APPENDIX

S

Aquatic Biodiversity Technical Report

NORTH STAR TO NSW/QUEENSLAND BORDER ENVIRONMENTAL IMPACT STATEMENT

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

Inland Rail North Star to NSW/QLD Border

Appendix S – Aquatic Biodiversity Technical Report

Australian Rail Track Corporation

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Abbreviations

Abbreviation	Explanation
AEP	Annual exceedance probability
AIAM	Adverse Impacts Assessment Methodology
AOI	Area of Influence
ARTC	Australian Rail Track Corporation Limited
AUSRIVAS	Australian River Assessment System
BoM	Bureau of Meteorology
CEEC	Critically Endangered Ecological Community
CEMP	Construction Environmental Management Plan
Ch	Chainage
CIA	cumulative impact assessment
DIWA	Directory of Important Wetlands in Australia
DoEE	Commonwealth Department of the Environment and Energy (formerly DoE)
DOTE	Commonwealth Department of the Environment
DPI	Department of Primary Industries
DSEWPaC	Commonwealth Department of Sustainability, Environment, Water, Population and Communities
EAP	Environmental Assessment Procedure
EEC	Endangered Ecological Community
EIS	Environmental Impact Statement
EP&A Act	*Environmental Planning and Assessment Act 1979* (NSW)
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth)
FFJV	Future Freight Joint Venture
FM Act	*Fisheries Management Act 1994* (NSW)
GDE	groundwater dependent ecosystems
GIS	Geographical Information System
ha	hectares
Hr	hour
Inland Rail	Melbourne to Brisbane Inland Rail
km	kilometres
KTP	Key threatening process
LGA	Local Government Area
m	metre
MDBA	Murray Darling Basin Authority
MNES	Matters of National Environmental Significance
NS2B	North Star to Border proposal
NSW	New South Wales
OEH	NSW Office of Environment and Heritage
PMST	Protected Matters Search Tool
SEARs	Secretary's Environmental Assessment Requirements
the proponent	Australian Rail Track Corporation Limited

Glossary

Term	Explanation
Adverse impact	Adverse impacts are defined as those impacts that result in an unwanted and unanticipated result of taking a particular action. In an environmental context, an adverse impact means any change in the physical or biological conditions of the natural environment that results in a detrimental effect upon flora, fauna, air, water, minerals or other natural characteristic of the area.
Biodiversity	The biological diversity of life is commonly regarded as being made up of the following three components:
Critically endangered	Designated as Critically endangered under the EPBC Act. Refer to definition of EPBC Act conservation status for meaning of Critically endangered under the Act
Cumulative impacts	The impacts that result from the incremental impact of an activity when it is added to past, present, and reasonably foreseeable future activities. Cumulative impacts arise when several developments that may have insignificant effects but when taken together have a significant effect.
Ecological community	An ecological community, in line with the FM Act, is an assemblage of species of fish or vegetation (or both) occupying a particular area
Ecological receptor	A receptor is a feature, area or structure or grouping of the aforementioned that may be affected by direct or indirect changes to the environment. Within this report, an ecological receptor explicitly relates to a conservation significant species under the EPBC Act or a conservation significant species, population or ecological community of conservation significance under the FM Act.
Endangered	Designated as Endangered under the EPBC Act or FM Act. Refer to definitions of EPBC Act conservation status, FM Act conservation status, for meaning of Endangered under each Act
EPBC Act conservation status	Under the EPBC Act, listed species and threatened ecological communities are assigned a conservation status of Extinct in the wild, Critically endangered, Endangered or Vulnerable. Definitions of these terms under the Act are as follows: **Extinct in the wild** ■ It is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range or, ■ It has not been recorded in its known and/or expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a timeframe appropriate to its lifecycle and form **Critically endangered** ■ It is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria **Endangered** ■ It is not Critically Endangered, and ■ It is facing a very high risk of extinction in the wild in the near future, as determined in accordance with the prescribed criteria **Vulnerable** ■ It is not Critically Endangered or Endangered, and ■ It is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria
Habitat	An area or areas permanently, periodically or occasionally occupied by a species, population or ecological community, including any and all biotic and abiotic features of the area or areas occupied
Key Threatening Process	A process or event which adversely affects threatened species, populations of a species or ecological community or it could cause species, populations of a species or ecological communities to become threatened i.e. invasion of weeds or cane toads. Key threatening processes are identified under both the EPBC Act and the FM Act, with some overlap of certain threatening processes.
Negative impact	An impact that is considered to result in an unfavourable or adverse change to the receptor.
Proposal	The amount and area of works being proposed to occur

Term	Explanation
Significant impact	In accordance with the EPBC Act, a significant impact is an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value, and quality of the environment which is impacted, and upon the intensity, duration, magnitude and geographic extent of the impacts.
Spatial extent	Impacts are considered with respect to the biologically meaningful spatial extents of local, regional, State, and national/international
Threatened Species	In NSW a species in considered threatened if a) there is a reduction in its populations size b) it has a restricted geographical distribution or c) there are few mature individuals. A species may be listed under the Biodiversity Conservation Act 2016 as: ■ Vulnerable ■ Endangered ■ Critically endangered, or ■ Presumed extinct. How threatened a species is in NSW depends on: ■ The extent of its population reduction ■ The size of its geographical distribution, or ■ The number of mature individuals. Populations of a species and ecological communities can also be listed as threatened
Wetland	Are wetlands as defined in NSW are areas of land covered or saturated with water. Wetlands can be covered with fresh, brackish or salt water that's generally still or slow moving. The water can also sit just below the surface. Many wetlands in inland NSW can be dry for 10 years or longer before being flooded after heavy rainfall and then stay wet for several years. This allows wetland plants and animals to regenerate and reproduce.

Executive summary

This Aquatic Biodiversity Technical Report has been prepared to address the Secretary's Environmental Assessment Requirements (SEARs) pertaining to Aquatic Biodiversity, in particular SEARs 5. Biodiversity – 5.6, 5.7, SEARs 6 Protected and Sensitive Lands 6.1, 6.1 (b), SEARs 9 Water – Hydrology – 9.1, 10.1 (h).

ARTC propose to construct the North Start to Border (NS2B) section of Inland Rail ('the proposal'), which is a key component of the wider 1,700 kilometre (km) long Inland Rail network between Melbourne and Brisbane. The proposal will consist of 25 km of new track to be constructed within an existing non-operational rail corridor at Boggabilla and 5 km within a greenfield rail corridor. Key features will include one crossing loop, one maintenance siding and three associated turn outs. The construction of 39 culvert locations, 11 bridge crossings, 63 rail crossing locations and ancillary works. The proposal is located within the NSW Border Rivers Catchment orientated approximately north to south. The proposal is anticipated to cross the perennial Macintyre River as well as four ephemeral creeks at the northern end of the alignment, near the NSW border. The proposal was established considering key environmental features, engineering constraints social and environmental impact whilst meeting engineering design criteria.

The proposal is located within the Border Rivers Catchment with rivers and tributaries including the Macintyre River, Whalan Creek, Mobbindry Creek, Back Creek, Forest Creek and an unnamed tributary of Mobbindry Creek. Rivers of the catchment are located at the Great Dividing Range running west eventually merging to become the Barwon River which is orientated approximately 150 km south of the proposal. Rivers within the catchment, particularly the Macintyre River, provide highly sensitive fish habitats and may support threatened species such as the Murray Cod (*Maccullochella peelii*), listed under the EPBC Act, as well as other threatened species, populations and ecological communities under the FM Act. The Macintyre River is a major hydrological input of the Darling River Endangered Ecological Community.

The proposal has the potential to impact aquatic biodiversity during the construction and operation phases of the project. The following impacts have been determined to potentially impact aquatic fauna and associated habitat:

- Mortality as a result of construction activities
- Restriction to the movement of aquatic fauna resulting from physical barriers, changes to flow velocity, chemical barrier from pollution plumes from point sources such as hydrocarbon spills, noise and vibration, or behavioural barriers such as dark tunnels created by artificial infrastructure
- Fragmentation of aquatic habitat as a result of the installation of rail infrastructure
- Introduction of non-native aquatic pest species (flora and fauna) and pathogens

Loss of habitat within the proposal site has the potential to influence aquatic fauna population parameters, ecological function and ultimately result in population declines. These factors may result from the following:

- Vegetation clearing and drainage modification impacting invertebrate diversity
- A reduction in plant-animal interaction and symbiosis
- Alteration or reduction of microhabitat including specialised breeding habitat
- Erosion and sedimentation resulting in increased turbidity smothering benthic fauna and submerged aquatic plants
- Eutrophication resulting from decaying aquatic plants and algal blooms due to loss of oxygen

A mitigation hierarchy of avoid, minimise and mitigate was applied to the proposal which generally reduced the residual impacts to aquatic receptors. The detailed design, pre-construction/construction and operation phases of the proposal accounted for the following aspects when considering mitigation strategies:

- Aquatic biodiversity
- Aquatic fauna
- Riparian vegetation and aquatic habitats

- Water quality
- Weeds and pests
- Offsets

The assessment of aquatic receptors was undertaken using a significance-based impact assessment framework. The resulting impact assessment (aligning with commonwealth and state guidelines) included :

- Predictive habitat modelling were used to identify receptor habitat use and the Adverse Impact Assessment Methodology (AIAM) was used to determine the likelihood of significant residual impact upon EPBC Act listed species (and associated habitats)
- Aquatic Species Assessment – (Part 7A FM Act) to identify significant impact arising from key threating process (as identified within FM Act) to inform of state-based impacts and offset obligations.

The sensitivity or vulnerability of the ecological receptor and impact magnitude facilitated the assessment of the potential ecological impacts.

A total of 12 projects were identified within the cumulative impact study area with seven identified as contributing to a cumulative impact to aquatic receptors. The potential cumulative impacts of the proposal in the context of other proposals which are either underway or going through the EIS process include:

- Habitat loss and degradation from vegetation clearing/removal (leading to indirect impact from loss of potential stream complexity and water quality impacts)
- Fauna species injury or mortality (through indirect impact on water quality)
- Displacement of flora and fauna species from invasion of weed and pest species (from indirect impacts associated with incidental pest fauna species transport during works and operations)
- Habitat fragmentation (from potential direct impacts due to construction and operation)
- Noise, dust, and light (as an indirect impact from construction and operation)
- Increase in litter (as a direct impact from construction and operation).

Significant cumulative impacts as a result of the proposal and other similar projects are predicted to impact the following ecological receptors:

- Murray cod (EPBC and FM Act).

During Phase 2 of the proposal (detailed design, post-EIS), sensitive ecological features identified during the EIS will be subject to further investigation, in order to more accurately determine the magnitude of the significant adverse impacts upon the identified ecological receptors. The specific mitigation measures will then be applied to ensure that the significance ratings of any potential impacts are classified as low as reasonably practicable and the more significant adverse impacts are offset.

The current requirements for aquatic ecological receptors are considered 1.15 ha of like-for-like offsets for EPBC Act offsets and 14.60 ha of Type 1 and Type 3 fish habitat under the FM Act.

1 Introduction

1.1 Purpose

The purpose of this report is to assess potential biodiversity impacts from the construction and operation of the proposal, and where required, identify feasible and reasonable mitigation measures,

This technical report has been prepared to address the Secretary's Environmental Assessment Requirements (SEARs) (SSI-9371, 13 March 2020) that are associated with aquatic biodiversity. The structure and content of the report assesses matters of national environmental significance (MNES) in accordance with the EPBC Act, FM Act and relevant guidelines. The report will also address offset requirements and inform the feasibility of the proposal accordingly.

1.2 Secretary's Environmental Assessment Requirements

The SEARs set out for the proposal identified key requirements in relation to biodiversity. Table 1.1 identifies the requirements and where within the technical report the requirements have been addressed.

Table 1.1 Response to the North Star to Border SEARs

Desired performance outcome	SEARs reference	Requirement	Current Guidelines	Where addressed in the EIS
Biodiversity The project design considers all feasible measures to avoid and minimise impacts on terrestrial and aquatic biodiversity. Offsets and/or supplementary measures are assured which are equivalent to any remaining impacts of project construction and operation.	5.6	The Proponent must assess any impacts on biodiversity values not covered by the Biodiversity Assessment Method. This includes a threatened aquatic species assessment (Part 7A *Fisheries Management Act 1994*) to address whether there are likely to be any significant impact on listed threatened species, populations or ecological communities listed under the *Fisheries Management Act 1994.*	Biodiversity Assessment Method (OEH, 2017) Policy and Guidelines for Fish Habitat Conservation and Management – Update 2013 (DPI, 2013) Threatened Species Survey and Assessment Guidelines Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings (NSW Fisheries, 2003) NSW Sustainable Design Guidelines Version 4.0 (TfNSW, 2017) Aquatic Ecology in Environmental Impact Assessment – EIA Guideline (Marcus Lincoln Smith, 2003) Freshwater threatened species distribution maps	Section 6 and 7 (Appendix F)
	5.7	The Proponent must identify whether the project as a whole, or any component of the project, would be classified as a Key Threatening Process in accordance with the listings in the *Biodiversity Conservation Act 2016, Fisheries Management Act 1994* and EPBC Act.		Section 7 (Appendix F)

Desired performance outcome	SEARs reference	Requirement	Current Guidelines	Where addressed in the EIS
Protected and Sensitive Lands The project is designed, constructed and operated to avoid or minimise impacts on protected and sensitive lands. The project is designed, constructed and operated to avoid or minimise future exposure to coastal hazards and processes.	6.1	The Proponent must assess the impacts of the project on environmentally sensitive land and processes (and the impact of processes on the project) including, but not limited to:	Guidelines for developments adjoining land and water managed by the Department of Environment, Climate Change and Water (2010) Revocation, Re-categorisation and Road Adjustment Policy (OEH, 2012) Guidelines for controlled actives on waterfront land (DPI, 2012) Policy and Guidelines for Fish Habitat Conservation and Management – Update 2013 (DPI, 2013) Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings (NSW Fisheries, 2003)	-
	6.1 (a)	Protected areas (including land and water) managed by the Office for Environment and Heritage and/or Department of Primary Industries Fisheries under the *National Parks and Wildlife Act 1974* and the *Marine Estate Management Act 2014.*		Section 4.1.4 and 4.1.5.1
	6.1 (b)	Key Fish Habitat as mapped and defined in accordance with the *Fisheries Management Act 1994.*		Section 4.1.5
Water – Hydrology Long term impacts on surface water and groundwater hydrology (including drawdown, flow rates and volumes) are minimised. The environmental values of nearby, connected and affected water sources, groundwater and dependent ecological systems including estuarine and marine water (if applicable) are maintained (where values are achieved) or improved and maintained (where values are not achieved). Sustainable use of water resources.	9.1	The Proponent must describe (and map) the existing hydrological regime for any surface and groundwater resource (including reliance by users and for ecological purposes) likely to be impacted by the project, including stream orders, as per the Biodiversity Assessment Method.	Biodiversity Assessment Method (OEH, 2017) Managing Urban Stormwater: Soils and Construction Volume 1 (Landcom, 2004) and Volume 2 (A. Installation of Services; B. Waste Landfills; C. Unsealed Roads; D. Main Roads; E. Mines and Quarries) (DECC, 2008) NSW Aquifer Interference Policy (DPI, 2012) NSW Sustainable Design Guidelines Version 4.0 (TfNSW) Risk assessment Guidelines for Groundwater Dependent Ecosystems (Office of Water, 2012)	Section 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.1.5, 4.1.6 and 4.1.7.

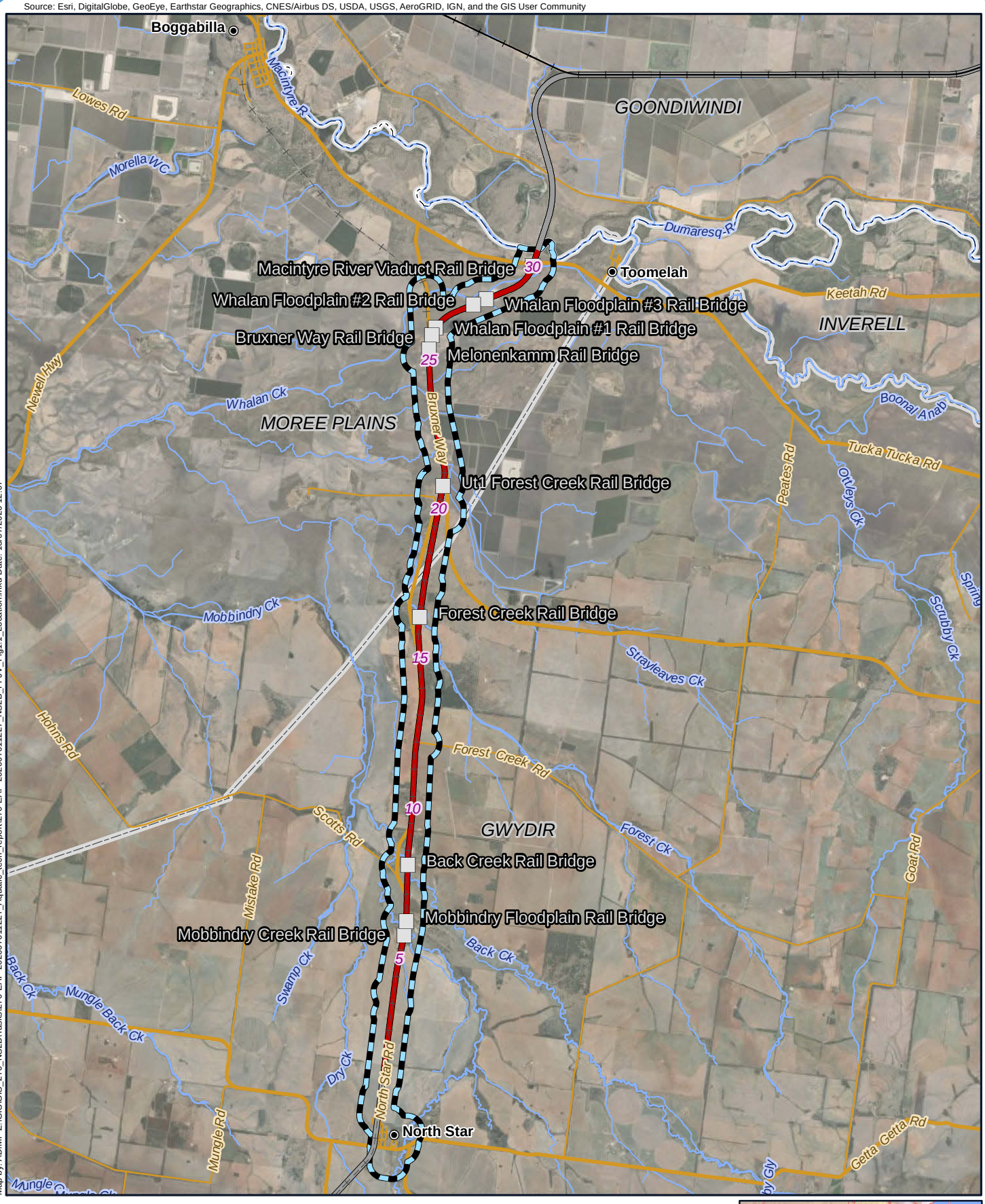
Desired performance outcome	SEARs reference	Requirement	Current Guidelines	Where addressed in the EIS
Water – Quality The project is designed, constructed and operated to protect the NSW Water Quality Objectives where they are currently being achieved, and contribute towards achievement of the Water Quality Objectives over time where they are currently not being achieved, including downstream of the project to the extent of the project impact including estuarine and marine waters (if applicable).	10.1 (h)	The Proponent must: Identify sensitive receiving environments (which may include estuarine and marine waters downstream) and develop a strategy to avoid or minimise impacts on these environments.	NSW Water Quality and River Flow Objectives Using the ANZECC Guidelines and Water Quality Objectives in NSW (DEC, 2006) Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC/ ARMCANZ, 2000) Approved Methods for the Sampling and Analysis of Water Pollutants in NSW (DECC, 2008) Managing Urban Stormwater: Soils and Construction Volume 1 (Landcom, 2004) and Volume 2 (A. Installation of Services; B. Wte Landfills; C. Unsealed Roads; D. Main Roads; E. Mines and Quarries) (DECC, 2008)	Section 4, 6 and 6.3.2

1.3 Overview of surface water environment

The proposal site falls within the Border Rivers catchment management area of NSW. This catchment is one of the northern most catchments within the Murray-Darling Basin and is made up of a group of rivers straddling the NSW/QLD border. The rivers of the catchment start at the Great Dividing Range and run westward, gradually merging to become the Barwon River approximately 150 km downstream of the proposal. The proposal study area was based on a 0.5 km buffer extending horizontally from both sides of the proposed alignment, as such, increasing the extent where multiple design options exist to account for an increased investigation area. The proposal study area was established to delineate the spatial extent of potential intersection of watercourses with temporary and permanent impact footprints of the proposal.

A number of watercourses and waterbodies occur within the proposal site (refer Figure 1.1). This includes the following watercourses which are classified for fish passage through the Policy-and-guidelines-for-fish-habitat NSW (2013):

- The Macintyre River which is a perennial waterway within the proposal site with a well vegetated riparian flood plain on either side of the river, it has high ecological value as a Class 1 Major Fish habitat and is can support threatened species such as the Murray cod (*Maccullochella peelii*), Silver Perch (*Bidyanus bidyanus*) and Purple-spotted gudgeon (*Mogurnda adspersa*).
- Whalan Creek which is an ephemeral waterway, larger than other creeks in the area and with a well-defined channel that is likely to flow seasonally, it is mapped as Class 2 Moderate Fish habitat and is known to support native fish populations when hydrological flow is present (as overflow from Macintyre River)
- Mobbindry Creek and Back Creek which are ephemeral waterways with well-defined channels with fringing rushes and sedges present, both waterways are mapped as Class 4 Unlikely fish habitat
- Forest Creek which is an ephemeral, highly modified waterway with a poorly defined channel and limited or poor riparian vegetation, it is classified as Class 4 Unlikely fish habitat
- An unnamed tributary of Mobbindry Creek, which is ephemeral, it is classified as Class 4 Unlikely fish habitat.


Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Boggabilla
Macintyre R
Lowes Rd
Morella WC
GOONDIWINDI
Dumaresq R
Toomelah
Macintyre River Viaduct Rail Bridge
30
Whalan Floodplain #2 Rail Bridge
Whalan Floodplain #3 Rail Bridge
Keetah Rd
INVERELL
Bruxner Way Rail Bridge
Whalan Floodplain #1 Rail Bridge
Melonenkamm Rail Bridge
25
Newell Hwy
Whalan Ck
MOREE PLAINS
Bruxner Way
Boonal Anab
Tucka Tucka Rd
Ut1 Forest Creek Rail Bridge
Peates Rd
Ottleys Ck
20
Mobbindry Ck
Forest Creek Rail Bridge
Scrubby Ck
15
Strayleaves Ck
Hohns Rd
Forest Creek Rd
10
Scotts Rd
GWYDIR
Forest Ck
Back Creek Rail Bridge
Goat Rd
Mistake Rd
Mobbindry Floodplain Rail Bridge
Mobbindry Creek Rail Bridge
5
Back Ck
Swamp Ck
Back Ck
Mungle Back Ck
Dry Ck
North Star Rd
Mungle Rd
North Star
Getta Getta Rd
Mungle
Map by: AD/MF Z:\GIS\GIS_270_NS2B\Tasks\270-EAP-20200701227_Aquatic_tech_report\270-EAP-20200701227_NS2B_FFJV_Fig1.1_Location.mxd Date: 13/07/2020 12:07
Legend
Bridges
Chainage (km)
Localities
Existing rail (operational)
Existing rail (non-operational)
North Star to NSW/QLD border alignment
Adjoining alignments
Major roads
Minor roads
NSW/QLD border
Watercourses
Local Government Areas
Study area
Toowoomba
Brisbane
Ipswich
Grandchester
Warwick
Goondiwindi
Narrabri
A4 scale: 1:170,000
0 1 2 3 4 5km
Future Freight
Integrating Community, Environment and Engineering
Date: 03/07/2020 Version: 0
Coordinate System: GDA 1994 MGA Zone 56
North Star to NSW/QLD border
Figure 1.1:
Proposal location and context

There is one Endangered Ecological community (EEC) listed under the *Fisheries Management Act 1994* (NSW), the 'Aquatic Ecological Community in the Natural Drainage System of the Lowland Catchment of the Darling River' (here within referred to as the Daring River EEC).

1.4 Key features of the proposal

1.4.1 Permanent footprint

The proposal is in accordance with the following parameters:

- Generally, aligns with the existing non-operational Boggabilla rail corridor between North Star (Chainage (Ch) 0.9 km) and the greenfield deviation (Ch 25.7 km)
- A strip of land at least 10 m wide has been allowed on either side of the earthworks footprint to accommodate track-side infrastructure such as fencing, drainage, etc.
  - Encompasses the ultimate footprint of:
    - New track and associated earthworks
    - Bridge and drainage structures, including scour protection around culverts
    - Level crossings
    - Road realignments
    - Possible upgrades to adjacent roads and infrastructure
    - Rail maintenance access road, including access points, passing bays and turnarounds
    - Fencing and signage.

The width of the permanent footprint varies along the proposed alignment depending on the shape and size of the features listed above. A minimum width of 40 m has been adopted for the permanent footprint; however, the width of the permanent footprint increases to approximately 200 m in the vicinity of the Bruxner Highway realignment to allow for realignment.

1.4.2 Temporary footprint

Areas of temporary disturbance are proposed including:

- Laydown areas
- Access tracks
- Workers camp at North Star
- Borrow pits (not included in the proposal disturbance footprint for aquatic biodiversity impact assessment).

These areas are considered temporary because they are only required during the construction phase of the proposal and are needed for construction purposes.

1.4.3 New track

Track within the existing non-operational Boggabilla rail corridor is considered unsuitable for reuse due to its' alignment. Therefore, the proposal consists of:

- Approximately 25 km of new, single line, standard gauge track within the existing non-operational Boggabilla rail corridor, between North Star (Ch 0.9 km) and the greenfield deviation (Ch 25.7 km)
- Approximately 5 km of new, single line, standard gauge track within a greenfield rail corridor, between the greenfield deviation (Ch 25.7 km) and the NSW/QLD border (Ch 30.6 km).

1.4.4 Bridges

Bridges are required so that water, vehicles, and in some cases, stock and pedestrians may cross the proposed rail corridor. Two types of bridges are proposed:

- Rail over water
- Rail over road.

The type of bridge proposed depends on a range of factors, including the local topography, road usership, rail and road alignments at the crossing point, and access requirements. Bridges have been provided at all major watercourse crossings along the proposed alignment to minimise impacts to the local riverine system, and to avoid having to divert watercourses.

A total of 11 new bridges are proposed. An approximately length for each bridge is included in Table 1.2.

Table 1.2 Proposed bridges

Chainage of the southern-most end of the bridge (km)	Bridge	Approximate bridge length
Ch 5.7	Mobbindry Creek Rail Bridge	112 m
Ch 6.1	Mobbindry Floodplain Rail Bridge	182 m
Ch 8.1	Back Creek Rail Bridge	70 m
Ch 16.3	Forest Creek Rail Bridge	154 m
Ch 20.7	UT1 Forest Creek Rail Bridge	136 m
Ch 25.2	Melonenkamm Rail Bridge	160 m
Ch 25.7	Bruxner Highway Rail Bridge	114 m
Ch 26.0	Whalan Floodplain #1 Rail	183 m
Ch 27.5	Whalan Floodplain #2 Rail	126 m
Ch 28.0	Whalan Floodplain #3 Rail	126 m
Ch 29.3	Macintyre River Viaduct	1,750 m

1.4.5 Macintyre River viaduct

The includes an approximately 1.8 km long viaduct that crosses Whalan Creek, Tucka Tucka Road and the Macintyre River. Approximately 1.2 km of the viaduct is located in NSW, while the remaining 0.6 km is located in Queensland, where the NSW/QLD border is defined by the centre point of the Macintyre River.

During the feasibility design phase, the design of the Macintyre River viaduct was informed by geotechnical and flooding studies. Initially, three separate bridge structures were proposed over Whalan Creek, Tucka Tucka Road, and the Macintyre River. However, an iterative flood assessment of the design has resulted in a single viaduct structure that minimises upstream flooding impacts.

1.4.6 Culverts

Culverts are structures that allow water, whether in a watercourse or drainage line, to pass under the proposed alignment. During the feasibility design phase, proposed designs and locations for culverts were developed based on:

- Addressing hydrologic, hydraulic and geotechnical constraints associated with the proposal
- Minimising potential flooding impacts by:
  - Locating culverts at low points along the proposed alignment in order to prevent upstream water ponding
  - Ensuring that the inside base of culverts is level with the natural surface

- Designing culverts to withstand a 100-year flood event (i.e. 1% annual exceedance probability (AEP))
- Maintaining existing patterns of flow across the floodplain so as not to divert or concentrate flows.

Culverts associated with the proposal will be a mix of reinforced concrete pipe culverts and reinforced concrete box culverts. Scour protection measures will be installed as required around culverts, on disturbed stream banks, and around waterfront land (defined as the bed of any river, lake or estuary and the land within 40 m of the river banks, lake shore or estuary mean high water mark, *Water Management Act 2000*) to prevent erosion.

A total of 48 culvert locations were identified during the feasibility design phase. The number of culverts and their locations will be further refined during the detailed design phase in order to minimise potential impacts, especially flooding impacts.

1.4.7 Road realignments

The proposal involves a minor realignment of Bruxner Highway. Bruxner Highway is a main road pursuant to the *Roads Act 1993*. It is a two lane, two-way road with a posted speed limit of 100 km/hr.

In order to achieve flood immunity, the elevation of the proposal must be significantly higher than Bruxner Highway at the point where the proposal intersects Bruxner Highway. Therefore, a rail over road grade separation with a minimum vertical clearance of 5.4 m is proposed at the point of intersection.

At the point where the proposal intersects the existing Bruxner Highway, the skew angle is approximately 75 degrees. Maintaining this skew angle would involve constructing a bridge with excessively long, non-standard spans.

A more practical skew angle is 45 degrees. To achieve a 45-degree skew angle, it is proposed to realign Bruxner Highway to the east, and then back to the existing Bruxner Highway on a slight curve.

As part of the reconfiguration, the elevation of Bruxner Highway will be maintained or slightly increased. This will maintain or improve flood immunity at this location.

2 Legislative, policy standards and guidelines

2.1 Commonwealth and State legislation

This section describes the legislative, policy and management framework for the proposal, including:

- Legislative framework which applies to the assessment of aquatic ecology applicable to the proposal at the Commonwealth, State and local levels, and provides the statutory context for which the aquatic ecological assessment has been undertaken.
- Discusses statutory approvals and/or offsets that may be required as a result of potential impacts to aquatic ecology, based on consideration of the overall approvals pathway
- Discusses ARTC's existing management plans and protocols, and their relevance to the proposal.
- Identifies Commonwealth and State legislation/policies that are relevant to the proposal and this report, outlining their applicability to the proposal (refer Table 2.1).

Table 2.1 Legislation, policies, standards and guidelines relevant to the proposal

Legislation, policy or guideline	Relevance to the proposal
Commonwealth legislation	
Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act)	The EPBC Act is the Australian Government's central piece of environmental legislation. It provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places — defined in the Act as matters of national environmental significance. There are nine MNES to which the EPBC Act applies, these are: ■ World heritage properties ■ National heritage places ■ Wetlands of international importance ■ Listed threatened species and ecological communities ■ Migratory species ■ Commonwealth marine areas ■ Great Barrier Reef Marine Park ■ Nuclear actions ■ A water resource, in relation to coal seam gas. The proposal was considered a *controlled action* (2018/8222) and must therefore assess the significance of any potential impacts on MNES threatened species and communities.
EPBC Act Environmental Offsets Policy (2012)	Where the proposal is determined to have a significant 'residual impact' on a MNES offsets will need to be determined and approved by the Department of Environment and Energy (DoEE). Offsets are required under the EPBC Act to compensate for any residual impacts to MNES once avoidance and mitigation measures have been considered (DSEWPaC 2012). An offset must deliver an overall conservation outcome that improves or maintains the viability of the MNES and should be tailored specifically to the attribute of the MNES that is to be affected. An offsets package is defined in the EPBC Offsets Policy (DSEWPaC 2012) as a suite of actions that a proponent undertakes in order to compensate for the residual significant impact of a project. An offsets package can comprise of a combination of direct offset and other compensatory measures. Direct offsets are actions that deliver a measurable conservation gain for an impacted protected matter. Conservation gains may be achieved by: ■ Improving existing habitat for the protected matter; ■ Creating new habitat for the protected matter; ■ Reducing threats to the protected matter; ■ Increasing values of a heritage place; and/or ■ Averting the loss of a protected matter or its habitat that are under threat. Where the proposal is determined to have a significant 'residual impact' on a MNES offsets will need to be determined and approved by the Department of Environment and Energy (DoEE).

Legislation, policy or guideline	Relevance to the proposal
Water Act amendment 2007	The *Water Act 2007* (Cth) provides the legislative framework for ensuring that Murray Darling Basin (Australia's largest water resource) is managed in accordance with Australia's national interests. Watercourses of the impact assessment area are located within the Murray Darling Basin and are subject to the Murray Darling Basin Plan – a strategic plan for the integrated and sustainable management of water resources in the Murray Darling Basin. The Queensland Government has prepared Healthy Waters Management Plans to meet accreditation requirements under the Commonwealth *Water Act 2007* – Basin Plan 2012 (Commonwealth of Australia 2012). The Act recognises that Australian states in which the Murray Darling Basin is located continue to manage water resources within their jurisdictions. The Act: ■ Establishes the Murray Darling Basin Authority with the functions and powers, including enforcement powers, needed to ensure that Basin water resources are managed in an integrated and sustainable way ■ Establishes a Commonwealth Environmental Water Holder to manage the Commonwealth's environmental water to protect and restore the environmental assets of the Murray Darling Basin, and outside the Basin where the Commonwealth owns water ■ Provides the Australian Competition and Consumer Commission with a key role in developing and enforcing water charge and water market rules along the lines agreed in the National Water Initiative ■ Gives the Bureau of Meteorology (BoM) water information functions that are in addition to its existing functions under the *Meteorology Act 1955* ■ Gives the Productivity Commission a role in reporting on the effectiveness of the implementation of the Murray-Darling Basin Plan and water resource plans and the progress towards achieving the objectives and outcomes of the National Water Initiative.
State legislation, policies and guidelines (NSW)	
Fisheries Management Act 1994 (FM Act)	The FM Act provides for the conservation, protection and management of fisheries, aquatic systems and habitats in NSW. The FM Act applies in relation to all waters that are within the limits of the State, and regulates certain activities that have the potential to impact on aquatic habitats and identifies key threatening processes. The objects of the FM Act are: ■ To conserve fish stocks and key fish habitats ■ To conserve threatened species, populations and ecological communities of fish and marine vegetation ■ To promote ecologically sustainable development, including the conservation of biological diversity. Under the FM Act, development proponents are required to provide regulator notification of proposed works. Permits issued under the Act are required for: ■ Works that would block the passage of fish in a bay, inlet, river or creek ■ Dredging or reclamation works ■ The construction of structures within aquatic habitats (e.g. bridges, roads, causeways, pipelines) ■ Works that would cause harm to marine vegetation.

Legislation, policy or guideline	Relevance to the proposal
Noxious Weeds Act 1993	The objects of this Act are as follows: ■ To reduce the negative impact of weeds on the economy, community and environment of this State by establishing control mechanisms to: i) prevent the establishment in this State of significant new weeds, and ii) prevent, eliminate or restrict the spread in this State of particular significant weeds, and iii) effectively manage widespread significant weeds in this State, ■ To provide for the monitoring of and reporting on the effectiveness of the management of weeds in this State. ■ The Act will be relevant during the construction and operation of the proposal.
Policy and Guidelines for Fish Habitat Conservation and Management	These guidelines aim to maintain and enhance fish habitat for the benefit of native fish species, including threatened species, in marine, estuarine and freshwater environments. It is intended to assist developers, consultants, government and non-government organisations to comply with legislation, policies and guidelines related to fish habitat conservation and management. The guidelines provide: ■ Definitions of key fish habitat that legislative controls apply to ■ Information on policy and legislation for planning and development assessment processes ■ Tailored assessment processes for different development activities ■ Guidance for proponents of developments or other activities affecting fish habitats ■ The guidelines identify that the following activities applicable to this project may require a permit under Part 4 of the EP&A Act: ■ Bridges, culverts, causeways (both piped or unpiped) or other road-crossings of waterways (temporary or permanent) which require placing material on the bed of the waterway (i.e. Reclamation) and/or which may obstruct the free passage of fish ■ Channelisation, relocation or realignment of waterways, ■ Installation of pipelines across a waterway (involving dredging or reclamation), ■ Installation of stormwater outlets (involving reclamation of the bed or bank of a waterway), ■ Stream bed or bank stabilisation works (involving dredging or reclamation to halt erosion). It is noted that the Infrastructure SEPP does not 'switch off' the requirement for these approvals or permits for works affecting key fish habitat.
Water Management Act 2000 (NSW)	Establishes a statutory framework for the sustainable and integrated management of water in NSW. This Act applies to the proposal as the protection, enhancement and restoration of water resources is recognised as a key objective of the Act and this needs to be considered in the design process. The key objectives are as follows: ■ To apply the principles of ecologically sustainable development ■ To protect, enhance and restore water sources, their associated ecosystems, ecological processes and biological diversity and their water quality ■ To recognise and foster the significant social and economic benefits to the State that result from the sustainable and efficient use of water, including – Benefits to the environment – Benefits to urban communities, agriculture, fisheries, industry and recreation – Benefits to culture and heritage – Benefits to the Aboriginal people in relation to their spiritual, social, customary and economic use of land and water ■ To recognise the role of the community, as a partner with government, in resolving issues relating to the management of water sources

Legislation, policy or guideline	Relevance to the proposal
	■ To provide for the orderly, efficient and equitable sharing of water from water sources ■ To integrate the management of water sources with the management of other aspects of the environment, including the land, its soil, its native vegetation and its native fauna ■ To encourage the sharing of responsibility for the sustainable and efficient use of water between the Government and water users To encourage best practice in the management and use of water. This Act applies to the proposal as the protection, enhancement and restoration of water resources is recognised as a key objective of the Act and this needs to be considered in the design process and implemented during the proposal.
Why do fish need to cross the road? Fish passage requirements for waterway crossings (Fairfull and Witheridge 2003)	This document has been developed to assist those involved in the planning, design, construction and maintenance of waterway crossings by providing practical guidelines to minimise impacts on fish passage and general aquatic wildlife. The guidelines include information on how crossings impact on fish passage, planning crossings, assessing crossing sites, design considerations, construction considerations, monitoring and maintenance considerations.

