTC has reviewed a cross-section of available published literature on effectiveness of mitigation measures used on linear infrastructure. There is significant literature that 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; Carvalho 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 & 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 road-kill
- 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 per cent of individual animals that approach a crossing structure successfully cross it, or to maintain the risk of extinction of a population to less than 5 per cent 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.

ARTC will undertake additional ecological surveys in accordance with relevant Commonwealth and State surveys guidelines. Ecological survey plans (e.g. targeted fauna and flora surveys, vegetation mapping verification) have been developed, with on-ground surveys to commence in Q2/Q3 2021. The surveys will aim to confirm and map out terrestrial and aquatic habitat, vegetation communities, and extant threatened populations, along with known threats within and adjacent the Project disturbance footprint.

These additional works will inform relevant approvals and management plans, along with necessary offset requirements and disturbance limits.

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

TABLE 11.27: PROJECT IMPACT MITIGATION MEASURES

Delivery phase	Environmental value impacted	Mitigation and management measures
Detailed design	Flora and fauna	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 to 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 Government and Australian Government survey guidelines and conservation advice for each target species, such as the *Flora survey guidelines—protected plants* (DEHP, 2016g), *Protected Plants Survey Guidelines* (DES, 2020g) and *Survey guidelines for Australia's threatened birds* (DEWHA, 2010).
		Flora species to be targeted through these surveys include, but are not limited to the following species:
		▸ MSES:
		  ▸ Bailey's Cypress Pine (*Callitris baileyi*)
		  ▸ Helidon Ironbark (*Eucalyptus taurina*)
		  ▸ Swamp Tea-Tree (*Melaleuca irbyana*)
		▸ MNES:
		  ▸ Hairy-joint Grass (*Arthraxon hispidus*)
		  ▸ Four-tailed Grevillea (*Grevillea quadricauda*)
		  ▸ Blunt-leaved Leionema (*Leionema obtusifolium*)
		  ▸ Lloyd's Olive (*Notelaea lloydii*)
		  ▸ a grass *Paspalidium grandispiculatum*
		  ▸ Brush Sophora (*Sophora fraseri*)
		  ▸ Austral Toadflax (*Thesium australe*)

Delivery phase	Environmental value impacted	Mitigation and management measures
Detailed design (continued)	Flora and fauna (continued)	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: ▸ MSES and MNES (non-threatened): **(* indicates migratory species)** ▸ Common Sandpiper (*Actitis hypoleucos*)* ▸ Sharp-tailed Sandpiper (*Calidris acuminata*)* ▸ Pectoral Sandpiper (*Calidris melanotos*)* ▸ Red-necked Stint (*Calidris ruficollis*)* ▸ Glossy Black-cockatoo (*Calyptorhynchus lathami lathami*) ▸ Oriental Dotterel (*Charadrius veredus*)* ▸ Oriental Cuckoo (*Cuculus optatus*)* ▸ Latham's Snipe (*Gallinago hardwickii*)* ▸ Gull-billed Tern (*Gelochelidon nilotica*)* ▸ Caspian Tern (*Hydroprogne caspia*)* ▸ Black-tailed Godwit (*Limosa limosa*)* ▸ Black-faced Monarch (*Monarcha melanopsis*)* ▸ Yellow Wagtail (*Motacilla flava*)* ▸ Satin Flycatcher (*Myiagra cyanoleuca*)* ▸ Powerful Owl (*Ninox strenua*)* ▸ Platypus (*Ornithorhynchus anatinus*) ▸ Eastern Osprey (*Pandion haliaetus*)* ▸ Red-necked Phalarope (*Phalaropus lobatus*)* ▸ Glossy Ibis (*Plegadis falcinellus*)* ▸ Pacific Golden Plover (*Pluvialis fulva*)* ▸ Rufous Fantail (*Rhipidura rufifrons*)* ▸ Spectacled Monarch (*Symposiachrus trivirgatus*)* ▸ Short-beaked Echidna (*Tachyglossus aculeatus*) ▸ Common Greenshank (*Tringa nebularia*)* ▸ Marsh Sandpiper (*Tringa stagnatilis*)* ▸ MNES: ▸ Regent Honeyeater (Anthocharea phrygia) ▸ Australasian Bittern (Botaurus poiciloptilus) ▸ Curlew Sandpiper (Calidris ferruginea) ▸ Spotted-tail Quoll (Dasyurus maculatus maculatus) ▸ Collared Delma (Delma torquata) ▸ Red Goshawk (Erythrotriorchis radiatus) ▸ Grey Falcon (*Falco hypoleucos*) ▸ Painted Honeyeater (Grantiella picta) ▸ Swift Parrot (Lathamus discolor) ▸ Australian Lungfish (Neoceratodus forster*i*) ▸ Greater Glider (Petauroides 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)

Delivery phase	Environmental value impacted	Mitigation and management measures
Detailed design (continued)	Flora and fauna (continued)	Where a species is detected, it 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, remnant and regrowth vegetation communities that will be impacted by the Project will be undertaken during the detailed design phase 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, 2012) as relevant, to enable a condition assessment of vegetation communities that require offset for the Project.
		Based on the outcome of flora, fauna, vegetation communities 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, 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, though some are used in the horticultural industry.
	MNES: Hairy-joint Grass (*Arthraxon hispidus*), Four-tailed Grevillea (*Grevillea quadricauda*), Blunt-leaved Leionema (*Leionema obtusifolium*), Lloyd's Olive (*Notelaea lloydii*), *Paspalidium grandispiculatum* (a grass), Brush Sophora (*Sophora fraseri*) and Austral Toadflax (*Thesium australe*)	The following species-specific measures will also be implemented: ▸ Avoid works in areas that may support an important population of the species ▸ Undertake protected flora surveys as per *Protected Plants Survey Guidelines* (DES, 2020g) with a particular focus within the area suspected of supporting the species (refer species habitat mapping in Appendix F of Appendix J: Matters of National Environmental Significance Technical Report).

Delivery phase	Environmental value impacted	Mitigation and management measures
Detailed design (continued)	MNES: Australian Lungfish (*Neoceratodus forsteri*)	The following species-specific measures for Australian Lungfish (*Neoceratodus forsteri*) will also be implemented: ▸ Avoid clearing within and along major watercourses, 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, 2011b). ▸ 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 of the method of recovery, transport and release of fish. The Flora and Fauna Sub-plan will include requirements for the application of 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 ▸ 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).

	MNES: Spotted-tail Quoll (*Dasyurus maculatus maculatus*) Long-nosed Potoroo (*Potorous tridactylus tridactylus*), New Holland Mouse (*Pseudomys novaehollandiae*) and Brush-tailed Rock-wallaby (*Petrogale penicillata*)	The following species-specific measures will 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 F) 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
		▸ The Flora and Fauna Sub-plan will include restricted works measures for implementation if species 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 these species 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 during the breeding season for these species
		  ▸ 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).

Delivery phase	Environmental value impacted	Mitigation and management measures
Detailed design (continued)	MNES: Swift Parrot (*Lathamus discolor*)	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.
	MNES: Australian Painted Snipe (*Rostratula australis*), Curlew Sandpiper (*Calidris ferruginea*) and Australasian bittern (*Botaurus poiciloptilus*)	The following species-specific measures will also be implemented: ▸ Targeted surveys to be undertaken of potential habitat following the *Survey guidelines for Australia's threatened birds* (DEWHA 2010). ▸ Should these species 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 if nesting is detected. The CEMP will 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 Biosecurity Management Sub-plan will include site hygiene and waste management measures to ensure pest predator fauna are not attracted to works areas or using the Project disturbance footprint.
	MNES: Collared delma (*Delma torquata*)	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 2011d) where suitable habitat is identified (refer species habitat mapping in Appendix F of Appendix J: Matters of National Environmental Significance Technical Report) ▸ 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/minimises 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
Detailed design (continued)	MNES: Red Goshawk (*Erythrotriorchis radiatus*), Regent Honeyeater (*Anthochaera phrygia*), Painted Honeyeater (*Grantiella picta*), Black-breasted Button-quail (*Turnix melanogaster*) and Grey Falcon (*Falco hypoleucos*)	The following species-specific measures will also be implemented: ▸ Pre-clearing surveys of woodlands identified as potential habitat for these species (refer species habitat mapping in Appendix F of Appendix J: Matters of National Environmental Significance Technical Report) 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) is identified. ▸ Where 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. micro-siting 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).
	MNES: Koala (*Phascolarctos cinereus*)	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 F of Appendix J: Matters of National Environmental Significance Technical Report) 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, 2000; DTMR, 2010). Fencing extent will be determined by the availability of suitable habitat adjacent to alignment 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 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

Detailed design (continued)	MNES: Greater Glider (*Petauroides volans*)	The following species-specific measures for the Greater Glider (*Petauroides 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 F of Appendix J: Matters of National Environmental Significance Technical Report) to identify whether individuals occur within disturbance footprint, including potential movement pathways, nest sites (.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, 2000; 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:
		  ▸ Requirements for pre-clearing surveys to identify and map out hollow bearing trees, feed trees and potential movement pathways
		  ▸ In consultation with the project team and construction team to determine whether key microhabitats can be avoided
		  ▸ Where key microhabitats cannot be avoided develop protocols/procedures to manage these features, including relocating hollow bearing trees into adjacent habitat and the use of nest boxes, tapping of hollows nearing trees or where possible by lowering slowly with a claw extension

	MNES: Grey-headed Flying fox (*Pteropus poliocephalus*)	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 2015b).

Delivery phase	Environmental value impacted	Mitigation and management measures
Detailed design (continued)	MNES, MSES	For other species not listed above, review the outcome of the flora and fauna surveys, and adopt species-specific measures as appropriate for pre-clearing surveys, landscape design, the Reinstatement and Rehabilitation Plan and the Flora and Fauna Sub-plan.
	MNES	Develop a post-construction MNES monitoring plan, with reference to the survey results. The MNES monitoring plan will be developed in consultation with relevant stakeholders and imposed conditions. 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.
	Fauna	Project design to incorporate minimum lighting requirements feasible for Project safety.

	Flora and fauna	The potential for Project works to impact MNES and other ecological receptors 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
		- 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
		  - 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.

Delivery phase	Environmental value impacted	Mitigation and management measures
Detailed design (continued)	Flora and fauna (continued)	▸ Process for the continuous reviewed 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). ▸ The ESCP will be reviewed prior to the commencement of pre-construction activities, once construction methodology is finalised and to document location specific controls. ▸ 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 identified through appropriate baseline groundwater monitoring, modelling and analysis and incorporated into the CEMP.

Delivery phase	Environmental value impacted	Mitigation and management measures
Detailed design (continued)	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 ▸ 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 ▸ 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 ▸ 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.
	Fauna passage[1,2]	Refine fauna passage locations and associated rehabilitation areas in the design in accordance with the fauna crossing strategy to maintain infrastructure permeability, particularly at the key locations identified as part of the EIS assessment process to maintain and/or re-establish habitat connectivity for the targeted local species of: ▸ Spotted-tailed Quoll (*Dasyurus maculatus maculatus*) ▸ Greater Glider (*Petauroides 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, 2000; DTMR, 2010) and where applicable species-specific requirements.

Delivery phase	Environmental value impacted	Mitigation and management measures
Detailed design (continued)	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. Fauna fencing will be designed with reference to DTMR's *Fauna-Sensitive Road Design Manual* (DTMR, 2000; 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. Dewatering strategies will be required to comply with the *Biosecurity Act 2014* (Qld) to take 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.

Delivery phase	Environmental value impacted	Mitigation and management measures
Detailed design (continued)	Landscape, rehabilitation and stabilisation (continued)	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 should 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). 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 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 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 ▸ 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 detailed design as far as practical, to that required to safely and efficiently construct and operate the Project. 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[1] based on the outcomes of the flora, fauna and MNES habitat surveys. Re-calculated impacts will be used to confirm the Project's offset obligations under Australian Government and State Government requirements A Project offset delivery plan and offset 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 I of Appendix J: Matters of National Environmental Significance Technical Report for the Environmental Offset Delivery Strategy—Qld).

Delivery phase	Environmental value impacted	Mitigation and management measures
Detailed design (continued)	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, 2015b) ▸ Works protocols to allow safe movement away from works area, should other fauna be observed within or adjacent to the works area ▸ Works protocols to minimise construction noise as much as possible where fauna are observed staying within or adjacent to the works area ▸ Relocation of habitat features (such as hollow bearing logs, 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.
	Weeds and pests	Develop the Biosecurity Management Sub-plan[1,2,3] to include: ▸ Requirements for pre-clearing surveys in lands immediately adjacent to the disturbance footprint 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 2015c) 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 lands immediately adjacent to the disturbance footprint (restricted matters including mother of millions, Opuntioid Cactus, Lantana and Giant Rat's 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 in lands immediately adjacent to the activities

Delivery phase	Environmental value impacted	Mitigation and management measures
		▸ 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*) (Ipswich City Council, n.d.; Logan City Council, n.d.). ▸ 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 CEMP 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 and MSES 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 Plan during pre-construction to reduce the potential for the spread of weeds and pests into the immediate surrounding environments and land uses.
	Erosion and sediment control	The ESCP prepared during detailed design will be reviewed and updated by a CPESC, incorporating further construction methodology details as required Implement appropriate site stabilisation treatments, including seeding and planting requirements, in accordance with the ESCPs and Reinstatement and Rehabilitation Plan.

Delivery phase	Environmental value impacted	Mitigation and management measures
Construction and commissioning	Flora and fauna	Project clearing extents are limited to that 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 sequence 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.
		A qualified Fauna Spotter Catcher will undertake pre-clearance surveys of habitats and vegetation. 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.

Delivery phase	Environmental value impacted	Mitigation and management measures
Construction and commissioning (continued)	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). 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* (DAF, 2018b). 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 and culvert construction where practical and feasible, particularly in the 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.

Delivery phase	Environmental value impacted	Mitigation and management measures
Construction and commissioning (continued)	Flora	Minimise clearance of remnant vegetation to that necessary for construction and safe operation, and in accordance with the disturbance footprint and secondary approvals.[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 the 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.[1] Topsoil stockpiles will be managed to maintain the viability of soil seed banks for threatened flora species.[1] 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 identified fauna passages/creek crossing locations for the Project to maintain permeability in the alignment.[1,2]
	Weeds and pests	Implement the Biosecurity Management Plan during construction to reduce the potential for the spread of weeds and pests into the immediate 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.
	Landscape, rehabilitation and stabilisation	Construct landscaping treatments in accordance with the landscape design. Implement the Soil Management Plan to protect 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 and MSES such as weed invasion.

Delivery phase	Environmental value impacted	Mitigation and management measures
Construction and commissioning (continued)	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 onsite mulching or erosion protection without prior treatment. For any unsuitable material i.e. noxious weeds, the cleared and grubbed material shall be removed from the site and disposed of in accordance with relevant statutory requirements and the Biosecurity Management 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 *Biosecurity Act 2014* (Qld), 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 objective. . 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).

Delivery phase	Environmental value impacted	Mitigation and management measures
Operation (continued)	Fauna fencing	Inspect and maintain fauna fencing in accordance with ARTC's *Engineering (Track and Civil) Code of Practice—Section 17 Right of Way: Inspection and Assessment.* 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).

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.
3. Mitigation measure commonly applied across other projects as approved by the Commonwealth in central and southern Queensland.

11.9.3 Flora and fauna management and monitoring

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 mitigation measures used on similar projects that have been subject to legislative approval. It is acknowledged the effectiveness of these measures may not be subject to rigorous peer-reviewed analysis. 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 measures.

In addition, 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 and relevant State survey guidelines will be undertaken. The surveys will aim to address any changes to the Project design and footprint and limitations associated with the existing surveys (e.g. access constraints during previous surveys, relevance of the surveys (i.e. some surveys area over four years old or were during sub-optimal periods due to the dry conditions)), 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 (where they exist) 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.

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

11.10 Impact assessment

Potential flora and fauna impacts during construction, commissioning/reinstatement and operation have been assessed in accordance with the qualitative impact assessment methodology.

Potential impacts to environmental values due to Project construction have been assessed in Section 11.1.1. For the purposes of impact assessment, the maximum potential disturbance to each sensitive environmental receptor (e.g. areas identified using the predictive habitat mapping or the maximum extent government certified mapping) have been used.

The initial significance assessment is undertaken on the assumption that the design measures factored into the Project design (refer Section 11.9.1) have been implemented. The residual significance level of potential impacts is reassessed considering implementation of proposed additional mitigation measures (Table 11.27). This has been split into construction phase, commissioning and reinstatement phase, and operations. Offsets in response to residual impacts are discussed in Section 11.1.

11.10.1 Quantification of potential magnitude of impacts

Quantitative estimation of the potential magnitude of disturbance was undertaken for each of the sensitive environmental receptors identified during the desktop and field components of the Project EIS using predictive habitat modelling, which was supported by field validation, government GIS datasets and material gathered during the field component of the Project EIS. In addition, the Project disturbance footprint was used to determine the 'unmitigated' disturbance area as a percentage of the extent of the sensitive environmental receptors within the broader Project context (i.e. the ecology study area).

Calculated estimates of potential disturbance magnitudes for each of the sensitive environmental receptors is provided in the following tables:

- Table 11.28 (EPBC Act controlling provisions of the Project)
- Table 11.29 (non-threatened, migratory species listed under the EPBC Act)
- Table 11.30 (NC Act threatened, near-threatened and special least concern species)
- Table 11.31 (other state-based sensitive environmental receptors).

The magnitude of impacts is determined using techniques and tools that facilitate an estimation of the **extent**, **duration** and **frequency** of the impacts as described in Appendix I: Terrestrial and Aquatic Ecology Technical Report and Appendix J: Matters of National Environmental Significance Technical Report. The criteria used to determine magnitude of impacts is presented in Table 11.32.

TABLE 11.28: ESTIMATION OF POTENTIAL MAGNITUDE OF DISTURBANCE TO THREATENED (EPBC ACT) FLORA, FAUNA SPECIES AND ECOLOGICAL COMMUNITIES IDENTIFIED FOR THE PROJECT

Species name	Common name	NC Act status	EPBC Act status	Predicted habitat within the Project disturbance footprint (ha)* (634.58 ha) (refer Table 11.18 for areas of habitat within the ecology study area)#				Percentage (%) disturbance to sensitive environmental receptors within the ecology study area based on the unmitigated potential disturbance				Magnitude of disturbance area (based on total habitat available) (refer Table 11.32 for magnitude criteria)
				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	
Threatened ecological communities												
Swamp Tea-tree (*Melaleuca irbyana*) Forest of SEQ TEC		-	CE	**0.00**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Absent—negligible
Brigalow (*Acacia harpophylla* dominant and codominant)		-	E	**0.00**	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Absent—negligible
Flora (threatened)												
Arthraxon hispidus	Hairy-joint Grass	V	V	**0.00**	1.16	0.00	0.00	**0.00**	0.00	0.00	0.00	Absent—negligible
Dichanthium setosum	Bluegrass	LC	V	**0.00**	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00	Absent—negligible
Grevillea quadricauda	Four-tailed Grevillea	V	V	**26.06**	26.06	0.00	0.00	**5.47**	5.47	0.00	0.00	Moderate
Leionema obtusifolium	Blunt-leaved Leionema	V	V	**29.26**	29.26	0.00	0.00	**3.29**	3.29	0.00	0.00	Moderate
Lepidium peregrinum	Wandering Pepper-cress	LC	E	**0.00**	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00	Absent—negligible
Notelaea lloydii	Lloyd's Olive	V	V	**134.03**	112.77	0.00	21.26	**5.17**	4.67	0.00	12.05	Moderate
Paspalidium grandispiculatum	a grass	V	V	**84.58**	84.58	0.00	0.00	**3.58**	3.58	0.00	0.00	Moderate
Phebalium distans	Mt Berryman Phebalium	E	CE	**0.00**	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00	Absent—negligible
Sophora fraseri	Brush Sophora	V	V	**39.98**	39.98	0.00	0.00	**9.64**	9.64	0.00	0.00	Moderate
Thesium australe	Austral Toadflax	V	V	**94.77**	94.77	0.00	0.00	**14.51**	14.51	0.00	0.00	High

Species name	Common name	NC Act status	EPBC Act status	Predicted habitat within the Project disturbance footprint (ha)* (634.58 ha) (refer Table 11.18 for areas of habitat within the ecology study area)#				Percentage (%) disturbance to sensitive environmental receptors within the ecology study area based on the unmitigated potential disturbance				Magnitude of disturbance area (based on total habitat available) (refer Table 11.32 for magnitude criteria)
				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	
Fauna (threatened)												
Anomalopus mackayi	Five-clawed Worm-skink	E	V	**0.00**	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00	Absent—negligible
Anthochaera phrygia	Regent Honeyeater	E	CE	**84.58**	84.58	0.00	0.00	**3.74**	3.74	0.00	0.00	Moderate
Botaurus poiciloptilus	Australasian Bittern	LC	E	**15.43**	15.43	0.00	0.00	**3.46**	3.71	0.00	0.00	Moderate
Calidris ferruginea	Curlew Sandpiper	E	CE, M	**15.43**	15.43	0.00	0.00	**1.89**	1.90	0.00	0.00	Low
Erythrotriorchis radiatus	Red Goshawk	E	V	**88.82**	71.08	0	17.74	**3.66**	5.15	0.00	1.86	Moderate
Falco hypoleucos	Grey Falcon	V	V	**351.97**	351.97	0	0	**5.48**	5.48	0.00	0.00	Moderate
Grantiella picta	Painted Honeyeater	V	V	**13.34**	13.34	0.00	0.00	**1.95**	1.96	0.00	0.00	Low
Hirundapus caudacutus	White-throated Needletail^	SLC	M, V	**634.58**	535.12	99.46	0.00	**5.35**	5.91	3.54	0.00	Moderate
Lathamus discolor	Swift Parrot	E	CE	**98.67**	85.33	0	13.34	**3.56**	3.54	0.00	3.68	Moderate
Rostratula australis	Australian Painted Snipe	V	E	**33.38**	17.95	0.00	15.43	**4.22**	5.21	0.00	3.46	Moderate
Turnix melanogaster	Black-breasted Button-quail	V	V	**0.00**	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00	Absent—negligible
Dasyurus maculatus	Spotted-tail Quoll (Southern subspecies)	V	E	**77.07**	75.48	0.00	1.59	**3.62**	4.18	0.00	0.50	Moderate
Petauroides volans	Greater Glider	V	V	**30.64**	30.64	0.00	0.00	**2.01**	2.01	0.00	0.00	Moderate
Petrogale penicillata	Brush-tailed Rock-wallaby	V	V	**41.25**	36.37	0.00	4.88	**13.85**	15.42	0.00	7.89	High
Phascolarctos cinereus	Koala	V	V	**303.95**	205.29	0.00	98.66	**4.70**	5.43	0.00	3.67	Moderate
Potorous tridactylus tridactylus	Long-nosed Potoroo	V	V	**84.58**	84.58	0.00	0.00	**3.75**	3.75	0.00	0.00	Moderate
Pseudomys novaehollandiae	New Holland Mouse	V	V	**88.12**	88.12	0.00	0.00	**3.67**	3.67	0.00	0.00	Moderate
Pteropus poliocephalus	Grey-headed Flying-fox	LC	V	**99.46**	0.00	0.00	99.46	**3.54**	0.00	0.00	3.54	Moderate

Species name	Common name	NC Act status	EPBC Act status	Predicted habitat within the Project disturbance footprint (ha)* (634.58 ha) (refer Table 11.18 for areas of habitat within the ecology study area)#				Percentage (%) disturbance to sensitive environmental receptors within the ecology study area based on the unmitigated potential disturbance				Magnitude of disturbance area (based on total habitat available) (refer Table 11.32 for magnitude criteria)
				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	
Delma torquata	Collared Delma	V	V	**85.33**	0.00	85.33	0.00	**3.67**	0.00	3.67	0.00	Moderate
Furina dunmalli	Dunmall's Snake	V	V	**0.00**	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00	Absent—negligible
Neoceratodus forsteri	Australian Lungfish	-	V	**2.24**	0.28	0.00	1.96	**0.48**	0.08	0.00	1.58	Negligible

Table notes:

CE = Critically endangered E = Endangered V = Vulnerable M = Migratory LC = Least concern - = Not listed

^ = Aerial species, all 'air-space' above the Project is considered habitat. However, these areas will not be impacted by the Project.

* = No value (i.e. 0) represents areas where habitat modelling has indicated that no predicted habitat has been identified within a particular area. Sensitive environmental receptors that recorded a magnitude of 'Not applicable' were not subject to an assessment of impact significance as the sensitive environmental receptor was not subject to impacts.

= There is potential for each of the sensitive environmental receptor 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 Project disturbance footprint.

TABLE 11.29: ESTIMATION OF POTENTIAL MAGNITUDE OF DISTURBANCE FOR EPBC ACT LISTED, NON-THREATENED MIGRATORY SPECIES FOR THE PROJECT

Species name	Common name	NC Act status	EPBC Act status	Predicted habitat within the Project disturbance footprint (ha)* (634.58 ha) (refer Table 11.19 for areas of habitat within the ecology study area)#			Percentage (%) disturbance to sensitive environmental receptors within the ecology study area based on the unmitigated potential disturbance			Magnitude of disturbance area (based on total habitat available) (refer Table 11.2 for magnitude criteria)
				Total habitat	Potential habitat	Important habitat	Total habitat	Potential habitat	Important habitat	
EPBC Act migratory species										
Actitis hypoleucos	Common Sandpiper	SLC	M	**80.58**	15.43	65.15	**4.63**	3.46	5.03	Moderate
Apus pacificus	Fork-tailed Swift^	SLC	M	**634.58**	535.12	99.46	**5.35**	5.91	3.54	Moderate
Calidris acuminata	Sharp-tailed Sandpiper	SLC	M	**92.00**	26.85	65.15	**4.55**	3.54	5.16	Moderate
Calidris melanotos	Pectoral Sandpiper	SLC	M	**80.58**	15.43	65.15	**4.63**	3.46	5.03	Moderate
Calidris ruficollis	Red-necked Stint	SLC	M	**80.58**	15.43	65.15	**4.63**	3.46	5.03	Moderate
Charadrius veredus	Oriental Dotterel	SLC	M	**98.40**	33.25	65.15	**5.00**	4.79	5.12	Moderate
Cuculus optatus	Oriental Cuckoo	SLC	M	**0.52**	0.08	0.43	**0.55**	0.11	2.05	Negligible
Gallinago hardwickii	Latham's Snipe	SLC	M	**133.88**	68.73	65.15	**5.19**	5.06	5.34	Moderate
Gelochelidon nilotica	Gull-billed Tern	SLC	M	**15.43**	15.43	0.00	**3.07**	3.35	0.00	Moderate
Hydroprogne caspia	Caspian Tern	SLC	M	**20.51**	20.51	0.00	**2.90**	3.10	0.00	Moderate
Limosa limosa	Black-tailed Godwit	SLC	M	**80.58**	15.43	65.15	**4.63**	3.46	5.03	Moderate
Monarcha melanopsis	Black-faced Monarch	SLC	M	**6.07**	5.64	0.43	**2.20**	2.22	2.05	Moderate
Monarcha trivirgatus	Spectacled Monarch	SLC	M	**80.58**	15.43	65.15	**4.63**	3.46	5.03	Moderate
Motacilla flava	Yellow Wagtail	SLC	M	**0.52**	0.08	0.43	**0.85**	0.20	2.05	Negligible
Myiagra cyanoleuca	Satin Flycatcher	SLC	M	**15.43**	15.43	0.00	**3.46**	3.82	0.00	Moderate
Pandion haliaetus	Eastern Osprey	SLC	M	**80.58**	15.43	65.15	**4.63**	3.46	5.03	Moderate
Phalarops lobatus	Red-necked Phalarope	SLC	M	**184.68**	126.73	57.95	**4.37**	3.84	6.27	Moderate
Plegadis falcinellus	Glossy Ibis	SLC	M	**80.58**	15.43	65.15	**4.63**	3.46	5.03	Moderate
Pluvialis fulva	Pacific Golden Plover	SLC	M	**0.52**	0.08	0.43	**0.85**	0.20	2.05	Negligible
Rhipidura rufifrons	Rufous Fantail	SLC	M	**0.52**	0.08	0.43	**0.85**	0.20	2.05	Negligible
Tringa nebularia	Common Greenshank	SLC	M	**80.58**	15.43	65.15	**4.63**	3.46	5.03	Moderate
Tringa stagnatilis	Marsh Sandpiper	SLC	M	**92.22**	27.07	65.15	**4.55**	3.54	5.16	Moderate

Table notes:
M = Migratory SLC = Special Least Concern
* There is potential for each of the sensitive environmental receptor 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 Project disturbance footprint.
^ = Aerial species, all 'air-space' above the Project is considered habitat. However, these areas will not be impacted by the Project.
\# Sensitive environmental receptors that recorded a magnitude of 'N/A' were not subject to an assessment of impact significance as the sensitive environmental receptor was not subject to impacts.

TABLE 11.30: ESTIMATION OF POTENTIAL MAGNITUDE OF DISTURBANCE FOR NC ACT CONSERVATION SIGNIFICANT FLORA AND FAUNA SPECIES (EXCLUDING MNES) FOR THE PROJECT

			Predicted habitat within the Project disturbance footprint (ha)* (634.58 ha) (refer Table 11.18 for areas of habitat within the ecology study area)				Percentage (%) disturbance to sensitive environmental receptors within the ecology study area based on the unmitigated potential disturbance				Magnitude of total habitat disturbance (based on total habitat available) area (refer Table 11.2for magnitude criteria)
Species name	**Common name**	**NC Act status**	**Total habitat**	**General**	**Essential**	**Core**	**Total habitat**	**General**	**Essential**	**Core**	
NC Act conservation significant flora											
Callitris baileyi	Bailey's Cypress Pine	NT	**28.40**	28.40	0.00	0.00	**2.03**	2.03	0.00	0.00	Moderate
Eucalyptus taurina	Helidon Ironbark	V	**0.00**	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00	Absent - Not applicable
Melaleuca irbyana	Swamp Tea-tree	E	**128.78**	124.35	4.43	0.00	**4.12**	4.27	2.12	0.00	Moderate
NC Act conservation significant fauna											
Calyptorhynchus lathami	Glossy Black-cockatoo	V	**45.11**	45.11	0.00	0.00	**6.44**	6.44	0.00	0.00	Moderate
Hemiaspis damelii	Grey Snake	E	**0.00**	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00	Absent - Not applicable
Ninox strenua	Powerful Owl	V	**28.63**	28.63	0.00	0.00	8.33	8.33	0.00	0.00	Moderate
NC Act special least concern animals											
Ornithorhynchus anatinus	Platypus	SLC	**47.77**	47.77	0.00	0.00	**3.92**	3.92	0.00	0.00	Moderate
Tachyglossus aculeatus	Short-beaked Echidna	SLC	**75.71**	75.71	0.00	0.00	**3.04**	3.04	0.00	0.00	Moderate

Table notes:

E = Endangered V = Vulnerable NT = Near threatened SLC = Special Least Concern

* There is potential for each of the sensitive environmental receptor 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 Project disturbance footprint.

\# Sensitive environmental receptors that recorded a magnitude of 'N/A' were not subject to an assessment of impact significance (refer Table 11.31) as the sensitive environmental receptor was not subject to impacts.

TABLE 11.31: ESTIMATION OF POTENTIAL MAGNITUDE OF DISTURBANCE FOR SENSITIVE ENVIRONMENTAL RECEPTORS (EXCLUDING THREATENED AND MIGRATORY SPECIES) IDENTIFIED FOR THE PROJECT

Sensitive environmental receptor	Total coverage of environmental sensitive environmental receptor within the ecology study area (ha) (11,866.54 ha)	Total unmitigated potential disturbance area associated within the Project (ha) (634.58 ha)	Percentage (%) disturbance to sensitive environmental receptors within the ecology study area based on the unmitigated potential disturbance	Magnitude of disturbance area (refer Table 11.2 for magnitude criteria)
State significant environmental constraints (MSES)				
Protected areas (i.e. Bowman Park Koala Nature Refuge)	9.97	0.00	0.00	Negligible
Regulated vegetation (VM Act)				
Endangered remnant vegetation (REs) (Category B)	104.97	1.62	1.54	Low
Of concern remnant vegetation (REs) (Category B)	136.24	1.08	0.79	Negligible
Least concern remnant vegetation (REs) (Category B)	1462.09	29.56	2.02	Moderate
High value regrowth vegetation (HVR) (Category C)	1093.72	66.39	6.07	Moderate
Regulated vegetation (Category B) intersecting watercourses and wetlands	63.45	0.77	1.21	Low
Regulated vegetation (Category C) intersecting watercourses and wetlands	30.71	1.52	4.95	Moderate
MSES wildlife habitat	2940.06	19.84	0.67	Negligible
Essential habitat mapping	2679.75	95.66	3.57	Moderate
Nature Conservation (Koala) Conservation Plan 2017 mapping				
Koala Priority Areas	4407.30	193.49	4.39	Moderate
Koala Habitat Areas	2649.01	95.62	3.61	Moderate
Koala Habitat Restoration Areas	3,962.79	161.07	**4.06**	Moderate
Locally Refined Koala Habitat Areas	0.00	0.00	0.00	Absent–not applicable
Wetlands and watercourses#				
State significant wetlands (HES)	22.77	0.00	0.00	Negligible
State significant wetlands (HEV)	64.57	6.44	9.97	Moderate
Watercourses#				
Least concern flora and fauna* (NC Act) and Priority Back on Track flora and fauna species				
Least concern flora and fauna	11,861.54	638.28	5.38	Moderate

Sensitive environmental receptor	Total coverage of environmental sensitive environmental receptor within the ecology study area (ha) (11,866.54 ha)	Total unmitigated potential disturbance area associated within the Project (ha) (634.58 ha)	Percentage (%) disturbance to sensitive environmental receptors within the ecology study area based on the unmitigated potential disturbance	Magnitude of disturbance area (refer Table 11.2 for magnitude criteria)
Priority Back on Track species (not listed under the EPBC Act or NC Act)	11,861.54	638.28	5.38	Moderate
Biodiversity Planning Assessment (BPA)				
Local or Other Habitat Values	277.44	10.65	3.84	Moderate
Regional Habitat Values	667.14	9.10	1.36	Low
State Habitat Values	635.09	9.61	1.51	Low
State Habitat for EVNT taxa	155.12	2.90	1.87	Low
Regional Terrestrial Corridor	1805.81	140.81	7.80	Moderate
State Riparian Corridor	720.47	22.52	3.13	Moderate
State Riparian/Terrestrial Corridor	2.54	0.00	0.00	Negligible

Table notes:

* There is potential for impacts to each of the sensitive environmental receptor to overlap spatially. As a result, addition of disturbance values presented in the above table would not represent a true reflection of the total Project disturbance footprint.

\# Multiple watercourses are intersected by the Project (refer Section 11.6.8). It is noted that initial impact assessment of watercourses is not tractable to analysis. However, impacts to these watercourses is assessed in accordance with the MSES significant impact guidelines in Section 11.11.3.

TABLE 11.32: CRITERIA FOR MAGNITUDE OF DISTURBANCE

Magnitude	Description
Major	An impact that is widespread, permanent and results in substantial irreversible change to the environmental value (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 environmental value (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 (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 per cent of the habitat within the greater area disturbed).

Table note: * 'Greater area disturbed' refers to the wider area within which the proposed impact is situated and compared against (e.g. the ecology study area).

11.10.2 Initial significance of potential impacts

Following an assessment of the sensitivity of sensitive environmental receptors, identification of the potential impacts to these sensitive environmental receptors and the magnitude of impact, an assessment into the impact of the Project on each sensitive environmental receptor was undertaken.

The magnitude of impacts used in Table 11.33 (EPBC Act controlling provisions), Table 11.34 (non-threatened EPBC Act listed migratory species and State-based sensitive environmental receptors), takes into consideration those associated with direct impacts associated with the direct removal of habitat (refer Table 11.28 (EPBC Act controlling provisions of the Project), Table 11.31 (non-threatened, migratory species listed under the EPBC Act), Table 11.30 (NC Act threatened, near-threatened and special least concern species) and Table 11.31 (other State-based sensitive environmental receptors)) and also considers those impacts associated with air quality (refer Chapter 12), surface water and hydrology (refer Chapter 13), groundwater (refer Chapter 14) and noise and vibration (refer Chapter 15).

The impact assessment of the Project on sensitive environmental receptors is provided in Table 11.33 (EPBC Act controlling provisions) and Table 11.34 (non-threatened EPBC Act listed migratory species and State based sensitive environmental receptors), presenting both initial impact significance (i.e. application of mitigation measures already incorporated into the design) of impact for each as well as the significance of impact following the application of Project mitigation measures.

In addition to the mitigation measures presented in Section 11.9.1 and Table 11.27, rehabilitation works may also be an effective mitigation measure to minimise potential impacts over time. However, the potential significant adverse residual impacts are likely to require some level of offset (refer Section 11.1).

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

Significance ratings of low, moderate, high and major may constitute a potential significant residual impact to an MNES (migratory species) or State-based prescribed environmental matters, and were subsequently re-assessed against the MNES significant impact guidelines (for species/communities listed under the EPBC Act, including migratory species) or MSES significant impact guidelines (for prescribed environmental matters) to confirm the initial impact assessment results (refer Sections 11.11.1, 11.11.2 and 11.11.3).

TABLE 11.33: INITIAL ASSESSMENT OF SIGNIFICANCE OF IMPACTS OF THE PROJECT ON IDENTIFIED SENSITIVE ENVIRONMENTAL RECEPTORS (EPBC ACT CONTROLLING PROVISIONS)

NEGLIGIBLE LOW MODERATE HIGH MAJOR

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (APPLICATION OF DESIGN CONSIDERATION MEASURES PRESENTED IN SECTION 11.9.1)		Application of proposed mitigation measures presented in Table 11.27 BY 'ENVIRONMENTAL VALUE IMPACTED' AND 'DELIVERY PHASE'	Residual impact significance FOLLOWING THE APPLICATION OF PROJECT MITIGATION MEASURES PRESENTED IN Table 11.27	
			Magnitude[1]	Significance		Magnitude	Significance
TECs—Swamp Tea-tree (*Melaleuca irbyana*) Forest of SEQ and Brigalow (*Acacia harpophylla* dominant and co-dominant)							
	Commissioning and reinstatement	▸ Displacement of flora and fauna species from invasion of weed and pest species ▸ Dust impacts ▸ Erosion and sedimentation	Low	**Moderate**	▸ The nearest mapped instance of the Swamp Tea-tree TEC to the Project is over 500 m from the Project disturbance footprint. The nearest mapped instance of Brigalow TEC is 30 m from the Project disturbance footprint. Neither community has been confirmed as present. ▸ Flora and Fauna Management Sub-plan developed and in place prior to construction. Pre-construction surveys will be carried out to confirm whether TECs occur in the vicinity of the Project disturbance footprint. ▸ Land Resources Sub-plan developed and in place prior to construction. To include soil conservation measures and erosion and sediment controls with specific reference/controls to identified TEC areas ▸ Biosecurity Management Sub-plan developed and in place prior to construction and will include: ▸ Control protocols will be designed so as to reduce the risk of herbicides/chemicals entering the TEC. ▸ Project Air Quality Management Sub-plan will include measures to minimise dust impacts including dust monitoring and suppression methods.	Negligible	**Low** (refer Section 11.11.1 for assessment against MNES Guidelines)

	Commissioning and reinstatement	▸ Displacement of flora and fauna species from invasion of weed and pest species
		▸ Erosion and sedimentation
			Low	**Moderate**	▸ Land Resources Sub-plan—continued maintenance of erosion and sediment controls with specific reference/controls to identified TEC areas
					▸ Biosecurity Management Sub-plan ongoing:
					  ▸ Construction vehicle weed certification and wash down procedures in place
					  ▸ Continued weed monitoring within TEC in vicinity of Project disturbance footprint with required control protocols in place where weed invasion is identified
					  ▸ Continued TEC monitoring against initial assessment values. Corrective actions to be implemented where Project-associated impacts are identified
					  ▸ Landscape, rehabilitation and stabilisation—rehabilitation of temporary construction areas.
						Negligible	**Low**

	Operation	▸ Displacement of flora and fauna species from invasion of weed and pest species
		▸ Erosion and sedimentation
			Negligible	**Low**	▸ Land Resources Sub-plan—ongoing regular monitoring and maintenance of erosion and sediment devices/infrastructure with specific reference/controls to identified TEC areas.
					▸ Biosecurity Management Sub-plan ongoing:
					  ▸ Ongoing weed monitoring within Project disturbance footprint, with a focus on areas adjacent to sensitive environments such as TECs with required control protocols in place where weed invasion is identified
					  ▸
						Negligible	**Low**

■ NEGLIGIBLE ■ LOW ■ MODERATE ■ HIGH ■ MAJOR

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (APPLICATION OF DESIGN CONSIDERATION MEASURES PRESENTED IN SECTION 11.9.1)		Application of proposed mitigation measures presented in Table 11.27 BY 'ENVIRONMENTAL VALUE IMPACTED' AND 'DELIVERY PHASE'	Residual impact significance FOLLOWING THE APPLICATION OF PROJECT MITIGATION MEASURES PRESENTED IN Table 11.27	
			Magnitude[1]	Significance		Magnitude	Significance
Four-tailed Grevillea (*Grevillea quadricauda*), Lloyd's Olive (*Notelaea lloydii*), *Paspalidium grandispiculatum* (a grass), Blunt-leaved Leionema (*Leionema obtusifolium*) and Austral Toadflax (*Thesium australe*)							

	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**	▸ Flora and Fauna Management Sub-plan developed and in place prior to construction. Will detail pre-construction protected flora surveys as per DEHP 2020c throughout identified habitat within alignment to identify whether protected species occur. Particular focus on the following:
					  ▸ Lloyd's Olive, which has been recorded during project surveys within Project disturbance footprint near Laidley and suitable habitat identified within Little Liverpool Range
					  ▸ Suitable habitat in Helidon area for Four-tailed Grevillea and *Paspalidium grandispiculatum*.
					  ▸ Translocation of specimens where deemed appropriate and approved.
					▸ Where threatened flora species cannot be avoided, relevant approvals will be sort and where applicable translocation of specimens in accordance with the guidelines for the Translocation of Threatened Plants in Australia. Translocation (including propagation) will be determined in consultation with the Queensland Herbarium and other specialists
					▸ Where a threatened flora species is found to occur—pre-construction condition assessment of species habitat in vicinity of Project disturbance footprint (using BioCondition assessment) with regular monitoring against initial assessment values. Corrective actions to be implemented where Project-associated impacts are identified.
					▸ Vegetation clearing to include at a minimum:
					  ▸ All vegetation outside of temporary construction disturbance footprint will be appropriately marked as a No-Go Zone to site workers
					  ▸ Vegetation clearance will be approved and carried out under ecological supervision
					  ▸ All workers will be briefed on the importance of threatened flora species, their location (where they are found to occur within or near Project disturbance footprint), and procedures for working around them.
					▸ Land Resources Sub-plan developed and in place prior to construction to include:
					  ▸ soil conservation measures and erosion and sediment controls with specific reference to identified habitat for threatened flora (where they are found to occur)
					▸ Biosecurity Management Sub-plan developed and in place prior to construction to include:
					  ▸ Pre-construction weed assessment of threatened flora species habitat (where found to occur) in areas adjacent to temporary construction disturbance footprint
					  ▸ Construction vehicle weed certification and wash down procedures in place
					  ▸ Weed monitoring within threatened flora habitat in vicinity of Project disturbance footprint with required control protocols in place where weed invasion is identified.
					▸ Project Air Quality Management Sub-plan will include measures to minimise dust impacts including dust monitoring and suppression methods.
						Moderate	**High** (refer Section 11.11.1 for assessment against MNES Guidelines)

■ NEGLIGIBLE ■ LOW ■ MODERATE ■ HIGH ■ MAJOR

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (APPLICATION OF DESIGN CONSIDERATION MEASURES PRESENTED IN SECTION 11.9.1)		Application of proposed mitigation measures presented in Table 11.27 BY 'ENVIRONMENTAL VALUE IMPACTED' AND 'DELIVERY PHASE'	Residual impact significance FOLLOWING THE APPLICATION OF PROJECT MITIGATION MEASURES PRESENTED IN Table 11.27	
			Magnitude[1]	Significance		Magnitude	Significance
Four-tailed Grevillea (*Grevillea quadricauda*), Lloyd's Olive (*Notelaea lloydii*), *Paspalidium grandispiculatum* (a grass), Blunt-leaved Leionema (*Leionema obtusifolium*) and Austral Toadflax (*Thesium australe*) (CONTINUED)							

	Commissioning and reinstatement	▸ Displacement of flora species from invasion of weed species
		▸ Edge effects
		▸ Erosion and sedimentation
			Negligible	**Low**	▸ Biosecurity Management Sub-plan ongoing:
					  ▸ Construction vehicle weed certification and wash down procedures in place
					  ▸ Continued weed monitoring within threatened flora habitat in vicinity of Project disturbance footprint with required control protocols in place where weed invasion is identified.
					▸ Where previously identified, continued threatened flora habitat monitoring against initial assessment values. Corrective actions to be implemented where Project-associated impacts are identified.
					▸ Project Reinstatement and Rehabilitation Management Plan will include rehabilitation of temporary construction areas.
					  ▸ Land Resources Sub-plan—continued maintenance of erosion and sediment controls with specific reference/controls to identified threatened flora habitat areas.
						Negligible	**Low**

	Operation	▸ Displacement of flora species from invasion of weed and pest species ▸ Erosion and sedimentation	Negligible	**Low**	▸ Land Resources Sub-plan—ongoing regular monitoring and maintenance of erosion and sediment devices/infrastructure to identified threatened flora habitat areas. ▸ Biosecurity Management Sub-plan ongoing: ▸ Ongoing annual weed monitoring within identified threatened flora habitat in vicinity of Project disturbance footprint with required control protocols in place where weed invasion is identified. ▸ Annual monitoring of previously identified threatened flora habitat against initial assessment values. Corrective actions to be implemented where Project-associated impacts are identified.	Negligible	**Low**