3 Methods

3.1 Introduction

The assessment of biodiversity components for the proposal was undertaken using a multiple stage assessment process that was driven by legislative requirements. Different assessment pathways were applied to receptors with different assessment requirements according to the relevant legislation. Receptors listed under the EPBC and FM Acts, assessments were undertaken in accordance with a significant impact assessment and cumulative impact assessment.

Table 3.1 summarises the ecological receptors relevant to each assessment methodology. The sections below describe the significant impact methodologies and cumulative impact assessment (CIA) methodology in more detail. An aquatic species impact assessment was also completed for each FM Act receptor to ensure compliance and consistency with the Act (refer Appendix F).

Table 3.1 Assessment methodologies with corresponding legislation and relevant ecological receptors

Assessment methodology	Legislation associated with environmental receptor	Environmental receptor
Significant impact assessment using magnitude and sensitivity (refer Section 3.4)	*Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act)	Threatened aquatic fauna
	Fisheries Management 1994 (FM Act)	Threatened aquatic species
		Threatened populations
		Threatened ecological community
Cumulative impact assessment (refer Section 3.7)	All relevant to environmental receptors	All environmental receptors

3.2 Study area

The study area for the purposes of this aquatic biodiversity technical report includes the catchments through which the proposal is to be developed. The proposal study area was based on a 0.5 km buffer extending horizontally from both sides of the proposed alignment, as such, increasing the extent where multiple design options exist to account for an increased investigation area.

The waterways are within the Border Rivers catchment. Specific focus is given to watercourses that cross the proposed alignment, which includes the Macintyre River, Whalan Creek, Mobbindry Creek, Back Creek, Forest Creek, and an unnamed tributary of Mobbindry Creek (refer Figure 1.1).

Small waterbodies exist at many of the proposed borrow pits sites, however these are considered to be artificial impoundments resulting from extractive industries and were not subject to further assessment. It is considered that under the FM Act these waterbodies are excluded on the basis that they fit the definition as Intermittent lagoons or wetlands filled from localised runoff and not otherwise hydrologically connected to other permanent habitats such as rivers, creeks, estuaries and ocean.

3.3 Predictive habitat modelling for conservation significant fauna species

3.3.1 Introduction

Predictive habitat modelling was undertaken to identify and map areas that were identified as having the potential to provide habitat for conservation significant species in accordance with the EIS SEAR.

A number of environmental GIS base layers were incorporated into the predictive habitat model where applicable for each species. The model was designed to recognise specific requirements of each conservation significant species listed under the EPBC Act, which were identified through the broader desktop analysis.

Databases (including data from recovery plans where available) and other information that were used to feed into the predictive GIS based model are identified in Section 3.9, Appendix A. In addition to database information, data collected during field-based assessments (refer Section 3.10) was used to verify and "fine-tune" model outputs (refer Appendix D).

The predictive habitat models allowed partitioning of habitat using current scientific knowledge and pre-existing data derived from historic surveys, State based mapping and scientific publications and advice from industry recognised experts. The specific habitat assumptions for each species are provided in Appendix A.

The predictive habitat modelling provides greater certainty in predicting the likelihood of a conservation significant species (EPBC Act) occurring with the proposal area, and is one of the inputs into the AIAM which was used to quantify significant residual impacts associated with the Proposal, in accordance with the EPBC Act.

As part of the predictive habitat modelling, species-specific assumptions allowed the following areas to be identified for each conservation significant species where applicable:

- Core habitat
- Essential habitat
- General habitat
- Unlikely habitat.

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

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 and regulations (such as Species Recovery Plans or Approved Conservation Advice for EPBC Act species (refer Appendix A). Where essential habitat intersects with any identified areas, these areas have been elevated to the core habitat category. Species specific assumptions associated with the mapping of core habitat areas are detailed in Appendix A.

Essential habitat

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, 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. site based evidence). Essential habitat has been defined from known records (regardless of currency), generally with a 1 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. Species specific assumptions associated with the mapping of essential habitat, and instances that deviate from the above criteria are detailed in Appendix A.

General habitat

General habitat consisted 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 species. As potential habitat for many aquatic species are limited to watercourses (as species are typically obligate aquatic species), the general habitat category restricts the habitat to a more limited and realistic set of environmental parameters which are supported by literature and field-based observation. Species specific assumptions that define the general habitat category are identified in Appendix A.

Unlikely habitat

Unlikely habitat consisted of areas that do not contain specimen backed records of the particular species (i.e. no point data derived from the positive identification/confirmation of a species in the field) and contain no evidence of habitat values to support the presence or existence of resident individuals or populations of the species.

3.4 Impact assessment methodology

An overview of the stages involved in the assessment methodology and modelling employed by the impact assessment approach is provided graphically in Figure 3.1. A brief description of the modelling used as part of the identification of aquatic ecological constraints is provided below. Further information regarding the development of these models is provided in Appendices A and B.

A significant impact depends upon the sensitivity of an ecological value, the quality of the environment, which is impacted, and upon the intensity, duration, magnitude and potential spatial extent of the potential impacts. Determination of the sensitivity or vulnerability of the ecological value and the magnitude of the potential impacts facilitate the assessment of the significance of potential ecological impacts.

The impact assessment utilised two differing bases of assessment; one for MNES and one for MSES.

For the purposes of the MNES impact assessment, modelling was used to identify, map and provide a direct input into the assessment of potential impact significance to ecological values (threatened species, populations and communities identified as receptors). Modelling utilised existing datasets applicable to ecological values and also utilised field derived data (refer Section 3.3) to increase its robustness and accuracy. Two distinct stages in the modelling process were undertaken as follows:

- Predictive habitat modelling methodology (refer Section 3.3). This modelling was used to identify constraints through predictive modelling which incorporated site derived datasets where available.
- AIAM (refer Section 3.5). This methodology was used following the initial assessment of proposal impacts, to identify areas where the proposal is considered likely to have a significant residual adverse impact upon EPBC Act listed species (and associated habitat). The AIAM has been designed to provide for a transparent, consistent, repeatable and defendable approach to assessing significant residual adverse impacts. Information inputs are sourced from published, peer-reviewed scientific literature, field validated data and expert opinion.

For the purposes of the state based significant impact assessment, the initial impact assessment was used to identify potential significance of impact before and after impact. After this was conducted, an aquatic receptor assessment was conducted using the significant impact assessment (as defined with the FM Act). This enabled an assessment of potential offset obligation associated with impacts areas (associated with the proposal) and whether the resulting impact area was considered to have a significant impact on the state conservation Signiant species.

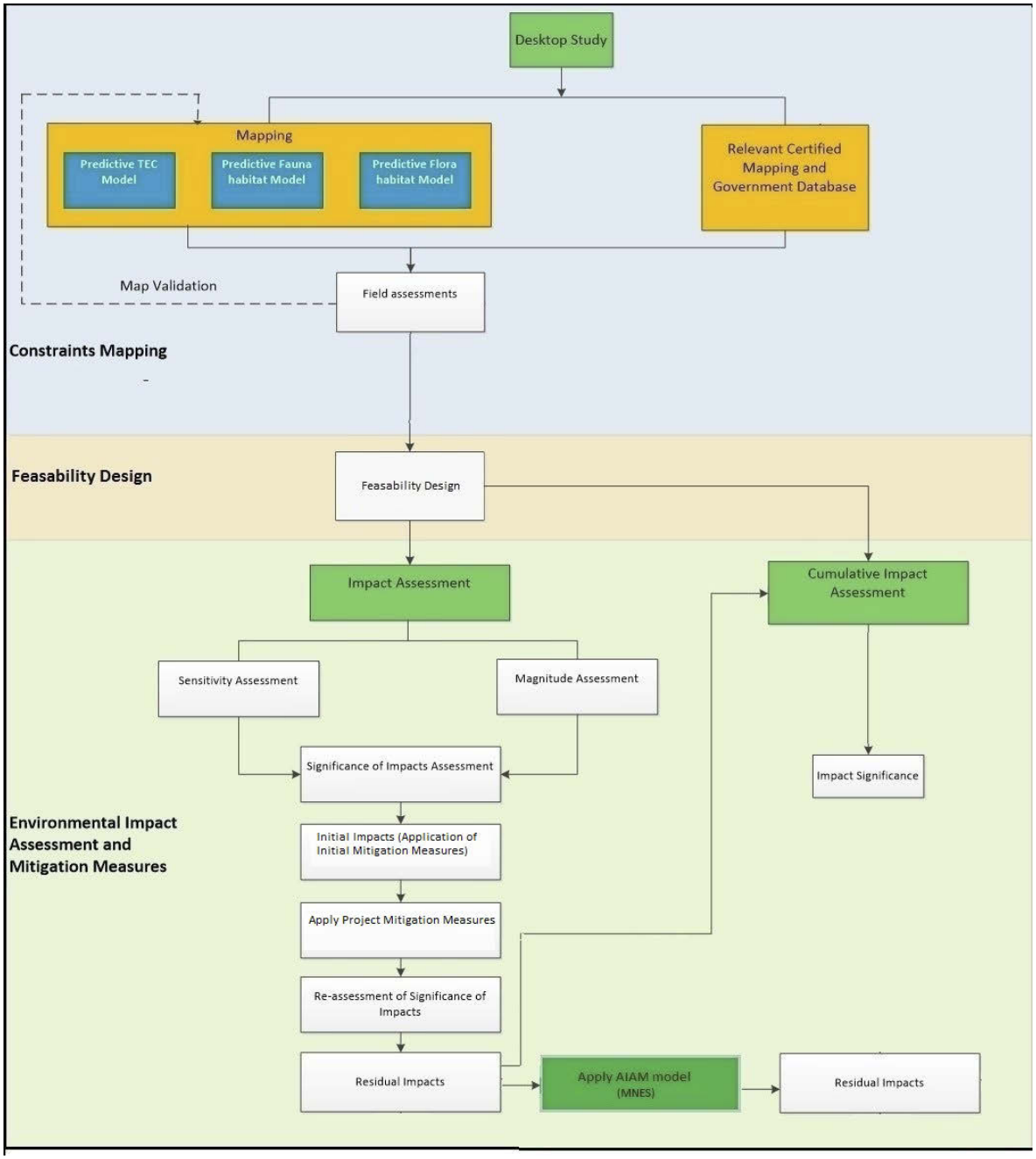


Figure 3.1 **Signifcant impact assessment approach**

3.4.1 Magnitude of impacts

The magnitude of a potential impact is essential to the determination of its level of significance on receptors. For the purposes of this assessment, impact magnitude is defined as being comprised of the nature and extent of the potential impacts, including direct and indirect impacts. The impact magnitude is divided into five categories (refer Table 3.2). The magnitude of impacts is determined using techniques and tools that facilitate an estimation of the extent, duration (refer Table 3.3) and frequency of the impacts.

Table 3.2 Criteria for magnitude

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

Table 3.3 Timeframes for duration terms

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

Table notes:

1 Derived from the term ‘moderate’ EAM Risk Management Framework 2009 (GBRMPA 2009)
2 Derived from the term ‘major’ EAM Risk Management Framework 2009 (GBRMPA 2009)
3 Derived from the term ‘catastrophic’ EAM Risk Management Framework 2009 (GBRMPA 2009)

3.4.2 Sensitivity

To assess the significance of potential impacts on significant receptors, sensitive categories are applied to each of the features. The sensitivity categories are split into five discrete groups as described in Table 3.4. These groupings are based on qualitative assessments utilising information related to the receptor, in addition to the potential of a receptor’s occurrence within the receiving environment.

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

Sensitive features are treated individually. In the case where there are conflicting classes, the "worst-case" is taken.

Table 3.4 Sensitivity criteria for receptors within the proposal study area

Sensitivity	Description
Major	■ The receptor is listed on a recognised or statutory state, national or international register as being of conservation significance ■ The receptor is entirely intact and wholly retains its intrinsic value ■ The receptor is unique to the environment in which it occurs. It is isolated to the affected system/area, which is poorly represented in the region, state, country or the world ■ It has not been exposed to threatening processes, or they have not had a noticeable impact on the integrity of the environmental value ■ Project activities would have an adverse effect on the value.
High	■ The receptor is listed on a recognised or statutory state, national or international register as being of conservation significance ■ The receptor is relatively intact and largely retains its intrinsic value ■ The receptor is unique to the environment in which it occurs. It is isolated to the affected system/area, which is poorly represented in the region ■ The receptor has not been exposed to threatening processes, or they have not had a noticeable impact on the integrity of the receptor ■ Project activities would have an adverse effect on the receptor.
Moderate	■ The receptor is recorded as being important at a regional level, and may have been nominated for listing on recognised or statutory registers ■ The receptor is in a moderate to good condition despite it being exposed to threatening processes. It retains many of its intrinsic characteristics and structural elements ■ The receptor is relatively well represented in the systems/areas in which it occurs but its abundance and distribution are exposed to threatening processes ■ Threatening processes have reduced the receptor's resilience to change. Consequently, changes resulting from Project activities may lead to degradation of the prescribed value ■ Replacement of unavoidable losses is possible due to its abundance and distribution.
Low	■ The receptor is not listed on any recognised or statutory register. It might be recognised locally by relevant suitably qualified experts or organisations (e.g. historical societies) ■ The receptor is in a poor to moderate condition as a result of threatening processes, which have degraded its intrinsic value ■ It is not unique or rare and numerous representative examples exist throughout the system/area ■ It is abundant and widely distributed throughout the host systems/areas ■ There is no detectable response to change or change does not result in further degradation of the environmental value ■ The abundance and wide distribution of the receptor ensures replacement of unavoidable losses is achievable.
Negligible	■ The receptor is not listed on any recognised or statutory register and is not recognised locally by relevant suitably qualified experts or organisations ■ The receptor is not unique or rare and numerous representative examples exist throughout the system/area ■ There is no detectable response to change or change does not result in further degradation of the receptor.

3.4.3 Significance of impact

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

Once the receptor has been identified, and the sensitivity of the receptor and the magnitude of the potential impact have been determined, this will facilitate the assessment of the significance of the potential impact through use of a five by five matrix (refer Table 3.5). The significance rating descriptions are noted in Table 3.6.

Table 3.5 Significance assessment matrix

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

Table note:
Significance categories as identified in Table 3.5 are defined

Table 3.6 Significance classifications

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

Following the identification of the level of significance, mitigation measures were then applied to the potential (unmitigated) impacts to identify the residual (mitigated) impacts in a tabular form. Impacts that resulted in a significant residual impact upon a EEC, threatened species or population were then quantitatively rationalised using the AIAM to determine the EPBC Act offset requirements in accordance with the relevant legislative guidelines.

3.5 Adverse Impact Assessment Methodology

The EPBC Act Offsets Policy outlines the Commonwealth Government's approach to the use of offsets under the EPBC Act. The policy defines offsets as "measures that compensate for the residual adverse impacts of an action on the environment" (DSEWPaC 2012).

The purpose of the AIAM is to identify areas within the proposal area where the proposal's activities will (and will not) result in a significant residual adverse impact to MNES their associated habitat (henceforth referred to as MNES) following initial proposal impact assessment (refer Section 3.4). To identify such areas, an assessment ranking approach was used to develop an assessment matrix to provide a consistent, transparent and repeatable method by which the proposal's impacts to MNES could be ranked and reflected in a GIS model. The structure and implementation of the assessment ranking approach and assessment matrix were influenced by risk assessment theory and application.

To align with the SEARs, the assessment matrix which determines the nature of the proposal's impact to each MNES is an assessment of significant residual adverse impact. All assumptions and assessment criteria being based on scientific literature. All MNES identified as being likely to occur within the proposal study area were assessed using the AIAM.

To assess the nature (adverse or not adverse) and extent (significant or not significant) of a proposal's impact on a MNES, the following five key factors, or inputs, were identified:

- Habitat suitability
- Species resilience
- Habitat resilience
- Landscape attributes
- Disturbance nature.

The key factors identified above, have been ranked and modelled for this AIAM for the proposal's footprint.

The ranking system includes the provision of a 'fatal flaw' trigger. 'Fatal flaw' triggers have been built into the assessment matrix to identify extreme risk factors that automatically result in a significant residual adverse impact on the target species and/or their preferred habitat.

To acknowledge and reflect the EPBC Act significant impact assessment for MNES in the assessment matrix outputs, the significant impact criteria contained in the guidelines were built into the assessment matrix inputs. Table 3.7 presents the DOE (2013) significant impact criteria for critically endangered, endangered, and vulnerable species, and, notes how the criteria is reflected in the AIAM's assessment.

To ensure that the adversely impacted areas are captured, the assessment methodology assesses proposal impact to the target MNES at the time of disturbance, which is the point in which the greatest impact to MNES is anticipated (i.e. directly after habitat removal or modification).

Table 3.7 Incorporation of significant impact criteria for threatened species

Significant impact criteria	Assessment matrix input (refer Appendix B for detailed methodology and AIAM questions identified below)
Lead to a long-term decrease in the size of a population	**Species resilience** (Q1 – Q12 of the AIAM) – Provides for assessment of the species capacity to recover from disturbance **Habitat suitability** – Provides for assessment on species important habitat **Landscape attributes** – Provides for reference to impacts on local fauna assemblages
Reduce the area of occupancy of the species	**Habitat suitability** – Accounts for species area of occupancy by reflecting the category of habitat present for the species (i.e. 'core', 'essential', 'general')
Fragment an existing important population into two or more populations	**Landscape attributes** – The connectivity assessment conducted as part of the landscape attribute assessment provides for assessment of potential proposal impact on fragmentation **Species resilience** (Q5 – Q6 of the AIAM) – Provides for assessment of the species capacity to colonise new areas and its reliance on habitat linkages
Adversely affect habitat critical to the survival of a species	**Species resilience** (Q1 – Q4) – Provides for assessment of species capacity to respond to disturbances to breeding and non-breeding habitat **Habitat resilience** – Accounts for the capacity of a species habitat to respond to disturbance **Habitat suitability** – Provides for assessment on species important habitat
Disrupt the breeding cycle of a population	**Species resilience** (Q8 of the AIAM) – Provides for assessment of species resilience to breeding cycle disruptions

Significant impact criteria	Assessment matrix input (refer Appendix B for detailed methodology and AIAM questions identified below)
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	**Species resilience** (Q1 – Q4 of the AIAM) – Provides for assessment of species capacity to respond to disturbances to breeding and non-breeding habitat **Habitat resilience** – Accounts for the capacity of a species habitat to respond to disturbance **Landscape attributes** - Provides for assessment of potential impacts on species habitat within proximity to the disturbance area by assessing proposal impacts on the size of habitat patch, connectivity and habitat availability.
Result in invasive species that are harmful to MNES species becoming established in the MNES species' habitat	**Species resilience** (Q10, Q12 of the AIAM) – Assesses proposal impact on invasive species and the species capacity to respond, including an assessment of the predation vulnerability of the target species
Introduce disease that may cause the species to decline	**Species resilience** (Q11 of the AIAM) – Assesses impact on disease prevalence and the species capacity to respond
Interfere with the recovery of the species	**Species resilience** (Q1 – Q12 of the AIAM) – Provides for assessment of the species capacity to recover from disturbance **Landscape attribute assessment** - Provides for assessment of the ability of the affected habitat patch to support the target species post disturbance

3.6 Residual significance impact assessment

The aquatic species assessment utilises impact assessment determinations under the FM Act for the *Determination of whether proposed development or activity likely to significantly affect threatened species, population or ecological community* as per FM Act. Each receptor (relevant to the FM Act) as MSES are assessed under matters identified under particulars contained within the FM Act including:

(a) in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,

(b) in the case of an endangered population, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,

(c) in the case of an EEC or critically endangered ecological community (CEEC), whether the proposed development or activity:

- **(i)** is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or
- **(ii)** is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,

(d) in relation to the habitat of a threatened species, population or ecological community:

- **(i)** the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and
- **(ii)** whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and
- **(iii)** the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the threatened species, population or ecological community in the locality,

(e) whether the proposed development or activity is likely to have an adverse effect on any critical habitat (either directly or indirectly),

(f) whether the proposed development or activity is consistent with a Priorities Action Statement, the proposed development is not at odds with the Priorities Actions Statement.

(g) whether the proposed development constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

For the full assessment against each of the relevant impact assessment determinations refer Appendix F.

3.7 Cumulative impact assessment

When numerous projects occur in a region, they can cause cumulative impacts. Cumulative impacts:

- May differ from those of an individual project when considered in isolation
- May be positive or negative
- Have a severity and duration that depend on the spatial and temporal overlap of projects occurring in a region.

This CIA only deals with:

- Projects that have been approved but where construction has not commenced
- Projects that have commenced construction
- Projects that have only recently been completed
- Projects that are currently being assessed as State significant infrastructure within Gwydir, Moree Plains and Inverell local government areas or Coordinated Projects in Goondiwindi local government area.

For the purpose of this assessment, the CIA area is defined as the spatial area of influence (AOI) which is determined by each of the environmental and social issues being assessed for the proposal. The AOI considered in the assessment included state significant infrastructure projects within 300km.

This CIA has been prepared in accordance with the SEARs, which requires:

'An assessment of the cumulative impacts of the project considering other projects that have been approved but where construction has not commenced, projects that have commenced construction, and projects that have recently been completed.'

3.7.1 Project selection

Projects included in the cumulative impact assessment are:

- Projects outside the overall Inland Rail programme of works. Only state significant infrastructure projects under Section 15U of the EP&A Act, and other 'strategic' projects in the public domain as being planned, constructed or operated at the time the SEARs were issued, have been included in the CIA. Where additional projects worthy of inclusion were identified, the Secretary of the NSW Department of Planning and Environment was consulted for a determination on whether or not to include the project.
- Inland Rail projects immediately adjacent to the proposal. This included the Narrabri to North Star and the NSW/QLD Border to Gowrie projects of Inland Rail.

Projects that were excluded from the CIA are:

- Proposed projects that have not been developed to the point that their environmental assessment process has been made public.

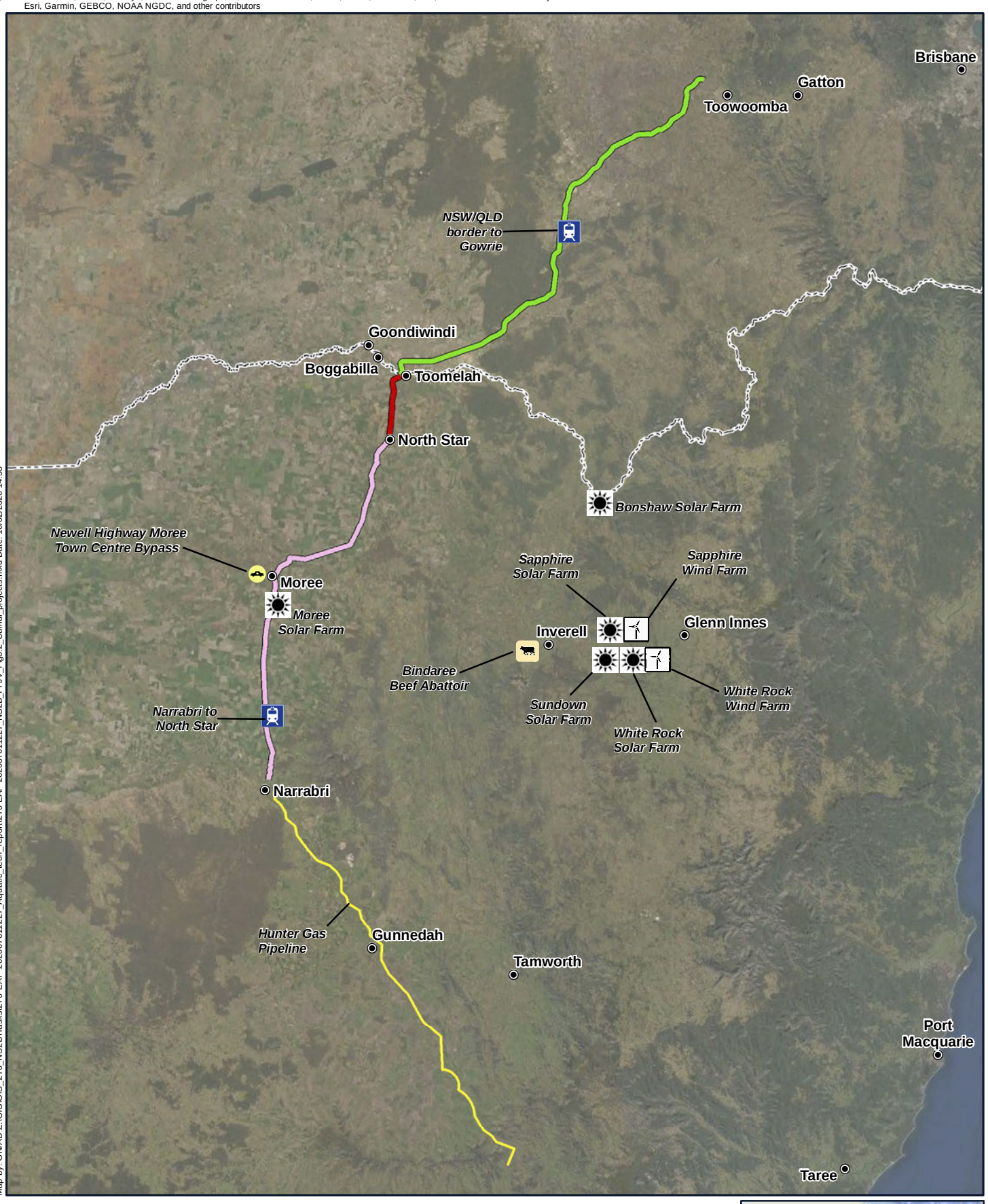
Based on the above criteria, the projects that have been included in the CIA are summarised in Table 3.8. The location of each project is shown in Figure 3.2.

Table 3.8 Projects to be included in cumulative assessment

Project and proponent	Location	Description	EIS status	Construction dates	Construction jobs	Operation years	Operation jobs	Selection criteria	Relationship to the proposal
Border to Gowrie – Inland Rail (ARTC)	NSW/QLD Border to Gowrie	Approximately 146 km of new dual gauge track and 78 km of upgraded track from the NSW/QLD border, near Yelarbon, to Gowrie Junction, north west of Toowoomba in QLD	Project referred to Commonwealth Minister for the Environment and Energy	2021 to 2025	1,600	-	TBA	b)	Potential overlap on construction commencement for Border to Gowrie and finalisation of North Star to Border
Narrabri to North Star – Inland Rail (ARTC)	Narrabri (NSW) to the village of North Star in NSW	An upgrade to approximately 188 km of track within the existing rail corridor and construction of approximately 1.6 km of new rail corridor	Proponent reviewing submissions	Mid 2018 to 2020	TBA	-	TBA	b)	Potential overlap of finalisation of Narrabri to North Star and commencement of North Star to Border construction
Moree Solar Farm	10 km south of Moree, off the Newell Highway in Northern NSW	Construction of a 56 MWac/ 70.1 MWdc single axis tracking solar PV facility. Construction works currently involve the installation of the framing system which consists of the BladePiles and the NexTracker tracking systems, the JA Solar photovoltaic modules, the DC and AC wiring of the electrical equipment, the 22/66 kV on-site substation and the 66 kV transmission line	Approved by the NSW Major Projects Office on 17/07/2011	2018 to 2022	1,050	-	10 - 12	c)	Potential increase of traffic on the Newell Highway. Construction of Moree Solar Farm is scheduled around the peak visitation to Moree in autumn
Newell Highway Moree Town Centre Bypass	Moree	Construction of a 4.4 km two-lane bypass of the Moree town centre	Approved by the NSW Major Projects Office on 20 July 2004. Latest modification 8 approved 7 July 2010	-	-	-	-	c)	Potential increase of traffic on the Newell Highway

Project and proponent	Location	Description	EIS status	Construction dates	Construction jobs	Operation years	Operation jobs	Selection criteria	Relationship to the proposal
Bindaree Beef Abattoir – Rendering Plant and Bio-digester Plant	Bindaree Beef Abattoir, Inverell	The proposed project involves the installation of a wastewater treatment system (bio-digester) and new render plant facility to reduce odour and carbon emissions at its existing abattoir site. The bio-digester generates a bio-gas from waste and waste water which would then be reused at the site	Approved by the NSW Major Projects Office on 10 December 2014	12 months construction. Start date unknown	60	-	-	c)	Potential conflict or demand for construction resources if projects overlap. Increase of traffic volumes on the Gwydir and Newell Highway
Queensland - Hunter Gas Pipeline	Wallumbilla to Newcastle	420 km gas pipeline from the Narrabri Gas Project to Newcastle via, Gunnedah, Quirindi, Scone, Muswellbrook, Singleton and Maitland	Project determined under Part 3A – now transitioned to State significant infrastructure	From approval, approximately 8 months of construction	600	-	150	c)	If construction occurs at the same time, there is potential for increase in traffic using similar routes and demand for construction resources and personnel
White Rock Solar Farm	20 km south-west of Glen Innes, 40 km east of Inverell NSW	Establishment of a 20-megawatt solar farm and associated infrastructure	Approved by the NSW Major Projects Office 14 June 2016	Construction forecast to take 6 months	50	25	TBA	c)	Potential increase in road traffic on the Gwydir Highway and the Newell highway
White Rock Wind Farm	20 km south-west of Glen Innes, 40 km east of Inverell NSW	Stage 2 of White Rock Wind Farm upgrades will consist of up to 48 turbines, producing up to 202 MW of clean renewable electricity	Approved by Major Projects Office on 10 July 2012	Late 2018	100	30	20	c)	Potential increase in road traffic on the Gwydir Highway and the Newell highway
Sundown Solar Farm	South of Gwydir Hwy, 30 km east of Inverell (NSW)	The project consists of a large-scale solar photovoltaic generation facility, including battery storage and associated infrastructure, with an estimated maximum capacity of up to 600 MW, enough to power over 250,000 homes	SEARs issued by Major Projects Office	2019 to 2023	-	-	-	c)	Potential increase in road traffic on the Gwydir Highway and the Newell highway

Project and proponent	Location	Description	EIS status	Construction dates	Construction jobs	Operation years	Operation jobs	Selection criteria	Relationship to the proposal
Bonshaw Solar Farm	Bruxner Highway, 16 km south of Bonshaw and 66 km north of Inverell (NSW)	GAIA Australia is proposing to develop a large scale solar photovoltaic generation facility and associated infrastructure with a capacity of 500 MW	SEARs issued by Major Projects Office	Mid 2019 to 2021	-	25	-	c)	Potential increase of traffic on the Bruxner Highway. North Star to Border alignment crossed the Bruxner Highway. Deconfliction at construction times may be required.
Sapphire Solar Farm	Project in the Kings Plains, Wellingrove and Sapphire areas, approximately 28 km east of Inverell and 18 km west of Glen Innes.	A 200 MW hybrid solar and battery power facility	Approved by the NSW Major Projects Office on 16 August 2018	2019 to 2020	200	25	150	c)	Potential increase of traffic on the Gwydir and Newell Highway
Sapphire Wind Farm	Project in the Kings Plains, Wellingrove and Sapphire areas, approximately 28 km east of Inverell and 18 km west of Glen Innes.	Construction of a 238 to 425 MW capacity wind farm (between 125 and 159 turbines)	Approved by the NSW Major Projects Office on 26 June 2013	TBA	-	-	-	c)	Potential increase of traffic on the Gwydir and Newell Highway



Legend

- Localities
- North Star to NSW/QLD border alignment
- NSW/QLD border

A4 scale: 1:2,300,000

0 20 40 60 80 100km

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Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Figure 3.2:
Cumulative impact projects

3.7.2 Approach

The approach used to identify and assess potential cumulative impacts of this proposal provided within this technical report is summarised below.

- A review of the potential impacts identified within the EIS assessments
  - The environment at the time of the EIS SEAR is the baseline, prior impacts from past land use has not be considered
- A register of assessable projects has been collated with timelines to demonstrate the temporal relationship between projects. This has included:
  - Identification of projects outside of the Inland Rail Programme
    - Only 'state significant' or 'strategic' projects that are in the public domain as being planned, constructed or operated at the time of the EIS SEARs have been considered
    - Where additional projects worthy of consideration have arisen after the finalisation of the EIS SEARs, the Secretary of DPIE 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 Narrabri to North Star Inland Rail Project and Border to Gowrie Inland rail Project have been considered
- Identification and mapping of the assessable projects and the areas of influence of the aspect being considered
  - Current operational projects and commercial or agricultural operations that are in the areas of influence around the proposal are accounted for in the corresponding technical baseline studies (e.g. air, noise, social, economic, etc.).
- Where there is a potential overlap in impacts (either spatially or temporally), a CIA has been undertaken to determine the nature of the cumulative impact. This includes:
  - Where possible the assessment method has been quantitative in nature, but qualitative assessment has also been undertaken
  - Where quantitative assessment is possible, the significance of impact should be assessed in comparison to the same criteria or guidelines as adopted by the relevant technical impact assessments
  - Where the impacts are expressed qualitatively, the probability, duration, and magnitude/intensity of the impacts should be considered as well as the sensitivity and receptor of the receiving environmental conditions.

The significance of the impact has been determined by using professional judgement to select the most appropriate relevance factor for each aspect in Table 3.9 and summing the relevance factors. The sum of the relevance factors determines the impact significance and consequence which are summarised in Table 3.10.

Table 3.9 Assessment matrix

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

Table 3.10 Impact significance

Impact significance	Sum of relevant factors	Consequence
Low	1 to 6	Negative impacts need to be managed by standard environmental management practices. 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. Targeted monitoring program required, where appropriate.
High	10 to 12	Alternative actions should be considered and/or mitigation measures applied to demonstrate improvement. Targeted monitoring program necessary, where appropriate.

3.8 Limitations of assessment

The following assumptions and limitations are applicable to this technical report:

- Recordings of fauna species observed during the aquatic field survey were taken at each aquatic ecology assessment site. Where suitable flow was observed 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. These surveys occurred during the time taken to collect water quality and complete visual assessments of waterways and do not constitute detailed aquatic fauna survey. Macroinvertebrate identification, extensive fish trapping (using methods such as fyke netting seine netting and bait trapping set over one or multiple nights), snorkelling and electrofishing were specifically excluded from the field methodology due to the largely ephemeral nature of the watercourses along the alignment. Adequate habitat assessment and field data was collected to inform a likelihood of occurrence assessment for threatened aquatic species within the proposal study area.
- No fish records occur within the proposal study area identified in a search of the BioNet database. A request for survey records was lodged with DPI Fisheries by the FFJV. This request was denied by DPI Fisheries who stated that the information requested is beyond that which is required for reporting for the EIS. DPI Fisheries instead directed FFJV to a number of online resources. In line with DPI Fisheries advice these resources were used to inform our assessment.
- As surveys were conducted at the end of a prolonged dry period, the waterbodies in the alignment assessed as part of the aquatic assessment were largely dry. As such results presented in this report are only indicative of values during drought conditions. Further monitoring during the wet season would further inform aquatic values, though this is reliant on sustained period of heavy rainfall and considered unlikely to occur within the period of proposal approvals. Results combined with a review of available literature are considered sufficient to indicate aquatic habitat values.