NEGLIGIBLE LOW MODERATE HIGH MAJOR

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (APPLICATION OF DESIGN CONSIDERATION MEASURES PRESENTED IN SECTION 11.9.1)		Application of proposed mitigation measures presented in Table 11.27 BY 'ENVIRONMENTAL VALUE IMPACTED' AND 'DELIVERY PHASE'	Residual impact significance FOLLOWING THE APPLICATION OF PROJECT MITIGATION MEASURES PRESENTED IN Table 11.27	
			Magnitude[1]	Significance		Magnitude	Significance
Hairy-joint Grass (*Arthraxon hispidus*) and Brush Sophora (*Sophora fraseri*)							

	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 Management Sub-plan developed and in place prior to construction. Will detail pre-construction protected flora surveys as per DEHP (2016g) throughout alignment to identify whether protected species occur. Translocation of specimens where deemed appropriate and approved.
					▸ Where a threatened flora species is found to occur—pre-construction condition assessment of species habitat in vicinity of Project disturbance footprint (using BioCondition assessment) with regular monitoring against initial assessment values. Corrective actions to be implemented where Project-associated impacts are identified.
					▸ Vegetation clearing to include:
					  ▸ All vegetation outside of temporary construction disturbance footprint will be appropriately marked as a No-Go Zone to site workers
					  ▸ Vegetation clearance will be approved and carried out under ecological supervision.
					▸ All workers will be briefed on the importance of threatened flora species, their location (where they are found to occur within or near Project disturbance footprint) and procedures for working around them.
					▸ Land Management Sub-plan developed and in place prior to construction to include:
					  ▸ soil conservation measures and erosion and sediment controls with specific reference to identified habitat for threatened flora (where they are found to occur).
					▸ Biosecurity Management Sub-plan developed and in place prior to construction. To include:
					  ▸ Pre-construction weed assessment of threatened flora species habitat (where found to occur) in areas adjacent to temporary construction disturbance footprint
					  ▸ Construction vehicle weed certification and wash down procedures in place
					  ▸ Weed monitoring within threatened flora habitat in vicinity of Project disturbance footprint with required control protocols in place where weed invasion is identified.
					▸ Project Air Quality Management Sub-plan will include measures to minimise dust impacts including dust monitoring and suppression methods.
						Negligible	**Low** (refer Section 11.11.1 for assessment against MNES Guidelines)

	Commissioning and reinstatement	▸ Displacement of flora species from invasion of weed species
		▸ Edge effects
		▸ Erosion and sedimentation
			Negligible	**Low**	▸ Biosecurity Management Sub-plan ongoing:
					  ▸ Construction vehicle weed certification and wash down procedures in place
					  ▸ Continued weed monitoring within threatened flora habitat in vicinity of Project disturbance footprint with required control protocols in place where weed invasion is identified.
					▸ Where previously identified continued threatened flora habitat monitoring against initial assessment values. Corrective actions to be implemented where Project-associated impacts are identified.
					▸ Project Reinstatement and Rehabilitation Management Plan will include rehabilitation of temporary construction areas.
					▸ Land Resources Sub-plan—continued maintenance of erosion and sediment controls with specific reference/controls to identified threatened flora habitat areas.
						Negligible	**Low**

NEGLIGIBLE LOW MODERATE HIGH MAJOR

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (APPLICATION OF DESIGN CONSIDERATION MEASURES PRESENTED IN SECTION 11.9.1) Magnitude[1]	Initial impact significance Significance	Application of proposed mitigation measures presented in Table 11.27 BY 'ENVIRONMENTAL VALUE IMPACTED' AND 'DELIVERY PHASE'	Residual impact significance (FOLLOWING THE APPLICATION OF PROJECT MITIGATION MEASURES PRESENTED IN Table 11.27) Magnitude	Residual impact significance Significance
Hairy-joint Grass (*Arthraxon hispidus*) and Brush Sophora (*Sophora fraseri*) (CONTINUED)							
	Operation	▸ Displacement of flora species from invasion of weed and pest species ▸ Erosion and sedimentation	Negligible	**Low**	▸ Land Resources Sub-plan—ongoing regular monitoring and maintenance of erosion and sediment devices/infrastructure to identified threatened flora habitat areas ▸ Biosecurity Management Sub-plan ongoing: ▸▸ Ongoing annual weed monitoring within identified threatened flora habitat in vicinity of Project disturbance footprint with required control protocols in place where weed invasion is identified. ▸ Annual monitoring of previously identified threatened flora habitat against initial assessment values. Corrective actions to be implemented where Project-associated impacts are identified.	Negligible	**Low**
Australian Lungfish							
	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**	▸ Detailed design—bridges are proposed over the larger watercourses where the species may occur, which will ensure fish passage is maintained. ▸ Construction method to avoid/minimise instream works and associated riparian habitat in identified habitat where possible. ▸ Flora and Fauna Management Sub-plan developed and in place prior to construction. Will detail pre-construction surveys of waterways identified as potential habitat of species (e.g. Lockyer Creek) to identify whether species occurs. Surveys will follow the *Survey guidelines for Australia's threatened fish* (DSEWPaC, 2011b). ▸ Where 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 (including Australian Lungfish, if present) and will follow relevant State (DAF) fish salvage guidelines during construction activities. 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). ▸ Biosecurity Management Sub-plan developed and in place prior to construction. To include: ▸▸ Pre-construction aquatic and riparian weed and pest fish assessment of waterways identified as potential habitat of species ▸▸ Construction vehicle weed certification and wash down procedures in place ▸▸ Weed monitoring within identified waterways in vicinity of Project disturbance footprint with required control protocols in place where weed invasion is identified. ▸ Project Air Quality Management Sub-plan will include measures to minimise dust impacts including dust monitoring and suppression methods. ▸ Through final 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. Surface Water Management Sub-plan developed and in place prior to construction. To include: ▸▸ Watercourse-specific water quality criteria based on baseline data ▸▸ A surface water quality monitoring program detailing water quality parameters and schedule ▸▸ Response framework where water quality impacts identified from Project activities. ▸ Project Soil Management Sub-plan developed and in place prior to construction. To include soil conservation measures and erosion and sediment controls with specific reference/controls to all waterways.	Moderate	**High** (refer Section 11.11.1 for assessment against MNES Guidelines)
Australian Lungfish (CONTINUED)							

NEGLIGIBLE LOW MODERATE HIGH MAJOR

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (APPLICATION OF DESIGN CONSIDERATION MEASURES PRESENTED IN SECTION 11.9.1)		Application of proposed mitigation measures presented in Table 11.27 BY 'ENVIRONMENTAL VALUE IMPACTED' AND 'DELIVERY PHASE'	Residual impact significance FOLLOWING THE APPLICATION OF PROJECT MITIGATION MEASURES PRESENTED IN Table 11.27	
			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**	▸ Biosecurity Management Sub-plan ongoing: ▸▸ Construction vehicle weed certification and wash down procedures in place ▸▸ Continued aquatic weed monitoring within waterways with required control protocols in place where weed invasion is identified. ▸ Land Resources Sub-plan—continued maintenance of erosion and sediment controls associated with all waterways. ▸ Project Reinstatement and Rehabilitation Management Plan will include rehabilitation of temporary construction areas including instream and riparian habitat features. ▸ Surface Water Management Sub-plan monitoring and evaluation ongoing.	Negligible	**Low**
	Operation	▸ Erosion and sedimentation	Negligible	**Low**	▸ Ongoing regular monitoring and maintenance of erosion and sediment devices/infrastructure associated with all waterways ▸ Ongoing maintenance of culverts and bridges, including fish passage structures.	Negligible	**Low**

■ NEGLIGIBLE ■ LOW ■ MODERATE ■ HIGH ■ MAJOR

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (APPLICATION OF DESIGN CONSIDERATION MEASURES PRESENTED IN SECTION 11.9.1)		Application of proposed mitigation measures presented in Table 11.27 BY 'ENVIRONMENTAL VALUE IMPACTED' AND 'DELIVERY PHASE'	Residual impact significance FOLLOWING THE APPLICATION OF PROJECT MITIGATION MEASURES PRESENTED IN Table 11.27	
			Magnitude[1]	Significance		Magnitude	Significance
Wetland birds: Australian Painted Snipe, Australasian Bittern and Curlew Sandpiper							

	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 Management Sub-plan developed and in place prior to construction. Will detail 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, 2010).
					▸ Clearing/construction works in potential habitat areas will be timed where possible to avoid wet conditions where habitat is likely to be most suitable.
					▸ Should the 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.
					▸ Measures to minimise habitat loss during vegetation clearing to include at a minimum:
					  ▸ All vegetation outside of temporary construction disturbance footprint will be appropriately marked as a No-Go Zone to site workers
					  ▸ Vegetation clearance will be approved and carried out under ecological supervision.
					▸ All workers will be briefed on the importance of threatened fauna species, their location (where they are found to occur within or near Project disturbance footprint), and procedures for working around them.
					▸ Biosecurity Management Sub-plan developed and in place prior to construction. To include:
					  ▸ Pre-construction wetland and riparian weed assessment of wetlands identified as potential habitat of species
					  ▸ Construction vehicle weed certification and wash down procedures in place
					  ▸ Weed monitoring within identified wetlands in vicinity of Project disturbance footprint with required control protocols in place where weed invasion is identified
					  ▸ Measures to ensure pest predator fauna are not attracted to works areas or using Project disturbance footprint for shelter.
					▸ Air Quality Management 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.
					▸ Through final 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. Surface Water Management Sub-plan developed and in place prior to construction. To include:
					  ▸ 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.
					▸ Land Resources Sub-plan developed and in place prior to construction. To include soil conservation measures and erosion and sediment controls with specific reference/controls to all waterways and wetland habitat.
						Low	**Moderate** (refer Section 11.11.1 for assessment against MNES Guidelines)

NEGLIGIBLE LOW MODERATE HIGH MAJOR

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (APPLICATION OF DESIGN CONSIDERATION MEASURES PRESENTED IN SECTION 11.9.1)		Application of proposed mitigation measures presented in Table 11.27 BY 'ENVIRONMENTAL VALUE IMPACTED' AND 'DELIVERY PHASE'	Residual impact significance FOLLOWING THE APPLICATION OF PROJECT MITIGATION MEASURES PRESENTED IN Table 11.27	
			Magnitude[1]	Significance		Magnitude	Significance
Wetland birds: Australian Painted Snipe, Australasian Bittern and Curlew Sandpiper (CONTINUED)							

	Commissioning and reinstatement	▸ Displacement of fauna species from invasion of weed and pest species
		▸ Edge effects
		▸ Noise, dust, and light impacts
		▸ Aquatic habitat degradation
		▸ Erosion and sedimentation
			Low	**Moderate**	▸ Biosecurity Management Sub-plan ongoing:
					  ▸ Construction vehicle weed certification and wash down procedures in place
					  ▸ Continued aquatic/wetland weed monitoring within waterways with required control protocols in place where weed invasion is identified
					  ▸ Continued monitoring to ensure pest predator fauna are not utilising Project infrastructure for shelter.
					▸ Noise and Vibration and Air Quality Management Sub-plans measures ongoing.
					▸ Project design to incorporate minimum lighting requirements feasible for Project safety.
					▸ Land Resources Sub-plan—continued maintenance of erosion and sediment controls associated with all waterways and wetland habitats.
					▸ Reinstatement and Rehabilitation Management Plan will include rehabilitation of temporary construction areas including riparian habitat.
					▸ Surface Water Management Sub-plan monitoring and evaluation ongoing.
						Negligible	**Low**

	Operation	▸ Displacement of fauna species from invasion of weed and pest species ▸ Light impacts ▸ Erosion and sedimentation	Negligible	**Low**	▸ Biosecurity Management Sub-plan ongoing: ▸ Ongoing annual weed monitoring within wetland habitat in vicinity of Project disturbance footprint with required control protocols in place where weed invasion is identified. ▸ Project design to incorporate minimum lighting requirements feasible for Project safety. ▸ Land Resources Sub-plan—ongoing regular monitoring and maintenance of erosion and sediment devices/infrastructure associated with all waterways	Negligible	**Low**

■ NEGLIGIBLE ■ LOW ■ MODERATE ■ HIGH ■ MAJOR

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (APPLICATION OF DESIGN CONSIDERATION MEASURES PRESENTED IN SECTION 11.9.1) Magnitude[1]	Initial impact significance Significance	Application of proposed mitigation measures presented in Table 11.27 BY 'ENVIRONMENTAL VALUE IMPACTED' AND 'DELIVERY PHASE'	Residual impact significance (FOLLOWING THE APPLICATION OF PROJECT MITIGATION MEASURES PRESENTED IN Table 11.27) Magnitude	Residual impact significance Significance
Koala and Greater glider							
	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 Management Sub-plan developed and in place prior to construction. Will detail pre-construction surveys of woodlands identified as potential habitat of species to identify whether individuals occur within Project disturbance footprint. Plan to include: ▸ Engagement of a qualified fauna spotter/ecologist for pre-construction Koala/Greater Glider surveys and tree hollow inspections ▸ Measures to ensure safe retrieval of tree hollows during vegetation clearing and allow safe movement of species away from works area ▸ Restricted works measures in place should Koala be observed within Project disturbance footprint to allow safe movement safe away from works area ▸ Vegetation clearing within the Project 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 ▸ Measures to responsibly handle injured fauna ▸ 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 ▸ Measures to control vehicle speed limits onsite to no more than 40 km/hr ▸ Fauna management and incident register. ▸ Measures to minimise habitat loss during vegetation clearing to include: ▸ All vegetation outside of temporary construction disturbance footprint will be appropriately marked as a No-Go Zone to site workers ▸ Vegetation clearance will be approved and carried out under ecological supervision ▸ All workers will be briefed on the importance of threatened fauna species, their location (where they are found to occur within or near Project disturbance footprint), and procedures for working around them. ▸ Project Biosecurity Management Sub-plan developed prior to construction. Weed species are not considered to be more than a minor impact on these species. The ecology study area is already subject to significant weed invasion. The Plan will consider relevant guidelines to control potential deleterious pathogens including *Phytophthora cinnamomi* (soil-borne mould) and Myrtle rust (e.g. DotE, 2015b) associated with Project activities both of which may impact eucalypt species. General measures to include: ▸ Pre-construction weed assessment of potential habitat of species ▸ Construction vehicle weed certification and wash down procedures in place ▸ Contractor education on the requirements for site access regarding identified habitat (including procedures regarding clean clothing/footwear) ▸ Weed monitoring within in immediate vicinity of Project disturbance footprint with required control protocols in place where weed invasion is identified ▸ Measures to ensure pest predator fauna are not attracted to works areas or using Project area for shelter.	Moderate	**High** (refer Section 11.11.1 for assessment against MNES Guidelines)

NEGLIGIBLE LOW MODERATE HIGH MAJOR

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (APPLICATION OF DESIGN CONSIDERATION MEASURES PRESENTED IN SECTION 11.9.1) Magnitude[1]	Initial impact significance Significance	Application of proposed mitigation measures presented in Table 11.27 BY 'ENVIRONMENTAL VALUE IMPACTED' AND 'DELIVERY PHASE'	Residual impact significance (FOLLOWING THE APPLICATION OF PROJECT MITIGATION MEASURES PRESENTED IN Table 11.27) Magnitude	Residual impact significance Significance
Koala and Greater glider (CONTINUED)							
	Construction (CONTINUED)	(CONTINUED FROM PREVIOUS PAGE)	High	**Major**	▸ Project design to incorporate fauna crossing structures to allow fauna movement across alignment. Fauna passage and Koala-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. ▸ Air Quality Management 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.	Moderate	**High**

	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 Management Sub-plan activities ongoing:
					  ▸ Measures to control vehicle speed limits onsite to no more than 40 km/hr
					  ▸ Fauna management and incident register.
					▸ Biosecurity Management Sub-plan ongoing:
					  ▸ Construction vehicle weed certification and wash down procedures in place
					  ▸ Contractor education on the requirements for site access regarding identified habitat (including procedures regarding clean clothing/footwear)
					  ▸ Continued weed monitoring with required control protocols in place where weed invasion is identified
					  ▸ Continued monitoring to ensure pest predator fauna are not utilising Project infrastructure for shelter.
					▸ Fauna crossing structures and fencing in place and completed.
					▸ Noise and Vibration and Air Quality Management Sub-plans measures ongoing.
					▸ Project design to incorporate minimum lighting requirements feasible for Project safety.
					▸ Project Reinstatement and Rehabilitation Management Plan will include rehabilitation of temporary construction areas where woodland habitat has been cleared. Aligned with Biosecurity Management Sub-plan revegetation plant species will be obtained from a reliable source that is certified free of pathogens.
						Negligible	**Low**

	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**	▸ Flora and Fauna Management Sub-plan activities ongoing:
					  ▸ 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.
					▸ Biosecurity Management Sub-plan ongoing:
					  ▸ Continued annual weed monitoring with required control protocols in place where weed invasion is identified
					  ▸ Continued opportunistic monitoring to ensure pest/predator fauna are not using Project infrastructure for shelter.
					▸ 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.
					▸ Project design to incorporate minimum lighting requirements feasible for Project safety.
						Negligible	**Low**

■ NEGLIGIBLE ■ LOW ■ MODERATE ■ HIGH ■ MAJOR

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (APPLICATION OF DESIGN CONSIDERATION MEASURES PRESENTED IN SECTION 11.9.1)		Application of proposed mitigation measures presented in Table 11.27 BY 'ENVIRONMENTAL VALUE IMPACTED' AND 'DELIVERY PHASE'	Residual impact significance FOLLOWING THE APPLICATION OF PROJECT MITIGATION MEASURES PRESENTED IN Table 11.27	
			Magnitude[1]	Significance		Magnitude	Significance
New Holland Mouse							
	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	Moderate	**High**	▸ Within the Project disturbance footprint, the Helidon Hills area may provide habitat and the species has been recorded nearby (Lockyer Forest Reserves). Flora and Fauna Management Sub-plan developed and in place prior to construction. Will detail pre-construction surveys of woodlands identified as potential habitat of species to identify whether individuals occur within Project disturbance footprint. Surveys will be species specific and include the following: ▸ Identification of species-specific habitat and habitat features considered suitable for species presence (e.g. well-developed ground/shrub layer) ▸ Targeted surveys as per relevant Queensland guidelines (Eyre et al., 2018) where suitable habitat is identified (noted species is not included in MNES guidelines). ▸ Flora and Fauna Management Sub-plan to include the following construction measures for pre-clearance surveys at a minimum: ▸ Engagement of a qualified fauna spotter/ecologist for pre-clearance surveys ▸ Restricted works measures in place should species be located during site inspections ▸ Measures to allow safe handling of fauna (where required) and repatriation in suitable habitat away from site ▸ Measures to responsibly handle injured fauna ▸ Measures to control vehicle speed limits onsite to no more than 40 km/hr. ▸ Fauna management and incident register. ▸ Measures to minimise habitat loss during vegetation clearing to include: ▸ All vegetation outside of temporary construction disturbance footprint will be appropriately marked as a No-Go Zone to site workers ▸ Vegetation clearance will be approved and carried out under ecological supervision. ▸ All workers will be briefed on the importance of threatened fauna species, their location (where they are found to occur within or near Project disturbance footprint), and procedures for working around them. ▸ Weed species are not considered a to be more than a minor impact on this species. The ecology study area is already subject to significant weed invasion including *Lantana* species. Habitat degradation via *Phytophthora cinnamomi* is thought to be a potential threat. Biosecurity Management Sub-plan developed and in place prior to construction. General measures to include: ▸ Pre-construction weed and *Phytophthora cinnamomi* assessment of potential habitat of species ▸ Construction vehicle weed certification and wash down procedures in place ▸ Contractor education on the requirements for site access regarding identified habitat (including procedures regarding clean clothing/footwear) ▸ Weed monitoring within immediate vicinity of Project disturbance footprint with required control protocols in place where weed invasion is identified ▸ Measures to ensure pest predator fauna are not attracted to works areas or using Project disturbance footprint for shelter.	Low	**Moderate** (refer Section 11.11.1 for assessment against MNES Guidelines)

NEGLIGIBLE LOW MODERATE HIGH MAJOR

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (APPLICATION OF DESIGN CONSIDERATION MEASURES PRESENTED IN SECTION 11.9.1) Magnitude[1]	Initial impact significance Significance	Application of proposed mitigation measures presented in Table 11.27 BY 'ENVIRONMENTAL VALUE IMPACTED' AND 'DELIVERY PHASE'	Residual impact significance (FOLLOWING THE APPLICATION OF PROJECT MITIGATION MEASURES PRESENTED IN Table 11.27) Magnitude	Residual impact significance Significance
New Holland Mouse (CONTINUED)							
	Construction (CONTINUED)	(CONTINUED FROM PREVIOUS PAGE)	Moderate	**High**	▸ 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. ▸ Air Quality Management 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.	Low	**High**

	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 Management Sub-plan activities ongoing:
					  ▸ Measures to control vehicle speed limits onsite to no more than 40 km/hr
					  ▸ Fauna management and incident register
					▸ Biosecurity Management Sub-plan ongoing:
					  ▸ Construction vehicle weed certification and wash down procedures in place
					  ▸ Continued weed and *Phytophthora cinnamomi* monitoring and with required control protocols in place where weed invasion is identified
					  ▸ Continued monitoring to ensure pest predator fauna are not utilising Project infrastructure for shelter.
					▸ Fauna crossing structures and fencing in place and completed.
					▸ Noise and Vibration and Air Quality Management Sub-plans measures ongoing.
					▸ Project design to incorporate minimum lighting requirements feasible for Project safety.
					▸ Project Reinstatement and Rehabilitation Management Plan will include rehabilitation of temporary construction areas where woodland habitat has been cleared. Revegetation species to be obtained from source certified free of *Phytophthora cinnamomi.*
						Negligible	**Low**

	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**	▸ Flora and Fauna Management Sub-plan activities ongoing:
					  ▸ Fauna management and incident register including observed collisions associated with rail operations
					▸ Biosecurity Management Sub-plan ongoing:
					  ▸ Continued weed and *Phytophthora cinnamomi* monitoring and with required control protocols in place where weed invasion is identified
					  ▸ Continued opportunistic monitoring to ensure pest predator fauna are not using Project infrastructure for shelter.
					▸ 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.
					▸ Project design to incorporate minimum lighting requirements feasible for Project safety.
						Negligible	**Low**

■ NEGLIGIBLE ■ LOW ■ MODERATE ■ HIGH ■ MAJOR

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (APPLICATION OF DESIGN CONSIDERATION MEASURES PRESENTED IN SECTION 11.9.1) Magnitude[1]	Initial impact significance Significance	Application of proposed mitigation measures presented in Table 11.27 BY 'ENVIRONMENTAL VALUE IMPACTED' AND 'DELIVERY PHASE'	Residual impact significance (FOLLOWING THE APPLICATION OF PROJECT MITIGATION MEASURES PRESENTED IN Table 11.27) Magnitude	Residual impact significance Significance
Spotted-tail Quoll, Brush-tailed Rock-wallaby and Collared Delma							

	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**	▸ Within the Project disturbance footprint the Helidon Hills may provide habitat for these species. Little Liverpool Range also provides potential habitat for Collared Delma. Flora and Fauna Management Sub-plan developed and in place prior to construction. Will detail pre-construction surveys of woodlands identified as potential habitat of species to identify whether individuals occur within Project disturbance footprint. Surveys will be species specific following the *Survey guidelines for Australia's threatened mammals* (DSEWPaC, 2011c) and *Survey guidelines for Australia's threatened reptiles* (DSEWPaC, 2011d) and include the following:
					  ▸ Identification of species-specific habitat and habitat features considered suitable for species presence (e.g. cliff faces/boulder piles for Brush-tailed Rock-wallaby and Spotted-tail Quoll, loose surface rocks for Collared Delma)
					  ▸ Targeted surveys as per MNES guidelines where suitable habitat is identified.
					▸ Flora and Fauna Management Sub-plan to include the following construction measures at a minimum:
					  ▸ Engagement of a qualified fauna spotter/ecologist for pre-construction surveys
					  ▸ Measures to ensure retrieval of potential habitat elements (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 Project disturbance footprint to allow safe movement safe away from works area
					  ▸ Measures to allow safe handling of fauna (where required) and repatriation in suitable habitat away from site
					  ▸ Measures to responsibly handle injured fauna
					  ▸ Measures to control vehicle speed limits onsite to no more than 40 km/hr.
					▸ Fauna management and incident register.
					▸ Measures to minimise habitat loss during vegetation clearing to include:
					  ▸ All vegetation outside of temporary construction disturbance footprint will be appropriately marked as a No-Go Zone to site workers
					  ▸ Vegetation clearance will be approved and carried out under ecological supervision
					  ▸ All workers will be briefed on the importance of threatened fauna species, their location (where they are found to occur within or near Project disturbance footprint), and procedures for working around them.
					▸ Weeds species are not considered to be more than a minor impact on these species excepting Brush-tailed Rock-wallaby (particularly *Lantana camara*). The ecology study area is already subject to significant weed invasion including *Lantana* species. Biosecurity Management Sub-plan developed and in place prior to construction. General measures to include:
					  ▸ Pre-construction weed assessment of potential habitat of species
					  ▸ Construction vehicle weed certification and wash down procedures in place
					  ▸ Weed monitoring within immediate vicinity of Project disturbance footprint with required control protocols in place where weed invasion is identified
					  ▸ Measures to ensure pest predator fauna are not attracted to works areas or using Project disturbance footprint for shelter.
						Moderate	**High** (refer Section 11.11.1 for assessment against MNES Guidelines)

NEGLIGIBLE LOW MODERATE HIGH MAJOR

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (APPLICATION OF DESIGN CONSIDERATION MEASURES PRESENTED IN SECTION 11.9.1) Magnitude[1]	Initial impact significance Significance	Application of proposed mitigation measures presented in Table 11.27 BY 'ENVIRONMENTAL VALUE IMPACTED' AND 'DELIVERY PHASE'	Residual impact significance (FOLLOWING THE APPLICATION OF PROJECT MITIGATION MEASURES PRESENTED IN Table 11.27) Magnitude	Residual impact significance Significance
Spotted-tail Quoll, Brush-tailed Rock-wallaby and Collared Delma (CONTINUED)							
	Construction (CONTINUED)	▸ (CONTINUED FROM PREVIOUS PAGE)			▸ 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. ▸ Air Quality Management 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.		

	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 Management Sub-plan activities ongoing:
					  ▸ Measures to control vehicle speed limits onsite to no more than 40 km/hr
					  ▸ Fauna management and incident register.
					▸ Biosecurity Management Sub-plan ongoing:
					  ▸ Construction vehicle weed certification and wash down procedures in place
					  ▸ Continued weed monitoring with required control protocols in place where weed invasion is identified
					  ▸ Continued monitoring to ensure pest predator fauna are not using Project infrastructure for shelter.
					▸ Fauna crossing structures and fencing in place and completed.
					▸ Noise and Vibration and Air Quality Management Sub-plans measures ongoing.
					▸ Project design to incorporate minimum lighting requirements feasible for Project safety.
					▸ Project Reinstatement and Rehabilitation Management Plan will include rehabilitation of temporary construction areas where woodland habitat has been cleared.
						Negligible	**Low**

	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**	▸ Flora and Fauna Management Sub-plan activities ongoing:
					  ▸ Fauna management and incident register including observed collisions associated with rail operations
					▸ Biosecurity Management Sub-plan ongoing:
					  ▸ Continued annual weed monitoring with required control protocols in place where weed invasion is identified
					  ▸ Continued opportunistic monitoring to ensure pest predator fauna are not using Project infrastructure for shelter.
					▸ 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.
					▸ Project design to incorporate minimum lighting requirements feasible for Project safety.
						Negligible	**Low**

NEGLIGIBLE LOW MODERATE HIGH MAJOR

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (APPLICATION OF DESIGN CONSIDERATION MEASURES PRESENTED IN SECTION 11.9.1)		Application of proposed mitigation measures presented in Table 11.27 BY 'ENVIRONMENTAL VALUE IMPACTED' AND 'DELIVERY PHASE'	Residual impact significance FOLLOWING THE APPLICATION OF PROJECT MITIGATION MEASURES PRESENTED IN Table 11.27	
			Magnitude[1]	Significance		Magnitude	Significance
Grey-headed Flying-fox							

	Construction	▸ Habitat loss from vegetation clearing/removal
		▸ Fauna species injury or mortality
		▸ Noise, dust, and light impacts
		▸ Aquatic habitat degradation
			High	**Major**	▸ A Flora and Fauna Management Sub-plan developed and in place prior to construction. The Plan will detail pre-construction surveys of riparian habitat identified as potential roost sites of species to identify whether camps occur within or near the Project disturbance footprint. The nearest known roost sites are located 600 m and 1.2 km from the Project. Should a roost site be found to occur management actions will incorporate the mitigation standards detailed in the *Referral guideline for management actions in Grey-headed and Spectacled Flying-fox camps* (DotE, 2015c).
					▸ Measures to minimise habitat loss during vegetation clearing to include at a minimum:
					  ▸ All vegetation outside of temporary construction disturbance footprint will be appropriately marked as a No-Go Zone to site workers
					  ▸ Vegetation clearance will be approved and carried out under ecological supervision
					  ▸ All workers will be briefed on the importance of threatened fauna species, their location (where they are found to occur within or near Project disturbance footprint), and procedures for working around them.
					▸ Air Quality Management 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.
					▸ Surface Water Management 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.
						Negligible	**High** (refer Section 11.11.1 for assessment against MNES Guidelines)

	Commissioning and reinstatement	▸ Noise, dust, and light impacts ▸ Aquatic habitat degradation	Negligible	**Low**	▸ Noise and Vibration and Air Quality Management Sub-plans measures ongoing. ▸ Project design to incorporate minimum lighting requirements feasible for Project safety.	Negligible	**Low**
	Operation	▸ Light impacts	Negligible	**Low**	▸ Project design to incorporate minimum lighting requirements feasible for Project safety.	Negligible	**Low**

■ NEGLIGIBLE ■ LOW ■ MODERATE ■ HIGH ■ MAJOR

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (APPLICATION OF DESIGN CONSIDERATION MEASURES PRESENTED IN SECTION 11.9.1) Magnitude[1]	Initial impact significance Significance	Application of proposed mitigation measures presented in Table 11.27 BY 'ENVIRONMENTAL VALUE IMPACTED' AND 'DELIVERY PHASE'	Residual impact significance (FOLLOWING THE APPLICATION OF PROJECT MITIGATION MEASURES PRESENTED IN Table 11.27) Magnitude	Residual impact significance Significance
Woodland birds: Swift Parrot, Painted Honeyeater, Regent Honeyeater, Grey Falcon and Red Goshawk							

	Construction	▸ Habitat loss from vegetation clearing/removal
		▸ Fauna species injury or mortality
		▸ Displacement of fauna species from invasion of weed and pest species
		▸ Noise, dust, and light impacts
		▸ Aquatic habitat degradation
			High	**Major**	▸ 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. A Flora and Fauna Management Sub-plan developed and in place prior to construction.
					▸ The Plan will detail pre-construction surveys of woodlands identified as potential habitat for Red Goshawk to identify whether individuals occur and potentially nest within the Project disturbance footprint. Surveys for nest sites within or adjacent to the Project disturbance footprint and 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.
					▸ Measures to minimise habitat loss during vegetation clearing to include:
					  ▸ All vegetation outside of temporary construction disturbance footprint will be appropriately marked as a No-Go Zone to site workers
					  ▸ Vegetation clearance will be approved and carried out under ecological supervision
					  ▸ All workers will be briefed on the importance of threatened fauna species, their location (where they are found to occur within or near Project disturbance footprint), and procedures for working around them.
					▸ Weeds species are not considered as an impact on these species. The ecology study area is already subject to significant weed invasion including *Lantana camara*. Biosecurity Management Sub-plan developed and in place prior to construction. General measures to include:
					  ▸ Pre-construction weed assessment of potential habitat of species
					  ▸ Construction vehicle weed certification and wash down procedures in place
					  ▸ Weed monitoring within immediate vicinity of Project disturbance footprint with required control protocols in place where weed invasion is identified
					  ▸ Measures to ensure pest predator fauna are not attracted to works areas or using Project disturbance footprint for shelter.
					▸ Air Quality Management 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.
					▸ Surface Water Management Sub-plan developed and in place prior to construction. To include:
					  ▸ 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.
						Moderate	**High** (refer Section 11.11.1 for assessment against MNES Guidelines)

■ NEGLIGIBLE ■ LOW ■ MODERATE ■ HIGH ■ MAJOR

Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (APPLICATION OF DESIGN CONSIDERATION MEASURES PRESENTED IN SECTION 11.9.1)		Application of proposed mitigation measures presented in Table 11.27 BY 'ENVIRONMENTAL VALUE IMPACTED' AND 'DELIVERY PHASE'	Residual impact significance FOLLOWING THE APPLICATION OF PROJECT MITIGATION MEASURES PRESENTED IN Table 11.27	
			Magnitude[1]	Significance		Magnitude	Significance
Woodland birds: Swift Parrot, Painted Honeyeater, Regent Honeyeater, Grey Falcon and Red Goshawk (CONTINUED)							
	Commissioning and reinstatement	▸ Displacement of fauna species from invasion of weed and pest species ▸ Noise, dust, and light impacts ▸ Aquatic habitat degradation	Low	**Moderate**	▸ Biosecurity Management Sub-plan ongoing: ▸▸ Construction vehicle weed certification and wash down procedures in place ▸▸ Continued weed monitoring with required control protocols in place where weed invasion is identified ▸▸ Continued monitoring to ensure pest predator fauna are not using Project infrastructure for shelter. ▸ Noise and Vibration and Air Quality Management Sub-plans measures ongoing. ▸ Project design to incorporate minimum lighting requirements feasible for Project safety. ▸ Project Reinstatement and Rehabilitation Management Plan will include rehabilitation of temporary construction areas where woodland habitat has been cleared. ▸ Surface Water Management Sub-plan monitoring and evaluation ongoing.	Negligible	**Low**
	Operation	▸ Displacement of fauna species from invasion of weed and pest species ▸ Noise and light impacts	Negligible	**Low**	▸ Flora and Fauna Management Sub-plan activities ongoing: ▸▸ Fauna management and incident register including observed collisions associated with rail operations. ▸ Biosecurity Management Sub-plan ongoing: ▸▸ Continued annual weed monitoring with required control protocols in place where weed invasion is identified ▸▸ Continued opportunistic monitoring to ensure pest predator fauna are not using Project infrastructure for shelter. ▸ Project design to incorporate minimum lighting requirements feasible for Project safety.	Negligible	**Low**

TABLE 11.34: INITIAL ASSESSMENT OF SIGNIFICANCE OF IMPACTS OF THE PROJECT ON IDENTIFIED SENSITIVE ENVIRONMENTAL RECEPTORS

NEGLIGIBLE LOW MODERATE HIGH MAJOR

Sensitive environmental receptor(s)	Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (APPLICATION OF DESIGN CONSIDERATION MEASURES PRESENTED IN SECTION 11.9.1) Magnitude[1]	Initial impact significance Significance	Application of proposed mitigation measures presented in Table 11.27, BY 'ENVIRONMENTAL VALUE IMPACTED' AND 'DELIVERY PHASE'	Residual significance (FOLLOWING THE APPLICATION OF PROJECT MITIGATION MEASURES PRESENTED IN **Table 11.27**[3]) Magnitude[1]	Residual significance Significance[4]
Commonwealth receptors (EPBC Act listed migratory species)								
Commonwealth Significant Ecological Constraint (Species listed as migratory under the EPBC Act): ▸ Oriental Cuckoo (*Cuculus optatus*) ▸ Yellow Wagtail (*Motacilla flava*) ▸ Pacific Golden Plover (*Pluvialis fulva*) ▸ Rufous Fantail (*Rhipidura rufifrons*)		Construction	(A) Habitat loss from vegetation clearing/removal (B) Fauna species injury or mortality (D) Displacement of fauna species from invasion of weed and pest species (F) Edge effects (G) Habitat fragmentation (H) Barrier effects (I) Noise, dust, and light impacts (J) Increase in litter (waste) (K) Aquatic habitat degradation	Low	**Moderate**	▸ Flora and fauna (detailed design, preconstruction and construction proposed mitigation measures) ▸ Weeds and pests (preconstruction and construction mitigation measures) ▸ Erosion and sediment control (pre-construction and construction) ▸ Riparian vegetation and aquatic habitats (construction)	Negligible	**Low** (refer Section 11.11.2 for assessment against MNES Significant Impact guidelines for migratory species)
		Operation	(B) Fauna species injury or mortality (D) Displacement of fauna species from invasion of weed and pest species (I) Noise, dust, and light impacts (K) Aquatic habitat degradation	Low	**Moderate**	▸ Weeds and pests (operations) ▸ Riparian vegetation and aquatic habitats (operations)	Negligible	**Low**
Commonwealth Significant Ecological Constraint (Species listed as migratory under the EPBC Act): ▸ Common Sandpiper (*Actitis hypoleucos*) ▸ Fork-tailed Swift (*Apus pacificus*) ▸ Sharp-tailed Sandpiper (*Calidris acuminata*) ▸ Pectoral Sandpiper (*Calidris melanotos*)		Construction	(A) Habitat loss from vegetation clearing/removal (B) Fauna species injury or mortality (D) Displacement of fauna species from invasion of weed and pest species (F) Edge effects (G) Habitat fragmentation (H) Barrier effects (I) Noise, dust, and light impacts (J) Increase in litter (waste) (K) Aquatic habitat degradation	High	Major	▸ Flora and fauna (detailed design, preconstruction and construction proposed mitigation measures) ▸ Weeds and pests (preconstruction and construction mitigation measures) ▸ Erosion and sediment control (pre-construction and construction) ▸ Riparian vegetation and aquatic habitats (construction)	Moderate	**High** (refer Section 11.11.2 for assessment against MNES Significant Impact guidelines for migratory species)

NEGLIGIBLE LOW MODERATE HIGH MAJOR

Sensitive environmental receptor(s)	Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (APPLICATION OF DESIGN CONSIDERATION MEASURES PRESENTED IN SECTION 11.9.1) Magnitude[1]	Initial impact significance Significance	Application of proposed mitigation measures presented in Table 11.27, BY 'ENVIRONMENTAL VALUE IMPACTED' AND 'DELIVERY PHASE'	Residual significance FOLLOWING THE APPLICATION OF PROJECT MITIGATION MEASURES PRESENTED IN **Table 11.27**[3] Magnitude[1]	Residual significance Significance[4]
Commonwealth receptors (EPBC Act listed migratory species) (CONTINUED)								
▸ Red-necked Stint (*Calidris ruficollis*) ▸ Oriental Dotterel (*Charadrius veredus*) ▸ Oriental Cuckoo (*Cuculus optatus*) ▸ Latham's Snipe (*Gallinago hardwickii*) ▸ Gull-billed Tern (*Gelochelidon nilotica*) ▸ Caspian Tern (*Hydroprogne caspia*) ▸ Black-tailed Godwit (*Limosa limosa*) ▸ Black-faced Monarch (*Monarcha melanopsis*) ▸ Spectacled Monarch (*Monarcha trivirgatus*) ▸ Satin Flycatcher (*Myiagra cyanoleuca*) ▸ Eastern Osprey (*Pandion haliaetus*) ▸ Red-necked Phalarope (*Phalarops lobatus*) ▸ Glossy Ibis (*Plegadis falcinellus*) ▸ Common Greenshank (*Tringa nebularia*) ▸ Marsh Sandpiper (*Tringa stagnatilis*)		Commissioning and reinstatement	(B) Fauna species injury or mortality (D) Displacement of fauna species from invasion of weed and pest species (I) Noise, dust, and light impacts (K) Aquatic habitat degradation	Low	**Moderate**	▸ Flora and fauna (detailed design, preconstruction and construction proposed mitigation measures) ▸ Weeds and pests (preconstruction and construction mitigation measures) ▸ Erosion and sediment control (pre-construction and construction) ▸ Riparian vegetation and aquatic habitats (construction) ▸ Landscape, rehabilitation and stabilisation (detailed design, pre-construction, construction)	Negligible	**Low**
		Operation	(B) Fauna species injury or mortality (D) Displacement of flora and fauna species from invasion of weed and pest species (I) Noise, dust, and light impacts (K) Aquatic habitat degradation	Low	**Moderate**	▸ Weeds and pests (operations) ▸ Riparian vegetation and aquatic habitats (operations)	Negligible	**Low**

■ NEGLIGIBLE ■ LOW ■ MODERATE ■ HIGH ■ MAJOR

Sensitive environmental receptor(s)	Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (APPLICATION OF DESIGN CONSIDERATION MEASURES PRESENTED IN SECTION 11.9.1) Magnitude[1]	Initial impact significance Significance	Application of proposed mitigation measures presented in Table 11.27, BY 'ENVIRONMENTAL VALUE IMPACTED' AND 'DELIVERY PHASE'	Residual significance FOLLOWING THE APPLICATION OF PROJECT MITIGATION MEASURES PRESENTED IN **Table 11.27**[3] Magnitude[1]	Residual significance Significance[4]
State receptors								
State Significant Ecological Constraint (VM Act): ▸ Endangered remnant vegetation (REs) (Category B)		Construction	(A) Habitat loss from vegetation clearing/removal (C) Reduction in biological viability of soil to support plant growth due to soil compaction (D) Displacement of flora and fauna species from invasion of weed and pest species (F) Edge effects (G) Habitat fragmentation (H) Barrier effects (J) Increase in litter (waste)	Moderate	**High**	▸ Flora and fauna (detailed design, pre-construction and construction proposed mitigation measures) ▸ Weeds and pests (pre-construction and construction mitigation measures) ▸ Erosion and sediment control (pre-construction and construction) ▸ Riparian vegetation and aquatic habitats (construction)	Low	**Moderate** (refer Section 11.11.3 for assessment against MSES Significant Impact guidelines)
		Commissioning and reinstatement	(D) Displacement of flora and fauna species from invasion of weed and pest species	Low	**Moderate**	▸ Flora and fauna (detailed design, pre-construction and construction proposed mitigation measures) ▸ Weeds and pests (pre-construction and construction mitigation measures) ▸ Erosion and sediment control (preconstruction and construction) ▸ Riparian vegetation and aquatic habitats (construction) ▸ Landscape, rehabilitation and stabilisation (detailed design, pre-construction, construction)	Negligible	**Low**
		Operation	(D) Displacement of flora and fauna species from invasion of weed and pest species	Low	**Moderate**	▸ Weeds and pests (operations) ▸ Riparian vegetation and aquatic habitats (operations)	Negligible	**Low**

NEGLIGIBLE LOW MODERATE HIGH MAJOR

Sensitive environmental receptor(s)	Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (APPLICATION OF DESIGN CONSIDERATION MEASURES PRESENTED IN SECTION 11.9.1) Magnitude[1]	Initial impact significance Significance	Application of proposed mitigation measures presented in Table 11.27, BY 'ENVIRONMENTAL VALUE IMPACTED' AND 'DELIVERY PHASE'	Residual significance FOLLOWING THE APPLICATION OF PROJECT MITIGATION MEASURES PRESENTED IN **Table 11.27**[3] Magnitude[1]	Residual significance Significance[4]
State receptors (CONTINUED)								
State significant ecological constraint (VM Act): ▸ Of concern remnant vegetation (REs) (Category B)		Construction	(D) Displacement of flora and fauna species from invasion of weed and pest species	Low	**Low**	▸ Flora and fauna (detailed design, pre-construction and construction proposed mitigation measures) ▸ Weeds and pests (pre-construction and construction mitigation measures) ▸ Erosion and sediment control (pre-construction and construction) ▸ Riparian vegetation and aquatic habitats (construction)	Negligible	**Low** (refer Section 11.11.3 for assessment against MSES Significant Impact guidelines)
		Commissioning and reinstatement	(D) Displacement of flora and fauna species from invasion of weed and pest species	Moderate	**Moderate**	▸ Flora and fauna (detailed design, pre-construction and construction proposed mitigation measures) ▸ Weeds and pests (pre-construction and construction mitigation measures) ▸ Erosion and sediment control (pre-construction and construction) ▸ Riparian vegetation and aquatic habitats (construction) ▸ Landscape, rehabilitation and stabilisation (detailed design, pre-construction, construction)	Negligible	**Low**
		Operation	(D) Displacement of flora and fauna species from invasion of weed and pest species	Moderate	**Moderate**	▸ Weeds and pests (operations) ▸ Riparian vegetation and aquatic habitats (operations)	Negligible	**Low**

■ NEGLIGIBLE ■ LOW ■ MODERATE ■ HIGH ■ MAJOR

Sensitive environmental receptor(s)	Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (APPLICATION OF DESIGN CONSIDERATION MEASURES PRESENTED IN SECTION 11.9.1) Magnitude[1]	Initial impact significance Significance	Application of proposed mitigation measures presented in Table 11.27, BY 'ENVIRONMENTAL VALUE IMPACTED' AND 'DELIVERY PHASE'	Residual significance FOLLOWING THE APPLICATION OF PROJECT MITIGATION MEASURES PRESENTED IN **Table 11.27**[3] Magnitude[1]	Residual significance Significance[4]
State receptors (CONTINUED)								
State significant ecological constraint (VM Act): Least concern remnant vegetation (REs) (Category B)		Construction	(A) Habitat loss from vegetation clearing/removal (C) Reduction in biological viability of soil to support plant growth due to soil compaction (D) Displacement of flora and fauna species from invasion of weed and pest species (F) Edge effects (G) Habitat fragmentation (H) Barrier effects (J) Increase in litter (waste)	High	**Moderate**	▸ Flora and fauna (detailed design, pre-construction and construction proposed mitigation measures) ▸ Weeds and pests (pre-construction and construction mitigation measures) ▸ Erosion and sediment control (pre-construction and construction) ▸ Riparian vegetation and aquatic habitats (construction)	Moderate	**Low** (refer Section 11.11.3 for assessment against MSES Significant Impact guidelines)
		Commissioning and reinstatement	(D) Displacement of flora and fauna species from invasion of weed and pest species	Moderate	**Low**	▸ Flora and fauna (detailed design, pre-construction and construction proposed mitigation measures) ▸ Weeds and pests (pre-construction and construction mitigation measures) ▸ Erosion and sediment control (pre-construction and construction) ▸ Riparian vegetation and aquatic habitats (construction) ▸ Landscape, rehabilitation and stabilisation (design, pre-construction, construction)	Negligible	**Negligible**
		Operation	(D) Displacement of flora and fauna species from invasion of weed and pest species	Moderate	**Low**	▸ Weeds and pests (operations) ▸ Riparian vegetation and aquatic habitats (operations)	Negligible	**Negligible**