3.9 Desktop assessment – aquatic ecology

Prior to field investigations for the alignment, a desktop analysis was undertaken to identify existing aquatic features associated with the Inland Rail NS2B. This was considered to be the alignment with a 10 km buffer applied (i.e. 20 km wide corridor in total width). Analysis included a review of existing field data collected prior to FFJV's involvement with the Inland Rail NS2B Project (refer Appendix E) as well as existing datasets that were publicly available including:

- Freshwater threatened species distribution maps
- FM Act Key Fish Habitat maps, 'Moree Plains' and 'Gwydir'
- Ramsar and Directory of Important Wetlands in Australia (DIWA) wetlands, and drainage mapping

3.9.1 Stream order mapping

The stream order was determined for the streams within the proposal study area using the Strahler method. This method assigns an 'order' to waterways based on the number of tributaries associated with the waterway. This system provides a measure of system complexity and the potential for fish habitat to be present.

Numbering for the Strahler method start at the top of the catchment with new headwater flow paths assigned the number 1. Where two first order streams join, the waterway downstream of the junction is considered to be a second order stream. A third order stream begins after the junction of two second order streams, and so on. Where a lower order stream joins a higher order stream (i.e. second order stream joins a third order stream) then the higher order number is retained (Industry and Investment NSW 2009).

In general, stream order corresponds to waterway classification as an indication of aquatic habitat complexity (refer Section 3.9.2):

- Class 4 = first and second order streams (sometimes also third order)
- Class 3 = third order streams
- Class 2 and Class 1 = third order and above.

First and second order streams on gaining streams (based on the Strahler method of stream ordering) are not considered key fish habitat unless they are found to be habitat of a listed threatened species, population or community (Fisheries NSW 2013).

3.9.2 Fish habitat mapping

Key fish habitat mapping has been prepared by NSW Department of Primary Industries (DPI) for all Local Government Ares (LGAs) across NSW. The current proposal study area is close to the boundary of the Gwydir and Moree Plains LGA and the Fish Habitat Maps for these LGAs were used to identify the mapped fish habitat.

NSW DPI has defined habitat that is considered 'key fish habitat' with respect to the application of the FM Act, FM regulations and the policies and guidelines provided (NSW DPI 2013). The classification includes the type of fish habitat and the sensitivity of that habitat (ranked as Type 1 – 3). The habitat type and sensitivity as applicable to the current proposal are outlined below:

- Type 1 - Highly sensitive key fish habitat that includes, freshwater habitats that contain in-stream gravel beds, rocks greater than 500 mm in two dimensions, snags greater than 300 mm in diameter or 3 m in length of native aquatic plants. Any known or expected protected threatened species habitat or area of declared 'critical habitat' under the FM Act.
- Type 2 – Moderately sensitive key fish habitat includes, freshwater habitats and brackish wetlands, lakes and lagoons other than those defined in Type 1. Weir pools and dams up to full supply level where the weir or dam is across a natural waterway.
- Type 3 – Minimally sensitive key fish habitat includes – ephemeral aquatic habitat not supporting native aquatic or wetland vegetation.

3.9.3 Wetlands of international importance (Ramsar)

The Ramsar and Directory of Important Wetlands in Australia (DIWA) wetlands, and drainage mapping was reviewed to determine if any important wetlands are within the study area or potentially impacted by the proposal.

3.10 Field assessment

3.10.1 Locations and timing

Aquatic investigations occurred between 21 to 27 August 2018 by the EIS project team. A single survey period was considered to be sufficient as the use of historical surveys and datasets accounted for seasonal detectability, in addition to the use of predictive habitat models in the ecology impact assessment. The predictive habitat models were verified in the field using data collected during the proposal field survey.

The investigations were initially scoped to occur over a total of 15 locations and were to comprise an upstream, impact and downstream site across five waterways which intersect the proposal study area. Aquatic investigation sites were selected in order to allow habitat assessment across a variety of watercourses (including but not limited to, waterways identified as potential suitable habitat) throughout the proposal area. To account for a potential lack of water, access constraints (permission and egress) and uncertainties of waterway size a total of 21 potential locations were identified via a desktop assessment prior to the field program commencing. As a result of limitations in access and water availability, 18 sites received rapid assessment with 15 of these locations being selected for detailed assessment. Sites were moved along waterways as necessary to accommodate access. The 15 sites occur across six separate waterways. Sites 19, 20 and 21 were not assessed and occurred on a minor, unnamed tributary/drain and are not considered further by this report. A complete list of aquatic site locations, inclusive of their coordinates, is provided in Table 3.11 and shown in Figure 3.3.

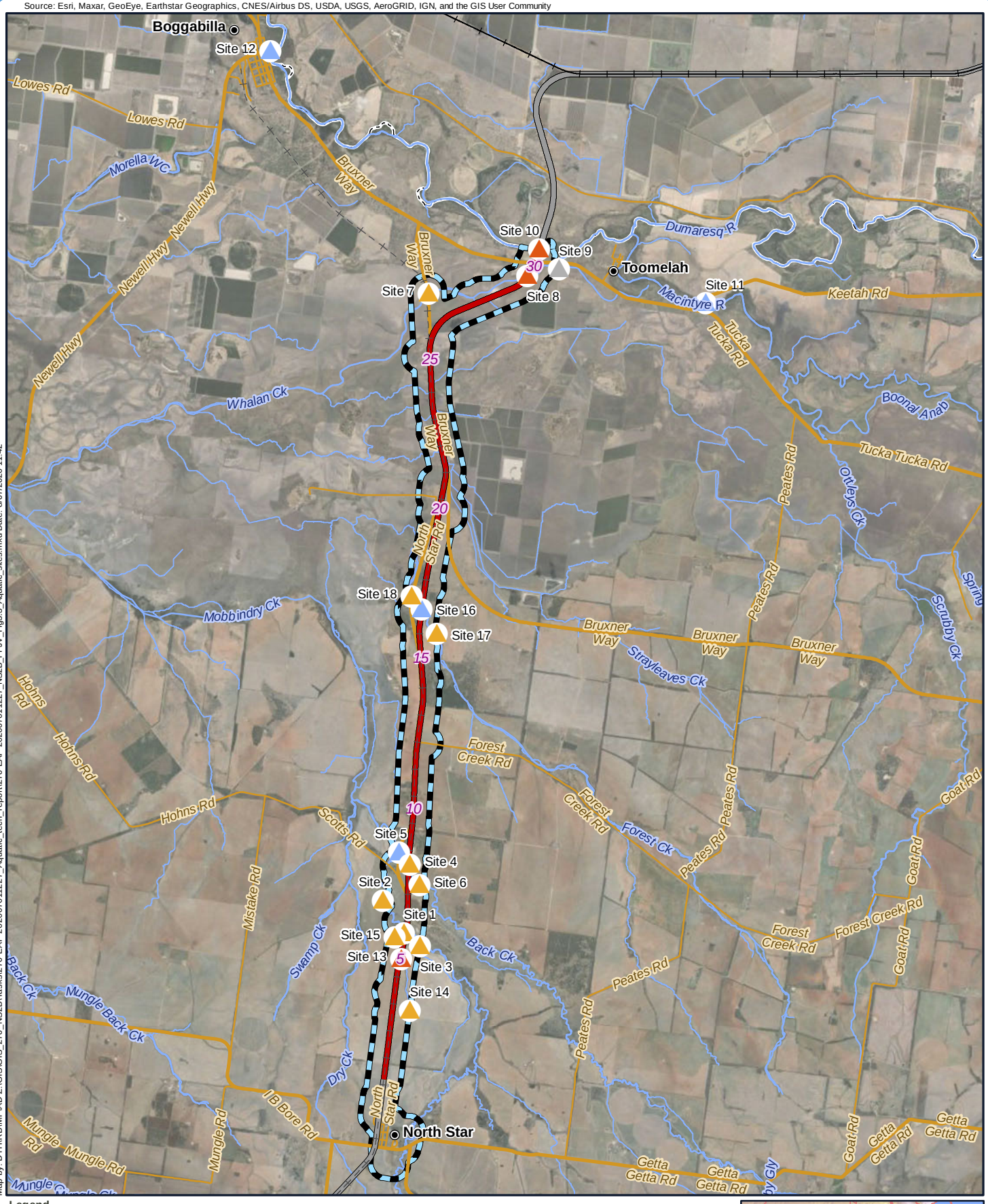
Small waterbodies exist at many of the proposed borrow pits sites, however these are considered to be artificial impoundments resulting from extractive industries and were not subject to further assessment. It is considered that under the FM Act these waterbodies are excluded on the basis that they fit the definition as Intermittent lagoons or wetlands filled from localised runoff and not otherwise hydrologically connected to other permanent habitats such as rivers, creeks, estuaries and ocean.

Table 3.11 Aquatic ecology field sampling locations and date of assessment

Site ID	Waterway	Location and distance (m, +/-100 m) in relation to proposal site	Site location	
			Easting	Northing
Site 1	Mobbinbry Creek	A (0)	246684.00 m E	6803707.00 m S
Site 2	Mobbinbry Creek	D/S (2000)	245894.00 m E	6804807.00 m S
Site 3	Mobbinbry Creek	U/S (1600)	247113.00 m E	6803292.00 m S
Site 4	Back Creek	A (0)	246781.00 m E	6806005.00 m S
Site 5	Back Creek	D/S (750)	246424.00 m E	6806400.00 m S
Site 6	Back Creek	U/S (1150)	247098.00 m E	6805323.00 m S
Site 7	Whalan Creek	D/S (3550)	247409.00 m E	6824885.00 m S
Site 8	Whalan Creek	A (0)	250661.00 m E	6825475.00 m S
Site 9	Whalan Creek	U/S (1150)	251714.00 m E	6825686.00 m S
Site 10	Macintyre River	A (0)	251053.00 m E	6826350.00 m S
Site 11	Macintyre River	U/S (1500)	251883.00 m E	6826097.00 m S
Site 12	Macintyre River	D/S (1100)	249936.00 m E	6826516.00 m S
Site 13	Unnamed trib of Mobbinbry Creek	A (0)	246495.00 m E	6802878.00 m S
Site 14	Unnamed trib of Mobbinbry Creek	U/S (1700)	246779.00 m E	6801163.00 m S
Site 15	Unnamed trib of Mobbinbry Creek	D/S (550)	246277.00 m E	6803590.00 m S
Site 16	Forest Creek	A (0)	247179.00 m E	6814447.00 m S
Site 17	Forest Creek	U/S (1250)	247672.00 m E	6813616.00 m S
Site 18	Forest Creek	D/S (550)	246835.00 m E	6814875.00 m S

Table note:

A, D/S & U/S denotes 'Alignment, Downstream and Upstream', respectively.



Map by: DTHRBIMF\AD Z:\GIS\GIS_270_NS2B\Tasks\270-EAP-20200701227_Aquatic_tech_report\270-EAP-20200701227_NS2B_FFJV_Fig3.3_Aquatic_sites.mxd Date: 8/07/2020 11:42

Legend

- Access, assessed
- Access, no sample as dry
- No access, assessed from road
- No access, not assessed
- 5 Chainage (km)
- Localities
- Existing rail (operational)
- Existing rail (non-operational)
- Adjoining alignments
- North Star to NSW/QLD border alignment
- Major roads
- Minor roads
- NSW/QLD border
- Watercourses

A4 scale: 1:170,000

0 1 2 3 4 5 km

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Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Figure 3.3:
Location of aquatic field sampling sites

3.10.2 General sampling approach

The habitat value of each aquatic ecology assessment site was assessed to describe the aquatic fauna assemblages which are considered likely to use the area. Recordings of incidental fauna species observed during the aquatic field survey were taken at each defined sampling location. 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[1] as appropriate. Adequate habitat assessment and field data was collected to inform a likelihood of occurrence assessment for threatened aquatic species within the proposal study area.

Electrofishing, snorkelling and macroinvertebrate sweeps were not undertaken as part of the aquatic ecology survey works due to the conservative approach to qualification of presence and the assessment of aquatic environmental receptors.

3.10.3 AUSRIVAS (Australian River Assessment System)

The aquatic ecology field assessment described the environmental values of targeted drainage systems within the proposal study area. The AUSRIVAS Physical Assessment Protocol (Parsons *et.al* 2002) was used in the field assessment of the drainage systems. The AUSRIVAS Physical Assessment Protocol is a standardised rapid method for the collection of geomorphological, physical habitat and riparian data and was used to maintain consistency with the sampling approach which has been employed on other Inland Rail packages, providing a repeatable and standard approach which allows for cumulative impacts associated with the proposal to be assessed.

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

- Valley characteristics, including valley shape and channel slope
- Land use, including catchment land use and local land use
- Physical morphology and bedform of the watercourse, including channel shape and extent and type of bars
- Cross sectional dimensions of the watercourse, including bankfull channel width and depth, bank width and height and baseflow stream width and depth
- Substrate characteristics, including bed compaction, sediment angularity, bed stability rating, sediment matrix and substrate composition
- Floodplain characteristics, including floodplain width and features
- Bank characteristics, including bank shape and slope, bank material, bedrock outcrops, factors affecting bank stability and artificial bank protection measures
- Instream vegetation and organic matter, including extent of large woody debris, macrophyte cover and species composition
- Physical condition indicators and habitat assessment
- Riparian vegetation characteristics, including shading of channel, extent of trailing bank vegetation, species compositions, riparian zone width and extent of disturbance
- 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 proposal surface water quality investigations (refer to EIS Chapter 13 and the Project Surface Water Quality Technical Report).

[1] Turtles have been assessed under habitat assessment within the EIS Appendix B: Terrestrial biodiversity technical report.

The habitat value of each aquatic ecology assessment site was assessed to predict the nature of faunal assemblages utilising the watercourse, in addition to results from fish habitat assessments and aquatic fauna surveys (refer Sections 3.10.4 and 3.10.5). Due to the locality of the EIS disturbance footprint, the habitat assessment was conducted for low gradient flow watercourses. Habitat scores were produced as a sum of the scores for each of the assessment parameters and were then broadly associated with category thresholds of poor (0-25 per cent), fair (25-50 per cent), good (50-75 per cent), and, excellent (75-100 per cent).

3.10.4 Fish habitat assessments

The habitat value and fish habitat type of each aquatic ecology assessment site was assessed to describe the aquatic fauna assemblages which were considered likely to use the area. Aquatic habitat assessments were conducted with respect to the *Policy and Guidelines for Fish Habitat Conservation and Management* (Fisheries NSW 2013), which outlines the features important for fish habitat in freshwater, estuarine, and marine areas.

Waterways within the NS2B proposal study area were assessed with regards to their classification for fish passage, with applicable waterways allocated a classification between Class 1 to 4 in accordance with the Fairfull and Witheridge 2003 document, *Why do fish need to cross the road? Fish passage requirements for waterway crossings* (refer Table 3.12).

Table 3.12 Waterway classifications for fish passage

Classification	Characteristics of waterway type
Class 1: Major fish habitat	Major permanently or intermittently flowing waterway (e.g. river or major creek), habitat of a threatened fish species.
Class 2: Moderate fish habitat	Named permanent or intermittent stream, creek or waterway with clearly defined bed and banks with semi - permanent to permanent waters in pools or in connected wetland areas. Marine or freshwater aquatic vegetation is present. Known fish habitat and/or fish observed inhabiting the area.
Class 3: Minimal fish habitat	Named or unnamed waterway with intermittent flow and potential refuge, breeding or feeding areas for some aquatic fauna (e.g. fish, yabbies). Semi - permanent pools form within the waterway or adjacent wetlands after a rain event. Otherwise, any minor waterway that interconnects with wetlands or recognised aquatic habitats.
Class 4: Unlikely fish habitat	Named or unnamed waterway with intermittent flow following rain events only, little or no defined drainage channel, little or no flow or free-standing water or pools after rain events (e.g. dry gullies or shallow floodplain depressions with no permanent aquatic flora present).

3.10.5 Aquatic fauna surveys

Habitat assessment and field data was collected to inform a likelihood of occurrence assessment for threatened aquatic species within the proposal study area. Due to the largely ephemeral nature of the watercourses along the alignment at the time of assessment, macroinvertebrate sweeps and electrofishing were excluded from the field methodology.

The habitat value of each aquatic ecology assessment site was assessed to predict the nature of faunal assemblages utilising the watercourse. Due to the locality of the EIS disturbance footprint, the habitat assessment was conducted for low gradient flow watercourses. The habitat assessment and field data were collected to inform a likelihood of occurrence assessment for threatened aquatic species within the EIS disturbance area.

During the seven-day aquatic ecology field investigations, data was collected with respect to any disturbances present within or affecting the aquatic environments.

3.10.6 *In-situ* surface water quality

Surface water quality samples were collected at each monitoring site in accordance with the '*Approved Methods for the Sampling and Analysis of Water Pollutants in New South Wales'* (DOC 2004).

Where possible, surface water quality samples were collected from the centre of the watercourse, where the velocity was the highest. In situ water quality values, where available, were used in consideration of habitat values. Typically, where water quality values were outside of the water quality objectives, habitat is considered sub-optimal for maintenance of fish and biological assemblages. The following *in-situ* parameters were collected:

- pH
- Turbidity
- Dissolved oxygen (% saturation)
- Salinity
- Electrical conductivity.

The aquatic ecology field assessment occurred concurrently with the surface water sampling program. This program included laboratory analysis of water samples and wider range of parameters and is not repeated here. For further details refer to the Surface Water Quality Technical Report (FFJV 2020).

3.11 Permits to conduct works

The ecological field surveys reported in this document were conducted under the provisions of Aurecon's Scientific Purposes Permit (WISP14453114), General fisheries permit (182654) and Animal ethics approval for General Fish Surveys (CA 2015/01/833).

3.12 Nomenclature

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

- Pusey, Kennard, Arthington (2004) for freshwater fish.

4 Description of environmental values

4.1 Desktop assessment

4.1.1 Catchment overview

The proposal study area falls within the Border Rivers catchment management area of NSW. This catchment is one of the northern most catchments within the Murray-Darling Basin and is made up of a group of rivers straddling the NSW/QLD border. The rivers of the catchment start at the Great Dividing Range and run westward, gradually merging to become the Barwon River.

The nationally significant Morella Watercourse, Boobera Lagoon and Pungbougal Lagoon are located on the Macintyre Floodplain within the catchment although this wetland is outside of the proposal study area. These two significant lagoons are located approximately 30km downstream of the proposal alignment along the Morella Watercourse at 25 km and 12 km, respectively. Hydrological flow comparisons are presented within the Hydrology and Flooding technical report prepared for the North Star to NSW/QLD Border EIS.

The catchment has the following characteristics:

- Climate is described as sub-tropical on the plains (i.e. the proposal study area)
- Rainfall is summer dominant
- The area of the catchment where the proposal is located is underlain by the Great Artesian Basin
- The Commonwealth Scientific and Industrial Research Organisation (CSIRO) reported in 2008 that 34 per cent of available surface water was extracted for use which was considered high in comparison with other catchments in the Murray-Darling Basin
- Land use in the catchment is dominated by extensive agriculture with approximately 67% of the catchment used for grazing and 18 per cent for dryland cropping. Approximately 2 per cent of the land has been developed for irrigation, mostly in the west of the catchment. Conservation and native vegetation account for 5 per cent of land use
- Surface water is used for stock watering, irrigation, drinking water, household use, recreation (primary and secondary) as well as for environmental and aesthetic purposes.

4.1.2 Watercourses and waterbodies

The stream order was determined for the watercourses within the proposal study area using the Strahler method as described in Section 3.8. The stream orders of waterways within the proposal study area are presented in Table 4.1.

Table 4.1 Strahler order by waterway

Waterway	Strahler order
Mobbindry Creek	3
Back Creek	3
Whalan Creek	2
Macintyre River	6
Unnamed trib of Mobbindry Creek	1/2
Forest Creek	3
Unnamed creek	2

First and second order streams (based on the Strahler method of stream ordering) are not considered key fish habitat unless they are found to be habitat of a listed threatened species, population or community (Fisheries NSW 2013). It should be noted that the unnamed tributary of Mobbindry Creek is considered to be both a first and second order stream depending on the section of the reach assessed.

The principal watercourses and associated waterbodies that occur within the proposal site are described in Table 4.2 (including an overview of geomorphological features) and mapped in Figure 4.1. Watercourses within the proposal typically consist of gravel and/or sandy bed composite and are not expected to be resistant to scour if exposed to high velocity waters. The EIS Hydrology and Flooding technical report prepared for the North Star to NSW/QLD Border EIS (FFJV 2020b) includes assessments of water levels, flow paths, and flow velocities. These assessments were used as input for the drainage design and drainage assessments of scour, the results of which are presented in the EIS Hydrology and Flooding technical report prepared for the North Star to NSW/QLD Border EIS (FFJV 2020b). Further detailed drainage design will be undertaken to detail scour protection (as an engineering standard) in regard to expected velocities from culverts.

Table 4.2 Watercourses within the proposal site

Watercourse	Description
Macintyre River:	The Macintyre River is the major river that begins in the Northern Tablelands between Glen Innes and Guyra. The river is 321 km long and is a tributary of the Barwon River. The proposed rail crossing location is situated between the confluence of the Dumaresq River and Macintyre River and Boggabilla. The only permanent waterway within the proposal site. There is a broad well vegetated riparian flood plain on both sides of the river. Impacts of human disturbance were high. There is an extensive riparian cover along both banks with an over story of *Eucalyptus* sp. and *Melaleuca* sp. The banks were 50 to 100 m wide and have a substantial cover of weedy species. The river bed includes gravel and sand beds with some mud banks and snags. The river level was low but flowing at the time of the survey and provides high value fish habitat. Emergent (*Phragmites australis*) macrophytes were along the banks.  Macintyre River downstream of Site 11 (Low flow at time of assessment – August 2018)

Watercourse	Description
Whalan Creek:	Whalan Creek is a is a major creek approximately 60 km long that discharges in a westerly direction into the Macintyre River, downstream of Goondiwindi. Whalan Creek is an anabranch of the Macintyre River and appears to also receive flows from the Macintyre River during over bank flow events. This creek is ephemeral but larger than other creeks in the area, with a well-defined channel likely to flow seasonally. The creek is about 50 to 70 m wide, is situated within a broad agricultural landscape with a mix of grazing and cropping on both banks. The width of the floodplain was undetermined as there were no distinctive features or changes in vegetation to identify the floodplain extent. However, the entire area adjacent to the creek is a flood plain. These sites were highly disturbed/modified with significant impacts to the waterway and the riparian zone. Riparian vegetation cover was highly degraded/modified, with an overstory of *Eucalyptus sp.* and *Acacia sp.* providing sparse cover. There was limited evidence of tree regeneration and shrub/ground cover was low. The bed of the creek is stable and is dominated by silt and some sand and there was limited fish habitat visible at the site. A large pool was visible outside of the assessment reach; however, the creek was otherwise dry at the time of the site inspection.  Whalan Creek upstream of Site 7 (Dry at time of assessment – August 2018)
Mobbindry Creek	Mobbindry Creek is a tributary of Whalan Creek and is approximately 55km long. The headwaters of the Creek are situated southeast of the township of North Star and flows parallel to the North Star Rd in a north westerly direction and appears to discharge into Whalan Creek within the vicinity of the Newell Highway. The proposed rail crossing location is adjacent to the Boggabilla-Warialda Rd. The creek is ephemeral, with a well-defined channel. The floodplain is broad and undefined adjacent to Mobbindry Creek. The local land use and the broader catchment are highly modified and impacted by agricultural activities (grazing and cropping). The creek is 26 to 30 m wide. The riparian corridor comprised of an overstory of *Eucalyptus sp.* and Brigalow with some shrub cover and a good understory cover. The creek bank vegetation included a continuous cover of fringing rushes and sedges. The creek bed was stable and includes silts and some sand. The channel form was varied but was dominated by run habitat with some pools expected to be present during flow. Obstructions to the waterway include the existing rail and road crossing and there were some natural barriers in the form of large snag piles.

Watercourse	Description
	 Mobbindry Creek downstream of Site 1 (Dry at time of assessment – August 2018)
Back Creek	Back Creek is a tributary of Mobbindry Creek and is approximately 25km long. There is a well vegetated riparian zone along both sides of the creek at the crossing location. There was recent evidence of stock presence at the sites investigated. This creek is ephemeral, with a well-defined channel. Riparian vegetation was dominated by *Eucalyptus sp.* and Brigalow with shrubs present and good understory of dominated by native species. The creek is about 18 to 30 m wide. The top of the banks along the creek are covered by *Carex* sp. The creek channel was approximately 1 m deep and 3 m wide. The substrate is unconsolidated silt and there is a large number of snags present in the creek. There was a slight sheen to the water and there was an anaerobic odour generated from the sediment when disturbed.  Back Creek upstream of Site 5 (Low flow at time of assessment – August 2018)

Watercourse	Description
Forest Creek	Forest Creek is over 20 km long and discharges in a north westerly direction and appears to discharge into Whalan Creek although the flow path is not clearly defined. The floodplain is broad and poorly defined along the Creek. There is a mixed coverage of riparian vegetation dominated by *Casuarina sp.* along the creek. The channel was variable in form and 31 to 40 m wide at the sites surveyed. It has a broad shallow (0.2 m) bed dominated by silt and sand with some gravel. The creek bed is vegetated with a mixture of terrestrial species with evidence of aquatic species in some shallow depressions. This creek is ephemeral, with a highly modified waterway and poorly defined channel. An on-stream dam has been constructed and all flows diverted to the dam. Two levees have been constructed that divert overland flow the creek to the on-stream dam before excess water is able to bypass the dam. Downstream of the dam the existing rail line has formed a barrier to flows. The rail line and levee banks have altered the hydrology of the site between the dam and the rail line that has allowed a stand of *Casuarina sp*. to establish.  Forest Creek downstream of Site 16 at the rail crossing (Isolated pool at time of assessment – August 2018)

Watercourse	Description
Unnamed tributary of Mobbindry Creek	The unnamed tributary of Mobbindry Creek is a short drainage line approximately 5 km long. The creek line is highly modified and impacted by agricultural land use. The creek is 9 to 30 m wide. It was narrow and shallow (<0.5 m) in parts with a uniform sand bed, and in other reaches contained highly mobile silt and sand that has a scoured low flow channel within it. The overstorey riparian zone is non-existent with highly degraded understorey and ground cover riparian vegetation. Levees have been constructed along both banks.  Unnamed tributary of Mobbindry Creek downstream of Site 15. Dry at the time of assessment in August 2018.

4.1.3 Surface water quality

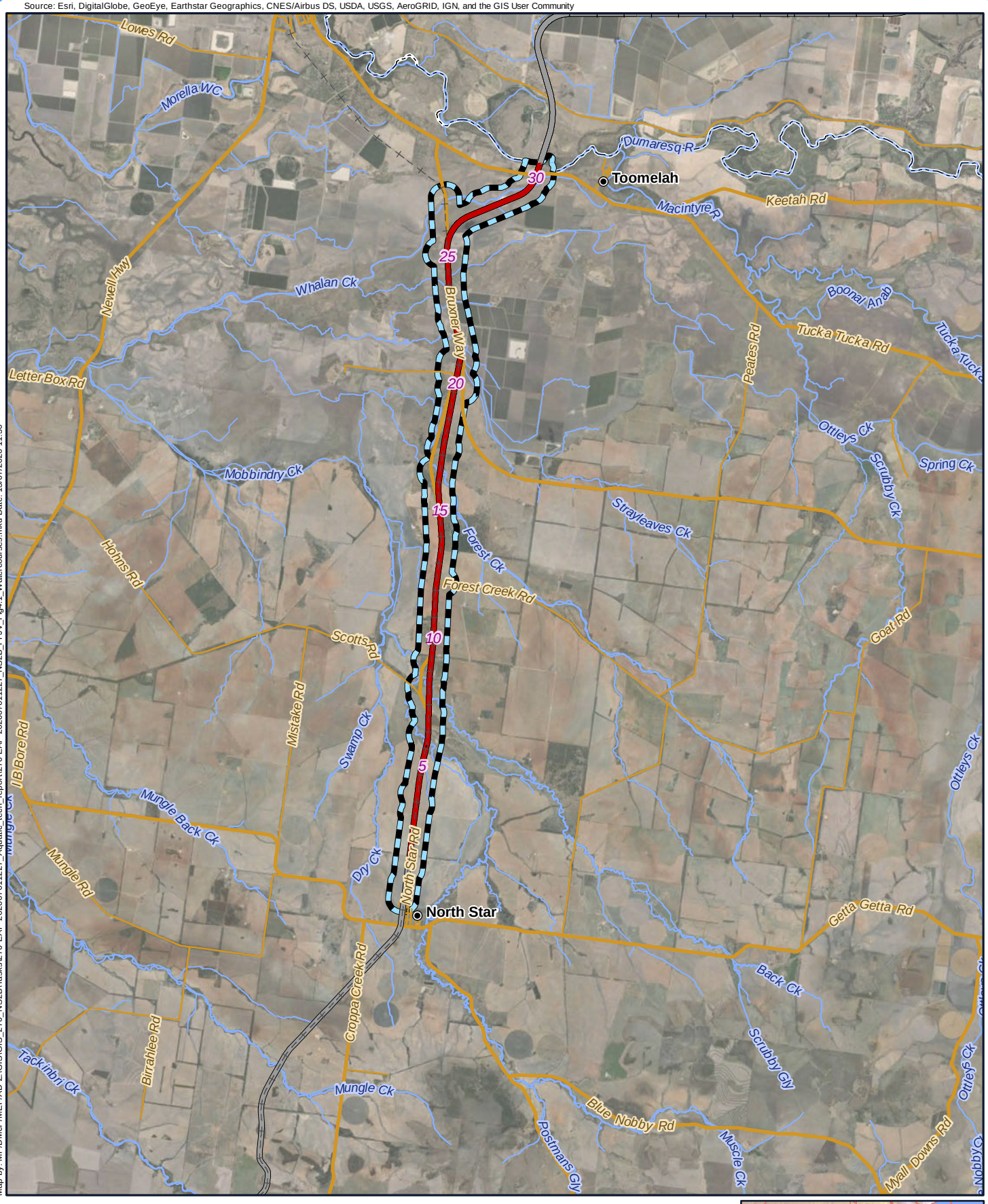
Water quality in the Border Rivers catchment has been assessed by the NSW Department of Industry (2018b). This report concluded that water quality in the Border Rivers varies from poor to good. The water quality index used for this assessment returned a condition rating of 'fair' (a score of between 60-79/100) for the upland catchments surrounding the proposal site, as follows:

- Upstream of the proposal site at Holdfast Crossing (about 40 km upstream) had a rating of 77/100
- Downstream of the proposal site at Boggabilla (about 5 km downstream) had a poorer rating of 66/100.

Within the unregulated catchments, water quality degradation is attributed to sediment and nutrients entering waterways as a result of poor land, soil and vegetation management. This report recommends reducing stream bank erosion to improve water quality by maintaining groundcover, vegetated buffer strips, and riparian vegetation, and good agronomic practices.

Within regulated reaches problems include dissolved oxygen issues (principally concerned with stratification and release of hypoxic water from regulated structures), contribution of sediment and nutrients through bank slumping, dissolved organic carbon transport and cold water pollution. It is recommended that these can be addressed through the implementation of flow rules; water supply works approvals, improvements in infrastructure and strategic environmental watering.

For a detailed assessment refer to EIS Appendix G: Surface water quality technical report.


Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Map by: MF/DMcP/MEF/AD Z:\GIS\GIS_270_NS2B\Tasks\270-EAP-20200701227_Aquatic_tech_report\270-EAP-20200701227_NS2B_FFJV_Fig4.1_Watercourses.mxd Date: 13/07/2020 11:50
Toomelah
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Lowes Rd
Morella WC
Dumaresq R
Macintyre R
Keetah Rd
Newell Hwy
Whalan Ck
Bruxner Way
Boonal Anab
Tucka Tucka Rd
Peates Rd
Letter Box Rd
Ottleys Ck
Spring Ck
Scrubby Ck
Mobbindry Ck
Strayleaves Ck
Hohns Rd
Forest Ck
Forest Creek Rd
Scotts Rd
Goat Rd
Mistake Rd
Swamp Ck
I/B Bore Rd
Mungle Back Ck
Mungle Ck
Mungle Rd
Dry Ck
North Star Rd
Getta Getta Rd
Back Ck
Croppa Creek Rd
Scrubby Gly
Birrahlee Rd
Tackinbri Ck
Mungle Ck
Blue Nobby Rd
Postmans Gly
Muscle Ck
Myall Downs Rd
Legend
Chainage (km)
Localities
Existing rail (operational)
Existing rail (non-operational)
North Star to NSW/QLD border alignment
Adjoining alignments
Major roads
Minor roads
Watercourses
NSW/QLD border
Study area
A4 scale: 1:200,000
0 1 2 3 4 5km
Toowoomba
Brisbane
Ipswich
Grandchester
Warwick
Goondiwindi
Narrabri
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Coordinate System: GDA 1994 MGA Zone 56
North Star to NSW/QLD border
Figure 4.1: Watercourses associated with the proposal study area

4.1.4 Sensitive environmental areas

4.1.4.1 Wetlands

There are no Wetlands of International Importance (Ramsar wetlands) within, or adjacent to (i.e. within 10 km) of the proposal. The following Ramsar wetlands are located 1,000 to 1,300 km from the proposal:

- Banrock Station wetland complex
- Riverland
- The Coorong and Lakes Alexandrina and Albert Wetland.

In addition, it is noted that a wetland complex consisting of Morella Lagoon, Pungbougal Lagoon and Boobera Lagoon are part of a remnant channel of the Macintyre River south of Goondiwindi (refer Figure 4.2). This wetland complex is listed as a site of national importance in the Directory of Important Wetlands in Australia (DIWA). It is not located within the proposal study area.

4.1.4.2 Groundwater dependent ecosystems

The Bureau of Meteorology Groundwater Dependent Ecosystems Atlas was accessed to assess potential GDEs within or near the proposal site. An approximate 2 km radius around the alignment centreline was reviewed for potential GDEs as a conservative approach to assess potential impacts on sensitive receptors.

The Groundwater Dependent Ecosystems Atlas (GDE Atlas, BoM 2018b) identifies three types of ecosystems:

- Aquatic ecosystems that rely on the surface expression of groundwater – this includes surface water ecosystems which 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.

The proposal site passes through, or in the vicinity of, the several aquatic GDEs (refer Figure 4.3 and Table 4.3).

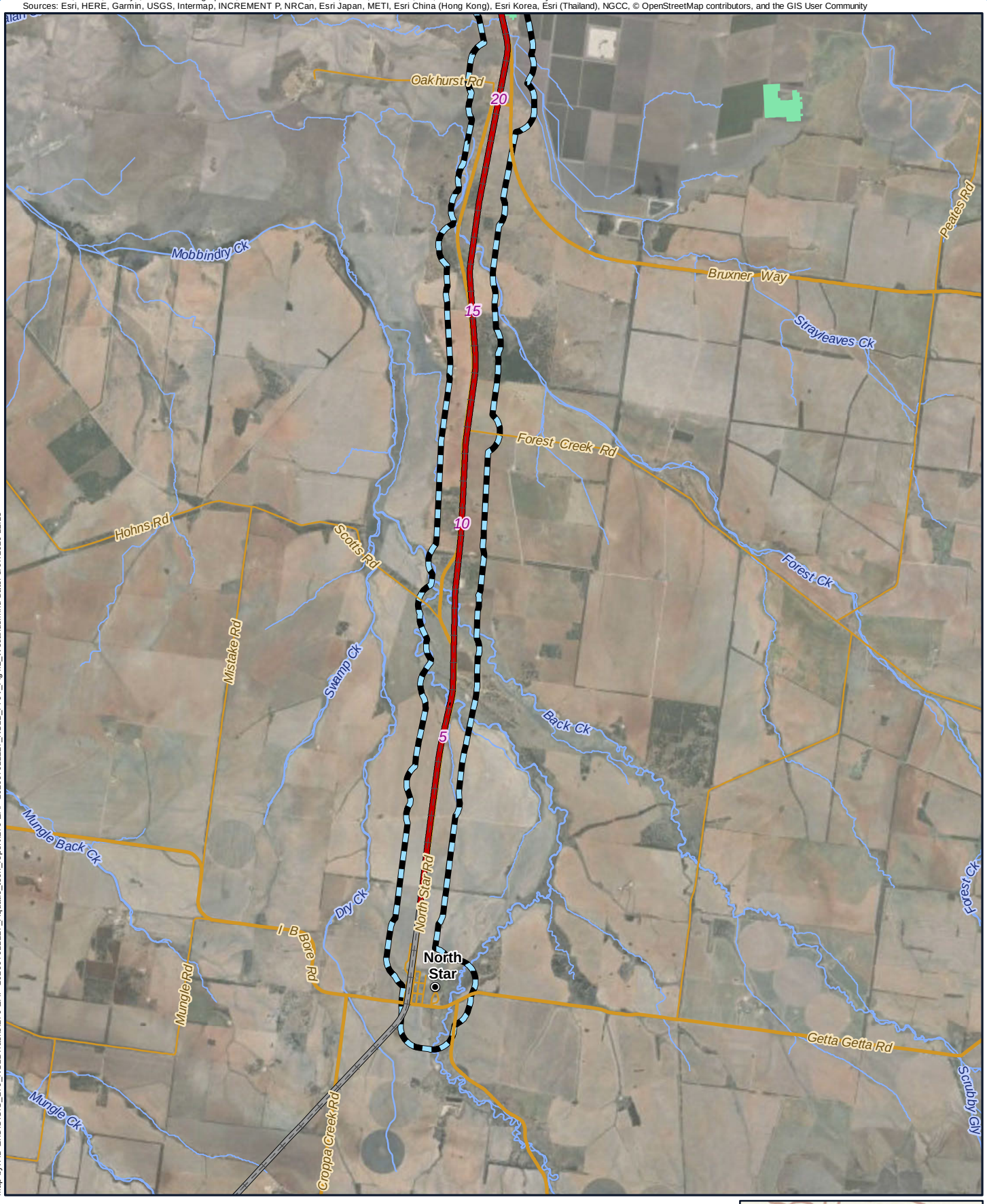
Table 4.3 Summary of aquatic groundwater dependent ecosystems

Chainage	GDE category	Aquatic GDE description
KP 5.70 km	Moderate	A narrow moderate potential aquatic GDE is identified in Mobbindry Creek. Proposed construction at this location is cut and fill. Classified ecosystem type is river.
KP 28.0 km	High	A high potential aquatic GDE is identified at Malgarai Lagoon located 1km to the southeast the alignment and 2.5km south of the Macintyre River. Classified ecosystem type is wetland. No construction activity in proximity to this feature.
KP 30.5 km	Moderate	A moderate potential aquatic GDE is identified within the active Macintyre River channel and will be crossed by the alignment via a cut and fill as well as a bridge structure. Classified ecosystem type is wetland.
KP 30.5 km	High	High potential aquatic GDEs are identified 2.5km east of the alignment where it intersects the Macintyre River. No construction activities proposed in proximity to this GDE. Classified ecosystem type is wetland.