■ NEGLIGIBLE ■ LOW ■ MODERATE ■ HIGH ■ MAJOR

Sensitive environmental receptor(s)	Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (APPLICATION OF DESIGN CONSIDERATION MEASURES PRESENTED IN SECTION 11.9.1) Magnitude[1]	Initial impact significance Significance	Application of proposed mitigation measures presented in Table 11.27, BY 'ENVIRONMENTAL VALUE IMPACTED' AND 'DELIVERY PHASE'	Residual significance FOLLOWING THE APPLICATION OF PROJECT MITIGATION MEASURES PRESENTED IN **Table 11.27**[3] Magnitude[1]	Residual significance Significance[4]
State receptors (CONTINUED)								
State Significant Ecological Constraint (VM Act): ▸ High value regrowth vegetation (Category C)		Construction	(A) Habitat loss from vegetation clearing/removal (C) Reduction in biological viability of soil to support plant growth due to soil compaction (D) Displacement of flora and fauna species from invasion of weed and pest species (F) Edge effects (G) Habitat fragmentation (H) Barrier effects (J) Increase in litter (waste) (K) Aquatic habitat degradation	High	**High**	▸ Flora and fauna (detailed design, pre-construction and construction proposed mitigation measures) ▸ Weeds and pests (pre-construction and construction mitigation measures) ▸ Erosion and sediment control (pre-construction and construction) ▸ Riparian vegetation and aquatic habitats (construction)	Moderate	**Moderate** (refer Section 11.11.3 for assessment against MSES Significant Impact guidelines)
		Commissioning and reinstatement	(D) Displacement of flora and fauna species from invasion of weed and pest species	Moderate	**Moderate**	▸ Flora and fauna (detailed design, pre-construction and construction proposed mitigation measures) ▸ Weeds and pests (pre-construction and construction mitigation measures) ▸ Erosion and sediment control (pre-construction and construction) ▸ Riparian vegetation and aquatic habitats (construction) ▸ Landscape, rehabilitation and stabilisation (detailed design, pre-construction, construction)	Low	**Low**
		Operation	(D) Displacement of flora and fauna species from invasion of weed and pest species	Moderate	**Moderate**	▸ Weeds and Pests (operations) ▸ Riparian vegetation and aquatic habitats (operations)	Low	**Low**

■ NEGLIGIBLE ■ LOW ■ MODERATE ■ HIGH ■ MAJOR

Sensitive environmental receptor(s)	Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (APPLICATION OF DESIGN CONSIDERATION MEASURES PRESENTED IN SECTION 11.9.1) Magnitude[1]	Initial impact significance Significance	Application of proposed mitigation measures presented in Table 11.27, BY 'ENVIRONMENTAL VALUE IMPACTED' AND 'DELIVERY PHASE'	Residual significance FOLLOWING THE APPLICATION OF PROJECT MITIGATION MEASURES PRESENTED IN **Table 11.27**[3] Magnitude[1]	Residual significance Significance[4]
State receptors (CONTINUED)								
State Significant Ecological Constraint (VM Act): ▸ Regulated vegetation (Category B) intersecting watercourses and wetlands		Construction	(A) Habitat loss from vegetation clearing/removal (C) Reduction in biological viability of soil to support plant growth due to soil compaction (D) Displacement of flora and fauna species from invasion of weed and pest species (F) Edge effects (G) Habitat fragmentation (H) Barrier effects (J) Increase in litter (waste)	Moderate	High	Flora and fauna (detailed design, pre-construction and construction proposed mitigation measures) Weeds and pests (pre-construction and construction mitigation measures) Erosion and sediment control (pre-construction and construction) Riparian vegetation and aquatic habitats (construction)	Low	**Moderate** (refer Section 11.11.3 for assessment against MSES Significant Impact guidelines)
		Commissioning and reinstatement	(D) Displacement of flora and fauna species from invasion of weed and pest species	Low	**Moderate**	▸ Flora and fauna (detailed design, pre-construction and construction proposed mitigation measures) ▸ Weeds and pests (pre-construction and construction mitigation measures) ▸ Erosion and sediment control (preconstruction and construction) ▸ Riparian vegetation and aquatic habitats (construction) ▸ Landscape, rehabilitation and stabilisation (design, pre-construction, construction)	Negligible	**Low**
		Operation	(D) Displacement of flora and fauna species from invasion of weed and pest species	Low	**Moderate**	▸ Weeds and pests (operations) ▸ Riparian vegetation and aquatic habitats (operations)	Negligible	**Low**

■ NEGLIGIBLE ■ LOW ■ MODERATE ■ HIGH ■ MAJOR

Sensitive environmental receptor(s)	Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (APPLICATION OF DESIGN CONSIDERATION MEASURES PRESENTED IN SECTION 11.9.1) Magnitude[1]	Initial impact significance Significance	Application of proposed mitigation measures presented in Table 11.27, BY 'ENVIRONMENTAL VALUE IMPACTED' AND 'DELIVERY PHASE'	Residual significance FOLLOWING THE APPLICATION OF PROJECT MITIGATION MEASURES PRESENTED IN **Table 11.27**[3] Magnitude[1]	Residual significance Significance[4]
State receptors (CONTINUED)								
State Significant Ecological Constraint (VM Act): ▸ Regulated vegetation (Category C) intersecting watercourses and wetlands		Construction	(A) Habitat loss from vegetation clearing/removal (C) Reduction in biological viability of soil to support plant growth due to soil compaction (D) Displacement of flora and fauna species from invasion of weed and pest species (F) Edge effects (G) Habitat fragmentation (H) Barrier effects (J) Increase in litter (waste) (K) Aquatic habitat degradation	High	**High**	▸ Flora and fauna (detailed design, pre-construction and construction proposed mitigation measures) ▸ Weeds and pests (pre-construction and construction mitigation measures) ▸ Erosion and sediment control (pre-construction and construction) ▸ Riparian vegetation and aquatic habitats (construction)	Moderate	**Moderate** (refer Section 11.11.3 for assessment against MSES Significant Impact guidelines)
		Commissioning and reinstatement	(D) Displacement of flora and fauna species from invasion of weed and pest species	Moderate	**Moderate**	▸ Flora and fauna (detailed design, pre-construction and construction proposed mitigation measures) ▸ Weeds and pests (pre-construction and construction mitigation measures) ▸ Erosion and sediment control (pre-construction and construction) ▸ Riparian vegetation and aquatic habitats (construction) ▸ Landscape, rehabilitation and stabilisation (detailed design, pre-construction, construction)	Low	**Low**
		Operation	(D) Displacement of flora and fauna species from invasion of weed and pest species	Moderate	**Moderate**	▸ Weeds and Pests (operations) ▸ Riparian vegetation and aquatic habitats (operations)	Low	**Low**

NEGLIGIBLE LOW MODERATE HIGH MAJOR

Sensitive environmental receptor(s)	Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (APPLICATION OF DESIGN CONSIDERATION MEASURES PRESENTED IN SECTION 11.9.1) Magnitude[1]	Initial impact significance Significance	Application of proposed mitigation measures presented in Table 11.27, BY 'ENVIRONMENTAL VALUE IMPACTED' AND 'DELIVERY PHASE'	Residual significance (FOLLOWING THE APPLICATION OF PROJECT MITIGATION MEASURES PRESENTED IN **Table 11.27**[3]) Magnitude[1]	Residual significance Significance[4]
State receptors (CONTINUED)								
State significant ecological constraint (VM Act): ▸ MSES wildlife habitat		Construction	(A) Habitat loss from vegetation clearing/removal (C) Reduction in biological viability of soil to support plant growth due to soil compaction (D) Displacement of flora and fauna species from invasion of weed and pest species (F) Edge effects (G) Habitat fragmentation (H) Barrier effects (J) Increase in litter (waste)	Low	**Moderate**	▸ Flora and fauna (detailed design, pre-construction and construction proposed mitigation measures) ▸ Weeds and pests (pre-construction and construction mitigation measures) ▸ Erosion and sediment control (pre-construction and construction) ▸ Riparian vegetation and aquatic habitats (construction) ▸ Fauna passage (design, construction)	Negligible	**Low** (refer Section 11.11.3 for assessment against MSES Significant Impact guidelines)
		Commissioning and reinstatement	(D) Displacement of flora and fauna species from invasion of weed and pest species	Low	**Moderate**	▸ Flora and fauna (detailed design, pre-construction and construction proposed mitigation measures) ▸ Weeds and pests (pre-construction and construction mitigation measures) ▸ Erosion and sediment control (pre-construction and construction) ▸ Riparian vegetation and aquatic habitats (construction) ▸ Landscape, rehabilitation and stabilisation (detailed design, pre-construction, construction)	Negligible	**Low**
		Operation	(D) Displacement of flora and fauna species from invasion of weed and pest species;	Low	**Moderate**	▸ Weeds and pests (operations) ▸ Riparian vegetation and aquatic habitats (operations) ▸ Fauna fencing (operations)	Negligible	**Low**

■ NEGLIGIBLE ■ LOW ■ MODERATE ■ HIGH ■ MAJOR

Sensitive environmental receptor(s)	Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (APPLICATION OF DESIGN CONSIDERATION MEASURES PRESENTED IN SECTION 11.9.1) Magnitude[1]	Initial impact significance Significance	Application of proposed mitigation measures presented in Table 11.27, BY 'ENVIRONMENTAL VALUE IMPACTED' AND 'DELIVERY PHASE'	Residual significance FOLLOWING THE APPLICATION OF PROJECT MITIGATION MEASURES PRESENTED IN **Table 11.27**[3] Magnitude[1]	Residual significance Significance[4]
State receptors (CONTINUED)								
State significant ecological constraint (VM Act): ▸ Essential habitat		Construction	(A) Habitat loss from vegetation clearing/removal (C) Reduction in biological viability of soil to support plant growth due to soil compaction (D) Displacement of flora and fauna species from invasion of weed and pest species (F) Edge effects (G) Habitat fragmentation (H) Barrier effects (J) Increase in litter (waste)	High	Major	Flora and fauna (detailed design, pre-construction and construction proposed mitigation measures) Weeds and pests (pre-construction and construction mitigation measures) Erosion and sediment control (pre-construction and construction) Riparian vegetation and aquatic habitats (construction) Fauna passage (detailed design, construction)	Moderate	**High** (refer Section 11.11.3 for assessment against MSES Significant Impact guidelines)
		Commissioning and reinstatement	(D) Displacement of flora and fauna species from invasion of weed and pest species	Low	**Moderate**	Flora and fauna (detailed design, pre-construction and construction proposed mitigation measures) Weeds and pests (pre-construction and construction mitigation measures) Erosion and sediment control (pre-construction and construction) Riparian vegetation and aquatic habitats (construction) Landscape, rehabilitation and stabilisation (design, pre-construction, construction)	Negligible	**Low**
		Operation	(D) Displacement of flora and fauna species from invasion of weed and pest species;	Low	**Moderate**	Weeds and pests (operations) Riparian vegetation and aquatic habitats (operations) Fauna fencing (operations)	Negligible	**Low**

NEGLIGIBLE LOW MODERATE HIGH MAJOR

Sensitive environmental receptor(s)	Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (APPLICATION OF DESIGN CONSIDERATION MEASURES PRESENTED IN SECTION 11.9.1) Magnitude[1]	Initial impact significance Significance	Application of proposed mitigation measures presented in Table 11.27, BY 'ENVIRONMENTAL VALUE IMPACTED' AND 'DELIVERY PHASE'	Residual significance FOLLOWING THE APPLICATION OF PROJECT MITIGATION MEASURES PRESENTED IN **Table 11.27**[3] Magnitude[1]	Residual significance Significance[4]
State receptors (CONTINUED)								
Nature Conservation (Koala) Conservation Plan 2017 mapping, including: ▸ Koala Priority Areas ▸ Koala Habitat Areas		Construction	(D) Displacement of flora and fauna species from invasion of weed and pest species (H) Barrier effects (I) Noise, dust, and light impacts	High	**Major**	▸ Flora and fauna (detailed design, pre-construction and construction proposed mitigation measures) ▸ Weeds and pests (pre-construction and construction mitigation measures) ▸ Erosion and sediment control (pre-construction and construction)	Moderate	**High** (refer Section 11.11.3 for assessment against MSES Significant Impact guidelines)
		Commissioning and reinstatement	(D) Displacement of flora and fauna species from invasion of weed and pest species (I) Noise, dust, and light impacts	Low	**Moderate**	▸ Flora and fauna (detailed design, pre-construction and construction proposed mitigation measures) ▸ Weeds and pests (pre-construction and construction mitigation measures) ▸ Erosion and sediment control (pre-construction and construction) ▸ Landscape, rehabilitation and stabilisation (detailed design, pre-construction, construction)	Negligible	**Low**
		Operation	(D) Displacement of flora and fauna species from invasion of weed and pest species (I) Noise, dust, and light impacts	Low	**Moderate**	▸ Weeds and pests (operations)	Negligible	**Low**

■ NEGLIGIBLE ■ LOW ■ MODERATE ■ HIGH ■ MAJOR

Sensitive environmental receptor(s)	Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (APPLICATION OF DESIGN CONSIDERATION MEASURES PRESENTED IN SECTION 11.9.1) Magnitude[1]	Initial impact significance Significance	Application of proposed mitigation measures presented in Table 11.27, BY 'ENVIRONMENTAL VALUE IMPACTED' AND 'DELIVERY PHASE'	Residual significance (FOLLOWING THE APPLICATION OF PROJECT MITIGATION MEASURES PRESENTED IN **Table 11.27**[3]) Magnitude[1]	Residual significance Significance[4]
State receptors (CONTINUED)								
State Significant Ecological Constraint (species listed as threatened under the NC Act): **Flora:** ▸ Bailey's cypress (*Callitris baileyi*) ▸ Swamp tea-tree (*Melaleuca irbyana*) **Fauna:** ▸ Powerful owl (*Ninox strenua*) ▸ Glossy Black-cockatoo (*Calyptorhynchus lathami*)		Construction	(A) Habitat loss from vegetation clearing/removal (B) Fauna species injury or mortality (C) Reduction in biological viability of soil to support plant growth due to soil compaction (D) Displacement of flora and fauna species from invasion of weed and pest species (F) Edge effects (G) Habitat fragmentation (H) Barrier effects (I) Noise, dust, and light impacts (J) Increase in litter (waste) (K) Aquatic habitat degradation	High	**Major**	▸ Flora and fauna (detailed design, pre-construction and construction proposed mitigation measures) ▸ Weeds and pests (pre-construction and construction mitigation measures) ▸ Erosion and sediment control (pre-construction and construction)	Moderate	**High** (refer Section 11.11.3 for assessment against MSES Significant Impact guidelines)
		Commissioning and reinstatement	(B) Fauna species injury or mortality (D) Displacement of flora and fauna species from invasion of weed and pest species (I) Noise, dust, and light impacts	Low	**Moderate**	▸ Flora and fauna (detailed design, pre-construction and construction proposed mitigation measures) ▸ Weeds and pests (pre-construction and construction mitigation measures) ▸ Erosion and sediment control (pre-construction and construction) ▸ Landscape, rehabilitation and stabilisation (detailed design, pre-construction, construction)	Negligible	**Low**
		Operation	(B) Fauna species injury or mortality (D) Displacement of flora and fauna species from invasion of weed and pest species (I) Noise, dust, and light impacts (K) Aquatic habitat degradation	Low	**Moderate**	▸ Weeds and pests (operations)	Negligible	**Low**

■ NEGLIGIBLE ■ LOW ■ MODERATE ■ HIGH ■ MAJOR

Sensitive environmental receptor(s)	Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (APPLICATION OF DESIGN CONSIDERATION MEASURES PRESENTED IN SECTION 11.9.1) Magnitude[1]	Initial impact significance Significance	Application of proposed mitigation measures presented in Table 11.27, BY 'ENVIRONMENTAL VALUE IMPACTED' AND 'DELIVERY PHASE'	Residual significance FOLLOWING THE APPLICATION OF PROJECT MITIGATION MEASURES PRESENTED IN **Table 11.27**[3] Magnitude[1]	Residual significance Significance[4]
State receptors (CONTINUED)								
State significant ecological constraint (Special least concern fauna species): ▸ Short-beaked Echidna (*Tachyglossus aculeatus*) ▸ Platypus (*Ornithorhynchus anatinus*)		Construction	(A) Habitat loss from vegetation clearing/removal (B) Fauna species injury or mortality (D) Displacement of flora and fauna species from invasion of weed and pest species (F) Edge effects (G) Habitat fragmentation (I) Noise, dust, and light impacts (J) Increase in litter (waste) (K) Aquatic habitat degradation	High	**High**	▸ Flora and fauna (detailed design, pre-construction and construction proposed mitigation measures) ▸ Weeds and pests (pre-construction and construction mitigation measures) ▸ Erosion and sediment control (pre-construction and construction) ▸ Fauna passage (detailed design and construction) ▸ Fauna fencing (detailed design and construction)	Moderate	**Moderate** (refer Section 11.11.3 for assessment against MSES Significant Impact guidelines)
		Commissioning and reinstatement	(D) Displacement of flora and fauna species from invasion of weed and pest species	Low	**Low**	▸ Flora and fauna (detailed design, pre-construction and construction proposed mitigation measures) ▸ Weeds and pests (pre-construction and construction mitigation measures) ▸ Erosion and sediment control (pre-construction and construction) ▸ Landscape, rehabilitation and stabilisation (detailed design, pre-construction, construction)	Negligible	**Low**
		Operation	(D) Displacement of flora and fauna species from invasion of weed and pest species (I) Noise, dust, and light impacts	Low	**Low**	▸ Weeds and pests (operation) ▸ Fauna fencing (operation)	Negligible	**Low**

■ NEGLIGIBLE ■ LOW ■ MODERATE ■ HIGH ■ MAJOR

Sensitive environmental receptor(s)	Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (APPLICATION OF DESIGN CONSIDERATION MEASURES PRESENTED IN SECTION 11.9.1) Magnitude[1]	Initial impact significance Significance	Application of proposed mitigation measures presented in Table 11.27, BY 'ENVIRONMENTAL VALUE IMPACTED' AND 'DELIVERY PHASE'	Residual significance FOLLOWING THE APPLICATION OF PROJECT MITIGATION MEASURES PRESENTED IN **Table 11.27**[3] Magnitude[1]	Residual significance Significance[4]
State receptors (CONTINUED)								
State significant ecological constraint: ▸ Priority Back on Track flora and fauna species (that are not listed under as threatened under the provisions of the EPBC Act or NC Act)		Construction	(A) Habitat loss from vegetation clearing/removal (B) Fauna species injury or mortality (C) Reduction in biological viability of soil to support plant growth due to soil compaction (D) Displacement of flora and fauna species from invasion of weed and pest species (F) Edge effects (G) Habitat fragmentation (H) Barrier effects (I) Noise, dust, and light impacts (J) Increase in litter (waste) (K) Aquatic habitat degradation	High	**Moderate**	▸ Flora and fauna (detailed design, pre-construction and construction proposed mitigation measures) ▸ Aquatic fauna (detailed design and construction) ▸ Weeds and pests (pre-construction and construction mitigation measures) ▸ Erosion and sediment control (pre-construction and construction) ▸ Fauna passage (detailed design and construction) ▸ Fauna fencing (detailed design and construction)	Moderate	**Low** (refer Section 11.11.3 for assessment against MSES Significant Impact guidelines)
		Commissioning and reinstatement	(D) Displacement of flora and fauna species from invasion of weed and pest species	Negligible	**Negligible**	▸ Flora and fauna (detailed design, pre-construction and construction proposed mitigation measures) ▸ Weeds and pests (pre-construction and construction mitigation measures) ▸ Erosion and sediment control (pre-construction and construction) ▸ Landscape, rehabilitation and stabilisation (detailed design, pre-construction, construction)	Negligible	Negligible
		Operation	(B) Fauna species injury or mortality (D) Displacement of flora and fauna species from invasion of weed and pest species (I) Noise, dust, and light impacts (K) Aquatic habitat degradation	Moderate	**Low**	▸ Weeds and pests (operation) ▸ Fauna fencing (operation)	Negligible	Negligible

■ NEGLIGIBLE ■ LOW ■ MODERATE ■ HIGH ■ MAJOR

Sensitive environmental receptor(s)	Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (APPLICATION OF DESIGN CONSIDERATION MEASURES PRESENTED IN SECTION 11.9.1) Magnitude[1]	Initial impact significance Significance	Application of proposed mitigation measures presented in Table 11.27, BY 'ENVIRONMENTAL VALUE IMPACTED' AND 'DELIVERY PHASE'	Residual significance FOLLOWING THE APPLICATION OF PROJECT MITIGATION MEASURES PRESENTED IN **Table 11.27**[3] Magnitude[1]	Residual significance Significance[4]
State receptors (CONTINUED)								
State significant ecological constraint: ▸ Flora and fauna species not listed under the EPBC Act but listed as Least concern under the provisions of the NC Act and flora that is listed as special least concern under the provisions of the NC Act		Construction	(A) Habitat loss from vegetation clearing/removal (B) Fauna species injury or mortality (C) Reduction in biological viability of soil to support plant growth due to soil compaction (D) Displacement of flora and fauna species from invasion of weed and pest species (F) Edge effects (G) Habitat fragmentation (H) Barrier effects (I) Noise, dust, and light impacts (J) Increase in litter (waste) (K) Aquatic habitat degradation.	High	**Moderate**	▸ Flora and fauna (detailed design, pre-construction and construction proposed mitigation measures) ▸ Aquatic fauna (detailed design and construction) ▸ Weeds and pests (pre-construction and construction mitigation measures) ▸ Erosion and sediment control (pre-construction and construction) ▸ Fauna passage (detailed design and construction) ▸ Fauna fencing (detailed design and construction)	Moderate	**Low** (refer Section 11.11.3 for assessment against MSES Significant Impact guidelines)
		Commissioning and reinstatement	(D) Displacement of flora and fauna species from invasion of weed and pest species	Negligible	**Negligible**	▸ Flora and fauna (detailed design, pre-construction and construction proposed mitigation measures) ▸ Weeds and pests (pre-construction and construction mitigation measures) ▸ Erosion and sediment control (pre-construction and construction) ▸ Landscape, rehabilitation and stabilisation (detailed design, pre-construction, construction)	Negligible	**Negligible**
		Operation	(B) Fauna species injury or mortality (D) Displacement of flora and fauna species from invasion of weed and pest species (I) Noise, dust, and light impacts (K) Aquatic habitat degradation	Moderate	**Low**	▸ Weeds and pests (operation) ▸ Fauna fencing (operation)	Negligible	**Negligible**