Source: BoM GDE Atlas

Regional assessments of surface water-groundwater interactions have identified the Macintyre River and other water courses region to be in a losing condition (Parson et al. 2008). This means that surface water typically infiltrates vertically to groundwater to recharge local groundwater within the alluvium.

The Glenlyon and Pindari Dams in the upper reaches of the Border Rivers Catchment result in regulated flows to the Severn and Macintyre Rivers (Green et al 2012). Consequently, there is likely to be an artificial influence on recharge to alluvial aquifers during low flow periods (periods of dam discharge to the rivers).



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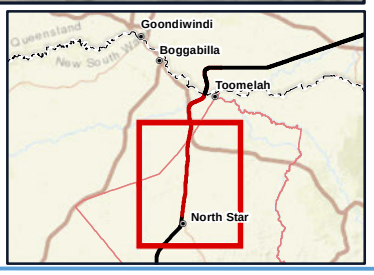
Legend

- 5 Chainage (km)
- Localities
- Existing rail (operational)
- Existing rail (non-operational)
- North Star to NSW/QLD border alignment
- Adjoining alignments
- Major roads
- Minor roads
- Watercourses
- Study area
- Wetland areas



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0 1 2 3 4 5km

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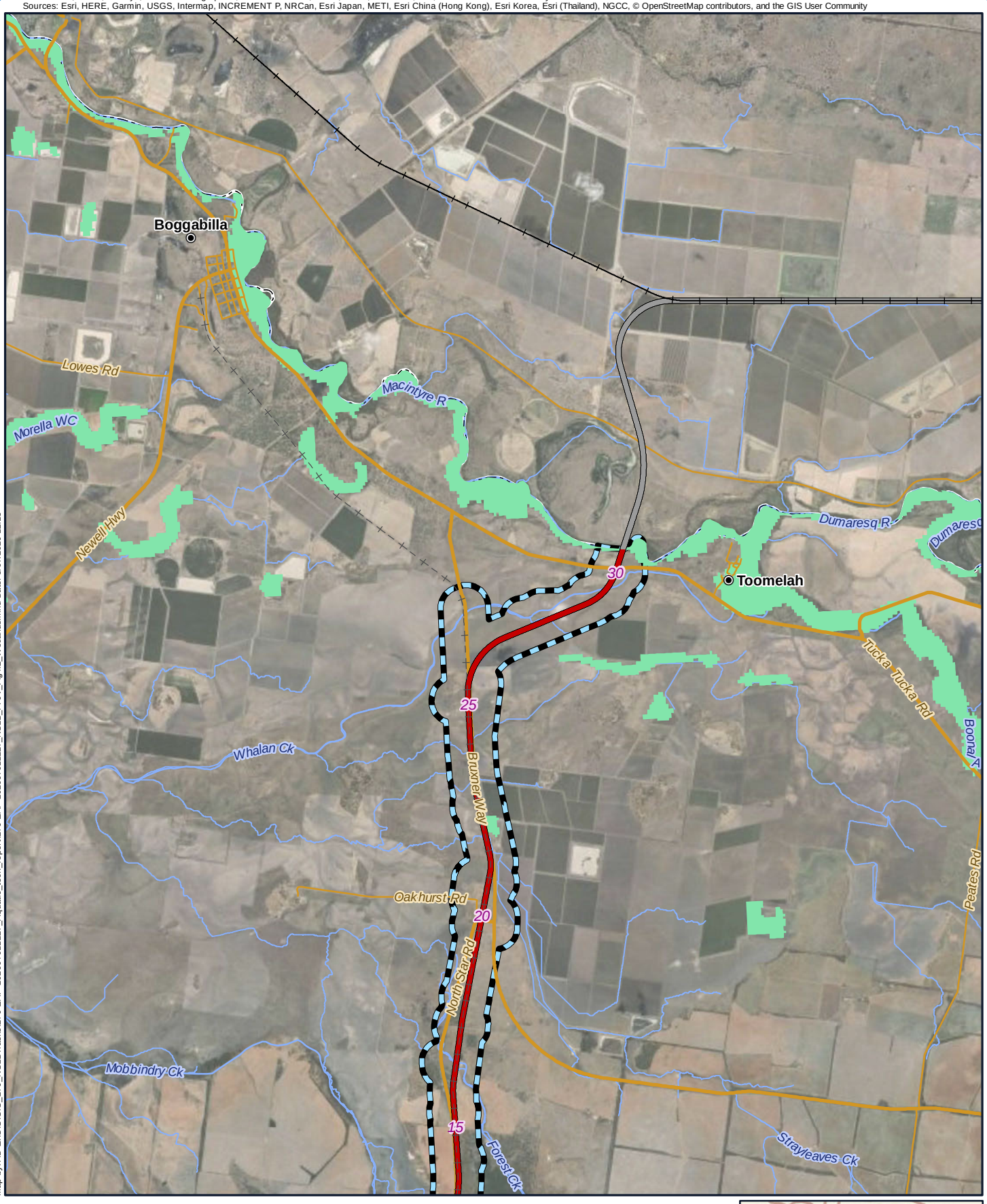
North Star to NSW/QLD border

Figure 4.2a: Wetlands associated with the proposal study area

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



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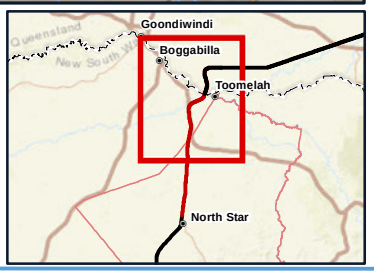
Legend

- 5 Chainage (km)
- Localities
- Existing rail (non-operational)
- North Star to NSW/QLD border alignment
- Adjoining alignments
- Major roads
- Minor roads
- Watercourses
- NSW/QLD border
- Study area
- Wetland areas



A4 scale: 1:120,000

0 1 2 3 4 5km

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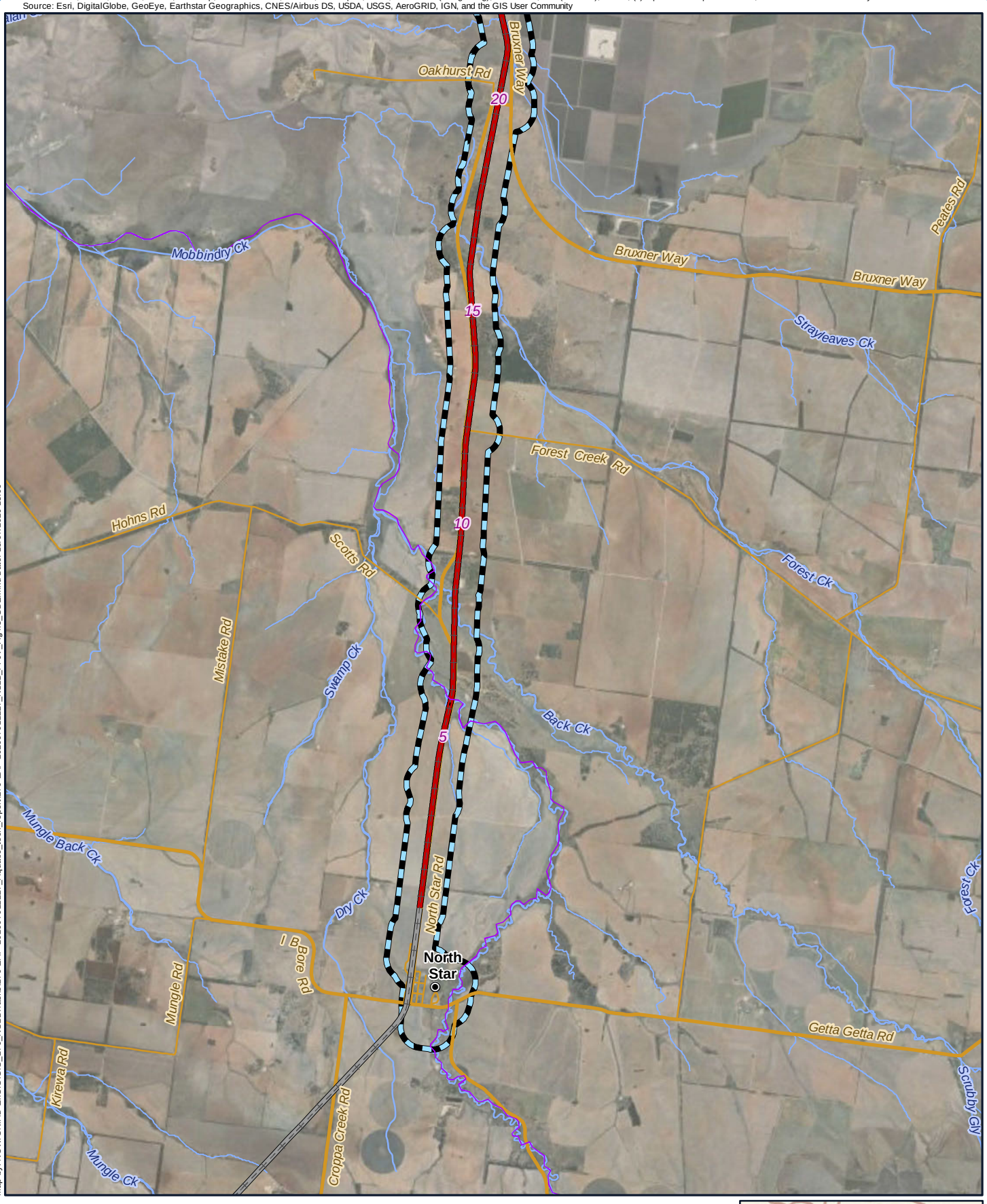
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Figure 4.2b: Wetlands associated with the proposal study area



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Legend

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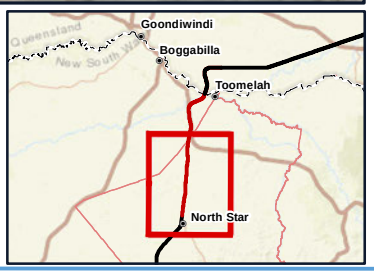
- Localities
- Existing rail (operational)
- Existing rail (non-operational)
- North Star to NSW/QLD border alignment
- Adjoining alignments
- Major roads
- Minor roads
- Watercourses
- Study area

Aquatic GDEs

- Moderate potential GDE



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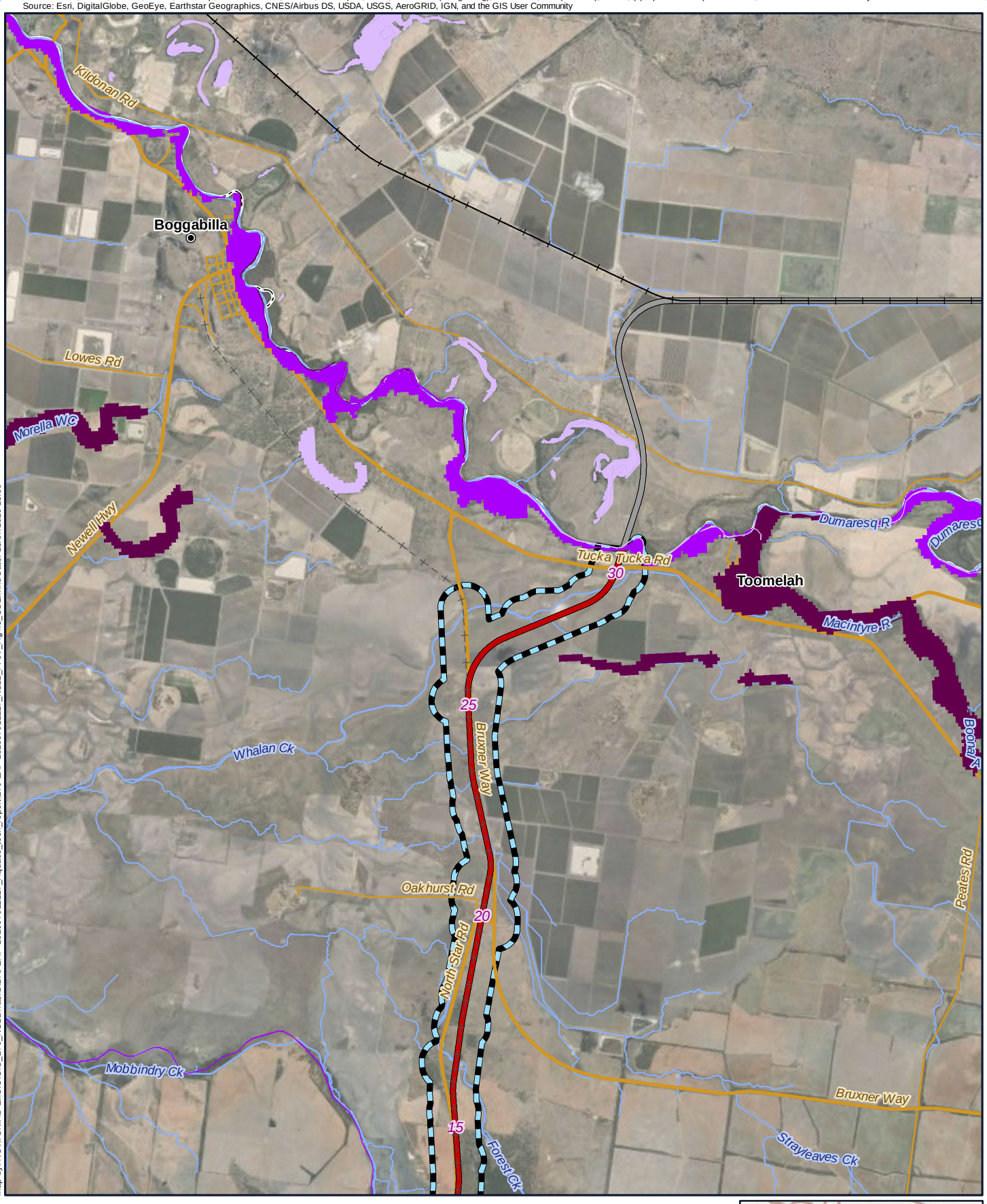
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Figure 4.3a: Aquatic Groundwater Dependant Ecosytems associated with the proposal study area



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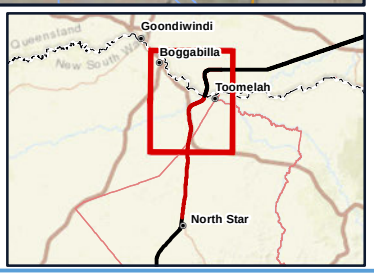
Legend

- 5 Chainage (km)
- Localities
- Existing rail (non-operational)
- North Star to NSW/QLD border alignment
- Adjoining alignments
- Major roads
- Minor roads
- Watercourses
- NSW/QLD border
- Study area

Aquatic GDEs

- High potential GDE
- Moderate potential GDE
- Low potential GDE



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0 1 2 3km

Future Freight
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Date: 06/07/2020 Version: 3

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Figure 4.3b: Aquatic Groundwater Dependant Ecosytems associated with the proposal study area

4.1.5 Fish habitat

This section summarises the field assessment in relation to *Why do fish need to cross the road? Fish passage requirements for waterway crossings* and is further informed by the outcomes of the desktop assessment.

The Macintyre River is the major waterway in the region and the only permanent waterway assessed. All other waterways were perennial or ephemeral and under the current drought conditions there was limited surface water present in these waterways. Whalan Creek is larger than the other creeks within the proposal study area and possibly receives overland flows from the Macintyre River during flood events. Back Creek and Mobbindry Creek had well defined channels that may flow for short periods seasonally with fringing sedges and rushes present. Forest Creek and the unnamed creek were highly modified waterways with poorly defined channels that would flow intermittently with limited or poor riparian vegetation.

All of the waterways (excluding the Macintyre River) have been significantly impacted by historic crossing structures for road, rail and agricultural infrastructure. The classifications for each creek along with corresponding site are provided in Table 4.4 and are summarised as follows:

- Mobbindry Creek and Back Creek were categorised as Class 3 (minimal fish habitat) and Type 1 (highly sensitive fish habitat). They are unlikely key fish habitat based on the observations obtained during the site inspections however, the DPI fish habitat mapping identifies it as potential habitat for Eel-tailed catfish and on this basis, it has been classified as a Type 1, highly sensitive fish habitat.
- Back Creek was assessed as Class 3 (minimal fish habitat) on the basis of intermittent flows in the creek and limited connectivity. However, the creek has been identified as highly sensitive fish habitat (Type 1) based on the DPI fish habitat maps with the possible presence of Eel-tailed catfish.
- Whalan Creek was categorised as Class 2 (moderate fish habitat) and Type 1 (highly sensitive fish habitat) as it has been mapped as Southern purple spotted gudgeon habitat
- The Macintyre River has been categorised as Class 1 (major fish habitat) and Type 1 (highly sensitive fish habitat) as it is mapped as potentially supporting a number of protected species. Observations from the site inspection support its assigned value.
- The unnamed tributary of Mobbindry Creek has been classed as Type 3, minimal sensitive habitat and categorised as Class 4, unlikely fish habitat
- Forrest Creek has been categorised as Class 4 (unlikely fish habitat) and as Type 3, minimal sensitivity fish habitat.

Table 4.4 Habitat sensitivity analysis of rivers and major creeks and waterways in the proposal study area

Site No	Watercourse	Strahler order[1]	Classification of waterway for fish passage[3]	Habitat sensitivity[2]	Mapped as key fish habitat (Yes/No)
1	Mobbindry Creek	3	Class 3	Type 1	Yes
2	Mobbindry Creek	3	Class 3	Type 1	Yes
3	Mobbindry Creek	3	Class 3	Type 1	Yes
4	Back Creek	3	Class 3	Type 1	Yes
5	Back Creek	3	Class 3	Type 1	Yes
6	Back Creek	3	Class 3	Type 1	Yes
7	Whalan Creek	2	Class 2	Type 1	Yes
8	Whalan Creek	2	Class 2	Type 1	Yes
9	Whalan Creek	2	Class 2	Type 1	Yes
10	Macintyre River	6	Class 1	Type 1	Yes
11	Macintyre River	6	Class 1	Type 1	Yes
12	Macintyre River	6	Class 1	Type 1	Yes

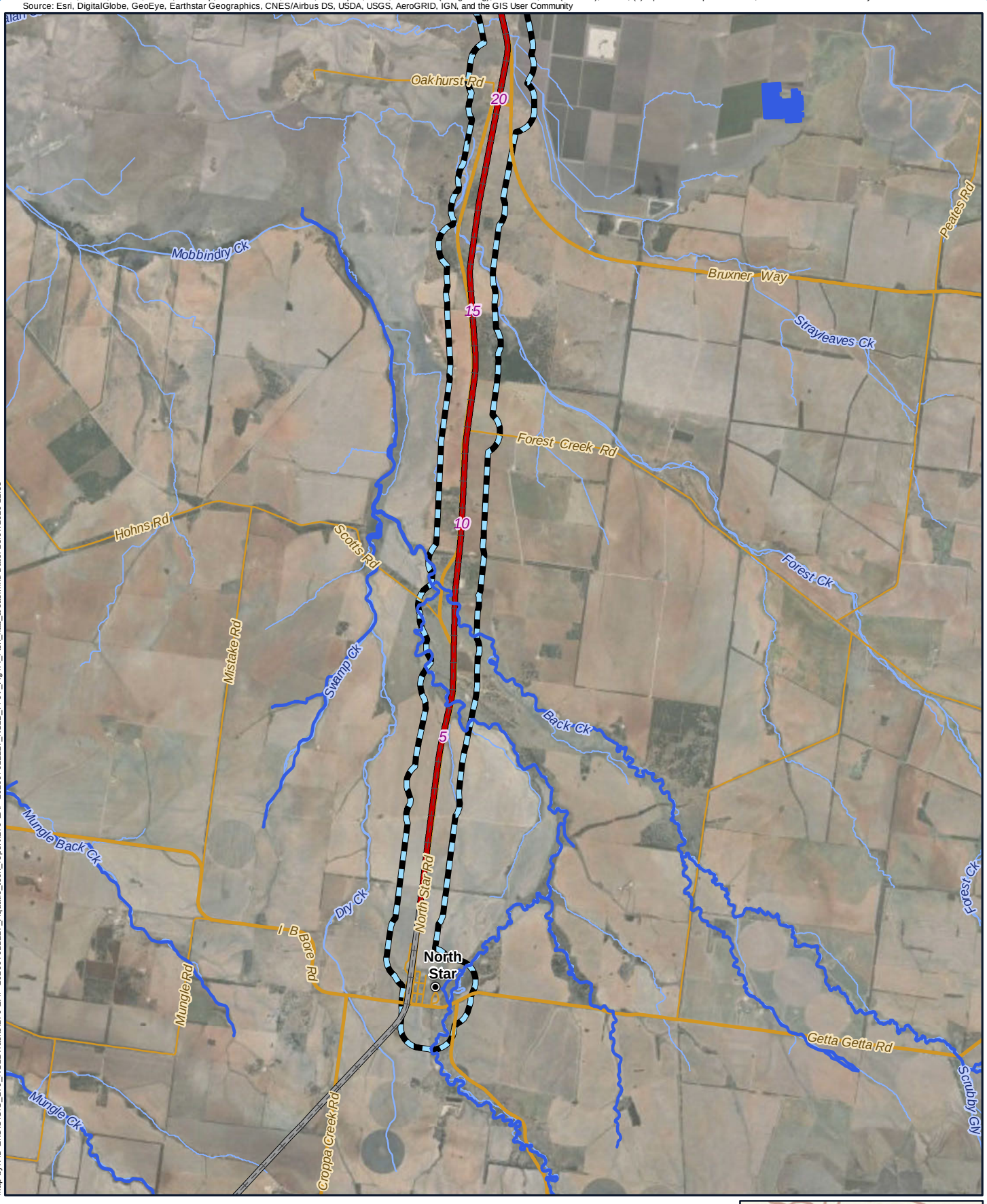
Site No	Watercourse	Strahler order[1]	Classification of waterway for fish passage[3]	Habitat sensitivity[2]	Mapped as key fish habitat (Yes/No)
13	Unnamed trib of Mobbindry Creek	1	Class 4	Type 3	No
14	Unnamed trib of Mobbindry Creek	1	Class 4	Type 3	No
15	Unnamed trib of Mobbindry Creek	2	Class 4	Type 3	No
16	Forest Creek	3	Class 4	Type 3	No
17	Forest Creek	3	Class 4	Type 3	No
18	Forest Creek	3	Class 4	Type 3	No

Table notes:

1 Strahler Stream Order Classification: First order – flow paths at top of catchment, Second order – downstream of where two first order streams join, Third order – downstream of where two second order streams join, Fourth order – downstream of where two third order streams join, Fifth order – downstream of where two fourth order streams join

2 Habitat sensitivity: Type 1 – highly sensitive fish habitat, Type 2 – Moderately sensitive fish habitat, Type 3 – Minimally sensitive fish habitat

3 Classification of water course: Class 1 – Major key fish habitat, Class 2 – Moderate key fish habitat, Class 3 – Minimal key fish habitat, Class 4 – Unlikely fish habitat.



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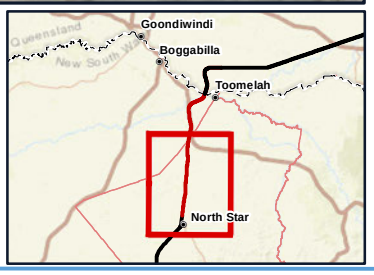
Legend

- 5 Chainage (km)
- Localities
- Existing rail (operational)
- Existing rail (non-operational)
- North Star to NSW/QLD border alignment
- Adjoining alignments
- Major roads
- Minor roads
- Watercourses
- Study area
- Fish habitat area



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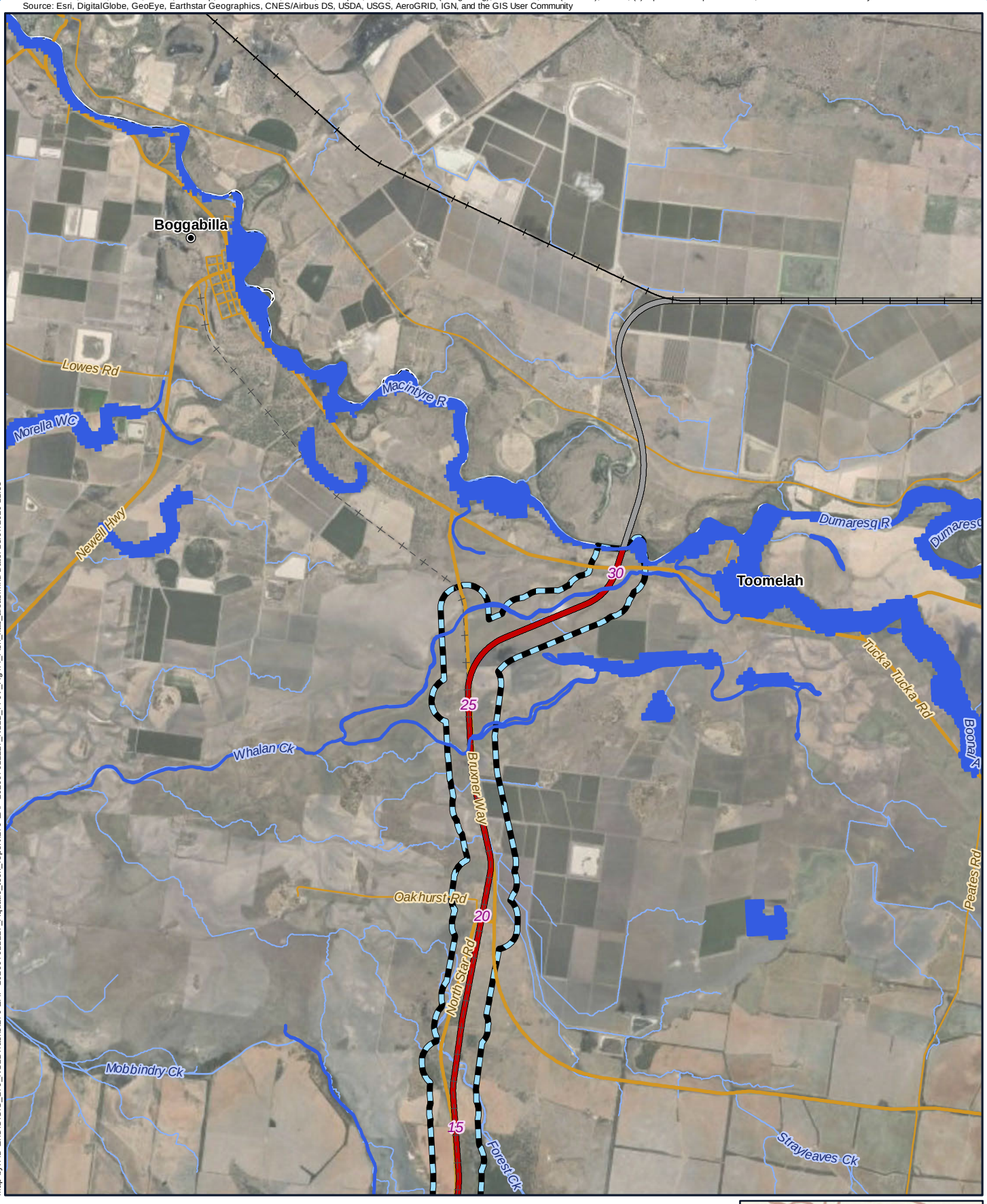
North Star to NSW/QLD border

Figure 4.4a: Fish Habitat Areas associated with the proposal study area



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Legend

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- Existing rail (non-operational)
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- Watercourses
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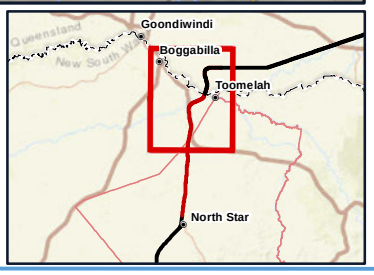
- Study area
- Fish habitat area



A4 scale: 1:120,000

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Integrating Community, Environment and Engineering

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Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Figure 4.4b: Fish Habitat Areas associated with the proposal study area

4.1.5.1 Waterfront Land

Under the NSW *Water Management Act 2000* 'waterfront land' is defined as the bed of a river and the land within 40 m of the river bank. Within the proposal area, all watercourses and associated tributaries and adjacent lands are classed as 'waterfront land' (including the Macintyre River and adjacent lands). Under the Act this may be classed as a 'controlled activity' requiring development approval. The Guidelines for controlled activities on waterfront land (Green et al 2012) provide a framework for development activities within the riparian corridor. However, the proposal has been classed as 'state significant infrastructure' and is exempt from requiring a controlled activity approval. As such, 'waterfront land' associated with the proposal is not referred to further in this report. Description of riparian and aquatic habitats associated with these areas are discussed elsewhere.

4.1.6 Endangered ecological communities

An endangered ecological community is a protected assemblage of species of fish or marine vegetation (or both) occupying a particular area (under Schedule 4 of the FM Act). The Darling River EEC includes all native fish and aquatic invertebrates within the natural creeks, rivers and streams, lagoons, billabongs, lakes, flow diversions to anabranches and the floodplains of the Darling River and includes the Macintyre River within the rail corridor. The Darling River EEC is sensitive to impacts with the following listed as key threatening processes for the community: degradation of the riparian zone, clearing of vegetation and the use of chemicals which impact on water quality. These impacts have the potential to occur during the construction phase of the proposal, with some continuing risk during operation (refer Section 6.2).

4.1.7 Potential threatened aquatic species and communities

No fish records occur within the rail corridor identified in a search of the BioNet database (refer Section 4.1). The only threatened aquatic species identified by the PMST was the Murray Cod (*Maccullochella peelii*) which is listed as vulnerable (EPBC Act). The Macintyre River provides suitable habitat for Murray cod. All other waterways surveyed are unlikely to support Murray cod. No aquatic communities were identified in the PMST report.

In the absence of species records the status of threatened species was informed by a review of resources prepared by the DPI NSW. The Border Rivers Water Resources and Management Overview (Green et al 2012) identifies three threatened aquatic species that may be found within the broader catchment, the River snail (*Notopala sublineata*), Silver perch (*Bidyanus bidyanus*) and the Southern purple spotted gudgeon (*Mogurnda adspersa*).There is one endangered population, Olive perchlet (*Ambassis agassizii*) western population and one EEC, the 'Aquatic Ecological Community in the Natural Drainage System of the Lowland Catchment of the Darling River'.

The fish distribution maps prepared by DPI are based on survey records, predicted occurrence and expert opinion and indicate there are a number of state listed species that are potentially present in the Macintyre River (including the Darling population of the Eel tailed catfish, however this population is not listed in Green et al. (2012)). Some of the other waterways that cross the rail corridor are also mapped as potential habitat for protected species and it is possible that these species utilise the habitat when conditions and connectivity permits.

4.1.8 Likelihood of threatened aquatic fauna

The Macintyre River provides suitable habitat for Murray cod. All other waterways surveyed are unlikely to support Murray cod due to a lack of key fish habitat (refer Figure 4.4), including but not limited to semi-permanence of aquatic refuges. No aquatic communities were identified in the PMST report.

The likelihood of occurrence status of threatened species was also informed by a review of resources prepared by the DPI NSW. The Border Rivers Water Resources and Management Overview (Green et al 2012) identifies four threatened aquatic species and one EEC that may be found within the broader catchment:

- River snail (*Notopala sublineata*)
- Silver perch (*Bidyanus bidyanus*)
- Southern purple spotted gudgeon (*Mogurnda adspersa*)
- Olive perchlet (*Ambassis agassizii*) western population, and,
- The EEC, the 'Aquatic Ecological Community in the Natural Drainage System of the Lowland Catchment of the Darling River' (Darling River EEC (FM Act)).

The Darling River EEC includes all native fish and aquatic invertebrates within the natural creeks rivers and streams, lagoons, billabongs, lakes, flow diversions to anabranches and the floodplains of the Darling River and includes the Macintyre River within the rail corridor.

Freshwater threatened species distribution maps prepared by DPI are based on survey records, predicted occurrence and expert opinion (refer Appendix A – Aquatic species profiles). These indicate there are a number of state listed species that are potentially present in the Macintyre River (including the Darling population of the Eel tailed catfish (*Tandanus tandanus*), however this population is not listed in Green et al (2012). Other waterways associated with the proposal (i.e. Mobbindry, Whalan and Back Creek) are also mapped as potential habitat for protected species and it is possible that these species utilise the habitat when conditions and connectivity permit accessibility.

Field investigations undertaken to support the EIS for the Border to Gowrie package of works in the Macintyre River recorded eight native species of fish including the Murray cod and Olive perchlet. Nesting habitat for freshwater turtles was also abundant (ARTC 2020).

It is unlikely that the areas of the waterways (excluding the Macintyre River) that were inspected are currently critical habitat for any of the listed species or populations in Section 3.10.4.

The likelihood of occurrence assessment for the aquatic fauna species identified five species with a 'possible' or 'likely' likelihood of occurring within the proposal study area (Macintyre River) based on the habitat encountered during the field survey including:

- Darling river snail (*Notopala sublineata*) - possible
- Southern purple spotted gudgeon (*Mogurnda adspersa*) - possible
- Murray cod (*Maccullochella peelii*) - known
- Eel-tailed catfish (*Tandanus tandanus*) (Murray – Darling population) - possible
- Olive perchlet (*Ambassis agassizii*) (western population) - likely.

Suitable habitat for these species/populations exists where the main channel of the Macintyre River intersects the proposal study area.

Silver perch was identified as an 'unlikely' likelihood of occurring within the proposal study area (including Macintyre River based on the habitat encountered during the field survey.

The likelihood of occurrence assessment for the aquatic fauna species is presented in Appendix C.

4.2 Field assessment

4.2.1 Aquatic physical habitat values and species diversity

4.2.1.1 Mobbindry Creek

Mobbindry Creek is a tributary of Whalan Creek and is approximately 55 km long. The headwaters of the creek are situated southeast of the township of North Star and flows parallel to the North Star Road in a north westerly direction and appears to discharge into Whalan Creek within the vicinity of the Newell Highway. The proposed rail crossing location is adjacent to the Boggabilla-Warialda Road.

Three sites were assessed on Mobbindry Creek in August 2018 and the site characteristics recorded at the time of the survey are summarised in Table 4.5.The floodplain is broad and undefined adjacent to Mobbindry Creek. The local land use space and the broader catchment are highly modified and impacted by agricultural activities (grazing and cropping). All three sites inspected had similar site characteristics and the creek features are discussed in general below. The riparian corridor comprised of an overstory of *Eucalyptus* sp. and Brigalow with some shrub cover and a good understory cover. The creek bank vegetation included a continuous cover of *Carex* sp. at the normal water line forming trailing bank vegetation. The creek bed was stable and include silts and some sand. The channel form was varied but was dominated by run habitat with some pools present. Obstructions to the waterway include the existing rail and road crossing and there were some natural barriers in the form of large snag piles.