■ NEGLIGIBLE ■ LOW ■ MODERATE ■ HIGH ■ MAJOR

Sensitive environmental receptor(s)	Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (APPLICATION OF DESIGN CONSIDERATION MEASURES PRESENTED IN SECTION 11.9.1) Magnitude[1]	Initial impact significance Significance	Application of proposed mitigation measures presented in Table 11.27, BY 'ENVIRONMENTAL VALUE IMPACTED' AND 'DELIVERY PHASE'	Residual significance (FOLLOWING THE APPLICATION OF PROJECT MITIGATION MEASURES PRESENTED IN **Table 11.27**[3]) Magnitude[1]	Residual significance Significance[4]
State receptors (CONTINUED)								
State significant ecological constraint (BPA): ▸ BPA habitat values for Endangered, Vulnerable and Near Threatened (EVNT) taxa (State) ▸ BPA habitat values (State)		Construction	(A) Habitat loss from vegetation clearing/removal (C) Reduction in biological viability of soil to support plant growth due to soil compaction (D) Displacement of flora and fauna species from invasion of weed and pest species (F) Edge effects (G) Habitat fragmentation (H) Barrier effects (J) Increase in litter (waste) (K) Aquatic habitat degradation	Moderate	**High**	▸ Flora and fauna (detailed design, pre-construction and construction proposed mitigation measures) ▸ Weeds and pests (pre-construction and construction mitigation measures) ▸ Erosion and sediment control (pre-construction and construction) ▸ Fauna passage (detailed design and construction) ▸ Fauna fencing (detailed design and construction)	Low	**Moderate** (refer Section 11.11.3 for assessment against MSES Significant Impact guidelines)
		Commissioning and reinstatement	(D) Displacement of flora and fauna species from invasion of weed and pest species	Low	**Moderate**	▸ Flora and fauna (detailed design, pre-construction and construction proposed mitigation measures) ▸ Weeds and pests (pre-construction and construction mitigation measures) ▸ Erosion and sediment control (pre-construction and construction) ▸ Landscape, rehabilitation and stabilisation (detailed design, pre-construction, construction)	Negligible	**Low**
		Operation	(D) Displacement of flora and fauna species from invasion of weed and pest species	Low	**Moderate**	▸ Weeds and pests (operation) ▸ Fauna fencing (operation) ▸ Ongoing management and maintenance of fauna passages, furniture, including fish passage (operation) ▸ Landscape, rehabilitation and stabilisation (operation)	Negligible	**Low**

■ NEGLIGIBLE ■ LOW ■ MODERATE ■ HIGH ■ MAJOR

Sensitive environmental receptor(s)	Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (APPLICATION OF DESIGN CONSIDERATION MEASURES PRESENTED IN SECTION 11.9.1) Magnitude[1]	Initial impact significance Significance	Application of proposed mitigation measures presented in Table 11.27, BY 'ENVIRONMENTAL VALUE IMPACTED' AND 'DELIVERY PHASE'	Residual significance FOLLOWING THE APPLICATION OF PROJECT MITIGATION MEASURES PRESENTED IN **Table 11.27**[3] Magnitude[1]	Residual significance Significance[4]
State receptors (CONTINUED)								
State significant ecological constraint (BPA): ▸ BPA habitat values (Regional)		Construction	(A) Habitat loss from vegetation clearing/removal (C) Reduction in biological viability of soil to support plant growth due to soil compaction (D) Displacement of flora and fauna species from invasion of weed and pest species (F) Edge effects (G) Habitat fragmentation (H) Barrier effects (J) Increase in litter (waste)	Moderate	**Moderate**	▸ Flora and fauna (detailed design, pre-construction and construction proposed mitigation measures) ▸ Weeds and pests (pre-construction and construction mitigation measures) ▸ Erosion and sediment control (pre-construction and construction) ▸ Fauna passage (detailed design and construction) ▸ Fauna fencing (detailed design and construction)	Low	**Low** (refer Section 11.11.3 for assessment against MSES Significant Impact guidelines)
		Commissioning and reinstatement	(D) Displacement of flora and fauna species from invasion of weed and pest species	Low	**Low**	▸ Flora and fauna (detailed design, pre-construction and construction proposed mitigation measures) ▸ Weeds and pests (pre-construction and construction mitigation measures) ▸ Erosion and sediment control (pre-construction and construction) ▸ Landscape, rehabilitation and stabilisation (detailed design, pre-construction, construction)	Negligible	**Low**
		Operation	(D) Displacement of flora and fauna species from invasion of weed and pest species	Low	**Low**	▸ Weeds and pests (operation) ▸ Fauna fencing (operation)	Negligible	**Low**

NEGLIGIBLE LOW MODERATE HIGH MAJOR

Sensitive environmental receptor(s)	Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (APPLICATION OF DESIGN CONSIDERATION MEASURES PRESENTED IN SECTION 11.9.1) Magnitude[1]	Initial impact significance Significance	Application of proposed mitigation measures presented in Table 11.27, BY 'ENVIRONMENTAL VALUE IMPACTED' AND 'DELIVERY PHASE'	Residual significance FOLLOWING THE APPLICATION OF PROJECT MITIGATION MEASURES PRESENTED IN **Table 11.27**[3] Magnitude[1]	Residual significance Significance[4]
State receptors (CONTINUED)								
State significant ecological constraint (BPA): State riparian corridors		Construction	(A) Habitat loss from vegetation clearing/removal (C) Reduction in biological viability of soil to support plant growth due to soil compaction (D) Displacement of flora and fauna species from invasion of weed and pest species (F) Edge effects (G) Habitat fragmentation (H) Barrier effects (J) Increase in litter (waste) (K) Aquatic habitat degradation	High	Major	▸ Flora and fauna (detailed design, pre-construction and construction proposed mitigation measures) ▸ Weeds and pests (pre-construction and construction mitigation measures) ▸ Erosion and sediment control (pre-construction and construction) ▸ Fauna passage (detailed design and construction) ▸ Fauna fencing (detailed design and construction)	Moderate	**High** (refer Section 11.11.3 for assessment against MSES Significant Impact guidelines)
		Commissioning and reinstatement	(D) Displacement of flora and fauna species from invasion of weed and pest species	Low	**Moderate**	▸ Flora and fauna (detailed design, pre-construction and construction proposed mitigation measures) ▸ Weeds and pests (pre-construction and construction mitigation measures) ▸ Erosion and sediment control (pre-construction and construction) ▸ Landscape, rehabilitation and stabilisation (detailed design, pre-construction, construction)	Negligible	**Low**
		Operation	(D) Displacement of flora and fauna species from invasion of weed and pest species	Low	**Moderate**	▸ Weeds and pests (operation) ▸ Fauna fencing (operation) ▸ Ongoing management and maintenance of fauna passages, furniture, including fish passage (operation) ▸ Landscape, rehabilitation and stabilisation (operation)	Negligible	**Low**

■ NEGLIGIBLE ■ LOW ■ MODERATE ■ HIGH ■ MAJOR

Sensitive environmental receptor(s)	Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (APPLICATION OF DESIGN CONSIDERATION MEASURES PRESENTED IN SECTION 11.9.1) Magnitude[1]	Initial impact significance Significance	Application of proposed mitigation measures presented in Table 11.27, BY 'ENVIRONMENTAL VALUE IMPACTED' AND 'DELIVERY PHASE'	Residual significance (FOLLOWING THE APPLICATION OF PROJECT MITIGATION MEASURES PRESENTED IN **Table 11.27**[3]) Magnitude[1]	Residual significance Significance[4]
State receptors (CONTINUED)								
State significant ecological constraint (BPA): ▸ State terrestrial corridors		Construction	(A) Habitat loss from vegetation clearing/removal (C) Reduction in biological viability of soil to support plant growth due to soil compaction (D) Displacement of flora and fauna species from invasion of weed and pest species (F) Edge effects (G) Habitat fragmentation (H) Barrier effects (J) Increase in litter (waste) (K) Aquatic habitat degradation	Moderate	**High**	▸ Flora and fauna (detailed design, pre-construction and construction proposed mitigation measures) ▸ Weeds and pests (pre-construction and construction mitigation measures) ▸ Erosion and sediment control (pre-construction and construction) ▸ Fauna passage (detailed design and construction) ▸ Fauna fencing (detailed design and construction)	Negligible	**Moderate** (refer Section 11.11.3 for assessment against MSES Significant Impact guidelines)
		Commissioning and reinstatement	(D) Displacement of flora and fauna species from invasion of weed and pest species	Low	**Moderate**	▸ Flora and fauna (detailed design, pre-construction and construction proposed mitigation measures) ▸ Weeds and pests (pre-construction and construction mitigation measures) ▸ Erosion and sediment control (pre-construction and construction) ▸ Landscape, rehabilitation and stabilisation (detailed design, pre-construction, construction)	Negligible	**Low**
		Operation	(D) Displacement of flora and fauna species from invasion of weed and pest species	Low	**Moderate**	▸ Weeds and pests (operation) ▸ Fauna fencing (operation) ▸ Ongoing management and maintenance of fauna passages, furniture, including fish passage (operation) ▸ Landscape, rehabilitation and stabilisation (operation)	Negligible	**Low**

■ NEGLIGIBLE ■ LOW ■ MODERATE ■ HIGH ■ MAJOR

Sensitive environmental receptor(s)	Sensitivity[1]	Phase	Potential impacts[2]	Initial impact significance (APPLICATION OF DESIGN CONSIDERATION MEASURES PRESENTED IN SECTION 11.9.1) Magnitude[1]	Initial impact significance Significance	Application of proposed mitigation measures presented in Table 11.27, BY 'ENVIRONMENTAL VALUE IMPACTED' AND 'DELIVERY PHASE'	Residual significance FOLLOWING THE APPLICATION OF PROJECT MITIGATION MEASURES PRESENTED IN **Table 11.27**[3] Magnitude[1]	Residual significance Significance[4]
State receptors (CONTINUED)								
State Significant Ecological Constraint (BPA): ▸ Regional terrestrial corridors		Construction	(A) Habitat loss from vegetation clearing/removal (C) Reduction in biological viability of soil to support plant growth due to soil compaction (D) Displacement of flora and fauna species from invasion of weed and pest species (F) Edge effects (G) Habitat fragmentation (H) Barrier effects (J) Increase in litter (waste)	High	High	▸ Flora and fauna (detailed design, pre-construction and construction proposed mitigation measures) ▸ Weeds and pests (pre-construction and construction mitigation measures) ▸ Erosion and sediment control (pre-construction and construction) ▸ Fauna passage (detailed design and construction) ▸ Fauna fencing (detailed design and construction)	Moderate	**Moderate** (refer Section 11.11.3 for assessment against MSES Significant Impact guidelines)
		Commissioning and reinstatement	(D) Displacement of flora and fauna species from invasion of weed and pest species	Low	**Low**	▸ Flora and fauna (detailed design, pre-construction and construction proposed mitigation measures) ▸ Weeds and pests (pre-construction and construction mitigation measures) ▸ Erosion and sediment control (pre-construction and construction) ▸ Landscape, rehabilitation and stabilisation (design, pre-construction, construction)	Negligible	**Low**
		Operation	(D) Displacement of flora and fauna species from invasion of weed and pest species	Low	**Low**	▸ Weeds and pests (operation) ▸ Fauna fencing (operation) ▸ Ongoing management and maintenance of fauna passages, furniture, including fish passage (operation) ▸ Landscape, rehabilitation and stabilisation (operation)	Negligible	**Low**

Table notes:

1. Refer Appendix I: Terrestrial and Aquatic Ecology Technical Report for the assessment methodology for 'sensitivity' and 'magnitude' criteria.
2. Potential impacts to terrestrial and aquatic ecology values in the above table are based on those presented in Section 11.8.
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.
4. In instances where the mitigated significance returns a rating of High or above, offsets may be an option to reduce the residual ecological impacts in the long term. Offset for biodiversity values are discussed further in Appendix I: Terrestrial and Aquatic Ecology Technical Report and Appendix J: Matters of National Environmental Significance Technical Report.

11.11 Significant residual impact assessment

11.11.1 Significant residual impact assessment for MNES (threatened species and communities)

This section assesses the potential for significant residual impacts from the Project on the EPBC Act controlling provisions of the Project, using the relevant criteria outlined in the *Matters of National Environmental Significance: Significant impact guidelines 1.1—Environmental Protection and Biodiversity Conservation Act 1999* (DotE, 2013) and the EPBC Act Referral Guidelines for the vulnerable koala (combined populations of Queensland, New South Wales and the Australian Capital Territory (DotE, 2014). Within the guidelines there are specific criteria depending on whether the species/community is listed as critically endangered or endangered or vulnerable. Full assessment in accordance with the guidelines is provided in Appendix J: Matters of National Environmental Significance Technical Report. A summary of the outcomes of this assessment is provide in Table 11.35.

TABLE 11.35: SUMMARY OF THE RESULTS OF THE SIGNIFICANT IMPACT ASSESSMENT THE EPBC ACT CONTROLLING PROVISIONS OF THE PROJECT

MNES species/community	EPBC Act status*	Results of assessment (refer Appendix J: MNES Technical Report)
TECs		
Swamp Tea-tree (*Melaleuca irbyana*) Forest of SEQ TEC	CE	No significant residual impact expected as this community does not occur within the Project disturbance footprint and the nears patch is sufficiently displaced from any indirect impacts
Brigalow (*Acacia harpophylla* dominant and codominant) TEC	E	No significant residual impact expected as this community does not occur within the Project disturbance footprint and the nears patch is sufficiently displaced from any indirect impacts
Flora		
Hairy-joint Grass (*Arthraxon hispidus*)	V	No significant residual impact—no important populations or *Habitat critical to the survival of the species* have been identified for this species within the Project disturbance footprint
Four-tailed Grevillea (*Grevillea quadricauda*)	V	Project has potential to cause 'significant residual impacts' on an important population of Four-tailed Grevillea
Blunt-leaved Leionema (*Leionema obtusifolium*)	V	Project has a minor potential to cause 'significant residual impacts' on an important population of Blunt-leaved Leionema
Lloyd's Olive (*Notelaea lloydii*)	V	Project is likely to cause 'significant residual impacts' on an important population of Lloyd's Olive
Paspalidium grandispiculatum (a grass)	V	Project has potential to cause 'significant residual impacts' on an important population of *Paspalidium grandispiculatum*
Brush Sophora (*Sophora fraseri*)	V	No significant residual impact—no important populations or *Habitat critical to the survival of the species* have been identified for this species within the Project disturbance footprint
Austral Toadflax (*Thesium australe*)	V	No significant residual impact—no important populations or *Habitat critical to the survival* of the species have been identified for this species within the Project disturbance footprint
Fauna		
Regent Honeyeater (*Anthochaera phrygia*)	E	No significant residual impact
Australasian Bittern (*Botaurus poiciloptilus*)	E	No significant residual impact
Curlew Sandpiper (*Calidris ferruginea*)	CE	No significant residual impact
Spotted-tail Quoll (*Dasyurus maculatus maculatus*)	E	Project has potential to cause 'significant residual impacts'
Swift Parrot (*Lathamus discolor*)	CE	Project has potential to cause 'significant residual impacts'
Australian Painted Snipe (*Rostratula australis*)	E	Project has potential to cause 'significant residual impacts'

MNES species/community	EPBC Act status*	Results of assessment (refer Appendix J: MNES Technical Report)
Collared Delma (*Delma torquata*)	V	Project is likely to cause 'significant residual impacts'
Red Goshawk (*Erythrotriorchis radiatus*)	V	Project has potential to cause 'significant residual impacts'
Grey Falcon (*Falco hypoleucos*)	V	No significant residual impact—no important populations or *Habitat critical to the survival of the species* have been identified for this species within the Project disturbance footprint
Painted Honeyeater (*Grantiella picta*)	V	No significant residual impact—no important populations or *Habitat critical to the survival of the species* have been identified for this species within the Project disturbance footprint
Australian Lungfish (*Neoceratodus forsteri*)	V	No significant residual impact—no important populations or *Habitat critical to the survival of the species* have been identified for this species within the Project disturbance footprint
Greater Glider (*Petauroides volans*)	V	No significant residual impact—no important populations or *Habitat critical to the survival of the species* have been identified for this species within the Project disturbance footprint
Brush-tailed Rock-wallaby (*Petrogale penicillata*)	V	Project has potential to cause 'significant residual impacts'
Koala (*Phascolarctos cinereus*)	V	Project is likely to cause 'significant residual impacts'
Long-nosed Potoroo (*Potorous tridactylus tridactylus*)	V	No significant residual impact—no important populations or *Habitat critical to the survival of the species* have been identified for this species within the Project disturbance footprint
New Holland Mouse (*Pseudomys novaehollandiae*)	V	Project has potential to cause 'significant residual impacts'
Grey-headed Flying-fox (*Pteropus poliocephalus*)	V	Project has potential to cause 'significant residual impacts'

Table notes:
* CE = Critically endangered, E = Endangered, V = Vulnerable

11.11.2 Significant residual impact assessment for MNES (non-threatened migratory species)

This section assesses the potential for significant residual impacts from the Project on the EPBC Act controlling provisions of the Project, using the relevant criteria outlined in the *Matters of National Environmental Significance: Significant impact guidelines 1.1—EPBC Act* (DotE, 2013) and the *Draft Referral guidelines for 14 birds listed as migratory species under the EPBC Act* (DAWE, 2020a). Full assessment in accordance with the guidelines is provided in Appendix J: Terrestrial and Aquatic Ecology Technical Report. A summary of the outcomes of this assessment is provide in Table 11.36.

TABLE 11.36: SUMMARY OF THE RESULTS OF THE SIGNIFICANT IMPACT ASSESSMENT FOR MIGRATORY SPECIES

Migratory species	EPBC Act status	NC Act status	Results of assessment
Aerial migrants			
Fork-tailed Swift (*Apus pacificus*)		M	Significant impact unlikely
Marine migrants			
Gull-billed Tern (*Gelochelidon nilotica*)	M	SLC	Significant impact unlikely
Pacific Golden Plover (*Pluvialis fulva*)	M	SLC	Significant impact unlikely
Caspian Tern (*Hydroprogne caspia*)	M	SLC	Significant impact unlikely
Common Sandpiper (*Actitis hypoleucos*)	M	SLC	Significant impact unlikely
Sharp-tailed Sandpiper (*Calidris acuminata*)	M	SLC	Significant impact unlikely
Pectoral Sandpiper (*Calidris melanotos*)	M	SLC	Significant impact unlikely
Red-necked Stint (*Calidris ruficollis*)	M	SLC	Significant impact unlikely
Latham's Snipe (*Gallinago harwickii*)	M	SLC	Significant impact unlikely
Black-tailed Godwit (*Limosa limosa*)	M	SLC	Significant impact unlikely
Red-necked Phalarope (*Phalaropus lobatus*)	M	SLC	Significant impact unlikely
Common Greenshank (*Tringa nebularia*)	M	SLC	Significant impact unlikely
Marsh Sandpiper (*Tringa stagnatilis*)	M	SLC	Significant impact unlikely
Oriental Dotterel (*Charadrius veredus*)	M	SLC	Significant impact unlikely
Woodland migrants			
Rufous Fantail (*Rhipidura rufifrons*)	M	SLC	Significant impact unlikely
Oriental Cuckoo (*Cuculus optatus*)	M	SLC	Significant impact unlikely
Spectacled Monarch (*Symposiachrus trivirgatus*)	M	SLC	Significant impact unlikely
Black-faced Monarch (*Monarcha melanopsis*)	M	SLC	Significant impact unlikely
Satin Flycatcher (*Myiagra cyanoleuca*)	M	SLC	Significant impact unlikely
Wetland migrants			
Yellow Wagtail (*Motacilla flava*)	M	SLC	Significant impact unlikely
Eastern Osprey (*Pandion haliaetus*)	M	SLC	Significant impact unlikely
Glossy Ibis (*Plegadis falcinellus*)	M	SLC	Significant impact unlikely

Table notes:
M—migratory SLC—Special least concern

11.11.3 Significant residual impact assessment for MSES

This section provides detail of the outcome of the Significant Impact Assessment for Prescribed Environmental Matters Associated with Queensland. The Significant Residual Impact (SRI) guideline criteria details when an action is likely to have a 'significant residual impact' to a MSES as defined in the Environmental Offsets Regulation 2014 (Qld). Full assessment in accordance with the guidelines is provided in Appendix I: Terrestrial and Aquatic Ecology Technical Report. A summary of the outcomes of this assessment is provide in Table 11.37.

TABLE 11.37: SUMMARY OF THE RESULTS SIGNIFICANT IMPACT ASSESSMENT PRESCRIBED ENVIRONMENTAL MATTERS

Matter	Outcome of assessment (refer Appendix I: Terrestrial and aquatic ecology technical report)
Regulated vegetation	
Endangered' or 'of concern' regional ecosystem (RE)	Significant impact not anticipated
▸ a prescribed RE (*Category B other than grassland*) within a defined distance from the defining banks of a relevant watercourse or relevant drainage feature (Appendix 3 of the Queensland Environmental Offsets Policy	Significant impact anticipated
Remnant vegetation intersection with a VM Act wetland	Significant impact not anticipated
Essential Habitat	Significant impact anticipated
Connectivity areas	
Connectivity areas (including the landscape fragmentation connectivity tool)	Significant impact not anticipated. (i.e. outputs from landscape fragmentation and connective analysis indicate that impacts for core areas will equate to 0.31% (Significance Test 1), and are therefore not significant (Significance Test 2)).
Wetlands and watercourses	Significant impact not anticipated
Designated precincts in Strategic Environmental Areas	
Designated precincts in Strategic Environmental Areas	Significant impact not anticipated (no areas are present within or near the Project disturbance footprint)
Wetlands and watercourses	
A wetland in a wetland protection area, or wetlands of high ecological significance shown on the map of Queensland wetland environmental values A wetland or watercourse in high ecological value waters	Significant impact anticipated The Disturbance footprint intercepts Wrights Creek and Sheep Station Creek which are high ecological value waters
Protected wildlife habitat	
An area contains plants that are endangered wildlife or vulnerable wildlife	Significant impact anticipated.
A habitat for an animal that is: ▸ endangered wildlife, or ▸ vulnerable wildlife, or ▸ a special least concern animal (an echidna or a platypus)	Significant impact anticipated. The following species habitat will be impacted: ▸ Bailey's Cypress Pine (*Callitris baileyi*) ▸ Swamp Tea-tree (*Melaleuca irbyana*) ▸ Glossy Black-cockatoo (*Calyptorhynchus lathami*) ▸ Powerful Owl (*Ninox strenua*)
Fish habitat area	
An area declared under the *Fisheries Act 1994* (Qld) to be a fish habitat area	Significant impact not anticipated
Waterway providing for fish passage	
Any part of a waterway providing for passage of fish only if the construction, installation or modification of waterway barrier works will limit the passage of fish along the waterway.	Significant impact not anticipated

11.12 Biodiversity offsets

Residual impacts are those impacts that remain after the successful implementation of the avoidance hierarchy and mitigation measures. 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.

Although sensitive environmental receptors will be avoided where practicable, and potential impacts will be minimised and mitigated to the greatest extent practical (refer Section 11.9.2), in some instances the magnitude and significance ratings will remain unchanged following the implementation of the mitigation measures.

To mitigate the residual impacts to the sensitive environmental receptors identified above, environmental offsets will be required. ARTC's Environmental Offset Delivery Strategy–Qld is contained in Appendix J: Matters of National Environmental Significance Technical Report and Appendix I: Terrestrial and Aquatic Ecology Technical 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, subject to Regulatory approval, prior to construction commencement.

11.12.1 MNES

There is the potential for some Project activities to have a cumulative, irreversible and/or permanent impact on some MNES (i.e. threatened species), even after the implementation of all mitigation measures, including rehabilitation. In the majority of these cases, the residual impact will require an offset should the residual impact be considered significant in accordance with the *EPBC Act Matters of National Environmental Significance Significant Impact Assessment* 1.1 (DotE, 2013).