Table 4.5 Summary data from the AUSRIVAS Physical Assessment Protocol Field Data Sheets for the Mobbindry Creek assessed during site investigations in August 2018

Site 1 – D/S of proposed rail crossing		
Stream width (m)	26	
Survey reach (m)	260	
Valley shape	Symmetrical floodplain	
Stream impacts	Grazing	
Floodplain width	Cannot be determined	
Floodplain features	None	
Local land use	Grazing	
Shading of stream channel	26-50%	
Extent of trailing bank veg	Native	80
	Exotic	20
Overall veg disturbance rating	Very high disturbance	
Longitudinal extent of riparian vegetation	LB	Regularly spaced
	RB	Regularly spaced
Channel shape	U shaped	
Bank shape	LB	Convex
	RB	Convex
Bank slope	LB	Moderate
	RB	Moderate
Artificial features at sampling site	Ford and rail bridge u/s	
Habitat score	95	

Site 1 – D/S of proposed rail crossing	
 Upstream	 Downstream

Site 2 – D/S of proposed rail crossing		
Stream width (m)	30	
Survey reach (m)	300	
Valley shape	Symmetrical floodplain	
Stream impacts	Grazing	
Floodplain width	Undefined	
Floodplain features	None	
Local land use	Grazing	
Shading of stream channel	51-75%	
Extent of trailing bank veg	% Native	80
	% Exotic	20
Overall veg disturbance rating	Very high disturbance	
Longitudinal extent of riparian vegetation	LB	Semi-continuous
	RB	Semi-continuous
Channel shape	Deepened U shape	
Bank shape	LB	Concave
	RB	Concave
Bank slope	LB	Low
	RB	Low
Artificial features at sampling site	Nil	
Habitat score	62	

Site 2 – D/S of proposed rail crossing	
 Upstream	 Downstream

Site 3 – U/S of proposed rail crossing		
Stream width (m)	27	
Survey reach (m)	270	
Valley shape	Symmetrical floodplain	
Stream impacts	Grazing	
Floodplain width	Cannot be determined	
Floodplain features	None	
Local land use	Grazing	
Shading of stream channel	26-50%	
Extent of trailing bank veg	% Native	80
	% Exotic	20
Overall veg disturbance rating	Very high disturbance	
Longitudinal extent of riparian vegetation	LB	Clumps
	RB	Regularly spaced
Channel shape	Two stage	
Bank shape	LB	Convex
	RB	Stepped
Bank slope	LB	Moderate
	RB	Moderate
Artificial features at sampling site	Nil	
Habitat score	84	

Site 3 – U/S of proposed rail crossing	
 Upstream	 Downstream

4.2.1.2 Back Creek

Back Creek is a tributary of Mobbindry Creek and is approximately 25 km long. There is a well vegetated riparian zone along both sides of the creek at the crossing location (Site 4) and the upstream site (Site 5), the site downstream (Site 6) of the rail corridor is situated within a Travelling Stock Route and has a well vegetated riparian cover. There was recent evidence of stock presence at the site. The site characteristics recorded at the time of the survey for the three survey sites are summarised in Table 4.6.

The proposed rail crossing site and the upstream rail site (Sites 4 and 5) had similar habitat values. Riparian vegetation was dominated by *Eucalyptus* sp. and Brigalow with shrubs present and good understory of dominated by native species. The bed was dominated by silt and sand with some debris and small snags present. Site 4 was situated immediately upstream of the road and rail crossing.

The downstream site (Site 6) located in the a travelling stock route included a large pool of water. The riparian zone is dominated by an overstory of *Eucalyptus* sp. and the understory was impacted by the recent presence of stock at the site. The top of the banks along the creek are covered by *Carex* sp. The creek channel at this site was approximately 1m deep and 3m wide. The substrate is unconsolidated silt and there is a large number of snags present in the creek. There was a slight sheen to the water and there was an anaerobic odour generated from the sediment when disturbed.

Table 4.6 Summary data from the AUSRIVAS Physical Assessment Protocol Field Data Sheets for the Back Creek assessed during site investigations in August 2018

Site 4 – Proposed rail crossing site		
Stream width (m)	25	
Survey reach (m)	250	
Valley shape	Symmetrical floodplain	
Stream impacts	Grazing	
Floodplain width	Poorly defined	
Floodplain features	Flood channels from paddock	
Local land use	Grazing	
Shading of stream channel	51-75%	
Extent of trailing bank veg	Native	80
	Exotic	20
Overall veg disturbance rating	Very high disturbance	

Site 4 – Proposed rail crossing site		
Longitudinal extent of riparian vegetation	LB	Continuous
	RB	Continuous
Channel shape	Flat U shaped	
Bank shape	LB	Convex
	RB	Convex
Bank slope	LB	Low
	RB	Low
Artificial features at sampling site	Ford at d/s extent	
Habitat score	91	
 Upstream	 Downstream	

Site 5 – D/S rail crossing		
Stream width (m)	18	
Survey reach (m)	180	
Valley shape	Symmetrical floodplain	
Stream impacts	Grazing, roadside litter	
Floodplain width	Entire landscape	
Floodplain features	None	
Local land use	Grazing and native grassland	
Shading of stream channel	51-75%	
Extent of trailing bank veg	% Native	90
	% Exotic	10
Overall veg disturbance rating	Very high disturbance	
Longitudinal extent of riparian vegetation	LB	Clumps
	RB	Semi-continuous
Channel shape	U shaped	
Bank shape	LB	Concave
	RB	Concave
Bank slope	LB	Steep
	RB	Steep
Artificial features at sampling site	Culvert upstream	
Habitat score	129	

Site 5 – D/S rail crossing	
 Upstream	 Downstream

Site 6 – U/S rail crossing		
Stream width (m)	30	
Survey reach (m)	300	
Valley shape	Symmetrical floodplain	
Stream impacts	Grazing	
Floodplain width	~200m	
Floodplain features	None	
Local land use	Grazing	
Shading of stream channel	>76%	
Extent of trailing bank veg	% Native	80
	% Exotic	20
Overall veg disturbance rating	Very high disturbance	
Longitudinal extent of riparian vegetation	LB	Continuous
	RB	Continuous
Channel shape	Flat U shaped	
Bank shape	LB	Concave
	RB	Concave
Bank slope	LB	Flat
	RB	Flat
Artificial features at sampling site	Nil	
Habitat score	94	

Site 6 – U/S rail crossing	
 Upstream	 Downstream

4.2.1.3 Whalan Creek

Whalan Creek is a major creek approximately 60 km long that discharges in a westerly direction into the Macintyre River, downstream of Goondiwindi. Based on the site visits Whalan Creek appears to also receive flows from the Macintyre River during high flow and over bank flow events.

Whalan Creek was assessed from the road at both locations due to restricted access. A large pool was visible form the road at Site 9, however the creek was very dry at the time of the site inspection. The creek is situated within a broad agricultural landscape with a mix of grazing and cropping on both banks. Both sites were highly disturbed/modified with significant impacts to the waterway and the riparian zone.

The downstream site (Site 7) was assessed from the roadside, upstream of the Bruxner Highway. The other site characteristics recorded at the time of the survey are summarised in Table 4.7. Riparian vegetation cover was highly degraded/modified, with an overstory of *Eucalyptus* sp. and *Acacia* sp. providing approximately 40 per cent cover. There was limited evidence of tree regeneration and shrub/ground cover was low. The width of the floodplain was undetermined as there were no distinctive features or changes in vegetation to identify the floodplain extent. However, the entire area adjacent to the creek is a floodplain. The bed of the creek is stable and is dominated by silt and some sand and there was limited fish habitat visible at the site. At the downstream extent of the assessed site is a ford (Bruxner Highway crossing) and a rail bridge crossing.

The proposed crossing location (Site 8) was not assessed due to a lack of access.

The upstream site adjacent to Tucka Tucka Road on Whalan Creek (Site 9) was assessed from the roadside as access was restricted. Whalan Creek was dry at the time of the inspection and had similar habitat values to the downstream site. Other site characteristics recorded during the site visits are outlined in Table 4.7. Riparian vegetation cover was highly degraded/modified, with an overstory of *Eucalyptus* sp. and *Acacia* sp. providing approximately 10 per cent cover. Floodplain width and the creek bed appeared similar to Site 7 and there was a ford crossing at the upstream extent of the site.

Table 4.7 Summary data from the AUSRIVAS Physical Assessment Protocol field data sheets for the Whalan Creek assessed during site investigations in August 2018

Site 7 – Upstream of Bruxner Highway	
Stream width (m)	71
Survey reach (m)	710
Valley shape	Symmetrical floodplain
Stream impacts	Bridge, ford, grazing, litter
Floodplain width	Undetermined

Site 7 – Upstream of Bruxner Highway		
Floodplain features	None	
Local land use	Grazing	
Shading of stream channel	%5	
Extent of trailing bank veg	% Native	60
	% Exotic	40
Overall veg disturbance rating	Very high disturbance	
Longitudinal extent of riparian vegetation	LB	Semi continuous
	RB	Semi continuous
Channel shape	U shaped	
Bank shape	LB	Convex
	RB	Convex
Bank slope	LB	Low
	RB	Low
Artificial features at sampling site	Ford and bridge	
Habitat score	93	
 Upstream	 Downstream	

Site 9 – Adjacent to Tucka Tucka Road		
Stream width (m)	50	
Survey reach (m)	500	
Valley shape	Symmetrical floodplain	
Stream impacts	Litter, ford, grazing	
Floodplain width	Undetermined	
Floodplain features	None	
Local land use	Grazing	
Shading of stream channel	%5	
Extent of trailing bank veg	% Native	50
	% Exotic	50
Overall veg disturbance rating	Very high disturbance	
Longitudinal extent of riparian vegetation	LB	Occasional clumps
	RB	Semi continuous
Channel shape	Two stage	

Site 9 – Adjacent to Tucka Tucka Road		
Bank shape	LB	Convex
	RB	Convex
Bank slope	LB	Low
	RB	Low
Artificial features at sampling site	Ford	
Habitat score	81	
 Upstream	 Downstream	

4.2.1.4 Macintyre River

The Macintyre River is the major river that begins in the northern tablelands between Glen Innes and Guyra. The river is 321 km long and is a tributary of the Barwon River. The proposed rail crossing location is situated between the confluence of the Damaresq River and Macintyre River and Boggabilla.

There is a broad well vegetated riparian floodplain on both sides of the river. Impacts of human disturbance were high at the two sites assessed during the site investigations (Boggabilla and upstream of Toomelah at the Keetah-Boonal road crossing).

An aquatic habitat assessment was completed in August 2018. The site at Boggabilla (Site 12) is located within the township and there is a high level of human impacts at the site. The site assessment was restricted to the left bank of the river at the Boggabilla site due to the depth and width of the river. The other site characteristics recorded at the time of the survey are summarised in Table 4.8. There is an extensive riparian cover along both banks with an over story of *Eucalyptus* sp. and *Melaleuca* sp. The left bank has a substantial cover of weedy species and is heavily impacted by a recent fire. The river bed includes gravel and sand beds with some mud banks and snags. The river level was low but flowing at the time of the survey and provides high value fish habitat. Dip netting and bait trapping (n = 4) was undertaken at the site for two hours and no fish were captured.

The proposed crossing location (Site 10) was not assessed due to a lack of access.

The upstream site on the Macintyre River (Site 11) is located upstream of the confluence of the Damaresq River and Macintyre River and was substantially narrower than the downstream site and was assessed from both banks of the river. Other site characteristics recorded during the site visits are outlined in Table 4.8. The riparian zone is wide and dominated by an overstory of *Eucalyptus* sp., *Casuarina* sp. and *Melaleuca* sp. with some shrubs present and an extensive ground cover. The river was flowing, and the level was low at the time of the site inspection. The river bed included gravel and sand with some snags present. Emergent (*Phragmites australis*) macrophytes were along the banks.

Table 4.8 **Summary data from the AUSRIVAS Physical Assessment Protocol field data sheets for the Macintyre River assessed during site investigations in August 2018**

Site 11 – Keetah-Boonal Road crossing		
Stream width (m)	55	
Survey reach (m)	550	
Valley shape	Symmetrical floodplain	
Stream impacts	Bridge, recreation	
Floodplain width	~85 m	
Floodplain features	Remnant channels	
Local land use	Grazing and cropping	
Shading of stream channel	% 6-25	
Extent of trailing bank veg	% Native	90
	% Exotic	10
Overall veg disturbance rating	Very high disturbance	
Longitudinal extent of riparian vegetation	LB	continuous
	RB	continuous
Channel shape	Two-stage	
Bank shape	LB	concave
	RB	concave
Bank slope	LB	Moderate
	RB	moderate
Artificial features at sampling site	Old bridge	
Habitat score	152	
 Upstream	 Downstream	

Site 12 – Boggabilla		
Stream width (m)	102	
Survey reach (m)	1,200	
Valley shape	Symmetrical floodplain	
Stream impacts	Litter, recreation, fire	
Floodplain width	~200 m	
Floodplain features	Oxbow billabongs and scroll systems	
Local land use	Urban res and recreation	

Site 12 – Boggabilla		
Shading of stream channel	%5	
Extent of trailing bank veg	% Native	75
	% Exotic	25
Overall veg disturbance rating	Very high disturbance	
Longitudinal extent of riparian vegetation	LB	continuous
	RB	continuous
Channel shape	U-shaped	
Bank shape	LB	stepped
	RB	concave
Bank slope	LB	Low
	RB	steep
Artificial features at sampling site	nil	
Habitat score	135	
 Upstream	 Downstream	

4.2.1.5 Unnamed tributary of Mobbindry Creek

The unnamed tributary of Mobbindry Creek is a short drainage line approximately 5 km long. The creek line is highly modified and impacted by agricultural land use. Only two sites were assessed on the drainage line, Site 14 was located upstream of the proposed crossing (1st order) and Site 15 was located downstream (2nd order) of the proposed rail crossing. Site 13 was located at the proposed rail crossing and was not assessed as the waterway at the upstream site has been diverted to discharge into Mobbindry Creek upstream of the road crossing and subsequently the waterway at site 13 only discharges road runoff. The site characteristics recorded at the time of the survey are summarised in Table 4.9.

The creek at the downstream site (Site 15) was narrow and shallow with a uniform sand bed. The waterway was narrower at the downstream site due to the diversion at Site 13. The riparian zone is completely non-existent and has been removed for agricultural activity. There was a small upstream dam situated upstream of the survey location.

The upstream site (Site 14) was much wider than the downstream site. The drainage line is located in an agricultural paddock and has been extensively modified. A track and culverts has been constructed across the drainage line. The drainage line is 30 m wide and the bed consists of highly mobile silt and sand that has a scoured low flow channel within it. Levees have been constructed along both banks. There is no riparian vegetation along either bank.

Table 4.9 **Summary data from the AUSRIVAS Physical Assessment Protocol Field Data Sheets for the Unnamed tributary of Mobbindry Creek assessed during site investigations in August 2018**

Site 14 – U/S of proposed rail crossing		
Stream width (m)	30	
Survey reach (m)	300	
Valley shape	Symmetrical floodplain	
Stream impacts	Ford, channel straightening, levee along both banks	
Floodplain width	Too broad to measure	
Floodplain features	None	
Local land use	Rainfed cropping	
Shading of stream channel	>5%	
Extent of trailing bank veg	Native	80
	Exotic	20
Overall veg disturbance rating	Extreme disturbance	
Longitudinal extent of riparian vegetation	LB	None
	RB	None
Channel shape	Flat U shaped	
Bank shape	LB	Convex
	RB	Convex
Bank slope	LB	Moderate
	RB	Moderate
Artificial features at sampling site	Levee on cropping area banks	
Habitat score	48	
 Upstream	 Downstream	

Site 15 – D/S of proposed rail crossing	
Stream width (m)	9
Survey reach (m)	90
Valley shape	Shallow valley
Stream impacts	On stream dam
Floodplain width	Whole area
Floodplain features	None
Local land use	Rain-fed cropping

Site 15 – D/S of proposed rail crossing		
Shading of stream channel	>5%	
Extent of trailing bank veg	% Native	80
	% Exotic	20
Overall veg disturbance rating	Extreme disturbance	
Longitudinal extent of riparian vegetation	LB	None
	RB	None
Channel shape	U shaped	
Bank shape	LB	Convex
	RB	Convex
Bank slope	LB	Low
	RB	Low
Artificial features at sampling site	None	
Habitat score	64	
 Upstream	 Downstream	

4.2.1.6 Forest Creek

Forest Creek is over 20 km long and discharges in a north westerly direction and appears to discharge into Whalan Creek although the flow path is not clearly defined downstream of the road crossing (Site 18).

An aquatic habitat assessment was completed in August 2018. The site characteristics recorded at the time of the survey for Forest Creek are summarised in Table 4.10. The floodplain is broad and poorly defined along the creek. There is a mixed coverage of riparian vegetation dominated by *Casuarina* sp. along the creek line at the sites surveyed. The channel was variable in form at all three sites.

The upstream site (Site 17) has a broad shallow bed. There is some riparian vegetation dominated by *Casurina* sp. The bed of Forest Creek is dominated by silt and sand with some gravel. The creek bed is vegetated with a mixture of terrestrial species with evidence of aquatic species in some shallow depressions.

The crossing site (Site 16) is highly modified, the waterway has been highly modified and an onstream dam has been constructed and all flows diverted to the dam. Two levees have been constructed that divert overland flow toward the creek to the onstream dam before excess water is able to bypass the dam. Downstream of the dam the existing rail line has formed a barrier to flows. The rail line and levee banks have altered the hydrology of the site between the dam and the rail line that has allowed a stand of *Casuarina* sp. to establish.

The downstream site (Site 18) is also highly modified and impacted by the culverts under the road crossing. There was no defined channel or flow path at the site except for the culvert under the roadway. The road way has altered the hydrology of the area upstream as indicated by the vegetation (*Casuarina* sp. and Nardoo *Marsilea* sp.).

Table 4.10 Summary data from the AUSRIVAS Physical Assessment Protocol Field Data Sheets for the Forest Creek assessed during site investigations in August 2018.

Site 16 – @ rail crossing		
Stream width (m)	30	
Survey reach (m)	300	
Valley shape	Symmetrical floodplain	
Stream impacts	Water extraction, grazing, diversion of creek	
Floodplain width	Broad undefined	
Floodplain features	Splays caused by Casuarina d/s dam overflow	
Local land use	Grazing	
Shading of stream channel	51-75%	
Extent of trailing bank veg	Native	70
	Exotic	30
Overall veg disturbance rating	Very high disturbance	
Longitudinal extent of riparian vegetation	LB	Clumps
	RB	Clumps
Channel shape	Widened	
Bank shape	LB	N/A
	RB	N/A
Bank slope	LB	Flat
	RB	Flat
Artificial features at sampling site	Levee banks and Dam	
Habitat score	26	
 Upstream	 Downstream	

Site 17 – U/P of rail crossing	
Stream width (m)	41
Survey reach (m)	400
Valley shape	Symmetrical floodplain
Stream impacts	Grazing, cropping

Site 17 – U/P of rail crossing		
Floodplain width	Drains over floodplain with high ground to east	
Floodplain features	None	
Local land use	Rainfed Cropping	
Shading of stream channel	<5%	
Extent of trailing bank veg	% Native	99
	% Exotic	1
Overall veg disturbance rating	Very high disturbance	
Longitudinal extent of riparian vegetation	LB	Clumps
	RB	Clumps
Channel shape	Widened	
Bank shape	LB	Convex
	RB	Convex
Bank slope	LB	Flat
	RB	Flat
Artificial features at sampling site	None	
Habitat score	39	
 Upstream	 Downstream	

Site 18 – D/S of rail crossing		
Stream width (m)	Not determined	
Survey reach (m)	200	
Valley shape	Symmetrical floodplain	
Stream impacts	Road, bridge, grazing	
Floodplain width	Broad undefined	
Floodplain features	None	
Local land use	Grazing	
Shading of stream channel	51-75%	
Extent of trailing bank veg	% Native	90
	% Exotic	10
Overall veg disturbance rating	Very high disturbance	
Longitudinal extent of riparian vegetation	LB	N/A
	RB	N/A
Channel shape	Widened	

Site 18 – D/S of rail crossing		
Bank shape	LB	Convex
	RB	Convex
Bank slope	LB	Flat
	RB	Flat
Artificial features at sampling site	Culvert	
Habitat score	69	
 Upstream	 Downstream	

4.2.1.7 In-situ water quality

As described in Section 5.4.2.1 most the waterways were dry at the time of field assessment which includes three sites in Mobbindry Creek, two sites in Back Creek, all sites in Whalan Creek, one site in the Macintyre River, three unnamed tributaries of Mobbindry Creek and two sites within Forest Creek. As such only limited water quality data could be gathered from four sites in total (refer Table 4.11). Given the lack of rainfall in the period preceding the assessment water quality at the sites assessed has been compromised and is not considered representative of times of normal flows. Macroinvertebrate sampling was not completed at any of the sites and is outside of the scope of this assessment. Detailed water quality inclusive of laboratory analysis is presented in the Surface Water Quality Technical Report.

Table 4.11 In-situ water quality

Site No.	Waterway/ comment	Temp (ºC)	Conductivity (µs/cm)'	DO (mg/l)	DO (Saturated) (%)	pH	Turbidity	Salinity	Alkalinity (mg/l)
5	Back Creek/ sample from large pool	8.3	261.1	3.9	34.2	7.21	119	0.12	35
11	Macintyre River/ continuous	11.7	428.6	9.44	89.5	7.92	13.1	0.21	65
12	Macintyre River/ continuous	12	410.3	8.79	83.5	7.74	12.5	0.2	55
16	Forest creek/ sample taken from isolated pool	15.7	516.4	9.29	96.8	8.18	74.5	0.25	90

4.2.1.8 Incidental aquatic fauna surveys

Due to a paucity of suitable sample locations as a result of drought conditions the survey effort for incidental aquatic fauna survey was low. Surveys only occurred at the Back Creek (Site 5) and Macintyre River (Sites 11 and 12). Despite the presence of a small pool at Forest Creek (Site 16) no incidental aquatic surveys were undertaken.

No fauna were observed at any location where samples were completed. A species of freshwater mussel was (*Alathyria jacksoni*) was recorded on Mobbindry Creek despite all three sites being dry at the time of assessment. This species is not listed.

4.2.2 Comparison with water quality trigger values and variability

A summary of the surface water quality variability of the catchment is provided below. For further detail, refer to EIS Appendix G: Surface water quality technical report.

The habitats of the Border Rivers Catchment are known for their diversity of hydrological environments and the varied responses of different species to varying dryness or flood (as discussed in DES 2018). These ecosystems are well represented with species adapted to ephemeral water availability. Many aquatic organisms in this environment are adapted to these drying phases and persist in pools/waterholes which act as refugia (DES 2018). As water availability changes, so does water quality since the compounds in the water column (such as salts) may become more concentrated as pools dry. Persistence in the waterholes would be determined by physiological thresholds of individual species. Floods and floodplain connectivity act to relieve these physiological stressors and are typically triggers for migration and breeding. Therefore, increased concentrations or decreased water availability may reduce the viability of some species if floods recur at infrequent intervals.

Only a limited assessment of temporal and spatial variability in surface water quality can be made as only one round of surface water quality monitoring has been conducted at four monitoring locations. In addition, it is noted that monitoring was conducted during spring which is outside the peak rainfall period for the area. Therefore, surface water monitoring results may not be representative of average conditions. Given that there was < 2 mm rain for a period of approximately 40 days prior to the August 2018 sampling event, evaporation of the pooled water is likely to have occurred, potentially resulting in increased concentrations of some water quality parameters.

Back Creek and Forest Creek - Physico-chemical data and laboratory assessment of water quality indicate that there is an observable anthropogenic impact at these sites. Both of these watercourses had elevated total phosphorus and nitrogen loads exceeding regional water quality trigger values.

Macintyre River - The two Macintyre River monitoring sites were closer to regional water quality trigger values for nutrients, however the site downstream of the proposal alignment exceeded water quality trigger values for three heavy metals, Chromium (VI), Copper and Nickel.

Long term electrical conductivity data from the gauging stations located upstream of the proposal alignment, at the Dumaresq River and Macintyre River site indicated that the values observed within the single field survey were comparable to long term datasets.

Laboratory analysis of poly aromatic hydrocarbon concentrations at all sites were below detection limits, indicating no continued point source contamination of sampled sites, though it is recognised that these compounds are volatile and may not be very persistent in the environment.

In summary, noting the constraint of limited field data, it is evident that during dry conditions, the watercourses that cross the proposed alignment have water quality values that are not fully meeting WQOs. It should be noted that conditions for the Forest and Back Creek (pools) during sampling do not constitute base-flow conditions used for an objective basis, and hence these data should to be compared with caution for the assessment of water quality trigger values.

5 Ecological values

5.1 Ecological values

Consistent with the relevant legislation as stated in Section 2, the overarching ecological values adopted for the proposal study area for the proposal consisted of the following:

- NSW natural environmental and native flora, fauna and ecological communities
- Finite natural resources, including conservations parks, and wetlands
- Land conducive to the maintenance of existing land forms, ecological health, biodiversity, riverine and wetland areas
- Biodiversity.

5.2 Ecological receptors

For conservation significant receptors, predictive habitat mapping has been used to assess the species potential to occur within the proposal study area. In instances where species/communities did not have potential habitat contained within the proposal study area, these species were not subject to impact assessment and were no longer considered to constitute receptors as the risk of impacts to any these species are considered low.

Within this assessment, the silver perch (*Bidyanus bidyanus*) is identified as not having potential habitat within the proposal study area (refer Section 4.1.8) and has been removed as a potential ecological receptor.

The remaining aquatic ecological receptors (*sans* silver perch) within the proposal study area are identified in Table 5.1 along with their assigned sensitivity value as determined by Table 3.4.

Table 5.1 Identified aquatic ecological receptors within the proposal study area

Associated ecological value	Identified ecological receptors	Assigned sensitivity (refer Table 3.4)	Justification
▪ Native flora and fauna ▪ Biodiversity	Threatened aquatic fauna species listed under the provisions of the EPBC Act: **Aquatic fauna:** ▪ Murray cod (*Maccullochella peelii*)	High	▪ Protected by EPBC Act ▪ Rare ▪ High sensitivity, high vulnerability
▪ Native flora and fauna ▪ Biodiversity	Threatened aquatic fauna species, populations and communities listed under the provisions of the FM Act (NSW): **Aquatic fauna:** ▪ Darling river snail (*Notopala sublineata*) ▪ Eel-tailed catfish (Murray – Darling population) (*Tandanus tandanus*) ▪ Silver perch (*Bidyanus bidyanus*) ▪ Southern purple spotted gudgeon (*Mogurnda adspersa*) ▪ Western olive perchlet (Western population) (*Ambassis agassizii*) ▪ Darling River EEC	High	▪ Protected by FM Act ▪ Rare ▪ High sensitivity, high vulnerability
▪ Land conducive to the maintenance of existing land forms, ecological health, biodiversity, riverine and wetland areas ▪ Biodiversity.	Important and local wetlands	Moderate	▪ The receptor is in moderate condition as a result of threatening processes, which have degraded its intrinsic value ▪ May provide habitat for threatened species
	Waterways and riparian buffers	Moderate	▪ The receptor is in moderate condition as a result of threatening processes, which have degraded its intrinsic value ▪ May provide habitat for threatened species
	Type 1 fish habitat: ▪ Mobbindry Creek ▪ Back Creek ▪ Whalan Creek ▪ Macintyre River	Moderate	▪ The receptor is in a moderate to good condition despite it being exposed to threatening processes. It retains many of its intrinsic characteristics and structural elements ▪ May provide habitat for threatened species
	Type 3 fish habitat: ▪ Unnamed tributary of Mobbindry Creek ▪ Forest Creek	Low	▪ The receptor is in a poor to moderate condition as a result of threatening processes, which have degraded its intrinsic value

6 Potential impacts and impact mitigation

The location and type of the disturbance footprint associated with the proposal has been determined through the feasibility design process. In order to have a consistent assessment process to determine impacts associated with the proposal, potential impacts (within this section) are assessed in an impact assessment (refer Section 7).

Proposal activities and associated potential impacts to aquatic biodiversity are described in the following sections. These impacts are then assessed against the sensitive environmental values, with standard mitigation considered as part of 'pre-mitigation' impact assessment. Identification of additional mitigation measures and assessment of the residual risk of impact with all mitigation in place is also provided within this section.

6.1 Proposal activities

Infrastructure activities proposed as part of the proposal have been categorised into three phases; construction, commissioning and reinstatement, and operation. A description of proposal related activities and the duration of their disturbance is provided in Table 6.1.

Table 6.1 Description of proposal related activities associated with construction, commissioning and reinstatement, operation, and decommissioning phases

Phase	Infrastructure activity	Description of activities	Duration of disturbance (refer Table 3.3 for definitions)
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	Medium term
		Installation of offices, hardstands, etc.	Medium term
		Stockpiling	Medium term
	Utility diversions	Excavation	Permanent
		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	Permanent
		Road/rail bridge construction	Permanent
	Civil works	Cutting construction	Permanent
		Embankment construction using cut to fill from rail alignment and borrow to fill from external borrow sources, where required	Permanent
		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

Phase	Infrastructure activity	Description of activities	Duration of disturbance (refer Table 3.3 for definitions)
	Rail construction	Drilling	Temporary
		Blasting	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
		Removal of redundant structures	Temporary
		Decommissioning work site signs	Temporary
		Decommissioning access roads	Short term
		Forming and stabilising of spoil mounds	Short term
	Signals and communications installation	Removal of temporary fencing	Temporary
Commissioning and reinstatement	Demobilisation/ Decommissioning	Establish permanent fencing	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 rail corridor	Permanent
Decommissioning	Trains decommissioned	Increased vehicle movement within rail corridor	Short term

6.2 Nature of impacts

The following impacts may potentially occur to the aquatic environment as a result of the proposal:

- Mortality of obligate aquatic fauna and flora species as a result of construction activities (e.g. vehicle strikes, removal and/or disturbance of nests and burrows, adverse impacts to water quality)

- Creation or exacerbation of barriers to fish and other aquatic fauna movement (e.g. physical barriers such as rock beds, hydraulic barriers such as areas of high velocity flows where channels are created, chemical barriers such as pollution plumes from point sources such as hydrocarbon spills, noise and vibration, or behavioural barriers such as dark tunnels created by culverts)
- Further fragmentation of aquatic habitat as a result of the instalment of road-based infrastructure resulting in a potential loss of biodiversity value from a reduction in ecosystem services
- Introduction of non-native aquatic species and pathogens such as the introduction of noxious fish, aquatic weeds and diseases. The effects of proliferation of weed and pest species may not be noticeable immediately or even in the short term, as visible signs may take several months or seasons to impact on 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 habitat for threatened species, wetlands and waterways.

The loss of habitat within the proposal disturbance area may influence fauna densities and distributions, and potentially result in localised species population oscillations and declines. This may occur as a result of the following mechanisms:

- Impact on invertebrate biodiversity through vegetation clearing and drainage line modification which would impact on higher trophic organisms (e.g. reptiles, fish and aquatic birds)
- Reduced plant-animal interaction and symbiotic relationships (e.g. plant pollinator and dispersal interactions) resulting in a loss of ecosystem services (and consequent value)
- Reduction of naturally occurring microhabitats available within an area to the extent that not all life stages of aquatic organisms are supported (e.g. instream structures, loss of riparian habitat) resulting in a loss of aquatic biodiversity value
- Removal of specialised breeding habitat (e.g. sand banks) resulting a loss of aquatic biodiversity value
- Vegetation clearing may increase the pressure and exposure from other processes, including erosion, exotic/pest species, and water quality degradation.

Potential impacts to water quality and flow during the construction phase may be caused by soil erosion from vegetation clearing, sedimentation from construction of batter slopes and fill embankment, nitrification from chemical use and revegetation activities, and from the disturbance of waterway and drainage line beds and banks. 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. 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. The potential impact may result in specific instances of:

- Increased turbidity
- Smothering of benthic organisms
- Reduced water clarity and sunlight penetration, impacting submerged aquatic plants
- Dissolved oxygen depletion from loss of aquatic plants
- Eutrophication (excessive nutrient enrichment) of waterways and subsequent algal blooms and dissolved oxygen depletion.

A range of mitigation measures have been identified and will be implemented to reduce impacts from the construction and operation of the proposal on aquatic ecology. These mitigations will be identified in a construction environmental management plan (CEMP) and for site management plans. These plans will include erosion and sediment control measures, requirements wildlife spotter catcher and restricting vegetation clearing to the minimum required to complete the proposal).

6.3 Impact mitigation

This section outlines the impact mitigation measures included as part of the proposal design. The mitigation measures proposed to manage predicted environmental impacts are also described. The impacts are initially assessed with consideration of the design mitigation measures and then reassessed to determine residual impact after the amended of the proposed mitigation measures.

6.3.1 Design considerations

The mitigation measures and controls presented in Table 6.2 have been factored into the feasibility designs for the proposal. These design considerations are proposed to minimise the environmental impacts of the proposal on flora and fauna and therefore contribute to a lowering of the initial impact risk rating for each potential impact.

Table 6.2 Initial mitigations of relevance to aquatic ecology

Aspect	Initial mitigations
Minimisation of impacts to aquatic ecology	■ Portions of the proposal are located within the existing rail corridor and wherever possible, has been aligned to be co-located with existing road infrastructure, minimising the need to develop natural and rural landscapes that have not previously been subject to disturbance to the greatest extent possible. However, the alignment is within a protected corridor, so avoidance opportunities are limited ■ Disturbance footprints will be limited to those areas required to construct and operate the works, as practical for safety, especially in regard to the clearing of existing vegetation communities ■ The rail corridor is typically 40 m wide, with wider areas to provide temporary and permanent erosion and sediment control measures/pollution control measures, where required ■ Disturbance footprints are limited to that required to construct the works and associated environmental management controls ■ Design defines temporary and permanent storm water, erosion and sediment/pollution control measures in an Erosion and Sediment Control Plan and Reinstatement and Rehabilitation Plan, that complies with the relevant regulatory requirements and guidance. 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 plans are to also establish and specify the monitoring and performance objectives for handover on completion of construction ■ Watercourse crossing structures (including culverts and bridges) are designed to minimise the need for ongoing maintenance and inspection to maintain aquatic fauna passage and minimise the risk of blockages in reference to fish passage requirements (Fairfull and Witheridge 2003) and the Policy and guidelines for fish habitat conservation (DPI 2013) ■ Bridges and waterway crossings are designed to minimise impacts to bed, banks and environmental flows, in accordance with relevant regulatory requirements (as per requirements of DPI and the FM Act 1994)

6.3.2 Mitigation measures

In order to manage and mitigate proposal risks during construction mitigation measures have been proposed. In the construction phase of the proposal, dust sources will be variable and transitory in nature and the potential for impacts will vary with proximity to sensitive receptors. Construction phase mitigations have been identified with consideration of this potential for variability.

The proposed additional mitigation measures are presented in Table 6.3. These proposed mitigation measures respond to proposal specific issues and opportunities, address legislative requirements, and incorporate both ARTC and industry standard practice. The measures have been presented separately for each phase of the proposal.

These proposed mitigation measures have been segregated with the phase during which they would be implemented:

- Detailed design
- Pre-construction
- Construction
- Operation.

Table 6.3 Proposed additional mitigation measures

Delivery phase	Aspect	Proposed mitigation measures
Detailed design	Aquatic biodiversity	■ Undertake detailed design and/or construction planning to minimise the construction footprint and avoid impacts to vegetation as far as practicable. Clearing of vegetation will be limited as far as practicable and disturbance is to only occur within the approved footprint ■ Develop a Soil Management Sub-plan which includes procedures and protocols relevant to potential impacts to the receiving environment: – Soil/land conservation objectives for the proposal – Management of problem soils (refer Chapter 15: Land Resources and Contamination), such as: ■ Cracking clays (vertosols) that are expected to be encountered directly south of the Macintyre River ■ Saline soils, particularly in potential expression areas such as soil salt stores, artificial restrictions and roads. – Specification of the type and location of erosion and sediment controls. The erosion and sediment control measures, developed in accordance with the 'Managing Urban Stormwater' series (Bluebook) to be implemented during construction of the proposal include: ■ Minimise disturbance of areas identified as susceptible to erosion ■ Where possible use existing tracks. Design new access tracks (permanent and temporary) with the aim of minimising disturbance of substrates and vegetation ■ Water quality and erosion control measures that consider site specific soil types ■ Prescribed erosion and sediment controls relevant to the site risk.
	Aquatic fauna	■ The design will continue to be developed to minimise the extent of impacts to waterways, riparian vegetation and in-stream flora and habitats, in accordance with the current applicable policies/legislation ■ The detailed design will be developed to minimise the potential for watercourse diversion, as defined under the FM *Act 2000* ■ Detailed design and construction will be undertaken to ensure fish passage is maintained. Any watercourse crossing structures will be designed in accordance with *Why do fish need to cross the road? Fish passage requirements for waterway crossings* (Fairfull and Witheridge 2003)
	Riparian vegetation and aquatic habitats	■ The design will continue to be developed to minimise the extent of impacts to waterways, riparian vegetation and in-stream flora and habitats, in accordance with relevant policies and guidelines, including: – Policy and Guidelines for Fish Habitat Conservation and Management Update 2013 – Guidelines for controlled activities on waterfront land (DPI 2012).