The EPBC Act Environmental Offsets Policy will take precedence in the assessment and delivery of offsets for MNES values as well as MSES and MLES values that are also the same or substantially the same as the MNES (consistent with the *Environmental Offsets Act 2014* (EO Act)). The hierarchy is specified under the Queensland EO Act as a 'packaging' approach to offsets, so that offsets will be consolidated to avoid duplication, but provide for offsets for substantially the same matters for substantially the same impacts.

A 'significant impact' is defined as 'an impact that 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 on the sensitivity, value, and quality of the environment that is impacted, and on the intensity, duration, magnitude and geographic extent of the impacts' (DoTE, 2013).

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 Section 11.11.1 and Appendix J: Matters of National Environmental Significance Technical Report). Analysis indicates that Significant Residual impacts for the following sensitive environmental receptors have potential to occur:

- Four-tailed Grevillea (*Grevillea quadricauda*)
- Blunt-leaved Leionema (*Leionema obtusifolium*)
- Lloyd's Olive (*Notelaea lloydii*)
- A grass *Paspalidium grandispiculatum*
- Spotted-tail Quoll (*Dasyurus maculatus*)
- Collared Delma (*Delma torquata*)
- Red Goshawk (*Erythrotriorchis radiatus*)
- Swift Parrot (*Lathamus discolor*)
- Brush-tailed Rock-wallaby (*Petrogale penicillata*)
- Koala (*Phascolarctos cinereus*)
- New Holland Mouse (*Pseudomys novaehollandiae*)
- Grey-headed Flying-fox (*Pteropus poliocephalus*)
- Australian Painted Snipe (*Rostratula australis*).

A summary of the volume of anticipated significant residual impacts to MSES is provided in Table 11.39.

TABLE 11.38: QUANTIFICATION OF ANTICIPATED SIGNIFICANT RESIDUAL IMPACTS TO MNES

Sensitive environmental receptor (MNES)	Identified Significant residual Impact
Lloyd's Olive (*Notelaea lloydii*)	21.26 ha—habitat critical to the survival of the species
Spotted-tail Quoll (*Dasyurus maculatus maculatus*)	1.59 ha—habitat critical to the survival of the species
Collared Delma (*Delma torquata*)	85.33 ha—important habitat
Red Goshawk (*Erythrotriorchis radiatus*)	4.15 ha—habitat critical to the survival of the species
Swift Parrot (*Lathamus discolor*)	13.34 ha—habitat critical to the survival of the species
Brush-tailed Rock-wallaby (*Petrogale penicillata*)	4.88 ha—habitat critical to the survival of the species
Koala (*Phascolarctos cinereus*)	98.66 ha—habitat critical to the survival of the species
Grey-headed Flying-fox (*Pteropus poliocephalus*)	99.46 ha—habitat critical to the survival of the species
Australian Painted Snipe (*Rostratula australis*)	15.43 ha—habitat critical to the survival of the species

The provisions of offsets for the MNES presented above will be required under the EPBC Act Offsets Policy. An Environmental Offset Delivery Strategy–Qld for the Project is provided in Appendix J: Matters of National Environmental Significance Technical Report.

11.12.2 MSES

For MSES, impacts to prescribed matters (MSES and MLES) that are considered to constitute significant residual impacts will be offset with regard to the Offsets Act. The Environmental Offsets Regulation 2014 (Qld) and associated Queensland Environmental Offsets Policy 2017 Offsets Policy), provides guidance related to the offsets related to MSES. The purpose of the Offsets Policy is to provide a decision-support tool to enable administrating agencies the ability to assess offsets offset proposals to ensure that they meet the requirements of the Offsets Act.

Assessment of MSES prescribed has been undertaken in accordance with the MSES significant impact criteria (refer Section 11.11.3 and Appendix I: Terrestrial and Aquatic Ecology Technical Report). Analysis indicates that Significant Residual impacts for the following sensitive environmental receptors occur:

- Regulated vegetation (Category B (other than grassland) within a defined distance from the defining banks of a relevant watercourse or relevant drainage feature)
- Essential Habitat (EH)
- Protected wildlife habitat for the following species:
  - Bailey's Cypress Pine (*Callitris baileyi*)
  - Swamp Tea-tree (*Melaleuca irbyana*)
  - Glossy Black-cockatoo (*Calyptorhynchus lathami*)
  - Powerful Owl (*Ninox strenua*)
  - Platypus (*Ornithorhynchus anatinus*)
  - Short-beaked Echidna (*Tachyglossus aculeatus*).

A summary of the volume of anticipated significant residual impacts to MSES is provided in Table 11.39.

TABLE 11.39: QUANTIFICATION OF ANTICIPATED SIGNIFICANT RESIDUAL IMPACTS TO MSES

Sensitive environmental receptor (MSES)	Identified significant residual impact
Regulated vegetation	
A prescribed RE (Category B other than grassland) within a defined distance from the defining banks of a relevant watercourse or relevant drainage feature	0.77 ha
Essential Habitat (EH)	95.66 ha
Protected wildlife habitat	
Flora	
Bailey's Cypress Pine (*Callitris baileyi*)	28.40 ha—general habitat
Swamp Tea-tree (*Melaleuca irbyana*)	128.78 ha—comprising 124.35 ha general habitat and 4.43 ha essential habitat
Fauna	
Glossy Black-cockatoo (*Calyptorhynchus lathami*)	45.11 ha—general habitat
Powerful Owl (*Ninox strenua*)	28.63 ha—general habitat
Special least concern fauna (excluding migratory species)	
Platypus (*Ornithorhynchus anatinus*)	47.77 ha—general habitat
Short-beaked Echidna (*Tachyglossus aculeatus*)	75.71 ha—general habitat

The provisions of offsets for the MSES presented above may be required for the Project. An offset strategy for the Project in Appendix J: Matters of national environmental significance technical report.

11.12.3 Offset development

ARTC's Environmental Offset Delivery Strategy–Qld (Strategy) is contained in Appendix J: Matters of National Environmental Significance Technical Report and Appendix I: Terrestrial and Aquatic Ecology Technical Report. This strategy informs the development of offset delivery components including an Environmental Offset Delivery Plan and Offset Area Management Plans.

The Environmental Offset Delivery Plan will:

- Quantify the significant residual impact of the Project on MSES and MNES
- Detail offsets to address significant residual impacts for MSES (except where those matters are also significant residual impacts 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.

A Detailed Environmental Offset Delivery Plan and Offset Area Management Plans will be developed and implemented by ARTC, subject to Regulatory approval, prior to construction commencement.

11.13 Cumulative impacts

Cumulative impacts were assessed using the methodology identified in Section 11.5.8, incorporating the projects identified in Table 11.6 and depicted in

Figure 11.4. The assessment has been based on MNES and MSES identified as occurring within the Project disturbance footprint (refer Section 11.5.8) and used a conservative approach to assessment of habitat lost (i.e. combines the habitat categories as identified in Table 11.21 to identify the maximum potential habitat loss).

The cumulative impacts of multiple projects occurring in the vicinity of the Project 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 these projects are likely to result in some extent of the following impacting processes on ecological matters:

- 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 of significant environmental receptors contained within the footprint of the projects occurring within the cumulative impact study area, based on bioregional and State extents, is provided in Table 11.40 and Table 11.41.

The results of the significance assessment of these cumulative impacts are presented in Table 11.42 and Table 11.43.

TABLE 11.40: CUMULATIVE IMPACTS FOR MNES

MNES	EPBC Act status	A. Extent within cumulative impact study area (50km extent) (ha) (i.e. 1,254,287 ha)	B. Extent within cumulative impact disturbance footprint (defined projects Figure 11.4) (i.e. 10,986 ha)	C. Extent within cumulative impact disturbance footprint (defined projects Figure 11.4) including the disturbance footprint	D. Percentage (%) total disturbance to receptors within Cumulative impact study area	E. Percentage (%) contribution of the Project to disturbance within the cumulative impact disturbance footprint	F. Magnitude of contribution to disturbance considering D and E
Commonwealth significant ecological receptors							
Threatened ecological communities							
Swamp Tea-tree (*Melaleuca irbyana*) Forest of SEQ TEC	CE	326.04	10.86	0.00	3.33	0.00	Negligible
Brigalow (*Acacia harpophylla* dominant and codominant)	E	377.19	0.00	0.00	0.00	0.00	Negligible
Threatened flora habitat							
Hairy-joint Grass (*Arthraxon hispidus*)	V	17,961.04	367.85	367.85	2.05	0.00	Negligible
Four-tailed Grevillea (*Grevillea quadricauda*)	V	20,806.43	1.02	27.08	0.13	96.22	Low
Blunt-leaved Leionema (*Leionema obtusifolium*)	V	34,928.48	0.63	29.89	0.09	97.99	Low
Lloyd's Olive (*Notelaea lloydii*)	V	83,970.92	375.19	509.23	0.61	26.32	Low
a grass (*Paspalidium grandispiculatum*)	V	126,600.68	511.97	596.55	0.47	14.18	Low
Brush Sophora (*Sophora fraseri*)	V	83,759.19	127.60	167.58	0.20	23.86	Low
Austral Toadflax (*Thesium australe*)	V	17,961.04	367.85	462.61	2.58	20.48	Low

MNES	EPBC Act status	A. Extent within cumulative impact study area (50km extent) (ha) (i.e. 1,254,287 ha)	B. Extent within cumulative impact disturbance footprint (defined projects Figure 11.4) (i.e. 10,986 ha)	C. Extent within cumulative impact disturbance footprint (defined projects Figure 11.4) including the disturbance footprint	D. Percentage (%) total disturbance to receptors within Cumulative impact study area	E. Percentage (%) contribution of the Project to disturbance within the cumulative impact disturbance footprint	F. Magnitude of contribution to disturbance considering D and E
Threatened fauna habitat							
Birds							
Regent Honeyeater (*Anthocharea phrygia*)	CE	218,434.97	611.13	695.71	0.32	12.16	Low
Australasian Bittern (*Botaurus poiciloptilus*)	E	43,323.05	289.26	304.70	0.70	5.06	Low
Curlew Sandpiper (*Calidris ferruginea*)	CE, M	43,512.94	289.26	304.70	0.70	5.06	Low
Red Goshawk (*Erythrotriorchis radiatus*)	V	52,578.33	256.89	345.71	0.67	25.69	Low
Grey Falcon (*Falco hypoleucos*)	V	461,283.59	8,833.77	9,185.74	1.99	3.83	Low
Painted Honeyeater (*Grantiella picta*)	V	30,573.73	402.15	415.49	1.36	3.21	Low
White-throated Needletail (*Hirundapus caudacutus*)	V	1,254,287.63	10,986.29	11,620.85	0.93	5.77	Low
Swift Parrot (*Lathamus discolor*)	CE	245,758.79	1,272.65	1,371.32	0.56	7.20	Low
Australian Painted Snipe (*Rostratula australis*)	E	45,887.01	320.01	353.39	0.77	9.44	Low
Black-breasted Button-quail (*Turnix melanogaster*)	V	103,702.86	9.18	9.18	0.01	0.00	Negligible

MNES	EPBC Act status	A. Extent within cumulative impact study area (50km extent) (ha) (i.e. 1,254,287 ha)	B. Extent within cumulative impact disturbance footprint (defined projects Figure 11.4) (i.e. 10,986 ha)	C. Extent within cumulative impact disturbance footprint (defined projects Figure 11.4) including the disturbance footprint	D. Percentage (%) total disturbance to receptors within Cumulative impact study area	E. Percentage (%) contribution of the Project to disturbance within the cumulative impact disturbance footprint	F. Magnitude of contribution to disturbance considering D and E
Mammals							
Spotted-tail Quoll (*Dasyurus maculatus maculatus*)	E	294,795.21	1,136.71	1,213.77	0.41	6.35	Low
Greater Glider (*Petauroides volans*)	V	122,616.32	350.18	380.82	0.31	8.75	Low
Brush-tailed Rock-wallaby (*Petrogale penicillata*)	V	47,808.99	0.00	41.25	0.09	100	Low
Koala (*Phascolarctos cinereus*)	V	434,266.23	3,517.35	3,821.32	0.88	7.95	Low
Long-nosed Potoroo (*Potorous tridactylus tridactylus*)	V	218,207.42	580.56	665.14	0.30	12.72	Low
New Holland Mouse (*Pseudomys novaehollandiae*)	V	175,517.0	582.54	670.66	0.38	13.14	Low
Grey-headed Flying-fox (*Pteropus poliocephalus*)	V	440,130.79	1,325.70	1,425.16	0.32	6.98	Low
Reptiles							
Collared Delma (*Delma torquata*)	V	212,161.94	808.25	893.57	0.42	9.55	Low
Fish							
Australian Lungfish (*Neoceratodus forsteri*)	V	10,691.44	103.92	106.16	0.99	2.12	Low

Table notes:
1. Sensitive environmental receptors that are not contained within the Project area been omitted from analysis
2. Denotes the combined footprint of the cumulative impact projects
3. Denotes the area of interest for the cumulative impact assessment, identified in Figure 3.3 Appendix I: Terrestrial and aquatic ecology technical report as a nominal 50 km buffer from the Project.

TABLE 11.41: CUMULATIVE IMPACTS FOR NON-MNES

Sensitive environmental receptor[1]	A. Extent within cumulative impact study area (50km extent) (ha) (i.e. 1,256,897.35 ha)	B. Extent within cumulative impact disturbance footprint[2] (defined projects Figure 11.4) (i.e. 13,596.00 ha)	C. Extent within cumulative impact disturbance footprint (defined projects Figure 11.4) including the disturbance footprint	D. Percentage (%) total disturbance to sensitive environmental receptors within Cumulative impact study area[3]	E. Percentage (%) contribution of the Project to disturbance within the cumulative impact disturbance footprint	F. Magnitude of contribution to disturbance considering D and E
Commonwealth receptors (EPBC Act listed migratory species)						
Common Sandpiper (*Actitis hypoleucos*)	117,370.20	1,332.74	1,413.32	1.20	5.70	Low
Fork-tailed Swift (*Apus pacificus*)	1,254,287.58	10,986.29	11,620.87	0.93	5.46	Low
Sharp-tailed Sandpiper (*Calidris acuminata*)	121,522.20	1,344.03	1,436.02	1.18	6.41	Low
Pectoral Sandpiper (*Calidris melanotos*)	117,516.26	1,332.74	1,413.32	1.20	5.70	Low
Red-necked Stint (*Calidris ruficollis*)	117,731.91	1,332.74	1,413.32	1.20	5.70	Low
Oriental Dotterel (*Charadrius veredus*)	118,392.34	1,367.67	1,466.07	1.24	6.71	Low
Oriental Cuckoo (*Cuculus optatus*)	47,172.47	67.65	68.16	0.14	0.76	Low
Latham's Snipe (*Gallinago hardwickii*)	139,791.00	1,665.53	1,799.41	1.29	7.44	Low
Gull-billed Tern (*Gelochelidon nilotica*)	43,628.59	289.26	304.70	0.70	5.06	Low
Caspian Tern (*Hydroprogne caspia*)	43,535.89	293.62	314.13	0.72	6.53	Low
Black-tailed Godwit (*Limosa limosa*)	118,399.55	1,332.74	1,413.32	1.19	5.70	Low
Black-faced Monarch (*Monarcha melanopsis*)	111,945.80	125.61	131.68	0.12	4.61	Low
Spectacled Monarch (*Symposiachrus trivirgatus*)	73,348.82	67.65	68.16	0.09	0.76	Low
Yellow Wagtail (*Motacilla flava*)	117,370.20	1,332.74	1,413.32	1.20	5.70	Low
Satin Flycatcher (*Myiagra cyanoleuca*)	51,603.33	67.65	68.16	0.13	0.76	Low
Eastern Osprey (*Pandion haliaetus*)	43,295.91	289.26	304.70	0.70	5.06	Low
Red-necked Phalarope (*Phalarops lobatus*)	117,370.20	1,332.74	1,413.32	1.20	5.70	Low
Glossy Ibis (*Plegadis falcinellus*)	150,840.86	1,654.96	1,839.64	1.22	10.04	Low
Pacific Golden Plover (*Pluvialis fulva*)	117,370.20	1,332.74	1,413.32	1.20	5.70	Low
Rufous Fantail (*Rhipidura rufifrons*)	63,774.15	81.42	81.94	0.13	0.63	Low
Common Greenshank (*Tringa nebularia*)	118,309.16	1,332.74	1,413.32	1.19	5.70	Low
Marsh Sandpiper (*Tringa stagnatilis*)	121,124.66	1,344.03	1,436.24	1.19	6.42	Low

Sensitive environmental receptor[1]	A. Extent within cumulative impact study area (50km extent) (ha) (i.e. 1,256,897.35 ha)	B. Extent within cumulative impact disturbance footprint[2] (defined projects Figure 11.4) (i.e. 13,596.00 ha)	C. Extent within cumulative impact disturbance footprint (defined projects Figure 11.4) including the disturbance footprint	D. Percentage (%) total disturbance to sensitive environmental receptors within Cumulative impact study area[3]	E. Percentage (%) contribution of the Project to disturbance within the cumulative impact disturbance footprint	F. Magnitude of contribution to disturbance considering D and E
State significant ecological constraints						
Regulated vegetation (VM Act)						
Endangered remnant vegetation (REs)	25442.55	57.27	58.89	0.23	2.75	Low
Of concern remnant vegetation (REs)	104163.37	194.41	196.77	0.19	1.20	Low
Least concern remnant vegetation (REs)	78848.87	270.88	300.45	0.38	9.84	Low
High value regrowth vegetation (HVR)	78263.40	854.84	922.04	1.18	7.29	Low
Regulated vegetation (Category B) intersecting watercourses and wetlands	18,934.45	66.37	67.14	0.35	1.15	Low
Regulated vegetation (Category C) intersecting watercourses and wetlands	4,132.32	84.16	85.69	2.07	1.78	Low
MSES wildlife habitat	510018.78	1154.75	1174.59	0.23	1.69	Low
Essential habitat	302360.68	1293.94	1389.60	0.46	6.88	Low
Nature Conservation (Koala) Conservation Plan 2017 mapping						
Koala Priority Areas	189410.50	268.66	462.15	0.24	41.87	Low
Koala Habitat Areas	242603.43	1289.48	1385.10	0.57	6.90	Low
Koala Habitat Restoration Area - Koala Priority Area	43,123.54	115.8	235.30	0.55	50.79	Low
Koala Habitat Restoration Area	146,479.11	592.62	753.69	0.51	21.37	Low
Wetlands						
State significant wetlands - HEV wetlands	2,344.79	0.05	6.48	0.28	99.28	Low
Threatened flora habitat * (NC Act):						
Bailey's Cypress Pine (*Callitris baileyi*)	193,406.43	0.00	28.40	0.01	100.00	Low
Swamp Tea-tree (*Melaleuca irbyana*)	453782.37	1584.21	1712.99	0.38	7.52	Low

Sensitive environmental receptor[1]	A. Extent within cumulative impact study area (50km extent) (ha) (i.e. 1,256,897.35 ha)	B. Extent within cumulative impact disturbance footprint[2] (defined projects Figure 11.4) (i.e. 13,596.00 ha)	C. Extent within cumulative impact disturbance footprint (defined projects Figure 11.4) including the disturbance footprint	D. Percentage (%) total disturbance to sensitive environmental receptors within Cumulative impact study area[3]	E. Percentage (%) contribution of the Project to disturbance within the cumulative impact disturbance footprint	F. Magnitude of contribution to disturbance considering D and E
Threatened fauna habitat * (NC Act):						
Birds						
Glossy Black-cockatoo (*Calyptorhynchus lathami lathami*)	112,453.89	0.00	45.11	0.04	100.00	Low
Powerful Owl *(Ninox strenua*)	62,071.30	0.00	28.63	0.05	100.00	Low
Least concern flora and fauna, special least concern fauna * (NC Act) and Priority Back on Track flora and fauna species						
Platypus (Ornithorhynchus anatinus)	93,010.69	0.00	47.77	0.05	100.00	Low
Short-beaked Echidna (*Tachyglossus aculeatus*)	452,100.31	0.00	75.71	0.02	100.00	Low
Least concern flora and fauna	1,254,288.00	11,393.00	12027.29	0.96	5.27	Low
Priority Back on Track species (not listed under the EPBC Act or NC Act)	1,254,288.00	11,393.00	12027.29	0.96	5.27	Low
Biodiversity Planning Assessment (BPA)						
Local or Other Habitat Values	7660.53	89.22	99.87	1.30	10.66	Low
Regional Habitat Values	43047.85	48.55	57.65	0.13	15.78	Low
State Habitat Values	194703.43	276.94	286.56	0.15	3.35	Low
State Habitat for EVNT taxa	65637.55	156.62	159.52	0.24	1.82	Low
Regional Terrestrial Corridor	255264.39	87.86	228.67	0.09	61.58	Low
State Riparian Corridor	42630.07	903.69	926.21	2.17	2.43	Low

Table notes:

1. Sensitive environmental receptors that are not contained within the Project area been omitted from analysis.
2. Denotes the combined footprint of the cumulative impact projects.
3. Denotes the area of interest for the cumulative impact assessment, identified in Figure 3.3 Appendix I: Terrestrial and aquatic ecology technical report as a nominal 50 km buffer from the Project.