Delivery phase	Aspect	Proposed mitigation measures
	Water quality	■ A Surface Water Management Sub-plan will be developed as a component of the CEMP. The Sub-plan will provide a surface water monitoring framework for the proposal that establishes: – Frequency, testing requirements and location of surface water sampling during construction of the proposal, with consideration for: ■ Construction activities with potential to impact water quality ■ Seasonality ■ Sensitivity of receiving watercourse. – A risk management framework for evaluation of the risks to surface water quality and ecosystems in the receiving environment, including definition of instances (including accidental discharge of contaminants and sediments) that trigger contingency and ameliorative measures – Responses to impact threshold exceedances.
	Weeds and pests	■ A Biosecurity Management Sub-plan will be developed as a component of the CEMP in accordance with the Biosecurity Act 2015 ■ Property-specific biosecurity requirements will be agreed with the relevant landowner/operator prior to pre-construction/construction activities occurring on that property. Agreed protocols will be documented in individual property management agreements, to be signed by ARTC and the landowner/operator.
	Offsets	■ A biodiversity offset strategy will be developed in consultation with the Department of Agriculture, Water and the Environment (Commonwealth) and the Department of Planning, Industry and Environment (NSW)
Pre-construction/ Construction	Riparian vegetation and aquatic habitats	■ Plant maintenance activities and refuelling must be carried out a minimum of 50 m from riparian vegetation and waterways, where practical, with appropriate interception measures in place to avoid impacts to waterways, aquatic habitats, and groundwater. Where this cannot be achieved, as risk management approach will be applied with additional management controls applied appropriate to the level of environmental risk ■ The Surface Water Management Sub-plan, as a component of the CEMP, will be implemented (refer above) ■ Works within or adjacent to watercourses will be conducted in accordance with the intent of: – Policy and Guidelines for Fish Habitat Conservation and Management Update 2013 – Guidelines for controlled activities on waterfront land (DPI 2012) – The salvage and relocation of fish within isolated aquatic environments will be managed in accordance with the Policy and Guidelines for Fish Habitat Conservation and Management Update 2013 – Why do fish need to cross the road? Fish passage requirements for waterway crossings (Fairfull and Witheridge 2003). ■ 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. ■ Construct temporary and permanent watercourse crossing structures in accordance with the detailed design and State code 18: Constructing or raising waterway barrier works in fish habitats. This is required to minimise impacts to aquatic fauna (i.e. fish passage) and hydrology during construction and operation.
	Weeds and pests	■ The Biosecurity Management Sub-plan, as a component of the CEMP, will be implemented (refer above) ■ The effectiveness of weed hygiene measures will be monitored as a component of the environmental monitoring procedure for the proposal ■ Vegetation material will be managed with a general biosecurity duty to prevent, eliminate or minimise any cross contamination due to the spreading of known weeds ■ ARTC's Enviroline (a phone hotline) will be advertised for the proposal to enable members of the public to notify ARTC of issues, including concerns regarding weeds and pests.

Delivery phase	Aspect	Proposed mitigation measures
	Erosion and sediment control	■ Implement the Soil Management Sub-plan including erosion and sediment controls as a component of the CEMP.
	Rehabilitation and landscaping	■ The Rehabilitation and Landscaping Management Sub-plan, as a component of the CEMP, will be implemented (refer above) ■ Rehabilitation of disturbed areas will be undertaken progressively and in accordance with the rehabilitation management sub-plan.
Operation	Riparian vegetation and aquatic habitats	■ Maintenance activities within or adjacent to watercourses will be conducted in accordance with relevant NSW policies and guidelines.
	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 2015* and incorporated into the OEMP. 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, due to sensitivity to spray-drift from the application of pesticides and herbicides. – Erosion and sediment control risks associated with broad scale weed removal or treatment. ■ ARTC's Enviroline will be advertised for the proposal to enable members of the public to notify ARTC of issues, including concerns regarding weeds and pests.

7 Assessment of significance of impacts

Potential impacts during construction, commissioning/reinstatement and operation have been assessed in accordance with the impact assessment methodology outlined in Section 3.4.

The initial significance assessment was undertaken on the assumption that the design measures factored into the Project design have been implemented (refer Section 6.3.2). The residual significance level of the potential impacts is reassessed taking into consideration the implementation of the proposed additional mitigation measures listed in Table 6.3. This has been split into consideration of the construction phase, the commissioning and reinstatement phase, and operations. Offsets in response to residual impacts are discussed in Section 9.

7.1 Quantification of potential magnitude of impacts

Quantitative estimations 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. The feasibility design of the Project disturbance footprint was used to calculate the "unmitigated' disturbance area as a percentage of the extent of the occurrence of the sensitive environmental receptor within the broader Project context (i.e. the proposal study area).

The aquatic ecological receptors listed within Table 7.1 are all identified as impacted approximately 2-13 per cent of the existing habitat of the greater area disturbed. As the impacts from the proposal are typically considered to be transient in nature (especially during construction), a moderate magnitude of disturbance is effective across each of the receptors with a quantifiable area of potential disturbance from within the proposal disturbance footprint.

Additionally, due to the ephemeral nature of most waterways within the proposal study area, the Macintyre River is identified as the principal environmental habitat for the aquatic ecological receptors in Table 7.1. As such, the coverage and unmitigated potential habitat disturbance to each of the receptors (with the exception of fish habitat) are identical due to the identification of the Macintyre River as the habitat considered to be potentially impacted.

Table 7.1 Estimation of potential magnitude of disturbance for each of the environmental receptors identified for the proposal

Environmental receptor	Total coverage of ecological receptor within the proposal study area (1km buffer). Context area extent = 12783.38 ha	Total unmitigated potential disturbance area associated with the disturbance footprint extent = 700.86 ha	Percentage (%) disturbance to receptors within the disturbance footprint area based on the unmitigated potential disturbance	Magnitude of disturbance area (refer Table 3.2 for magnitude criteria)[#]
Commonwealth significant ecological constraints				
Threatened fauna habitat (EPBC Act):				
Murray cod (*Maccullochella peelii*)	38.13	1.51	3.96	Moderate
Aquatic threatened species, populations and EECs (FM Act)				
Darling river snail	38.13	1.51	3.96	Moderate
Southern purple spotted gudgeon	38.13	1.51	3.96	Moderate
Eel-tailed catfish (Murray-Darling population)	38.13	1.51	3.96	Moderate
Western olive perchlet (Western population)	38.13	1.51	3.96	Moderate
Darling River EEC	38.13	1.51	3.96	Moderate
Key Fish Habitats				
Type 1 and Type 3 fish habitat	396.19	14.60	3.69	Moderate

7.2 Initial assessment of potential impact significance

The initial assessment of impacts resulting from initial mitigation measures presented in Table 6.2 were determined for each phase of the proposal for the identified ecological receptors presented in Table 5.1. Each receptor's sensitivity was determined using the criteria presented in Table 3.4 and presented in Table 7.1. Sensitivity of the receptor and the magnitude of potential impacts to the receptor allowed calculation of significance of impact in accordance with Table 7.1.

Following the calculation of significance for the initial mitigation scenario (including the design mitigation measures), the proposal impact mitigation measures presented in Table 6.2 (*excluding the use of Offsets*) were then considered and the significance was then recalculated using the adjusted magnitude where applicable. The calculated significance of impacts is presented in Table 7.2. The initial magnitude of impacts used in Table 3.2, take into consideration those associated with direct impacts also considers those impacts associated Air Quality, Surface water and Hydrology, Groundwater, and Noise and vibration.

The impacts to ecological receptors displayed below in Table 7.2 have been grouped by:

- Receptor (e.g. Commonwealth listed threatened species)
- Sensitivity (e.g. low, moderate, high)
- Magnitude of direct disturbance (refer to Table 3.2).

Using the information presented within Section 6 the initial assessment impacts were determined for each phase of the proposal for the identified ecological receptors presented in Table 5.1. The initial impact assessment incorporated the design mitigation measures. Following the calculation of significance for the initial impact scenario, the proposed additional mitigation measures (refer Section 6.3.2) were then considered and the significance was then recalculated using the adjusted magnitude where applicable. The calculated significance of impacts is presented in Table 7.2.

Table 7.2 Initial assessment of impact significance as a result of the proposal upon identified ecological receptors

Threatened species, population or endangered community	Sensitivity (refer Table 3.6)	Phase	Potential impacts[1]	Initial significance (application of initial mitigation measures in Table 6.2)		Proposed additional mitigation measures to be applied (refer Table 6.3)	Residual significance following the application of proposal mitigation measures presented in Table 6.3)	
				Magnitude	Significance		Magnitude	Significance[3]
Commonwealth significant ecological constraint (Species listed under the EPBC Act): **Fauna:** ▪ Murray cod (*Maccullochella peelii*)	High	Construction	▪ Aquatic habitat loss and degradation from vegetation clearing/removal ▪ Fauna species injury or mortality ▪ Displacement of flora and fauna species from invasion of weed and pest species ▪ Edge effects ▪ Habitat fragmentation ▪ Barrier effects ▪ Noise, dust and light impacts ▪ Increase in waste (litter) ▪ Erosion and sedimentation	High	Major	▪ Flora and fauna (design, preconstruction and construction proposed mitigation measures) ▪ Aquatic fauna (design and construction) ▪ Weeds and pests (preconstruction and construction mitigation measures) ▪ Erosion and sediment control (pre-construction and construction) ▪ Riparian vegetation and aquatic habitats (construction) ▪ Fauna passage (design and construction) ▪ Fauna fencing (design and construction)	Moderate	High (refer to Section 7.3.1for further assessment past this initial assessment of residual significant impact)
		Commissioning and reinstatement	▪ Displacement of flora and fauna species from invasion of weed and pest species ▪ Noise, dust and light impacts	Low	Moderate	▪ Flora and fauna (design, preconstruction and construction proposed mitigation measures) ▪ Weeds and pests (preconstruction and construction mitigation measures) ▪ Erosion and sediment control (construction) ▪ Landscape, rehabilitation and stabilisation (design, pre-construction, construction)	Negligible	Low (refer to Section 7.3.1 for further assessment past this initial assessment of residual significant impact)

Threatened species, population or endangered community	Sensitivity (refer Table 3.6)	Phase	Potential impacts[1]	Initial significance (application of initial mitigation measures in Table 6.2)		Proposed additional mitigation measures to be applied (refer Table 6.3)	Residual significance following the application of proposal mitigation measures presented in Table 6.3)	
				Magnitude	Significance		Magnitude	Significance[3]
		Operation	▪ Aquatic habitat loss and degradation from vegetation clearing/removal ▪ Fauna species injury or mortality ▪ Displacement of flora and fauna species from invasion of weed and pest species ▪ Noise, dust and light impacts	Low	Moderate	▪ Weeds and Pests (operations) ▪ Riparian vegetation and aquatic habitats (operations) ▪ Fauna fencing (operations) ▪ Fauna passage (design and construction)	Negligible	Low (refer to Section 7.3.1 for further assessment past this initial assessment of residual significant impact)
State significant ecological constraint (species/populations/communities listed under the FM Act as threatened): **Aquatic fauna:** ▪ Darling River snail (*Notopala sublineata*)^ ▪ Southern purple spotted gudgeon (*Mogurnda adspersa*)^ ▪ Eel-tailed catfish (Murray-Darling population) (*Tandanus tandanus*)^ ▪ Western olive perchlet (western population) (*Ambassis agassizii*)^	High	Construction	▪ Aquatic habitat loss and degradation from vegetation clearing/removal ▪ Aquatic fauna species injury or mortality ▪ Displacement of aquatic flora and fauna species from invasion of aquatic weed and pest species ▪ Habitat fragmentation ▪ Barrier effects ▪ Erosion and sedimentation	High	Major	▪ Flora and fauna (design, preconstruction and construction proposed mitigation measures) ▪ Aquatic fauna (design and construction) ▪ Weeds and pests (preconstruction and construction mitigation measures) ▪ Erosion and sediment control (pre-construction and construction) ▪ Riparian vegetation and aquatic habitats (construction) ▪ Fauna passage (design and construction)	Moderate	High (refer to Section 7.3.2 and Appendix F for further assessment past this initial assessment of residual significant impact)

Threatened species, population or endangered community	Sensitivity (refer Table 3.6)	Phase	Potential impacts[1]	Initial significance (application of initial mitigation measures in Table 6.2)		Proposed additional mitigation measures to be applied (refer Table 6.3)	Residual significance following the application of proposal mitigation measures presented in Table 6.3)	
				Magnitude	Significance		Magnitude	Significance[3]
▪ Darling River EEC		Commissioning and reinstatement	▪ Noise, dust and light impacts ▪ Displacement of flora and fauna species from invasion of weed and pest species ▪ Aquatic habitat degradation	Low	Moderate	▪ Aquatic fauna (design and construction) ▪ 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 to Section 7.3.2 and Appendix F for further assessment past this initial assessment of residual significant impact)
		Operation	▪ Aquatic habitat loss and degradation from vegetation clearing/removal ▪ Fauna species injury or mortality ▪ Displacement of flora and fauna species from invasion of weed and pest species ▪ Noise, dust and light impacts	Low	Moderate	▪ Weeds and Pests (operations) ▪ Riparian vegetation and aquatic habitats (operations) ▪ Fauna fencing (operations)	Negligible	Low (refer to Section 7.3.2 and Appendix F for further assessment past this initial assessment of residual significant impact)

Threatened species, population or endangered community	Sensitivity (refer Table 3.6)	Phase	Potential impacts[1]	Initial significance (application of initial mitigation measures in Table 6.2)		Proposed additional mitigation measures to be applied (refer Table 6.3)	Residual significance following the application of proposal mitigation measures presented in Table 6.3)	
				Magnitude	Significance		Magnitude	Significance[3]
State significant ecological constraint (KFH listed under the FM Act): Type 1 and Type 3 fish habitat	Moderate	Construction	▪ Aquatic habitat loss and degradation from vegetation clearing/removal ▪ Fauna species injury or mortality ▪ Reduction in biological viability of soil to support plant growth due to soil compaction ▪ Displacement of flora and fauna species from invasion of weed and pest species ▪ Reduction in the connectivity of biodiversity corridors ▪ Edge effects ▪ Habitat fragmentation ▪ Barrier effects ▪ Noise, dust and light impacts ▪ Increase in waste (litter) ▪ Erosion and sedimentation	High	High	▪ Flora and fauna (design, preconstruction and construction proposed mitigation measures) ▪ Aquatic fauna (design and construction) ▪ Weeds and pests (preconstruction and construction mitigation measures) ▪ Erosion and sediment control (pre-construction and construction) ▪ Riparian vegetation and aquatic habitats (construction) ▪ Fauna passage (design and construction) ▪ Fauna fencing (design and construction)	Moderate	Moderate
		Commissioning and reinstatement	▪ Fauna species injury or mortality ▪ Displacement of flora and fauna species from invasion of weed and pest species ▪ Noise, dust and light impacts ▪ Aquatic habitat degradation	Low	Moderate	▪ Weeds and Pests (operations) ▪ Riparian vegetation and aquatic habitats (operations) ▪ Fauna fencing (operations)	Negligible	Low

Threatened species, population or endangered community	Sensitivity (refer Table 3.6)	Phase	Potential impacts[1]	Initial significance (application of initial mitigation measures in Table 6.2)		Proposed additional mitigation measures to be applied (refer Table 6.3)	Residual significance following the application of proposal mitigation measures presented in Table 6.3)	
				Magnitude	Significance		Magnitude	Significance[3]
		Operation	▪ Aquatic habitat loss and degradation from vegetation clearing/removal ▪ Fauna species injury or mortality ▪ Displacement of flora and fauna species from invasion of weed and pest species ▪ Noise, dust and light impacts	Low	Moderate	▪ Weeds and Pests (operations) ▪ Riparian vegetation and aquatic habitats (operations) ▪ Fauna fencing (operations)	Negligible	Low

Table notes:

* The use of offsets has not been considered as a mitigation measure for the purposes of project mitigation for the assessment of potential impacts. Refer Section 5.8 for information related to the use of offset to compensate project related impact that are not sufficiently reduced in the above table.

^ 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 Section 9.

7.3 Significant impact assessment

7.3.1 Assessment under EPBC Act

There are 15 key threatening processes under the EPBC Act. Table 7.3 lists each these threatening processes and their applicability to the proposal. It is considered that no commonwealth key threatening processes will be impacted by the proposal.

Table 7.3 Commonwealth key threatening processes and their applicability to the proposal

Key threatening process	Applicable	Comments
Aggressive exclusion of birds from woodland and forest habitat by abundant Noisy miners (*Manorina melanocephala*)	No	The proposal is not considered likely to trigger this KTP
Anthropogenic climate change	No	The proposal is not considered likely to trigger this KTP
Clearing and degradation of native vegetation (riparian vegetation along water courses under FM Act)	Yes	The detailed design will determine the final area of native vegetation to be cleared. Section 6.1 discusses the impacts of native vegetation clearing as a result of the proposal.
Competition and grazing by the feral European Rabbit (*Oryctolagus cuniculus*)	No	The proposal is not considered likely to trigger this KTP
Competition and habitat degradation by Feral goats (*Capra hircus*)	No	The proposal is not considered likely to trigger this KTP
Importation of Red Imported Fire Ants (*Solenopsis invicta*)	Possible	The proposal is not considered likely to trigger this KTP. Mitigation measures including vehicle and soil hygiene will reduce the risks associated with the KTP.
Infection of frogs by amphibian chytrid causing the disease chytridiomycosis	No	The proposal is not considered likely to trigger this KTP
Infection of native plants by *Phytophthora cinnamomi*	No	The proposal is not considered likely to trigger this KTP
Invasion and establishment of the Cane Toad (*Bufo marinus*)	No	The proposal is not considered likely to trigger this KTP as the successful expansion of the species is restricted to their natural climatic ranges.
Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants	Potential	There are several invasive weed species currently recorded within the proposal area. Mitigation measures will assist in reducing the risk associated with this KTP
Predation by the European Red Fox *Vulpes Vulpes* (Linnaeus 1758)	No	The proposal is not considered likely to trigger this KTP
Predation by the Feral Cat Felis catus (Linnaeus 1758)	No	The proposal is not considered likely to trigger this KTP
Predation, habitat degradation, competition and disease transmission by Feral Pigs, *Sus scrofa*	No	The proposal is not considered likely to trigger this KTP
Invasion of northern Australia by Gamba Grass and other introduced grasses	No	The proposal is not located within northern Australia
Novel biota and their impact on biodiversity	Potential	The proposal does not involve the introduction of novel biota into Australia. Mitigation measures will assist in reducing the risk associated with this KTP

7.3.1.1 Significant residual impact under EPBC Act

Following assessments of species and habitat resilience and the subsequent assessment process, the area of habitat proposed for disturbance for each MNES which represents the significant residual adverse impact to the species and/or its habitat values was ascertained. This assessment of residual adverse impact includes all significant impacts. This data is presented in Table 7.4. The calculations presented in Table 7.4 are accurate for habitat attributes within the proposal study area only and does not account for the required habitat attributes outside of the proposal study area or the size and resilience of the MNES outside of the proposal study area.

Table 7.4 Significant residual impact for EPBC ecological receptors

MNES	Significant residual adversely impacted habitat disturbance area (ha)
Fauna	
Murray cod (*Maccullochella peelii*)	1.15

Table note:

Residual impacts are further discussed in offset approach in Section 9.1

7.3.2 Assessment under FM Act

There are eight key threatening processes listed under the FM Act. Table 7.5 lists each these threatening processes and their applicability to the proposal. The key threatening processes indicate that several of the key threatening processes under the FM Act are triggered. The threatening processes with the potential to be triggered are considered to be mitigated with additional control measures identified in Table 6.3. The aquatic species assessment (Fisheries Management Act) is further detailed in Appendix F.

Table 7.5 State key threatening processes and their applicability to the proposal

Key threatening process	Applicable	Comments
Installment and use of instream structures and other devices causing alteration to natural flow regimes of rivers and streams	Yes	Design considerations to reduce any impact on flow regimes are part of the detailed design process.
Anthropogenic climate change	No	The proposal is not considered likely to trigger this KTP
Clearing and degradation of native vegetation (riparian vegetation along water courses under FM Act)	Yes	The detailed design will determine the final area of native vegetation to be cleared. Section 6.1 discusses the impacts of native vegetation clearing as a result of the proposal.
Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants	Potential	There are several invasive weed species currently recorded within the proposal area. Mitigation measures will assist in reducing the risk associated with this KTP
Removal of dead wood and debris from rivers and streams	Yes	The removal of native vegetation within the final footprint is likely to trigger this KTP. Mitigation measures will assist in reducing the risk associated with this KTP
The use of hook and line fishing in important habitat for the survival of threatened fish species	No	The proposal is not considered likely to trigger this KTP
The introduction of non-native fish and marine vegetation to NSW coastal waterways	No	The proposal is not considered likely to trigger this KTP
Implementation of the current shark meshing program in NSW coastal areas	No	The proposal is not considered likely to trigger this KTP

7.3.2.1 Significance residual impact under FM Act

Following assessments of species and habitat resilience and the subsequent assessment process, the area of habitat proposed for disturbance for each state ecological receptor which represents the significant residual adverse impact to the species and/or its habitat values was ascertained. This was assessed using the FM Act significant impact assessment (refer Appendix F).

Table 7.6 Significant residual impact for FM Act ecological receptors

Environmental receptor	Initial assessment of impact area (ha)	Outcome of FM act significant impact assessment	Significant residual adversely impacted habitat disturbance area (ha)
Darling river snail	1.51	No significant impact	0.00
Southern purple spotted gudgeon	1.51	No significant impact	0.00
Eel-tailed catfish (Murray-Darling population)	1.51	No significant impact	0.00
Western olive perchlet (Western population)	1.51	No significant impact	0.00
Darling River EEC	1.51	No significant impact	0.00
Type 1 and Type 3 fish habitat	14.60	Significant impact	14.60

Table note:

Residual impacts are further discussed in offset approach in Section 9.2

8 Cumulative impact assessment

Cumulative impacts were assessed using the methodology identified in 3.7, incorporating the projects identified in Table 3.8 and depicted in Figure 3.2

The cumulative impacts of multiple projects occurring in the vicinity of the proposal study area will likely include the continued loss of biodiversity (including aquatic biodiversity through indirect impacts) in the Brigalow Belt South and Darling Riverine Plains bioregions. The major potential impacts identified as a result of the proposal are common to all projects throughout the region and are therefore cumulative in nature. Twelve projects have been identified within the cumulative impact study area.

Of these original twelve projects included within the cumulative impact assessment, seven were considered as contributing to cumulative impact. These include;

- Border to Gowrie – Inland Rail (ARTC)
- Narrabri to North Star – Inland Rail (ARTC)
- Moree Solar Farm
- Queensland -Hunter Gas Pipeline
- White Rock Solar Farm
- White Rock Wind Farm
- Sundown Solar Farm

These projects, within neighbouring regional hydrological catchments, may result in some extent of:

- Habitat loss and degradation from vegetation clearing/removal (leading to indirect impact from loss of potential stream complexity and water quality impacts)
- Fauna species injury or mortality (through indirect impact on water quality)
- Displacement of flora and fauna species from invasion of weed and pest species (from indirect impacts associated with incidental pest fauna species transport during works and operations)
- Habitat fragmentation (from potential direct impacts due to construction and operation)
- Noise, dust, and light (as an indirect impact from construction and operation)
- Increase in litter (as a direct impact from construction and operation).

Cumulative impacts range from short-term to long-term. The total impact area of significant 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 8.1. The results of the significance assessment of these cumulative impacts are presented in Table 8.2.

Table 8.1 Magnitude rating and justification of cumulative impacts within the cumulative impact study area

Receptor	Magnitude rating (1-3)	Justification for ranking
Murray cod (*Maccullochella peelii*)	2	■ Proportion of overall cumulative project impacts is low ■ Regional extent of receptor is large ■ Projects within known distribution
Aquatic EEC of the natural drainage system of the lowland catchment of the Darling River	2	■ Proportion of overall cumulative project impacts is low ■ Regional extent of receptor is large ■ Projects within known distribution
Darling river snail (*Notopala sublineata*)	2	■ Proportion of overall cumulative project impacts is low ■ Regional extent of receptor is small ■ Projects within known distribution

Receptor	Magnitude rating (1-3)	Justification for ranking
Eel-tailed catfish (*Tandanus tandanus*) (Murray – Darling population)	2	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of receptor is moderate ▪ Projects within known distribution
Southern purple spotted gudgeon (*Mogurnda adspersa*)	2	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of receptor is small ▪ Projects within known distribution
Western olive perchlet (*Ambassis agassizii*)	2	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of receptor is small ▪ Projects within known distribution
Important and local wetlands	2	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of receptor is small ▪ Projects within known distribution
Waterways and riparian buffers	2	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of receptor is moderate ▪ Projects within known distribution
Type 1 fish habitat	2	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of receptor is moderate ▪ Projects within known distribution
Type 3 fish habitat	2	▪ Proportion of overall cumulative project impacts is low ▪ Regional extent of receptor is moderate ▪ Projects within known distribution

Table 8.2 Significance assessment of cumulative impacts within the cumulative impact area

Receptor(s)	Potential impacts[#]	Relevance factor of aspects				Sum of relevance factors	Impact significance
		Probability	Duration	Magnitude	Sensitivity		
Commonwealth significant ecological constraint (species listed under the EPBC Act): ▪ Murray cod (*Maccullochella peelii*)	▪ Habitat loss and degradation from vegetation clearing/removal (including fragmentation)	1	1	2	3	7	Medium
	▪ Fauna species injury or mortality	1	1	2	3	7	Medium
	▪ Noise, dust and light and contaminant disturbance	1	1	2	3	7	Medium
	▪ Increase in litter (waste)	1	1	2	3	7	Medium
	▪ Displacement of species from invasion of weed and pest species	1	1	2	3	7	Medium
Threatened Ecological Communities (FM Act): ▪ The Aquatic Ecological Community in the Natural Drainage System of the Lowland Catchment of the Darling River	▪ Habitat loss and degradation from vegetation clearing/removal (including fragmentation)	1	1	2	3	7	Medium
	▪ Fauna species injury or mortality	1	1	2	3	7	Medium
	▪ Noise, dust and light and contaminant disturbance	1	1	2	3	7	Medium
	▪ Increase in litter (waste)	1	1	2	3	7	Medium
	▪ Displacement of species from invasion of weed and pest species	1	1	2	3	7	Medium
State Significant Ecological Constraint – Fish habitat (FM Act): ▪ Type 1 Fish habitat	▪ Habitat loss and degradation from vegetation clearing/removal (including fragmentation)	1	1	2	2	6	Low
	▪ Fauna species injury or mortality	1	1	2	2	6	Low
	▪ Noise, dust and light and contaminant disturbance	1	1	2	2	6	Low
	▪ Increase in litter (waste)	1	1	2	2	6	Low
	▪ Displacement of species from invasion of weed and pest species	1	1	2	2	6	Low

Receptor(s)	Potential impacts[#]	Relevance factor of aspects				Sum of relevance factors	Impact significance
		Probability	Duration	Magnitude	Sensitivity		
State Significant Ecological Constraint – Fish habitat (FM Act): ▪ Type 3 Fish habitat	▪ Habitat loss and degradation from vegetation clearing/removal (including fragmentation)	1	1	2	1	5	Low
	▪ Fauna species injury or mortality	1	1	2	1	5	Low
	▪ Noise, dust and light and contaminant disturbance	1	1	2	1	5	Low
	▪ Increase in litter (waste)	1	1	2	1	5	Low
	▪ Displacement of species from invasion of weed and pest species	1	1	2	1	5	Low
State Significant Ecological Constraint – Threatened species/populations (FM Act): ▪ Darling river snail (*Notopala sublineata*) ▪ Eel-tailed catfish (*Tandanus tandanus*) ▪ Southern purple spotted gudgeon (*Mogurnda adspersa*) ▪ Western olive perchlet (*Ambassis agassizii*)	▪ Habitat loss and degradation from vegetation clearing/removal (including fragmentation)	1	1	2	3	7	Medium
	▪ Fauna species injury or mortality	1	1	2	3	7	Medium
	▪ Noise, dust and light and contaminant disturbance	1	1	2	3	7	Medium
	▪ Increase in litter (waste)	1	1	2	3	7	Medium
	▪ Displacement of species from invasion of weed and pest species	1	1	2	3	7	Medium

Table notes:

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

9 Biodiversity offsets – approach

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 but allows for the identification of areas where further management measures may be required.

The identification and mapping of ecological receptors was undertaken using the principles of the precautionary approach, with calculations being based on a conservative proposal footprint that will be subject to further refinement / amendment during detail design. Therefore, the assessment of potential impacts is likely to reflect the maximum extent associated with the proposal. However, the significance ratings of most potential impacts identified in Section 6.2 will be reduced after the implementation of mitigation measures, including avoidance, minimisation and mitigation strategies. In addition, the implementation of the mitigation measures identified in Section 6.3.2 will considerably reduce the significance of these impacts potentially resulting from the proposal's activities.

Although aquatic ecological receptors will be avoided where practicable and potential impacts will be minimised and mitigated to the greatest extent practical, in some instances the magnitude and significance ratings will remain unchanged following the implementation of the mitigation measures. However, in many instances, a reduction in the magnitude of impacts will result in a reduction of impact significance following the application of mitigation measures.

There is the potential for some proposal activities to have a cumulative, irreversible and/or permanent impact upon aquatic ecological receptors, even after the implementation of all mitigation measures, including rehabilitation.

Post EIS and during the detailed design phase of the proposal, offsets will be delivered to offset residual adverse impacts to the MNES (under EPBC) (refer Section 9.1) and MSES receptors (refer Section 9.2) that are significant. An offset will be required for receptors that experience a significant residual adverse impact which may include areas containing habitat for EPBC Act listed species (refer Table 9.1).

Further information related to the initial quantum of potential impacts to Commonwealth and State based biodiversity issues and associated offsets is provided separately in the following sections.

9.1 Matters of national environmental significance offset requirements

The EPBC Act Offsets Policy states: 'Offsets provide environmental benefits to counterbalance the impacts that remain after avoidance and mitigation measures. These remaining, unavoidable impacts are termed 'residual impacts'. Offsets will be required to compensate for the significant adverse residual impacts on MNES as a result of the proposal.

A 'significant impact' is defined as 'an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value, and quality of the environment which is impacted, and upon the intensity, duration, magnitude and geographic extent of the impacts' (DotE 2013).

An assessment of the significant residual adverse impacts has been undertaken which has identified the location and quantum of residual impacts for MNES.

Initial investigations indicated through predictive habitat modelling and a following adverse impact assessment methodology, that a potential 38.13 ha of potential habitat for the Murray Cod occurred within the proposal study area. The significant residual impact area for the Murray Cod was determined to be 1.15 ha.

Post EIS and during the detailed design phase of the proposal, offsets will be delivered to offset residual adverse impacts to MNES (refer Section 9.1) and NSW (state) receptors (refer Section 9.2) that are significant.

An offset will be required for receptors that experience a significant residual adverse impact which may include areas containing habitat for EPBC Act listed species (refer Table 9.1).

Table 9.1 Quantum of significant adverse residual impact to MNES habitat

MNES species	Significant adverse residual impact (ha) (removing duplication of overlapping impact)
Murray Cod (*Maccullochella peelii*)	1.15

9.2 State offsets obligations

The current bilateral agreement between the Commonwealth of Australia and the State of New South Wales relating to environmental assessment, allows the Commonwealth Minister for the Environment to rely on specified environmental impact assessment processes of the State of New South Wales. A draft Bilateral agreement is currently under review and provides for accreditation of New South Wales processes for approval of proposed actions that would otherwise be assessed by the Australian Government for approval under the EPBC Act.

Offsets required for impacts to aquatic biodiversity receptors listed under provisions of the FM Act will be calculated following the detailed design phase. However an initial assessment of state based offset obligations for each environmental receptor is provide in Table 9.2, alongside identification of significant impact under the FM Act.

Table 9.2 Significant residual impact to state based environmental receptors

Environmental receptor	Offset requirements under significant residual assessment of impact area (ha)
Darling river snail	0.00
Southern purple spotted gudgeon	0.00
Eel-tailed catfish (Murray-Darling population)	0.00
Western olive perchlet (Western population)	0.00
Darling River EEC	0.00
Type 1 and Type 3 fish habitat	14.60

ARTC proposes to provide its offset obligation post-EIS, following the detailed design and before the construction phases. Detailed offset will be in multiple stages to align with the schedule of disturbance.

It is expected that the Biodiversity Offset Strategy will provide for the segmented delivery of offsets where appropriate, ahead of relevant clearing works being undertaken. The Biodiversity Offset Strategy will be developed in consultation of Commonwealth and State offsets policies, and in consultation with relevant stakeholders.

10 Evaluation and conclusion

The proposal study area provides suitable habitat for a number of conservation significant species listed under the provisions of the EPBC Act and/or the FM Act. The proposal study area contains a suite of other terrestrial and aquatic ecological values in the form of habitat connectivity, wetlands and waterways.

Seven aquatic ecological receptors were identified within the proposal study area for the purposes of this assessment. These varied from broad scale receptors such as landscape features, down to finer species-scale receptors and conservation significant species. These 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 proposal has the potential to impact on aquatic ecology receptors through:

- Habitat loss and degradation from vegetation clearing/removal
- Fauna species injury or mortality
- Displacement of flora and fauna species from invasion of weed and pest species
- Habitat fragmentation
- Barrier effects
- Noise, dust, and light
- Increase in litter (waste)

The nature of each unmitigated potential impact was considered in relation to the identified ecology receptors to derive an initial assessment of impact significance for the proposal (refer Table 7.2). This was determined by assigning sensitivity and magnitude ratings which were then allocated a significance rating through the significance assessment matrix. The potential impacts upon the ecological receptors were assigned a major, high, moderate, low or negligible rating (refer Table 7.2).

The proposed mitigation measures for the proposal were identified in order to reduce the significance of the potential impacts upon the ecological receptors. The mitigation strategies associated with the proposal are presented in Table 6.3. 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 ecological receptors were generally reduced (refer Table 7.2).

Significant impacts for MNES are predicted for one aquatic species from potential predicted impacts (direct disturbance) as a result of the proposal:

- Murray Cod (*Maccullochella peelii*): 1.51 ha

Processing of MNES using the Adverse Impact Assessment Methodology (AIAM) reduced the identified levels of potential impacts to those that are considered to constitute a significant adverse residual impact in accordance with the Commonwealth significant impact guidelines. The significant adverse residual impact for the MNES noted above are:

- Murray Cod (*Maccullochella peelii*): 1.15 ha

The initial assessment of state based offset obligations for each environmental receptor identified the potential for 1.51 ha of residual significant impact for the:

- Darling river snail (*Notopala sublineata*)
- Eel-tailed catfish (Murray – Darling population) (*Tandanus tandanus*)
- Southern purple spotted gudgeon (*Mogurnda adspersa*)
- Western olive perchlet (Western population) (*Ambassis agassizii*)
- Darling River EEC

Assessment using the receptor assessment under the FM Act identified that these conservation significant receptors were unlikely to be significantly impacted from the proposal. As such the receptor for significant residual impact under the FM Act for the proposal are:

- Type 1 and 3 key fish habitat

Predicted cumulative impacts were assessed incorporating twelve projects within the vicinity of the proposal that have been identified as either currently underway or are going through the EIS process and are likely to contribute to the continued loss of biodiversity in the Brigalow Belt South and Darling Riverine Plains bioregions. The cumulative impacts of multiple similar projects occurring in the vicinity of the proposal may include the following potential impacts:

- Habitat loss and degradation from vegetation clearing/removal (leading to indirect impact from loss of potential stream complexity and water quality impacts)
- Fauna species injury or mortality (through indirect impact on water quality)
- Displacement of flora and fauna species from invasion of weed and pest species (from indirect impacts associated with incidental pest fauna species transport during works and operations)
- Habitat fragmentation (from potential direct impacts due to construction and operation)
- Noise, dust, and light (as an indirect impact from construction and operation)
- Increase in litter (as a direct impact from construction and operation).

High significance cumulative impacts as a result of the proposal and other similar projects are predicted to impact the following ecological receptors:

- Threated fauna (EPBC and FM Act)

During Phase 2 of the proposal (detailed design, post-EIS), sensitive ecological features identified during the EIS will be subject to further investigation, in order to more accurately determine the magnitude of the significant adverse impacts upon the identified ecological receptors. The specific mitigation measures will then be applied to ensure that the significance ratings of any potential impacts are classified as low as reasonably practicable and the more significant adverse impacts are offset. The current requirements for aquatic ecological receptors are considered 1.15 ha of like-for-like offsets for EPBC Act offsets.

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APPENDIX S

Aquatic Biodiversity Technical Report

Appendix A Predictive Habitat Modelling Methodology

NORTH STAR TO NSW/QUEENSLAND BORDER ENVIRONMENTAL IMPACT STATEMENT

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

Inland Rail North Star to Border EIS

Appendix A – Predictive habitat modelling methodology

Australian Rail Track Corporation

Reference: 2700

Contents

Figures

Tables

1 Introduction

1.1 Background

The purpose of this document is to present the methodologies associated with the preparation of the predictive habitat models for aquatic threatened species associated with the Inland Rail Project (North Star to Border) (the Project). These models have been designed to map the potential areas that are likely to be analogous to habitat associated with *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth (Cth)) (EPBC Act) and/or the *Biodiversity Conservation Act 2016* (New South Wales (NSW) (BC Act) conservation significant species. This mapping has the following objective:

- To provide predictive habitat modelling for EPBC Act and FM Act listed aquatic species to:
  - Identify areas of potential habitat for EPBC Act and FM Act listed species
  - Facilitate the calculation of potential disturbance areas associated the Project and to subsequently inform the adverse impact assessment methodology (AIAMs) model to determine significant residual adverse impacts for matters of national environmental significance (MNES).

This document outlines the methodology used for the development of the predictive habitat models and provides the species/community specific assumptions and mapping requirements required to reproduce the predictive habitat models for each individual species or community. The models have been used to prepare maps indicating the potential extent of each conservation significant species associated with the Project as identified in the Project Environmental Impact Statement (EIS) Terms of Reference (ToR), in addition to those species identified from the desktop review phase of the Project EIS.

1.2 Context

For context with respect to the methodology's compliance with EPBC Act Survey Guidelines for threatened species, the more conservative approach of this methodology surpasses the guidelines expectations. The *'How to use these guidelines'* statement includes:

'…*alternatives to a dedicated survey may also be appropriate. For example, a desktop analysis of historic data may indicate that a significant impact is not likely. Similarly, a regional habitat analysis may be used to determine the importance of a site to the listed birds. Proponents should also consider the proposals impact in the context of the species' national, regional, district and site importance to establish the most effective survey technique(s)…'*

This methodology includes analysis of historic and current data gained from a range of sources (as listed in Table 1.1 (Section 1.3) with direct and current survey efforts including dedicated ground truthing surveys of the database mapping and follow-up aquatic assessments within the project area as part of the projects geotechnical drilling survey program.

1.3 Review of existing databases and literature

Each predictive fauna habitat model has been developed to deliver a process that is robust, transparent and repeatable. The first stage in developing each of the models involved determining the extent of species occurrence and the availability of information pertaining to available species habitat.

Government databases were accessed to identify MNES and FM Act listed species that have potential to occur within the study area. These data sources are listed in Table 1.1.

Table 1.1 Database and document review summary

Database/data source name	Database search date	Database search areas	Data type
EPBC Act Protected Matters Search Tool (Australian Government)	5/08/2019	10 km buffer from the Proposal	Records of conservation significant aquatic species protected under the EPBC Act.
Document title			**Reference**
North Star to NSW/QLD Border Project Study Area Selection Report			ARTC 2018
Melbourne to Brisbane Inland Rail, 2016 Phase 1 Continuity Alignment Report, North Star to Yelarbon (01-2700-PD-P00-DE-008)			WSP/PB 2017
Melbourne to Brisbane Inland Rail, 2016 Phase 2 Preparatory Alignment Assessment Report, North Star to Yelarbon (01-2700-PD-P00-DE-011)			WSP/PB 2017a

2 Aquatic species included within the predictive habitat mapping model

A total of two conservation significant aquatic fauna species listed under the provisions of the EPBC Act were identified as occurring or potentially occurring within the study area (refer Table 2.1).

Table 2.1 Conservation significant aquatic fauna species identified from database searches

Family	Species name	Common name	Conservation status		Data source	Likelihood of occurrence^
			FM Act	EPBC Act		
Percichthyidae	*Maccullochella peelii*	Murray cod	-	V	PMST	Possible
Terapontidae	*Bidyanus bidyanus*	Silver perch	V	CE	Green et al 2012	Possible

Table notes:

1 Listing under the *Environment Protection and Biodiversity Conservation Act 1999*: CE = Critically Endangered; E = Endangered; V = Vulnerable

3 Predictive habitat modelling input datasets

Predictive habitat modelling was undertaken to identify and map areas that are considered to have the potential to provide habitat for the conservation significant aquatic species listed in Table 5.1, which have potential to occur within the Proposal area. This modelling provides greater certainty in predicting the likelihood of a conservation significant species occurring within the Proposal area and is one of the inputs into the AIAMs model which is used to identified significant residual adverse impacts to MNES.

Additional GIS layers and field derived information have been utilised to identify areas of habitat within the Proposal area where applicable to a species. These layers include:

- High resolution aerial photography with site derived datasets
- Historic records of conservation significant species (derived from government databases and previous ecological investigations)
- Field derived datasets related to habitat suitability and the presence of micro-habitat features
- Topographic and geological information
- Government derived cadastral datasets
- Drainage feature datasets
- Government predicative habitat mapping datasets.

4 Predictive habitat modelling categories

4.1 Aquatic fauna species

4.1.1 General context

Each predictive habitat model allowed partitioning of habitat for aquatic fauna species using current scientific knowledge and pre-existing data. The specific habitat assumptions for each species that were subject to predictive mapping are provided in Table 5.1.

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

- Unlikely habitat
- General habitat
- Essential habitat
- Core habitat.

The use of these habitat definitions has been accepted by the Commonwealth Department of Environment and Energy for similar linear infrastructure project EISs (e.g. Santos Gas Field Development EIS) and negotiations with the regulators at the inception of the Project EIS has indicated that they are amenable to the use of this modelling for the Project EIS.

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

4.1.2 Unlikely habitat

Unlikely habitat consisted of areas that do not contain specimen backed records of the particular species (i.e. no point data derived from the positive identification/confirmation of a species in the field) and contain no evidence of habitat values to support the presence or existence of resident individuals or populations of the species. These areas are located outside of areas identified as potential habitat by OEH.

4.1.3 General habitat

General habitat consisted 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 or 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). In addition, areas identified as potential habitat by OEH have been included in the general habitat category. 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 species. The general habitat category restricts the habitat to a more limited and realistic set of environmental parameters which are supported by literature and field-based observation. Species specific assumptions that define the general habitat category are identified in Table 5.1.

4.1.4 Essential habitat

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. Essential habitat has been defined from known records (regardless of currency), generally with a 1 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. Species specific assumptions associated with the mapping of essential habitat, and instances that deviate from the above criteria are detailed in Table 5.1.

4.1.5 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 (excluding government predictive habitat mapping). Where essential habitat intersects with areas identified as important within the relevant region, these areas have been elevated to the core habitat category. Species specific assumptions associated with the mapping of core habitat areas are detailed in Table 5.1.

5 Predictive habitat models and general assumptions associated with their development

5.1 Aquatic fauna habitat models

The predictive habitat model for each aquatic fauna species was designed to provide a dynamic, robust and predictive GIS layer that could incorporate data from scientific literature, verified government datasets, specimen backed datasets (i.e. data derived from a known/confirmed location of an observed specimen) and field identified records into a single layer that could be used to identify areas that are known, or considered to have the potential to support specific conservation significant FM Act and/or EPBC Act listed aquatic fauna species. Development of these layers had the ultimate objects to:

- Predict areas that have the potential to support FM Act and/or EPBC Act significant aquatic species
- Predicted potential areas of conservation significant aquatic fauna habitat to be disturbed, and subsequent assessment of these areas using the AIAMs model to determine significant residual adverse impacts.

The habitat modelling was created using ESRI ArcGIS, specifically the ESRI ArcGIS Model Builder which facilitated the development of scripts that allowed for the species-specific development of queries that utilised a range of GIS input datasets.

The models also incorporated the use of selecting relevant components and performing functions such as buffers and intersects that reflected the preferred habitat of a particular species. As a result of this process output habitat layers were generated for each species according to their individual requirements. The species-specific requirements that were used to generate the species-specific queries used to map potential habitat are identified in Table 5.1 . However, it is noted that whilst species that were deemed to have potential to occur within the broader region underwent habitat modelling, the results of the modelling did not necessarily identify habitat within the Proposal area for all of the species modelled. Where this occurred, these species (i.e. without identified habitat within the Proposal area) did not undergo impact assessment as part of the Project EIS. Habitat assumptions were informed by a species profile for each EPBC threatened aquatic species (refer Appendix A).

As the predictive aquatic fauna habitat model mapping has been designed to identify areas of potential habitat for FM Act and/or EPBC Act listed species, several assumptions to the model have been made and derived from scientific literature and expert advice. These assumptions are outlined below.

- Buffers – Buffers have been used when integrating a specimen backed record into the predicted mapping. Generally, a 1 km buffer from the species data point is used when identifying essential habitat derived from a specimen backed record). Deviations from this methodology (where they occur, e.g. 30 m), are identified in Table 5.1.
- Essential habitat – The predictive flora and fauna habitat mapping outlined in this document primarily proposes general habitat as the preferred habitat requirements for many of the species mapped. This is as a result of their habitat not being fully understood or cannot be easily extrapolated from available datasets. In most cases, site derived species records were used to extrapolate preferred habitat by correlating with the underlying GIS layer. In these instances, mapped habitat will overlap with the predicted potential general habitat, which has not been elevated to the essential habitat level. For these species, where a species point record and associated buffer (i.e. typically a 1 km, but a reduced buffers of 30 m have been applied to some species) intersect with areas of predicted general habitat, the area of overlap has been elevated to the essential habitat category. In instances where essential habitat is located within an area of protection (excluding areas identified ads predicted habitat by OEH), this is elevated to core habitat. The relationship between general habitat, species records, essential habitat, protected areas and core habitat, is outlined in Figure 5.1.

- Minimum areas of habitat – Mapping has been designed to identify maximum areas of disturbance and therefore no minimum area of habitat has been identified. The methodology was developed to predict areas of potential habitat.
- Levels of habitat mapping – General habitat has primarily been indicated on the predictive mapping. However, where known population occur and were confirmed, and these areas overlap with areas of predicted general habitat, these areas have been elevated to essential habitat in accordance line with that used in relation of government mapping associated with the FM Act.

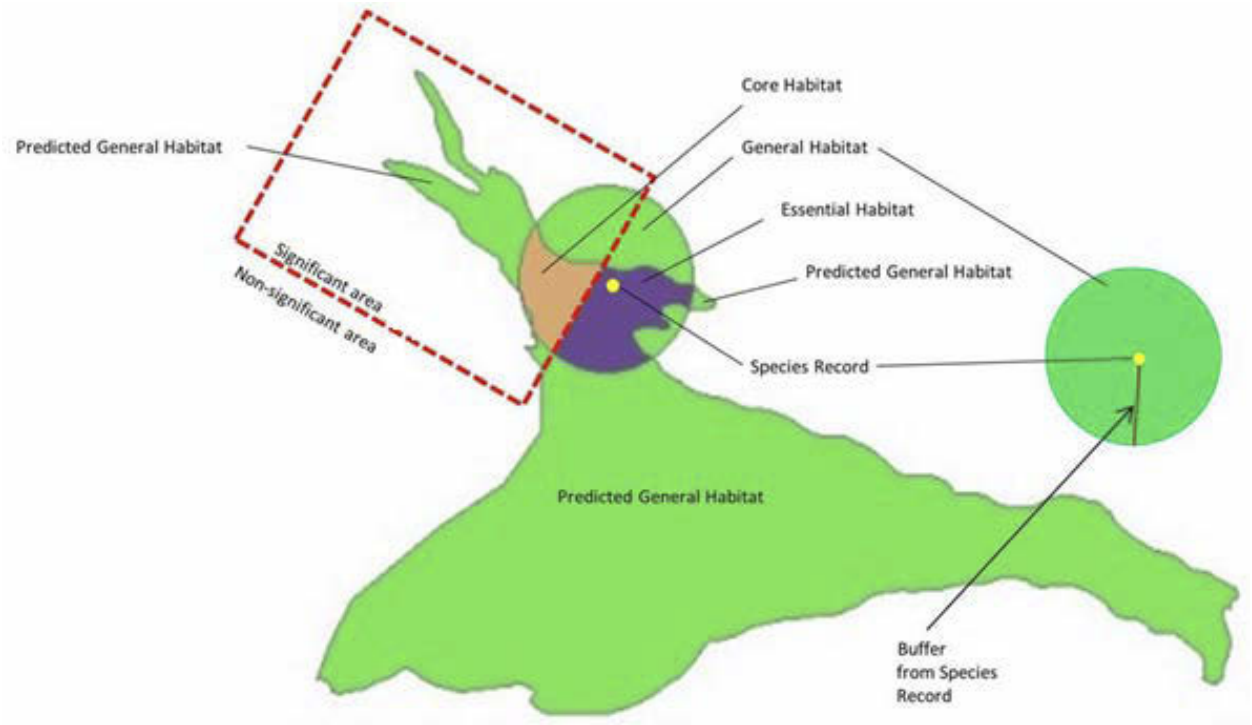

Figure 5.1 **Schematic indicating the relationship between specimen backed records, predicted general habitat, essential habitat and core habitat category designations**

Table 5.1 Threatened aquatic fauna species habitat assumptions used to map areas of occurrence within the study area

Class	Scientific Name	Common name	Habitat Requirements that are the Basis for the GIS assumptions (derived from SPRATS [Australian Government 2019] and other relevant peer reviewed sources)	GIS Habitat modelling instructions		
				General Habitat (NSW)	Essential Habitat	Core Habitat
Ray-finned fishes	*Maccullochella peelii*	Murray cod	The Murray cod has the ability to live in a diverse range of habitats, including clear rocky streams to slow flowing, turbid rivers and billabongs. It is demersal and usually found near complex structural cover such as large rocks, snags, overhanging vegetation, overhanging banks and other woody structures. It uses these points to shelter from fast-flowing water.	The following is considered to constitute General habitat: All areas mapped as perennial watercourses with a buffer of 100m applied. *Note: Any specimen backed records (buffered to a 1km radius) that fall outside of the areas identified above are considered to constitute General habitat*	Any specimen backed records (buffered to a 1km radius) that fall within areas mapped as *General habitat* (refer previous column) constitute *Essential habitat*	In NSW, any areas of essential habitat that overlap with a protected area constitute core habitat
	Bidyanus bidyanus	Silver perch	Silver perch formerly utilised a diversity of habitats within the Murray-Darling system. Silver perch are commonly described as a lowland species that are not found in the cooler upper reaches of rivers. Silver perch are consistently reported by anglers and researchers to show a general preference for faster-flowing water, including rapids and races, and more open sections of river, throughout the Murray-Darling Basin	The following is considered to constitute General habitat: All areas mapped as perennial watercourses with a buffer of 100m applied. *Note: Any specimen backed records (buffered to a 1km radius) that fall outside of the areas identified above are considered to constitute General habitat*	Any specimen backed records (buffered to a 1km radius) that fall within areas mapped as *General habitat* (refer previous column) constitute *Essential habitat*	In NSW, any areas of essential habitat that overlap with a protected area constitute core habitat

6 References

6.1 General references

ARTC 2018. *North Star to NSW/QLD Border Project Study Area Selection Report*

WSP/PB 2017. *Melbourne to Brisbane Inland Rail, 2016 Phase 1 Continuity Alignment Report, North Star to Yelarbon* (01-2700-PD-P00-DE-008)

WSP/PB 2017a. *Melbourne to Brisbane Inland Rail, 2016 Phase 2 Preparatory Alignment Assessment Report, North Star to Yelarbon* (01-2700-PD-P00-DE-011)

6.2 Species specific references:

6.2.1 Aquatic fauna

Murray cod (*Maccullochella peelii*)

Atlas of Living Australia. (2018). Maccullochella peelii. Available from: https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:54e10f17-f08c-4f93-b576-681f361ffe56 [Accessed 22 August 2018].

Department of Environment and Energy. (2018). Maccullochella peelii (Murray Cod) Species Profile and Threats Database. Australian Government. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=66633 [Accessed 22 August 2018].

Koehn J.D., J.A. McKenzie, D.J. O'Mahony, S.J. Nicol, J.P. O'Connor and W.G. O'Connor. (2009). Movements of Murray cod (Maccullochella peelii peelii) in a large Australian lowland river. Ecology of Freshwater Fish. 18:594-602. John Wiley and Sons A/S.

Murray Darling Basin Authority. (2007). Native Species – Murray Cod (Maccullochella peelii peelii). Available from: https://www.mdba.gov.au/sites/default/files/archived/mdbc-NFS-reports/2202_factsheet_native_murray_cod.pdf [Accessed 22 August 2018].

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Silver perch (*Bidyanus bidyanus*)

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Appendix A

Species profiles

Inland Rail NSW/QLD North Star to Border EIS

Aquatic Species Profiles

Australian Rail Track Corporation

Reference: 2700

Contents

Figures

1 Fauna species – Conservation significant species (Aquatic)

1.1 Murray cod (*Maccullochella peelii*)

1.1.1 Status

EPBC Act – Vulnerable

FM Act – Not listed

1.1.2 Biology and ecology

1.1.2.1 Characteristics

The Murray cod (Maccullochella peelii) is the largest freshwater species of fish in Australia, measuring up to 1.8 m in length and weighing about 10 kg although some records indicate the species may reach over 100 kg in weight. The Murray cod has a broad head, rounded snout, equal length jaws and has a concaved facial profile. The light olive to dark green scales of the fish has mottled pattern, with a white ventral colouration. The pectoral fins of the fish are rounded and large with soft dorsal, anal and caudal fins with distinctive red or white edging (DoEE 2019) (refer Photograph 1.1).

Photograph 1.1 Murray cod (*Maccullochella peelii*)

Source: flagstaffotos (2006)

1.1.2.2 Known distribution

The Murray cod was once a widespread species and abundant in the lower and mid reaches of the Murray-Darling Basin between Queensland and South Australia (refer Figure 1.1). However, the distribution of the species has now reduced to several bioregions between Queensland and Victoria, including the Brigalow Belt South Bioregion (National Murray Cod Recovery Team 2010, DoEE 2019).

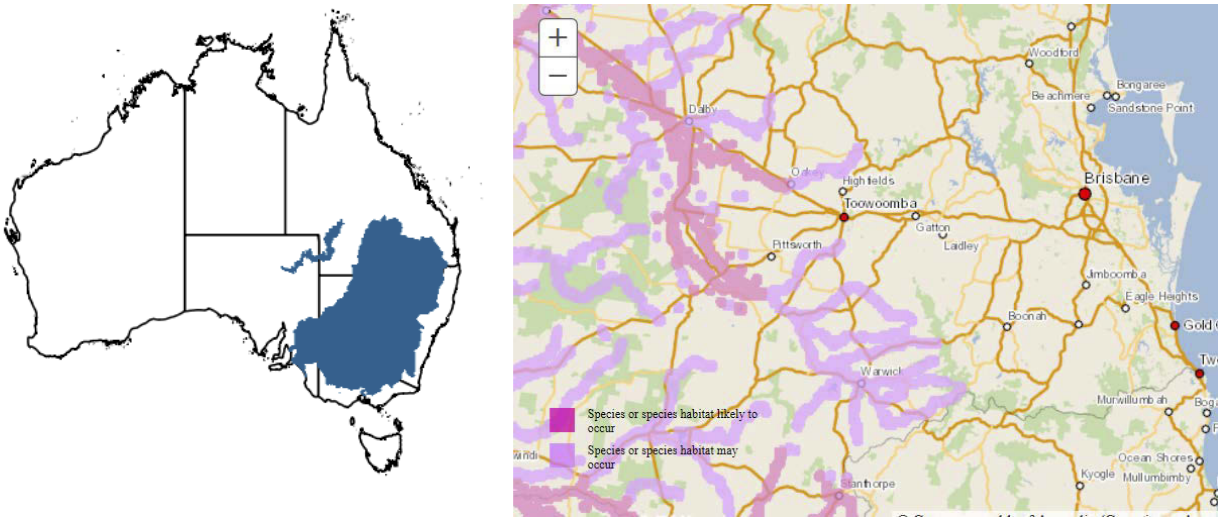

Figure 1.1 **Distribution range of Murray cod**

Source: ALA (2019), DoEE (2018)

1.1.2.3 Biology and reproduction

Due to the size of the Murray cod, it is considered the apex predator of the Murray-Darling river system and known to ambush its prey. The demersal species is known to hunt from sunset to sunrise, feeding on spiny crayfish and shrimp as well as reptiles and other fish species including cod (DoEE 2019).

The Murray cod has relatively low fertility compared to many other freshwater fish with the species generally reaching sexual maturity, which is heavily dependent on size, at 5 years of age. Male Murray cod, who are known to guard and fan the eggs during incubation, mature at a larger size than females with the species breeding as a pair. A female cod weighing 3 kg can produce up to 10,000 eggs often laid in logs or snags after developing them through winter until spawning, which is triggered by an increase in temperature and day length (DoEE 2019).

Upon hatching larvae tend to remain clustered in their nest for up to 11 days with the male continually providing protection before the larvae leave the nest to drift downstream and feed on zooplankton as well as aquatic insects (DoEE 2019).

1.1.3 Habitat

The habitat of the species is diverse, ranging from clear rocky streams to slow-flowing, turbid lowland rivers or billabongs where the fish is found frequently in the main channel. Due to the species preferred breeding environment, it is often found in streams containing large rock, snags, overhanging vegetation, stumps or other woody structures (DoEE 2019).

The species is known to take long distance journeys prior to spawning travelling up to several hundred kilometres upstream despite their naturally sedentary nature (Koehn et al. 2009).

1.1.4 Threatening processes

The following have been identified as potentially threatening processes to the Murray cod:

- Impoundment of streams and altered water flow
- Loss of riparian vegetation
- Habitat removal, modification and degradation (DoEE 2018).

1.1.5 Threat abatement/recovery plans

The following recovery plan is applicable to this species:

- National Murray Cod Recovery Team (2010). *National Recovery Plan for the Murray Cod* Maccullochella peelii peelii. Department of Sustainability and Environment, Melbourne. Available from: http://www.environment.gov.au/resource/national-recovery-plan-murray-cod-maccullochella-peelii-peelii. In effect under the EPBC Act from 16-Dec-2010 as *Maccullochella peelii*.

1.1.6 References

Atlas of Living Australia. (2019). Maccullochella peelii. Available from: https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:54e10f17-f08c-4f93-b576-681f361ffe56 [Accessed 17 September 2019].

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Koehn J.D., J.A. McKenzie, D.J. O'Mahony, S.J. Nicol, J.P. O'Connor and W.G. O'Connor. (2009). Movements of Murray cod (Maccullochella peelii peelii) in a large Australian lowland river. Ecology of Freshwater Fish. 18:594-602. John Wiley and Sons A/S.

Murray Darling Basin Authority. (2007). Native Species – Murray Cod (Maccullochella peelii peelii). Available from: https://www.mdba.gov.au/sites/default/files/archived/mdbc-NFS-reports/2202_factsheet_native_murray_cod.pdf [Accessed 18 September 2019].

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1.2 Silver perch (*Bidyanus bidyanus*)

1.2.1 Status

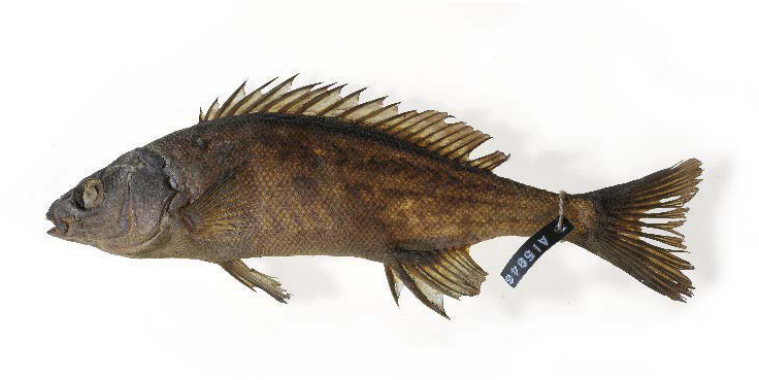
EPBC Act – Critically Endangered

FM Act – Vulnerable

1.2.2 Biology and ecology

1.2.2.1 Characteristics

A medium to large, fish with a body that becomes deeper and more laterally compressed with age. Maximum length ~500 mm and maximum weight 8 kg; usually 350 mm and 2 kg. The single dorsal fin has a higher, spinous anterior section and a lower, rayed section at the rear. They have a pointed head and snout and a relatively small mouth with equal jaws and narrow bands of very fine villiform (needle-like) teeth. The body colour is grey to grey-brown or dusky bronze with a lighter belly. The scales are much smaller than those on Golden or Macquarie perch. The tail is weakly forked. Very large specimens assume a slightly disproportionate appearance with a strongly humped forehead, strong lateral compression and a more distinctly pointed, almost beak-like head and snout (Lintermans 2007, OEH 2019).



Photograph 1.2 Silver Perch (Bidyanus bidyanus)

Source: Michelle (2017)

1.2.2.2 Known distribution

Formerly widespread over much of the Murray-Darling Basin excluding the most upper reaches, Silver perch has declined over most of its range. Numbers moving through a fishway at Euston Weir on the Murray River declined by 93% between 1940 and 1990. Only nine Silver perch were recorded in a two-year survey of 40 randomly selected sites in the NSW portion of the Basin in the mid-1990s. The species is still patchily abundant in the mid-Murray. The ACT probably represented the upstream limit of distribution in the Murrumbidgee catchment, although the large spawning run of fish that occurred in summer from Lake Burrinjuck is unfortunately a thing of the past (Lintermands 2007,OEH 219).

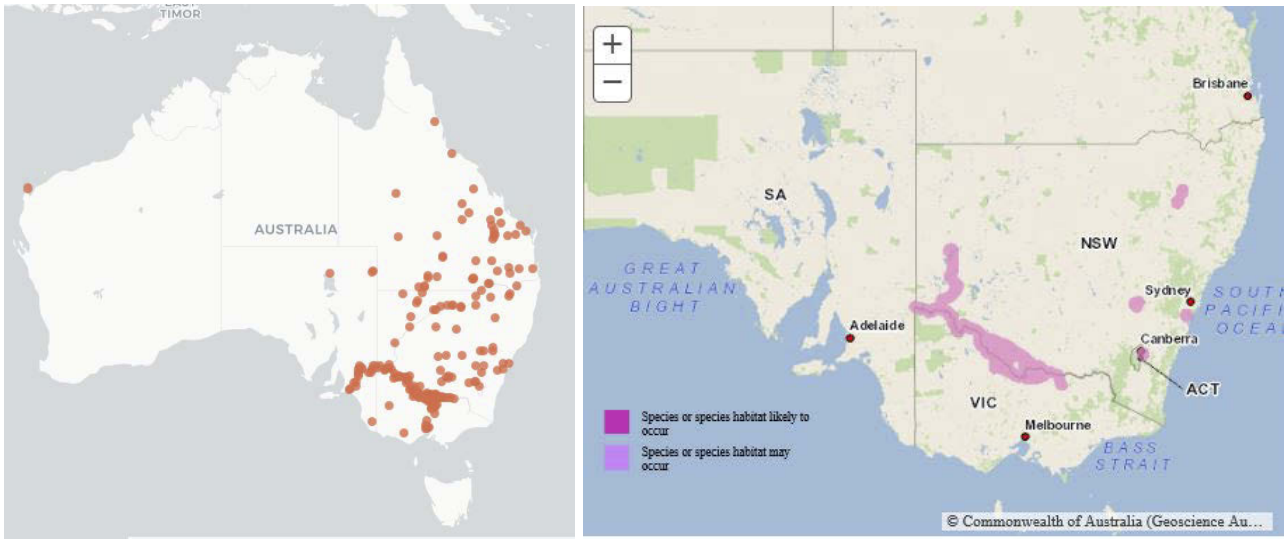


Figure 1.2 Distribution range of Silver Perch

Source: ALA (2019), DoEE (2019)

1.2.2.3 Biology and reproduction

Silver perch display sexual dimorphism, with females growing to a larger size. Growth varies between individual fish and is affected by the productivity of environments. Male fish reach sexual maturity at three years of age, and female fish reach sexual maturity at four to five years of age. Growth slows dramatically in both sexes after sexual maturity. Mallen-Cooper and Stuart (2003) estimated a mean maximum size for Murray River silver perch of 422 mm for female fish and 377 mm for male fish. They spawn in spring and summer after an upstream migration, when large schools often form. Spawning occurs in late afternoon, dusk or just after nightfall. Spawning occurs in shoals at or near the surface, involves simultaneous release of milt (sperm) and eggs by male and female fish respectively, and is often accompanied by thrashing at the surface (Lake, 1967a; Merrick and Schmida, 1984; Clunie and Koehn, 2001). Merrick and Schmida (1984) reported that spawning occurs where water flows over a gravel or rock rubble substrate. Whilst spawning can occur during non-flood conditions, spawning activity was significantly increased during a flood and environmental water release in 2005 in the mid-Murray River. Lake (1967b) found that fertilised, water-hardened eggs were 2.7–2.8 mm in diameter and hatched in 30–31 hours at temperatures of 26–27°C. Silver perch eggs spawned at cooler temperatures had longer hatching times. Importantly, Lake (1967b) noted that silver perch eggs are semi-pelagic and will sink to the bottom in the absence of current; he also noted the propensity for the chorion ('outer covering') of silver perch eggs to adsorb very fine suspended sediment. The cumulative evidence indicates that silver perch reproduction is flexible in terms of flow conditions and temperature; reproduction can occur in both within-channel flows and floods and at relatively cool water temperatures. Surveys found that silver perch across the Murray-Darling Basin failed to recruit during 2008–2010 drought conditions and that its current low densities may heighten the risk from extended recruitment failure in the future (Davies et al., 2012).

Silver perch are omnivorous. The diet contains aquatic plants, snails, shrimps, zooplankton and aquatic insect larvae.

This species is bred artificially in a number of government and commercial hatcheries and widely stocked into farm dams and reservoirs. While significant numbers of silver perch are bred and grown in aquaculture facilities for human consumption in Australia and Asia, these aqua cultured fish are not considered meaningful to the long-term survival of silver perch in the wild, as they are highly domesticated both in the behavioural and the genetic sense (Rowland, 2009). Similarly, large numbers of hatchery-bred silver perch are stocked, usually in impoundments, but these stocked silver perch appear to make little improvement to the conservation situation of wild silver perch (Davies et al., 2008; Rowland, 2009; Davies et al., 2012).

1.2.3 Habitat

Silver perch are found in similar habitats to Murray cod and Golden perch, i.e. lowland, turbid and slow-flowing rivers. However, numerous reliable accounts exist of silver perch penetrating to Cooma (~ 800 metres ASL) on the Murrumbidgee River in large-scale upstream migrations in summer in the early and mid 1900s. Silver perch are consistently reported by anglers and researchers to show a general preference for faster-flowing water, including rapids and races, and more open sections of river, throughout the Murray-Darling Basin (Clunie and Koehn, 2001). In the upper Murrumbidgee River during the 1960s and 1970s, the species was renowned for migrating into clear fast-flowing rapids in summer, in which anglers observed and targeted them (Pratt, 1979). Silver perch are a highly migratory freshwater fish. The extensive migration of adults, particularly during flooding, has long been recognised and is considered to be part of their spawning behaviour, likely a strategy to offset the downstream drift of eggs and larvae (Cadwallader, 1977; Reynolds, 1983; Mallen-Cooper et al., 1995). Reynolds (1983) tagged and then recovered a small number of tagged adult silver perch in the lower Murray River; most moved about 40 km upstream, while one fish moved 110 km and another 570 km upstream in 19 months.

1.2.4 Threatening processes

River regulation has severely affected this species through disruption of migration and reproductive behaviour. It is estimated there are 4000 barriers to fish movement in the Murray-Darling Basin in the form of dams, weirs and other structures (Lintermans, 2007), the vast majority of which do not have fishways. Between 2001 and 2013, the Sea to Hume Dam Fish Passage Program provided purpose-built fishways to give native fish passage past 15 weirs and barrages on the Murray River between the river's mouth and Hume Dam at Albury (Lintermans, in prep., 2013), thereby ameliorating the impacts of weirs on the movement of juvenile and adult native fish, including silver perch in the middle and lower Murray River (but not necessarily native fish eggs and larvae).

Thermal pollution In the upper Murray system, large dams release cold water from their base, below the lower thermal limits for hatching and growth of native fish eggs and larvae, and disrupting cues for movement by juvenile and adult fish (e.g. Astles et al., 2003). Thermal pollution typically takes several hundred kilometres for water temperatures to be restored to normal (summarised in Clunie and Koehn, 2001).

Blackwater events - Blackwater is water containing high levels of dissolved organic carbon which gives it a characteristic dark colour. Blackwater results from flood waters inundating floodplains or dry river channels, in the process leaching carbon compounds from inundated plant material. The dissolved organic carbon in blackwater encourages rapid bacterial growth which consumes dissolved oxygen and can reduce dissolved oxygen levels to very low levels that are fatal to fish and other aquatic organisms. While the extraction of dissolved organic carbon by floodwaters is a natural phenomenon, severe blackwater events are at least partially a result of river regulation, which has reduced the frequency and extent of floodplain inundation, and thus increased stores of dissolved organic carbon yielding plant material (Gerkhe et al., 1993; King et al., 2012).

Habitat degradation - It is widely recognised that Murray-Darling habitats have been degraded by desnagging, increased turbidity and salinity, loss of submergent macrophytes ('water weed'), and loss of riparian vegetation and associated siltation due to land clearing and a variety of poor farming practices including cattle grazing and trampling river banks (summarised in Clunie and Koehn, 2001). While all of these forms of habitat degradation have affected silver perch, key impacts are likely to be (1) loss of submergent macrophytes, which may be important nursery areas for juvenile silver perch and important sites for feeding for all life stages, and (2) siltation, which can smother silver perch eggs that sink to the substratum in the absence of current.

Alien pathogens - There are many pathogens and parasites present in Murray-Darling waterways capable of affecting silver perch. Almost all are introduced ('alien'), having been brought into Australia with imports of live alien fish. Diverse evidence suggests alien pathogens and parasites may have had greater impacts on native fish species than realised in the past, and ongoing impacts in the present. The key alien pathogens and parasites are of concern are EHNV, Saprolegnia and Aphanomyces, Chilodonella, Ichthyophthirius, Lernaea and Asian fish tapeworm.

Interactions with alien species (Carp, Brown and Rainbow trout, *Gamubzia holbrooki* and Redfin perch) are also suspected to be a threat.

1.2.5 Threat abatement/recovery plans

The following recovery plan is applicable to this species:

- Threatened Species Recovery Planning Program (2006). Silver perch *Bidyanun bidyanus* NSW Recovery Plan. NSW Department of Primary Industries. Available from: https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0007/636388/NSW-Silver-Perch-Recovery-Plan.pdf. In effect under the New South Wales Fisheries Management Act 1994.

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Department of Primary Industries 2019 Threatened species lists – Silver Perch Bidyanus bidyanus. Viewed online at: https://www.dpi.nsw.gov.au/fishing/threatened-species/what-current/vulnerable-species/silver-perch

Gehrke PC, Revel MB and Philbey AW (1993). Effects of river red gum, *Eucalyptus camaldulensis*, litter on Golden perch, *Macquaria ambigua.* Journal of Fish Biology 43: 265–279.

King AJ, Tonkin Z and Lieshcke J (2012). Short-term effects of a prolonged blackwater event on aquatic fauna in the Murray River, Australia: considerations for future events. Marine and Freshwater Research 63: 576–586.

Lintermands, M. 2007, *Fishes of the Murray Darling Basin: An introductory guide*. Murray Darling Basing Commission.

Mallen-Cooper M, Stuart IG, Hides-Pearson F and Harris J (1995) Fish migration in the Murray River and assessment of the Torrumbarry fishway. Final report for Natural Resource Management Strategy Project N002. NSW Fisheries Research Institute and the Cooperative Research Centre for Freshwater Ecology. Cited in: Clunie and Koehn (2001).

Merrick JR and Schmida GE (1984). Australian Freshwater Fishes — Biology and Management. Griffin Press Ltd. South Australia.

Michelle, M. (2017). Silver perch (Bidyanus bidyanus). [image] [online] Available from: https://images.ala.org.au/image/details?imageId=4d93d98a-ede5-4ad8-bd8e-40cc74a1c861. [19 September 2019].

Reynolds LF (1983). Migration patterns of five fish species in the Murray-Darling River system. Australian Journal of Marine and Freshwater Research 34: 857–871

Threatened Species Recovery Planning Program (2006). Silver perch Bidyanun bidyanus NSW Recovery Plan. NSW Department of Primary Industries. Available from: https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0007/636388/NSW-Silver-Perch-Recovery-Plan.pdf [Accessed: 25 September 2019].

1.3 Darling river snail (*Notopala sublineata*)

1.3.1 Status

EPBC Act – Not listed

FM Act - Endangered

1.3.2 Biology and ecology

1.3.2.1 Characteristics

The Darling river snail is a medium sized freshwater snail with a rounded shell that ends in a conical spire. Shell colouration ranges from dark green to greenish brown without banding. Like other snails in its body shape it can be further characterised by its prominent snout and short eye stalks on the outside of the tentacles (DPI 2007).

No image available.

1.3.2.2 Known distribution

The Darling river snail was once widely distributed along most large rivers with a high presence of woody debris, particularly from the Murray-Darling river system (refer Figure 1.3). Each sub-species is restricted in its distribution as follows; N. sublineata hanleyi is restricted to the Murray and Murrumbidgee drainages, N. sublineata sublineata is restricted to the Darling River and its tributaries whilst N. sublineata alisoni has a wide distribution in more norther inland and coastal drainages outside of New South Wales (DPI 2007).