* There is potential for impacts to ecological receptors 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 11.42: SIGNIFICANCE ASSESSMENT FOR CUMULATIVE IMPACTS TO MNES

Receptors	Potential impacts	Relevance factor of aspects				Sum of relevance factors	Impact significance
		Probability	Duration	Magnitude	Sensitivity		
Commonwealth significant ecological receptor (community listed under the EPBC Act): ▸ Swamp Tea-tree (*Melaleuca irbyana*) Forest of SEQ TEC ▸ Brigalow (*Acacia harpophylla* dominant and codominant)	▸ Habitat loss from vegetation clearing/removal	1	1	1	1	4	Low
	▸ Edge effects	1	2	1	1	5	Low
	▸ Habitat fragmentation	1	1	1	3	6	Low
	▸ Dust and light and contaminant disturbance	1	1	1	3	6	Low
	▸ Increase in litter (waste)	1	1	1	2	5	Low
	▸ Reduction in biological viability of soil to support growth due to soil compaction	1	1	1	3	6	Low
	▸ Displacement of species from invasion of weed and pest species	1	1	1	3	6	Low
Commonwealth significant ecological receptor (species listed under the EPBC Act): **Flora:** ▸ Hairy-joint Grass (*Arthraxon hispidus*) ▸ Four-tailed Grevillea (*Grevillea quadricauda*) ▸ Blunt-leaved Leionema (*Leionema obtusifolium*) ▸ Lloyd's Olive (*Notelaea lloydii*) ▸ a grass (*Paspalidium grandispiculatum*) ▸ Brush Sophora (*Sophora fraseri*) ▸ Austral Toadflax (*Thesium australe*) **Fauna:** ▸ Regent Honeyeater (*Anthocharea phrygia*) ▸ Australasian Bittern (*Botaurus poiciloptilus*) ▸ Curlew Sandpiper (*Calidris ferruginea*) ▸ Red Goshawk (*Erythrotriorchis radiatus*) ▸ Grey Falcon (*Falco hypoleucos*)	▸ Habitat loss from vegetation clearing/removal	2	3	1	3	9	Medium
	▸ Edge effects ▸ Habitat fragmentation ▸ Barrier effects ▸ Reduction in connectivity of biodiversity corridors	2	2	1	3	8	Medium
	▸ Fauna species injury or mortality	2	2	1	3	8	Medium
	▸ Dust and light and contaminant disturbance	1	1	1	2	5	Low
	▸ Increase in litter (waste)	1	1	1	2	5	Low
	▸ Reduction in biological viability of soil to support growth due to soil compaction	1	2	1	3	7	Medium
	▸ Displacement of species from invasion of weed and pest species	1	1	1	3	6	Low
	▸ Edge effects	2	2	1	3	8	Medium

Receptors	Potential impacts	Relevance factor of aspects				Sum of relevance factors	Impact significance
		Probability	Duration	Magnitude	Sensitivity		
Fauna (continued)**:** ▸ White-throated Needletail (*Hirundapus caudacutus*) ▸ Painted Honeyeater (*Grantiella picta*) ▸ Swift Parrot (*Lathamus discolor*) ▸ Australian Painted Snipe (*Rostratula australis*) ▸ Black-breasted Button-quail (*Turnix melanogaster*) ▸ Spotted-tail Quoll (*Dasyurus maculatus maculatus*) ▸ Greater Glider (*Petauroides 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*) ▸ Collared Delma (*Delma torquata*) ▸ Australian Lungfish (*Neoceratodus forsteri*)	▸ Habitat fragmentation	2	2	2	3	9	Medium
	▸ Barrier effects	2	2	1	3	7	Medium
	▸ Reduction in connectivity of biodiversity corridors	1	1	1	3	6	Low
	▸ Dust and light and contaminant disturbance	1	1	1	2	5	Low

Table notes:
Table 11.7 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 approval 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 approval conditions are likely. Targeted monitoring program required.
High (sum of relevance factors—10 to 12): Alternative actions should be considered and/or mitigation measures applied to demonstrate improvement. Specific approval conditions required. Targeted monitoring program necessary.

TABLE 11.43: SIGNIFICANCE ASSESSMENT FOR CUMULATIVE IMPACTS TO NON-MNES

Ecological receptor(s)	Potential impacts	Relevance factor of aspects				Sum of relevance factors	Impact significance
		Probability	Duration	Magnitude	Sensitivity		
Commonwealth receptors (EPBC Act listed migratory species)							
Commonwealth significant Sensitive environmental receptor (migratory species listed under the EPBC Act): ▸ Common Sandpiper (*Actitis hypoleucos*) ▸ Fork-tailed Swift (*Apus pacificus*) ▸ Sharp-tailed Sandpiper (*Calidris acuminata*) ▸ Pectoral Sandpiper (*Calidris melanotos*) ▸ Red-necked Stint (*Calidris ruficollis*) ▸ Oriental Dotterel (*Charadrius veredus*) ▸ Oriental Cuckoo (*Cuculus optatus*) ▸ Latham's Snipe (*Gallinago hardwickii*) ▸ Gull-billed Tern (*Gelochelidon nilotica*) ▸ Caspian Tern (*Hydroprogne caspia*) ▸ Black-tailed Godwit (*Limosa limosa*) ▸ Black-faced Monarch (*Monarcha melanopsis*) ▸ Yellow Wagtail (*Motacilla flava*) ▸ Satin Flycatcher (*Myiagra cyanoleuca*) ▸ Eastern Osprey (*Pandion haliaetus*)	Habitat loss from vegetation clearing/removal	2	3	1	3	9	Medium
	Edge effects	2	2	1	3	8	Medium
	Habitat fragmentation	1	1	1	3	6	Low
	Barrier effects	1	1	1	3	6	Low
	Reduction in connectivity of biodiversity corridors	1	1	1	3	6	Low
	Fauna species injury or mortality	1	2	1	3	7	Medium

Ecological receptor(s)	Potential impacts	Relevance factor of aspects				Sum of relevance factors	Impact significance
		Probability	Duration	Magnitude	Sensitivity		
▸ Red-necked Phalarope (*Phalaropus lobatus*) ▸ Glossy Ibis (*Plegadis falcinellus*) ▸ Pacific Golden Plover (*Pluvialis fulva*) ▸ Rufous Fantail (*Rhipidura rufifrons*) ▸ Spectacled Monarch (*Symposiachrus trivirgatus*) ▸ Common Greenshank (*Tringa nebularia*) ▸ Marsh Sandpiper (*Tringa stagnatilis*)	Dust and light and contaminant disturbance	1	1	1	3	6	Low
State significant ecological constraints							
State Significant Ecological Constraint (VM Act): ▸ Endangered remnant vegetation (REs)	Habitat loss from vegetation clearing/removal	2	3	1	3	9	Medium
	Edge effects Habitat fragmentation Barrier effects Reduction in connectivity of biodiversity corridors	1	2	1	3	7	Medium
	Fauna species injury or mortality	1	1	1	3	6	Low
	Dust and light and contaminant disturbance	1	1	1	3	6	Low
	Increase in litter (waste)	1	1	1	3	6	Low
	Reduction in biological viability of soil to support growth due to soil compaction	1	2	1	3	7	Medium
	Displacement of species from invasion of weed and pest species	1	1	1	3	6	Low
State Significant Ecological Constraint (VM Act): ▸ Of concern remnant vegetation (REs)	Habitat loss from vegetation clearing/removal	2	3	1	2	8	Medium
	Edge effects Habitat fragmentation Barrier effects Reduction in connectivity of biodiversity corridors	1	2	1	2	6	Low
	Fauna species injury or mortality	1	1	1	2	5	Low
	Dust and light and contaminant disturbance	1	1	1	2	5	Low
	Increase in litter (waste)	1	1	1	2	5	Low

Ecological receptor(s)	Potential impacts	Relevance factor of aspects				Sum of relevance factors	Impact significance
		Probability	Duration	Magnitude	Sensitivity		
	Reduction in biological viability of soil to support growth due to soil compaction	1	2	1	2	6	Low
	Displacement of species from invasion of weed and pest species	1	1	1	2	5	Low
State Significant Ecological Constraint (VM Act): ▸ Least concern remnant vegetation (REs)	Habitat loss from vegetation clearing/removal	2	3	1	1	7	Medium
	Edge effects Habitat fragmentation Barrier effects Reduction in connectivity of biodiversity corridors	1	2	1	1	5	Low
	Fauna species injury or mortality	1	1	1	1	4	Low
	Dust and light and contaminant disturbance	1	1	1	1	4	Low
	Increase in litter (waste)	1	1	1	1	4	Low
	Reduction in biological viability of soil to support growth due to soil compaction	1	2	1	1	5	Low
	Displacement of species from invasion of weed and pest species	1	1	1	1	4	Low
State Significant Ecological Constraint (VM Act): ▸ High value regrowth vegetation (HVR)	Habitat loss from vegetation clearing/removal	2	3	1	2	8	Medium
	Edge effects Habitat fragmentation Barrier effects Reduction in connectivity of biodiversity corridors	1	2	1	2	8	Medium
	Fauna species injury or mortality	1	1	1	2	5	Low
	Dust and light and contaminant disturbance	1	1	1	2	5	Low
	Increase in litter (waste)	1	1	1	2	5	Low
	Reduction in biological viability of soil to support growth due to soil compaction	1	2	1	2	6	Low
	Displacement of species from invasion of weed and pest species	1	1	1	2	5	Low

Ecological receptor(s)	Potential impacts	Relevance factor of aspects				Sum of relevance factors	Impact significance
		Probability	Duration	Magnitude	Sensitivity		
State Significant Ecological Constraint (VM Act): ▸ Regulated vegetation (Category B) intersecting watercourses and wetlands	Habitat loss from vegetation clearing/removal	2	3	1	2	8	Medium
	Edge effects Habitat fragmentation Barrier effects Reduction in connectivity of biodiversity corridors	1	2	1	2	6	Low
	Fauna species injury or mortality	1	1	1	2	5	Low
	Dust and light and contaminant disturbance	1	1	1	2	5	Low
	Increase in litter (waste)	1	1	1	2	5	Low
	Reduction in biological viability of soil to support growth due to soil compaction	1	2	1	2	6	Low
	Displacement of species from invasion of weed and pest species	1	1	1	2	5	Low
State Significant Ecological Constraint (VM Act): ▸ Regulated vegetation (Category C) intersecting watercourses and wetlands	Habitat loss from vegetation clearing/removal	2	3	1	2	8	Medium
	Edge effects Habitat fragmentation Barrier effects Reduction in connectivity of biodiversity corridors	1	2	1	2	8	Medium
	Fauna species injury or mortality	1	1	1	2	5	Low
	Dust and light and contaminant disturbance	1	1	1	2	5	Low
	Increase in litter (waste)	1	1	1	2	5	Low
	Reduction in biological viability of soil to support growth due to soil compaction	1	2	1	2	6	Low
	Displacement of species from invasion of weed and pest species	1	1	1	2	5	Low

Ecological receptor(s)	Potential impacts	Relevance factor of aspects				Sum of relevance factors	Impact significance
		Probability	Duration	Magnitude	Sensitivity		
State significant ecological constraint: ▸ MSES wildlife habitat ▸ Essential habitat	Habitat loss from vegetation clearing/removal	2	3	1	3	9	Medium
	Edge effects Habitat fragmentation Barrier effects Reduction in connectivity of biodiversity corridors	1	2	1	3	7	Medium
	Fauna species injury or mortality	1	1	1	3	6	Low
	Dust and light and contaminant disturbance	1	1	1	3	6	Low
	Increase in litter (waste)	1	1	1	3	6	Low
	Reduction in biological viability of soil to support growth due to soil compaction	1	2	1	3	7	Medium
	Displacement of species from invasion of weed and pest species	1	1	1	3	6	Low
State significant ecological constraint (*Nature Conservation (Koala) Conservation Plan 2017)*: ▸ Koala Priority Areas ▸ Koala Habitat Areas ▸ Koala Habitat Restoration Area—Koala Priority Area ▸ Koala Habitat Restoration Area	Habitat loss from vegetation clearing/removal	2	3	1	3	9	Medium
	Edge effects Habitat fragmentation Barrier effects Reduction in connectivity of biodiversity corridors	1	2	1	3	7	Medium
	Fauna species injury or mortality	1	1	1	3	6	Low
	Dust and light and contaminant disturbance	1	1	1	3	6	Low
	Increase in litter (waste)	1	1	1	3	6	Low
	Reduction in biological viability of soil to support growth due to soil compaction	1	2	1	3	7	Medium
	Displacement of species from invasion of weed and pest species	1	1	1	3	6	Low

Ecological receptor(s)	Potential impacts	Relevance factor of aspects				Sum of relevance factors	Impact significance
		Probability	Duration	Magnitude	Sensitivity		
State significant ecological constraint: ▸ State Significant High ecological value (HEV) Wetlands	Habitat loss from vegetation clearing/removal	2	3	1	3	9	Medium
	Edge effects Habitat fragmentation Barrier effects Reduction in connectivity of biodiversity corridors	1	2	1	3	7	Medium
	Fauna species injury or mortality	1	1	1	3	6	Low
	Dust and light and contaminant disturbance	1	1	1	3	6	Low
	Increase in litter (waste)	1	1	1	3	6	Low
	Reduction in biological viability of soil to support growth due to soil compaction	1	2	1	3	7	Medium
	Displacement of species from invasion of weed and pest species	1	1	1	3	6	Low
State Significant Ecological Constraint (species listed as threatened under the NC Act): **Flora:** ▸ Bailey's Cypress Pine (*Callitris baileyi*) ▸ Swamp Tea-tree (*Melaleuca irbyana*) **Fauna:** ▸ Glossy Black-cockatoo (*Calyptorhynchus lathami lathami*) ▸ Powerful Owl (*Ninox strenua*)	Habitat loss from vegetation clearing/removal	2	3	1	3	9	Medium
	Edge effects Habitat fragmentation Barrier effects Reduction in connectivity of biodiversity corridors	1	2	1	3	7	Medium
	Fauna species injury or mortality	1	1	1	3	6	Low
	Dust and light and contaminant disturbance	1	1	1	3	6	Low
	Increase in litter (waste)	1	1	1	3	6	Low
	Reduction in biological viability of soil to support growth due to soil compaction	1	2	1	3	7	Medium
	Displacement of species from invasion of weed and pest species	1	1	1	3	6	Medium

Ecological receptor(s)	Potential impacts	Relevance factor of aspects				Sum of relevance factors	Impact significance
		Probability	Duration	Magnitude	Sensitivity		
State significant ecological constraint: Special Least concern fauna species: - Platypus (*Ornithorhynchus anatinus*) - Short-beaked Echidna (*Tachyglossus aculeatus*)	Habitat loss from vegetation clearing/removal	2	3	1	2	8	Medium
	Edge effects Habitat fragmentation Barrier effects Reduction in connectivity of biodiversity corridors	1	2	1	2	6	Low
	Fauna species injury or mortality	1	1	1	2	5	Low
	Dust and light and contaminant disturbance	1	1	1	2	5	Low
	Increase in litter (waste)	1	1	1	2	5	Low
	Reduction in biological viability of soil to support growth due to soil compaction	1	2	1	2	6	Low
	Displacement of species from invasion of weed and pest species	1	1	1	2	5	Low
State significant ecological constraint: - Priority Back on Track flora and fauna species (that are not listed under as threatened under the provisions of the EPBC Act or NC Act)	Habitat loss from vegetation clearing/removal	2	3	1	1	7	Medium
	Edge effects Habitat fragmentation Barrier effects Reduction in connectivity of biodiversity corridors	1	2	1	1	5	Low
	Fauna species injury or mortality	1	1	1	1	4	Low
	Dust and light and contaminant disturbance	1	1	1	1	4	Low
	Increase in litter (waste)	1	1	1	1	4	Low
	Reduction in biological viability of soil to support growth due to soil compaction	1	2	1	1	5	Low
	Displacement of species from invasion of weed and pest species	1	1	1	1	4	Low

Ecological receptor(s)	Potential impacts	Relevance factor of aspects				Sum of relevance factors	Impact significance
		Probability	Duration	Magnitude	Sensitivity		
State significant ecological constraint: ▸ Flora and fauna species not listed under the EPBC Act but listed as Least concern under the provisions of the NC Act and flora that is listed as Special least concern under the provisions of the NC Act	Habitat loss from vegetation clearing/removal	3	3	1	1	8	Medium
	Edge effects Habitat fragmentation Barrier effects Reduction in connectivity of biodiversity corridors	1	2	1	1	5	Low
	Fauna species injury or mortality	1	1	1	1	4	Low
	Dust and light and contaminant disturbance	1	1	1	1	4	Low
	Increase in litter (waste)	1	1	1	1	4	Low
	Reduction in biological viability of soil to support growth due to soil compaction	1	2	1	1	5	Low
	Displacement of species from invasion of weed and pest species	1	1	1	1	4	Low
State Significant Ecological Constraint (BPA): ▸ Local or other habitat values	Habitat loss from vegetation clearing/removal	1	3	1	1	6	Low
	Edge effects Habitat fragmentation Barrier effects Reduction in connectivity of biodiversity corridors	1	2	1	1	5	Low
	Fauna species injury or mortality	1	1	1	1	4	Low
	Dust and light and contaminant disturbance	1	1	1	1	4	Low
	Increase in litter (waste)	1	1	1	1	4	Low
	Reduction in biological viability of soil to support growth due to soil compaction	1	2	1	1	5	Low
	Displacement of species from invasion of weed and pest species	1	1	1	1	4	Low

Ecological receptor(s)	Potential impacts	Relevance factor of aspects				Sum of relevance factors	Impact significance
		Probability	Duration	Magnitude	Sensitivity		
State Significant Ecological Constraint (BPA): ▸ State habitat values for EVNT taxa	Habitat loss from vegetation clearing/removal	2	3	1	3	9	Medium
	Edge effects Habitat fragmentation Barrier effects Reduction in connectivity of biodiversity corridors	1	2	1	3	7	Medium
	Fauna species injury or mortality	1	1	1	3	6	Low
	Dust and light and contaminant disturbance	1	1	1	3	6	Low
	Increase in litter (waste)	1	1	1	3	6	Low
	Reduction in biological viability of soil to support growth due to soil compaction	1	2	1	3	7	Medium
	Displacement of species from invasion of weed and pest species	1	1	1	3	6	Low
State Significant Ecological Constraint (BPA): ▸ State habitat values	Habitat loss from vegetation clearing/removal	2	3	1	3	9	Medium
	Edge effects Habitat fragmentation Barrier effects Reduction in connectivity of biodiversity corridors	1	2	1	3	7	Medium
	Fauna species injury or mortality	1	1	1	3	6	Low
	Dust and light and contaminant disturbance	1	1	1	3	6	Low
	Increase in litter (waste)	1	1	1	3	6	Low
	Reduction in biological viability of soil to support growth due to soil compaction	1	2	1	3	7	Medium
	Displacement of species from invasion of weed and pest species	1	1	1	3	6	Low

Ecological receptor(s)	Potential impacts	Relevance factor of aspects				Sum of relevance factors	Impact significance
		Probability	Duration	Magnitude	Sensitivity		
State Significant Ecological Constraint (BPA): ▸ Regional habitat values	Habitat loss from vegetation clearing/removal	2	3	1	2	8	Medium
	Edge effects Habitat fragmentation Barrier effects Reduction in connectivity of biodiversity corridors	1	2	1	2	6	Low
	Fauna species injury or mortality	1	1	1	2	5	Low
	Dust and light and contaminant disturbance	1	1	1	2	5	Low
	Increase in litter (waste)	1	1	1	2	5	Low
	Reduction in biological viability of soil to support growth due to soil compaction	1	2	1	2	6	Low
	Displacement of species from invasion of weed and pest species	1	1	1	2	6	Low
State Significant Ecological Constraint (BPA): ▸ Local habitat values	Habitat loss from vegetation clearing/removal	2	3	1	1	7	Medium
	Edge effects Habitat fragmentation Barrier effects Reduction in connectivity of biodiversity corridors	1	2	1	1	5	Low
	Fauna species injury or mortality	1	1	1	1	4	Low
	Dust and light and contaminant disturbance	1	1	1	1	4	Low
	Increase in litter (waste)	1	1	1	1	4	Low
	Reduction in biological viability of soil to support growth due to soil compaction	1	2	1	1	5	Low
	Displacement of species from invasion of weed and pest species	1	1	1	1	4	Low

Ecological receptor(s)	Potential impacts	Relevance factor of aspects				Sum of relevance factors	Impact significance
		Probability	Duration	Magnitude	Sensitivity		
State Significant Ecological Constraint (BPA): ▸ State significant corridor	Habitat loss from vegetation clearing/removal	2	3	1	3	9	Medium
	Edge effects Habitat fragmentation Barrier effects Reduction in connectivity of biodiversity corridors	1	2	1	3	7	Medium
	Fauna species injury or mortality	1	1	1	3	6	Low
	Dust and light and contaminant disturbance	1	1	1	3	6	Low
	Increase in litter (waste)	1	1	1	3	6	Low
	Reduction in biological viability of soil to support growth due to soil compaction	1	2	1	3	7	Medium
	Displacement of species from invasion of weed and pest species	1	1	1	3	6	Low

Table notes:
Table 11.7 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 approval 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 approval conditions are likely. Targeted monitoring program required.
- **High** (sum of relevance factors = 10 to 12): Alternative actions should be considered and/or mitigation measures applied to demonstrate improvement. Specific approval conditions required. Targeted monitoring program necessary.

11.14 Conclusions

The ecology study area provides suitable habitat, for two TECs and for 31 threatened species (10 flora and 21 fauna) listed under the provisions of the EPBC Act and/or the NC Act, 22 non-threatened migratory species listed under the EPBC Act and two special least-concern mammals listed under the NC Act. A number of endangered, of concern and least concern REs are also present within the ecology study area and are protected under the VM Act. The ecology study area contains a suite of other sensitive environmental receptors, including protected areas, high value regrowth vegetation, conservation significant flora and fauna species, regionally significant species as well as bioregional corridors (local, regional and state significant).

A total of 78 sensitive environmental receptors were identified within the ecology study area for the purposes of the assessment. These varied from broad scale receptors such as protected areas and bioregional corridors, down to finer species-scale receptors, including TECs and conservation significant species. These sensitive environmental receptors 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 sensitive environmental receptors through:

- 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.

During development of the Project, the alignment has been refined to (where possible):

- 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.

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 ecology 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.

The nature of each unmitigated potential impact was considered in relation to the identified sensitive environmental receptors to derive an initial assessment of impact significance for the Project. This impact was determined by assigning sensitivity and magnitude ratings which were then allocated a significance rating through the significance assessment approach as outlined in Chapter 4: Assessment methodology. The potential impacts on the sensitive environmental receptors were assigned a major, high, moderate, low or negligible rating.

The proposed mitigation measures for the Project were identified to reduce the significance of the potential impacts on the sensitive environmental receptors. The mitigation strategies associated with the Project are presented in Table 11.27. Following the application of the mitigation hierarchy (i.e. avoid, minimise, mitigate), which included a range of mitigation measures and management plans, the residual impacts to the identified sensitive environmental receptors were generally reduced. Aside from avoidance and impact minimisation, the application of additional mitigation measures was not likely to significantly reduce impacts associated with the loss of vegetation through clearing/removal, resulting in a residual impact to each of the sensitive environmental receptors.

Assessment of sensitive environmental receptors against the relevant Commonwealth or State significant impact assessment criteria (refer Sections 11.11.1, 11.11.2 and 11.11.3), indicates that the following will be subject to significant residual impacts as a result of the Project:

Commonwealth Matters

- Matters listed under the EPBC Act (Project controlling provisions):
  - Lloyd's Olive (*Notelaea lloydii*)
  - A grass *Paspalidium grandispiculatum*
  - Spotted-tail Quoll (*Dasyurus maculatus*)
  - Collared Delma (*Delma torquata*)
  - Red Goshawk (*Erythrotriorchis radiatus*)
  - Swift Parrot (*Lathamus discolor*)
  - Brush-tailed Rock-wallaby (*Petrogale penicillata*)
  - Koala (*Phascolarctos cinereus*)
  - Grey-headed Flying-fox (*Pteropus poliocephalus*)
  - Australian Painted Snipe (*Rostratula australis*).

State Matters

- Regulated vegetation (Category B (other than grassland) within a defined distance from the defining banks of a relevant watercourse or relevant drainage feature)
- Essential Habitat (EH)
- Protected wildlife habitat for the following species:
  - Bailey's Cypress Pine (*Callitris baileyi*)
  - Swamp Tea-tree (*Melaleuca irbyana*)
  - Glossy Black-cockatoo (*Calyptorhynchus lathami*)
  - Powerful Owl (*Ninox strenua*)
  - Platypus (*Ornithorhynchus anatinus*)
  - Short-beaked Echidna (*Tachyglossus aculeatus*).

The provisions of offsets for the MNES and State-based Prescribed Matters presented above will be required under the either the EPBC Act Offsets Policy or the Queensland Environmental Offsets Policy 2017.

The Project contributions 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 to the CEMP.

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.

ARTC's Environmental Offset Delivery Strategy—Qld will inform 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.