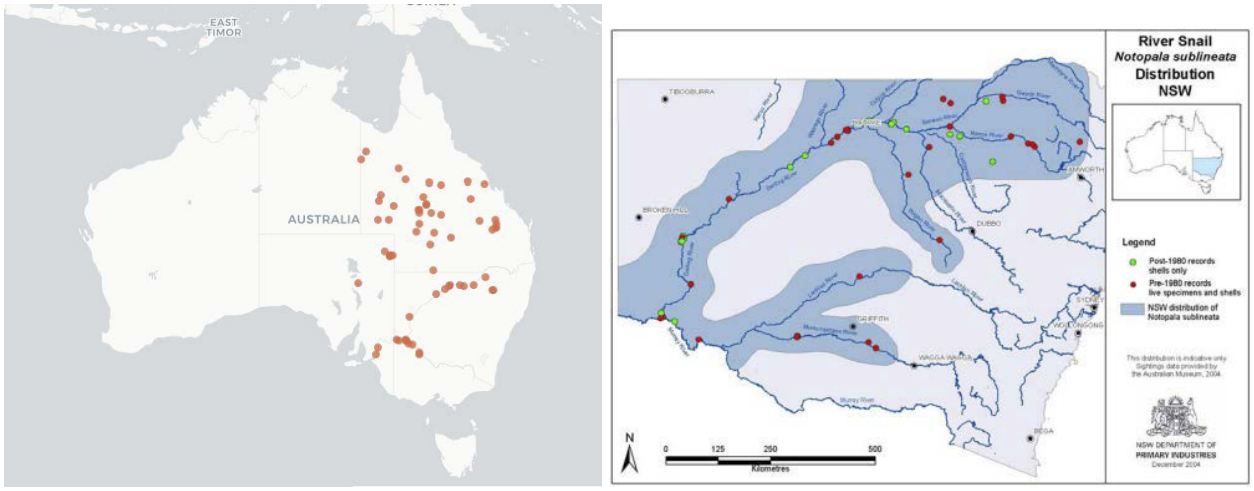

Figure 1.3 **Distribution range of the Darling river snail**

Source: ALA (2019), DPI (2007)

1.3.2.3 Biology and reproduction

Whilst there is very little information that exists about the reproduction of Darling river snails other members of the Viviparidae family are characterised by the females giving birth to live young, rather than the more common method of laying eggs. Fertilisation is internal and the embryos are retained within the pallial oviduct. Young remain with the female until they reach a size that is large enough for them to survive independently. The energetic cost of vivparity means the fecundity of viviparous snails is low compared to other freshwater gastropods. Biotic and abiotic factors such as periphyton quantity and quality, population density, water temperature, dissolved oxygen, calcium concentrations and current velocity also drive fecundity of freshwater vivparids (NSW DPI 2019).

1.3.3 Habitat

The Darling river snail once inhabited flowing rivers across the Murray-Darling system and could be found on logs and rocks along the river banks or crawling in the mud. The remaining suitable habitat consists of irrigation pipelines throughout the Murray and Darling systems. This artificial environment provides the suitable conditions to promote microbial production and organic accumulation which the snails rely on as a food source (DPI 2007).

1.3.4 Threatening processes

The following have been identified as potentially threatening processes to Darling river snails:

- River regulation and changes to natural river flows
- Removal of large woody debris 'snags' through de-snagging programs and clearing of riparian vegetation
- Chemical treatment of snails in artificial habitat (pipelines)
- Sedimentation
- The introduction of carp to the Murray-Darling Basin
- A lack of knowledge and understanding
- Low community awareness and support for the species.

1.3.5 Threat abatement/Recovery plans

The following recovery plan is applicable to this species:

- NSW Department of Primary Industries (2007) Recovery plan for the endangered river snail (*Notopala* sublineata). Available at: https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0007/635470/Recovery-plan-for-the-endangered-river-snail-Notopala-sublineata-June-2007.pdf. In effect under the Fisheries Management Act 1994.

1.3.6 References

Atlas of Living Australia (2019). Murray river snail, *Notopala sublineata*. Available from: https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:c77bc925-6cd1-49ce-9cb3-b0e1ab5dbf35. [25 September 2019].

Department of the Environment and Energy (2019). Murray river snail, Notopala sublineata. Available from: http://www.environment.gov.au/biodiversity/threatened/nominations/ineligible-species/notopala-sublineata. [25 September 2019].

NSW Department of Primary Industries (2007 Recovery plan for the endangered river snail (Notopala sublineata). Available at: https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0007/635470/Recovery-plan-for-the-endangered-river-snail-Notopala-sublineata-June-2007.pdf. [Accessed: 25 Sept. 2019]

Office of Environment and Heritage, NSW (2019).

1.4 Eel-tailed catfish (Murray – Darling population) (*Tandanus tandanus*)

1.4.1 Status

EPBC Act – Not listed

FM Act – Endangered population

1.4.2 Biology and ecology

1.4.2.1 Characteristics

Eel-tailed catfish have a large head, tough smooth skin and range in colour from olive-green to brown or black with a whitish underside. Larger specimens can reach almost 7 kg in weight but are rarely more than 2 kg. Their fleshy lips are surrounded by numerous barbels that aid in feeding. Their short dorsal fin located just behind the head has a serrated spine at the front (refer Photograph 1.3) (MDBC 2007).

Photograph 1.3 Eel-tailed catfish (Tandanus tandanus)

Source: McGrouther (2016)

1.4.2.2 Known distribution

Eel-tailed catfish historically inhabited slow-flowing rivers throughout the Murray-Darling Basin and coastal rivers from southern New South Wales to northern Queensland however these riverine populations have largely declined since the 1970's/early 1980's and is no longer common in its historical range (refer Figure 1.4) (MDBC 2007).

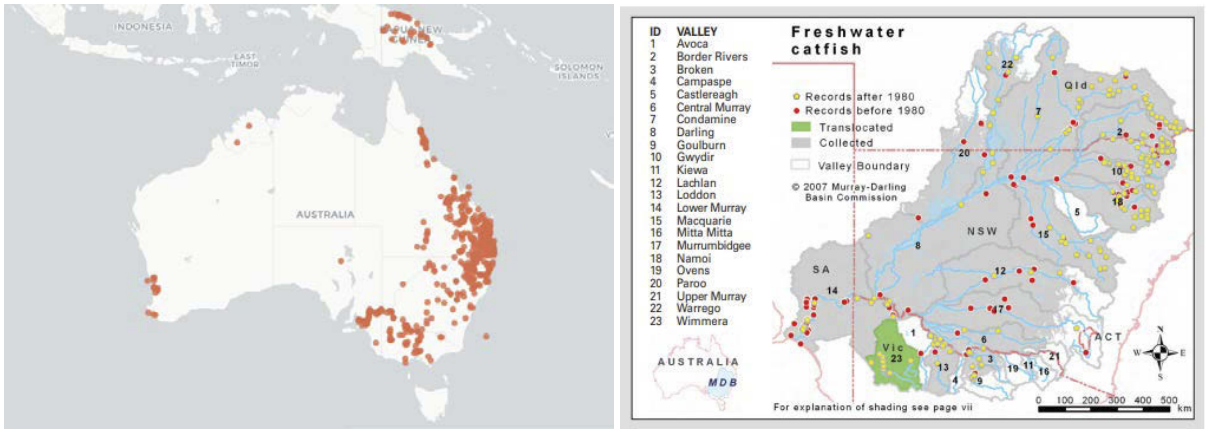

Figure 1.4 Distribution range of Eel-tailed catfish, *Tandanus tandanus*

Source: ALA (2019), Murray-Darling Basin Commission (2007)

1.4.2.3 Biology and reproduction

Eel-tailed catfish are a sedentary species preferring to remain in an area moving less than 5 km. Their carnivorous diet consists of crustaceans, molluscs, aquatic insects and small fish (DPI 2008) and will also consume aquatic insects, snails and small fishes. Juveniles rely more so on aquatic insects for their diet. Eel-tailed catfish are mostly active at dusk and in the early evening (MDBA 2007). This species is somewhat solitary however juveniles will sometimes form loose aggregations (Fishes of Australia 2019).

Eel-tailed catfish reach sexual maturity at 3-5 years of age spawning in spring and summer when water temperatures reach 20-24ºC. Males guard the nest, a circular or oval shaped depression, 0.6-2.0 m in diameter that is made from the pebbles and gravel of the benthos with coarser material in the centre. Males will also fan and clean the non-adhesive eggs which settle into the coarse substrate taking approximately seven days to hatch. It is thought that several spawning events may occur at each nest within a season either sequentially or concurrently (MDBA 2007).

1.4.3 Habitat

Eel-tailed catfish are a large bodied non-migratory catfish species that inhabits a range of aquatic ecosystems including rivers, creeks, lakes, billabongs and lagoons preferring slower moving water bodies. As a benthic species it lives, feeds, and breeds near the bottom of the water bodies it inhabits. It can be found in both clear and turbid with substrates ranging from mud to gravel and rock. Whilst now rare in natural river ecosystems it can be found in artificial dams and waterways.

1.4.4 Threatening processes

The following have been identified as potentially threatening processes to the Eel-tailed catfish:

- Historic commercial fisheries
- Loss of habitat (lakes, billabong, lagoons) through river regulation
- Barriers to movement or natural flow of rivers
- Competition with introduced species, such as carp (*Cyprinus carpio*) and Redfin perch (*Perca fluviatilis*) (MBDA 2007)
- Loss of spawning sites and suitable habitat as a result of siltation
- Change in river flow patterns and flooding regimes causing habitat loss
- Chemical pollution from agricultural runoff
- Temperature spawning cues effected by cold-water discharge from dams and weirs
- Loss of aquatic plants (DPI 2008).

1.4.5 Threat abatement/recovery plans

The following recovery plan is applicable to this species:

- NSW Department of Primary Industries (2015) Eel-tailed catfish population in the Murray-Darling Basin, *Tandanus tandanus* see section: *Conservation and recovery actions*. Available at: https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0005/635918/primefact-eel-tailed-catfish-population-in-the-murray-darling-basin.pdf. In effect under the Fisheries Management Act 1994.

1.4.6 References

Atlas of Living Australia (2019). Freshwater catfish, *Tandanus tandanus*. Available from: https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:f4138d26-9594-49ed-b3a5-b1851a634108. [Accessed: 26 September 2019].

Department of Primary Industries (2015). Eel-tailed catfish population in the Murray-Darling Basin, Tandanus tandanus. [online] Available at: https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0005/635918/primefact-eel-tailed-catfish-population-in-the-murray-darling-basin.pdf. [Accessed: 26 Sept. 2019].

McGrouther, M. (2016). Eel-tailed catfish (Tandanus tandanus). [image] [online] Available from: https://images.ala.org.au/image/details?imageId=9928dd92-dd90-43e6-bd0f-e2818ef51d21. [19 September 2019].

Murray-Darling Basin Commission (2007). Factsheet native freshwater catfish. Available at: https://www.mdba.gov.au/sites/default/files/archived/mdbc-NFS-reports/2202_factsheet_native_freshwater_catfish.pdf. [Accessed: 25 Sept. 2019].

1.5 Southern purple spotted gudgeon (*Mogurnda adspersa*)

1.5.1 Status

EPBC Act – Not listed

FM Act – Endangered

1.5.2 Biology and ecology

1.5.2.1 Characteristics

The Southern purple spotted gudgeon can be characterised by its rounded head and small mouth and rounded tail. Their colouration includes dark brown along the dorsal, fading to pale brown and whitish-cream colour on the belly. Distinguishing markings are present along the body with white, red and blue spots that become more apparent during breeding, at which time yellow bars become visible along the dorsal and anal fins. This species of gudgeon can be distinguished from others by the presence of three red-maroon bars along its cheek (refer Photograph 1.4). Other species found within the same distribution are of similar size and shape looking similar to this species (DPI 2015).

Photograph 1.4 Southern purple spotted gudgeon *(Mogurnda adspersa)*

Source: Schmida (2015)

1.5.2.2 Known distribution

The Southern purple spotted gudgeon is endemic to southeastern Australia, particularly the Murray-Darling Basin (ALA 2019). This species occurs in coastal drainages from the Pascoe River, Queensland to the Clarence River in New South Wales along with Inland Murray-Darling drainages from the Macquarie River, New South Wales to the Onkaparinga River, South Australia. In New South Wales the species is confined to small remnant populations in the Macquarie, Gwydir and Border Rivers catchments along with a self-sustaining population from captive-bred fish in the Castlereagh Catchment. The Richmond and Hunter valley are the sites of the only existing population in eastern New South Wales (Fishes of Australia 2018) (refer Figure 1.5).

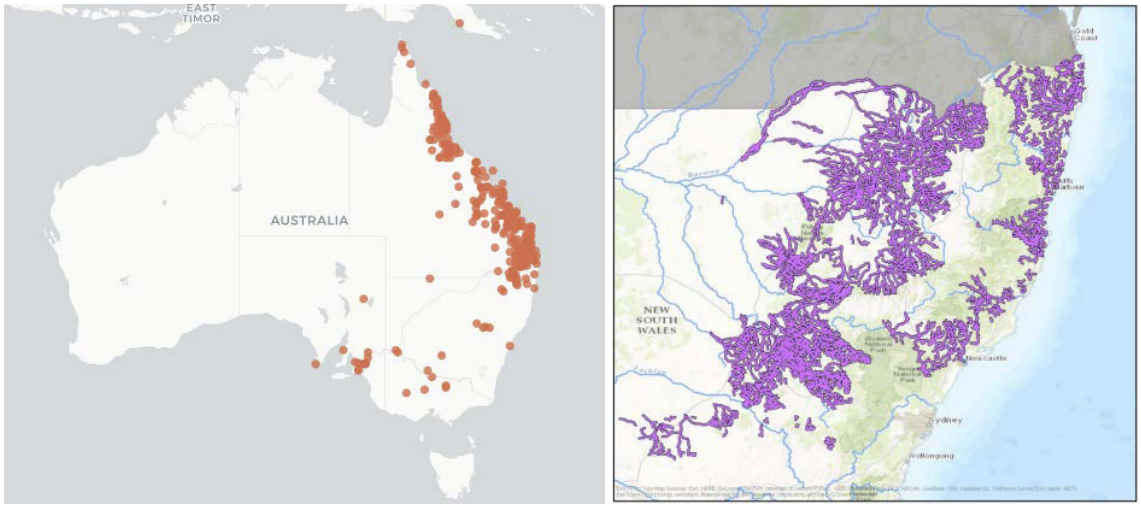

Figure 1.5 **Distribution range of the Southern purple spotted gudgeon *(Mogurnda adspersa)***

Source: ALA (2019), (DPI 2017)

1.5.2.3 Biology and reproduction

Southern purple spotted gudgeons rely primarily on terrestrial insects and their larvae as their source of food however will also feed on worms, small fish, tadpoles and plant material. For males of this species sexual maturity is reached once they grow to around 4.5 cm whilst females reach sexual maturity when 5 cm in length. Courtship occurs during the spring and summer months when water temperatures are warmer (20ºC) when males begin to demonstrate elaborate courting displays. Females can lay between 30 and 1300 eggs per batch during the mating season, which are deposited in clusters on rocks, wood or broad-leafed plants. The eggs take 3-8 days to hatch, during which time the males will guard and fan them. The new larvae are around 4 mm in length (DPI 2015).

1.5.3 Habitat

The Southern purple spotted gudgeon prefers calm rivers and creeks sheltering amongst underwater plants, wooden debris and rocks along the benthos (ALA 2019). Other important habitat features include low turbidity, cover from overhanging vegetation from river banks and leaf litter (DPI 2015).

1.5.4 Threatening processes

The following have been identified as potentially threatening processes to the Southern purple spotted gudgeon:

- Introduced species including Eastern gambusia (*Gambusia holbrooki*), common carp (*Cyprinus carpio*) and Redfin perch (*Perca fluviatilis*)
- Habitat disturbance cause by invasive species
- Reduction in aquatic plants resulting in loss of suitable habitat
- River regulation impacting the flow and water level of rivers and wetlands particularly in Southern purple spotted gudgeon breeding and recruitment habitat
- Temperature spawning cues effected by cold-water discharge from dams and weirs
- Livestock causing damage to river banks and increasing turbidity
- Agricultural runoff and siltation impacting water quality
- Small populations and inability to disperse long distances resulting in localised extinctions from severe events.

1.5.5 Threat abatement/recovery plans

The following recovery plan is applicable to this species:

- NSW Department of Primary Industries (2015). Southern purple spotted gudgeon see section: *Conservation and recovery actions*. Available at: https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0007/635290/Primefact-1275-Southern-Purple-Spotted-Gudgeon-Mogurnda-adspersa.pdf. In effect under the Fisheries Management Act 1994.
- Murray-Darling Basin Authority (2012). Reintroduction plan for the Purple spotted gudgeon in the southern Murray-Darling Basin. Available at: https://www.mdba.gov.au/sites/default/files/pubs/PSG-final-corporate-style_v2.pdf.

1.5.6 References

Atlas of Living Australia (2019). Southern purple spotted gudgeon (*Mogurnda adspersa*). [online] Available from: https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:fd34c28a-56cf-43cc-9e15-5a121f664c72. [26 September 2019].

Department of Primary Industries (2015). Southern purple spotted gudgeon (*Mogurnda adspersa*). [online] Available at: https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0007/635290/Primefact-1275-Southern-Purple-Spotted-Gudgeon-Mogurnda-adspersa.pdf. [Accessed: 26 Sept. 2019].

Department of Primary Industries (2015). Southern purple spotted gudgeon (Mogurnda adspersa). [online] Available at: https://www.mdba.gov.au/sites/default/files/pubs/PSG-final-corporate-style_v2.pdf. [Accessed: 26 Sept. 2019].

Fishes of Australia (2018). Southern purple spotted gudgeon (Mogurnda adspersa). [online] Available from: http://fishesofaustralia.net.au/home/species/4148. [26 September 2019].

Murray-Darling Basin Authority (2012). Reintroduction plan for the Purple spotted gudgeon in the southern Murray-Darling Basin. Available at: https://www.mdba.gov.au/sites/default/files/pubs/PSG-final-corporate-style_v2.pdf. [Accessed: 26 Sept. 2019].

Schmida, G. (2015). Southern purple spotted gudgeon (Mogurnda adspersa). [image] [online] Available from: https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0007/635290/Primefact-1275-Southern-Purple-Spotted-Gudgeon-Mogurnda-adspersa.pdf. [Accessed: 26 Sept. 2019].

1.6 Western olive perchlet (Western population) (*Ambassis agassizii*)

1.6.1 Status

EPBC Act – Not listed

FM Act – Endangered

1.6.2 Biology and ecology

1.6.2.1 Characteristics

The Western olive perchlet, also known at the Agassiz's glassfish is an oval shaped fish with a moderately large mouth, very large eyes and a forked tail. Their translucent scales have dark edging which forms a distinct pattern. The fins are clear however the dorsal and anal fins will usually have a broad dark streak along the edges (refer Photograph 1.5). Large individuals can reach 80 mm in length however most are less than 40 mm (DPI 2013)

Photograph 1.5 **Western olive perchlet *(Ambassis agassizii)***

Source: DPI (2013)

1.6.2.2 Known distribution

Historically the Western olive perchlet had a broad distribution from northern New South Wales to north Queensland and across much of the Murray-Darling Basin to South Australia and Victoria. This population has suffered a serious decline and is now extinct in South Australia except for a single translocate population in Swan Reach (Fishes of Australia 2019) and extinct in Victoria. This species was last recorded in South Australia from the Basin drainage was 1983. In New South Wales it is known from only a few populations in the Darling drainage upstream of Bourke, however is more abundant locally in the Border Rivers and Condamine-Balonne system (MDBA 2007) (refer Figure 1.6).

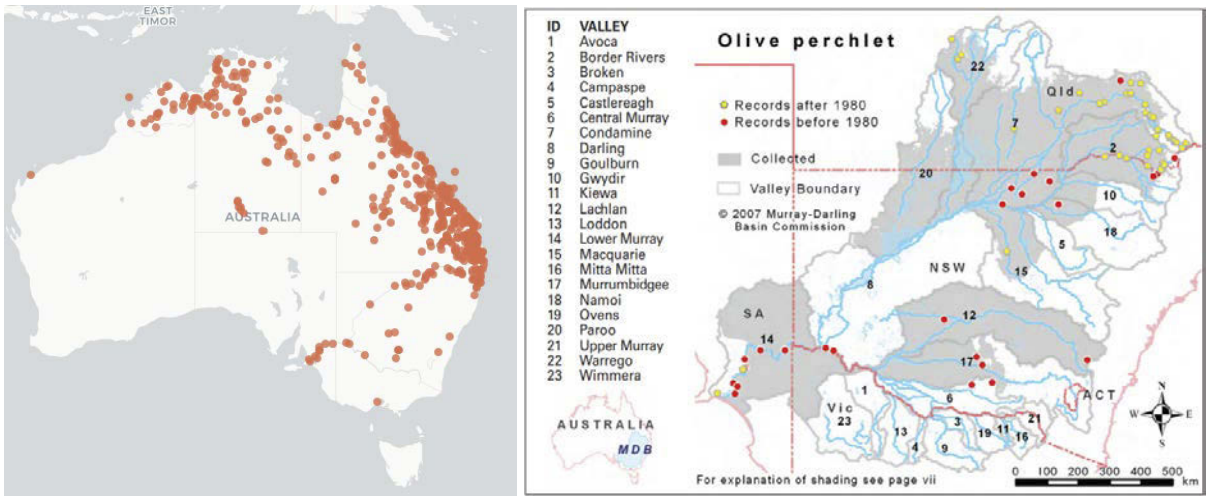

Figure 1.6 **Distribution range of Western olive perchlet *(Ambassis agassizii)***

Source: ALA (2019), MBDA (2007)

1.6.2.3 Biology and reproduction

Olive perchlets primarily carnivorous feeding on zooplankton such as Copepods and cladocera, along with aquatic and terrestrial insects. They will also eat mosquito wrigglers, small arachnids and occasionally small wish and feed primarily during daylight hours (MBDA 2007). Both males and female Olive perchlets reach sexual maturity after one year and live only for 2-4 years. Once water temperatures reach 23^{o}C, during the warmer months from October to December, spawning will occur. Utilising aquatic plants and rocks along the streambed females will lay 200-700 eggs (DPI 2019). A larger female specimen (49 mm long) was recorded carrying 2350 eggs. Eggs will hatch after 5-7 days at 22^{o}C with 3 mm sized larvae once hatched (MBDA 2007).

1.6.3 Habitat

Preferring backwards with little to no water movement and a strong association with woody habitat and aquatic vegetation the Western olive perchlet inhabits the vegetated edges of lakes, creeks, swamps, wetlands and rivers (MBDA 2007). During the day they are usually found in sheltered areas with overhanging vegetation, aquatic macrophyte beds, logs, dead branches and boulders dispersing in the evening to feed (DPI 2014).

1.6.4 Threatening processes

The following have been identified as potentially threatening processes to Western olive perchlet populations:

- Introduced species including Eastern gambusia (*Gambusia holbrooki*) and Redfin perch (*Perca fluviatilis*)
- Cold water pollution restricting breeding and spawning success
- Habitat disturbance and degradation
- River regulation and loss of wetlands (MDBA 2007)
- Loss of instream aquatic vegetation through river regulation and introduced species (carp *Cyprinus carpio*) (DPI 2014)

1.6.5 Threat abatement/recovery plans

The following recovery plan is applicable to this species:

- NSW Department of Primary Industries (2015). Olive Perchlet (western population) - *Ambassis agassizii*. Available at: under *Conservation and recovery actions* https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0008/635876/PUB12-10-Primefact-176-Western-Olive-Perchlet-Ambassis-agassizii.pdf. In effect under the Fisheries Management Act 1994.

1.6.6 References

Atlas of Living Australia (2019) Olive perchlet (western population) - *Ambassis agassizii*. [online] Available from https://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon:b0ff773c-19a9-4a1c-88cd-65fb4351276b. [26 September 2019].

Department of Primary Industries (2014) Prime fact: Olive perchlet (western population) - Ambassis agassizii. [online] Available at: https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0008/635876/PUB12-10-Primefact-176-Western-Olive-Perchlet-Ambassis-agassizii.pdf. [Accessed: 26 Sept. 2019].

Department of Primary Industries (2014) Prime fact: Olive perchlet (western population) - Ambassis agassizii. [photo] [online] Available from: https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0008/635876/PUB12-10-Primefact-176-Western-Olive-Perchlet-Ambassis-agassizii.pdf. [Accessed: 26 Sept. 2019].

Fishes of Australia (2019) Agassiz's Glassfish, Ambassis agassizii. [online] http://fishesofaustralia.net.au/home/species/1581#moreinfo. [26 September 2019].

Murray-Darling Basin Authority (2012). Reintroduction plan for the Purple spotted gudgeon in the southern Murray-Darling Basin. Available at: https://www.mdba.gov.au/sites/default/files/archived/mdbc-NFS-reports/2203_factsheet_native_olive_perchlet.pdf. [Accessed: 26 Sept. 2019].

APPENDIX

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Aquatic Biodiversity Technical Report

Appendix B Adverse Impact Assessment Methodology

NORTH STAR TO NSW/QUEENSLAND BORDER ENVIRONMENTAL IMPACT STATEMENT

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

Inland Rail: Phase 2 - North Star to NSW/QLD Border

Appendix B – Matters of National Environmental Significance Adverse Impact Assessment Methodology

Australian Rail Track Corporation

Reference: 2700

Contents

Appendices

Acronyms

Acronym	Definition
AIAM	adverse impact assessment methodology
BPA	biodiversity planning assessment
Cth	Commonwealth
DES	Department of Environment and Science (Qld)
DoEE	Department of Environment and Energy (Cth)
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communities (Cth)
EHP	Department of Environment and Heritage Protection (Qld)
EIS	Environmental Impact Statement
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Cth)
km	kilometre
m	metre
MNES	matters of national environmental significance
the Project	NSW Border to Gowrie Inland Rail Project
Qld	Queensland
RE	regional ecosystem
SAVS	system for assessing vulnerability of species
TEC	threatened ecological community

Reporting context

This report presents an adverse impact assessment methodology (AIAM) that has been developed to identify areas where a Project action is considered likely to have a significant residual adverse impact on an *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act) listed matters of national environmental significance (MNES). The AIAM has been designed to provide for a transparent, consistent, repeatable and defendable approach to assessing significant residual adverse impacts. Information inputs are sourced from published, peer-reviewed scientific literature, field validated data and expert opinion.

The AIAM is focused on EPBC Act listed species/communities and their habitat (i.e. MNES) that have been identified as having a moderate or higher significance of impact as determined by the initial impact assessment undertaken for the Project.

The Department of the Environment and Energy (DoEE) EPBC Act Environmental Offsets Policy defines offsets as "measures that compensate for the residual adverse impacts of an action on the environment" (DSEWPaC 2012).

The EPBC Act Environmental Offsets Policy (DSEWPaC 2012) states that 'environmental offsets' are measures that compensate for the **residual adverse impacts** of an action on the environment and defines **residual adverse impacts** as those impacts which remain after avoidance and mitigation measures have been implemented. The EPBC Act only requires residual adverse impacts to be offset if the impact is considered to be **'significant'** as defined by the 'Matters of National Environmental Significance – Significant Impact Guidelines Version 1.1' (DoEE 2013).

The purpose of the AIAM is to identify areas within a project footprint (in this case the North Star to Border (NS2B) Inland Rail footprint) where the proposal activities have resulted in a significant residual adverse impact to EPBC Act listed species and/or their associated habitat. An assessment ranking approach was used to develop an assessment matrix by which impacts could be ranked and reflected in a GIS model.

The AIAM uses five factors; including habitat suitability, habitat resilience, species resilience, landscape attributes and disturbance nature, in an assessment matrix to assess potential impacts of the proposal on the key elements which may result in a significant residual adverse impact to a specific MNES.

To acknowledge and reflect the EPBC Act significant impact assessment for MNES species in the adverse impact assessment matrix outputs, the significant impact criteria contained in the significant impact guidelines were built into the assessment matrix inputs. A summary of how the significant impact criteria (referenced in **bold** text) is reflected in the adverse impact assessment is provided below.

- **Lead to a long term decrease in the size of a population** – The species resilience input provides for an assessment of the species capacity to recover from disturbance whilst the habitat suitability provides for assessment of species important habitat and the landscape attribute assessment provides for reference to impacts on local fauna assemblages.
- **Reduce the area of occupancy of the species** – Habitat suitability input accounts for species area of occupancy and impacts to areas of important habitat.
- **Fragment an existing important population into two or more populations** – The connectivity assessment conducted as part of the landscape attribute assessment provides for an assessment of potential Project impact from fragmentation and the species resilience input provides for an assessment of the species capacity to colonise new areas and its reliance on habitat linkages.
- **Adversely affect habitat critical to the survival of a species** – Species resilience input provides assessment of a species capacity to respond to disturbances to breeding and non-breeding habitat, the habitat resilience input accounts for the capacity of a species habitat to respond to disturbance and the habitat suitability input provides for an assessment on areas of important habitat
- **Disrupt the breeding cycle of a population** – Species resilience input provides for an assessment of species resilience to breeding cycle disruptions.

- **Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline** – The landscape attribute assessment provides for an assessment of potential impacts on species habitat within proximity to the disturbance area by assessing Project impacts on the size of habitat patch, connectivity and habitat availability. The species resilience input provides for an assessment of a species capacity to respond to disturbances to breeding and non-breeding habitat. The habitat resilience input accounts for the capacity of a species habitat to respond to disturbance.
- **Result in invasive species that are harmful to MNES species becoming established in the MNES species' habitat** – Species resilience input assesses Project impact on invasive species and the species capacity to respond, including an assessment of the predation vulnerability of the target species.
- **Introduce disease that may cause the species to decline** – Species resilience input assesses Project impact on disease prevalence and the species capacity to respond.
- **Interfere with the recovery of the species** – Species resilience input provides for an assessment of the species capacity to recover from disturbance and the landscape attribute assessment provides for an assessment of the ability of the affected habitat patch to support the target species post disturbance.
- **Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species** – Species resilience input provides for an assessment of species capacity to respond to disturbances to breeding and non-breeding habitat, and the habitat resilience input accounts for the capacity of a species habitat to respond to disturbance. The landscape attribute assessment provides for an assessment of potential impacts on regionally available habitat by assessing impacts on the size of habitat patch, connectivity and habitat availability.
- **Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species** – Species resilience input assesses Project impact on invasive species and the species capacity to respond, including an assessment of the predation vulnerability of the target species.
- **Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species** – Species resilience input provides for an assessment of species ability to disperse and its capacity to respond to disturbances to breeding and non-breeding habitat and resource fluctuations.

To acknowledge and reflect the EPBC Act significant impact assessment for MNES threatened ecological communities in the adverse impact assessment matrix outputs, the significant impact criteria contained in the significant impact guidelines were built into the assessment matrix inputs. A summary of how the significant impact criteria (referenced in **bold** text) is reflected in the adverse impact assessment is provided below.

- **Reduce the extent of an ecological community** – Habitat suitability input accounts for species area of occupancy and impacts to areas of important habitat
- **Fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines** – The connectivity assessment conducted as part of the landscape attribute assessment provides for an assessment of potential Project impact from fragmentation and the community's resilience input provides for an assessment of the species capacity to colonise new areas and its reliance on habitat linkages
- **Adversely affect habitat critical to the survival of an ecological community** – Species resilience input provides assessment of a community's capacity to respond to disturbances to habitat, the habitat resilience input accounts for the capacity of a community's habitat to respond to disturbance and the habitat suitability input provides for an assessment on areas of important habitat

- **Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns** – The landscape attribute assessment provides for an assessment of potential impacts on community's habitat within proximity to the disturbance area by assessing Project impacts on the size of habitat patch, connectivity and habitat availability. The species resilience input provides for an assessment of a community's capacity to respond to disturbances to habitat. The habitat resilience input accounts for the capacity of a community's habitat to respond to disturbance
- **Cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting** – Species resilience input assesses Project impact of invasive species and the communities capacity to respond accordingly. The landscape attribute assessment provides for an assessment of potential impacts on community's habitat within proximity to the disturbance area by assessing Project impacts on the size of habitat patch, connectivity and habitat availability
- **Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to: (a) assisting invasive species, that are harmful to the listed ecological community, to become established, or (b) causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community** – Species resilience input provides for an assessment of community's capacity to respond to disturbances to habitat, and the habitat resilience input accounts for the capacity of a community's habitat to respond to disturbance. The landscape attribute assessment provides for an assessment of potential impacts on regionally available habitat by assessing impacts on the size of habitat patch, connectivity and habitat availability
- **Interfere with the recovery of an ecological community** – Species resilience input provides for an assessment of the community's capacity to recover from disturbance and the landscape attribute assessment provides for an assessment of the ability of the affected habitat patch to support the target community post disturbance.

The AIAM includes an assessment of potential impacts of the proposal on recognised threatening processes for a threatened species which have resulted in the species threatened status and subsequent decline. As such, the degree of vulnerability of the target species to disturbance is captured in the Project assessments of species resilience to reflect the differing sensitivities that Endangered, Vulnerable or Migratory species have to disturbance.

The AIAM provides for the provision of a 'fatal flaw' trigger which identifies extreme risk factors that result in a significant residual adverse impact on the target species and/or their preferred habitat. The fatal flaw trigger captures scenarios were the level of risk to the species is too high, automatically resulting in an 'adverse impact' output. Where a fatal flaw is triggered, the proponent would be required to provide a suitable offset.

Areas of important habitat are captured in this adverse impact assessment as 'core habitat'. Core habitat represents an area of habitat in which the target species is known and the area of habitat is recognised under relevant recovery plans or other relevant plans/policies/regulations. Core habitat also captures populations that are limited geographically within the region. As areas of core habitat represent important habitat for the target species, core habitat is allocated a fatal flaw to reflect the high ecological value of the habitat area.

This document presents the outcomes of the AIAM when applied to the Inland Rail feasibility design, to provide an indicative extent of significant residual adverse impact on EPBC Act listed species that have the potential to be impacted by the proposal.

1 Introduction

1.1 Background

The Australian Government has committed to delivering a significant piece of national transport infrastructure by constructing a high performance and direct interstate freight rail corridor between Melbourne and Brisbane, via central-west New South Wales (NSW) and Toowoomba in Queensland.

Inland Rail is a nationally significant transport initiative. Inland Rail will provide a high-capacity freight link between Melbourne and Brisbane through regional Australia to better connect cities, farms, and mines via ports to domestic and international markets.

The objectives of Inland Rail as a whole are to:

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

Inland Rail will enhance Australia's existing rail network and serve the interstate freight market by delivering a road competitive service that will see freight delivered from Melbourne to Brisbane, in less than 24 hours with reliability, pricing and availability that is equal to or better than road. Inland Rail provides a step-change in freight productivity, while also catalysing a range of potential benefits from complementary investments in land use and supply chains that leverage the enhanced logistics capabilities of Inland Rail.

The Inland Rail route will be approximately 1,700 kilometres (km) in length, including 1,200 km of enhanced and upgraded tracks and 500 km of new greenfield sections via regional Victoria, NSW and Queensland. Where possible, existing rail infrastructure will be used to minimise the environmental and community impacts associated with creating new rail corridors.

This adverse impact assessment methodology contained in this report is specific to the North Star to NSW/QLD Border (NS2B) (henceforth referred to as "the proposal") which is the northern most NSW section of the Inland Rail alignment.

1.2 Purpose and scope of this report

This report has been prepared to consolidate existing and collate additional data, to ascertain the degree of the Project's impact on EPBC Act listed species (and associated habitats) (i.e. MNES species) subject to disturbance from the Project.

An investigation of all MNES species (i.e. flora, fauna and threatened ecological communities (TECs) as necessary) and their associated habitat's resilience to disturbance was conducted via review of published, peer-reviewed scientific literature. This investigation identified MNES species that are considered to be disturbance tolerant or disturbance specialists and habitat areas that are considered to represent disturbance resilient habitat.

To provide for a transparent, consistent and repeatable approach to assess species resilience, a scoring system was developed to rank species in order of their resilience using a set of defined criteria. The scoring system was informed by the 'system for assessing vulnerability of species (SAVS)' (Bagne et al. 2011) which was developed to assess the relative vulnerability, or resilience, of a species to the potential effects of climate change. The species resilience questionnaire which was completed for each MNES species is discussed in further detail in Section 2.3, with results for each species presented in Appendix B2.

Habitat resilience was defined by the natural regeneration time associated with each key vegetation community which occurs within the Project construction and operational footprint. Habitat resilience is discussed in further detail in Section 2.4.

The potential impact of the proposal's disturbance on regionally availably habitat for each species was assessed via a landscape attribute assessment which provided for assessment of three key landscape attributes; including size of habitat patch, habitat connectivity and habitat context. The assessment of landscape attributes is described in further detail in Section 2.5.

Using the results from the assessments of species resilience, habitat resilience and landscape attributes together with the habitat category identified for the species at the location of works (i.e. core, essential, general or unlikely habitat as defined in Appendix A of the Biodiversity Technical Report (i.e. Predictive Habitat Modelling Methodology), an assessment matrix was developed to provide a consistent, transparent and repeatable method by which the proposal's impacts to MNES species could be ranked and reflected in a GIS model. The habitat category input is based on ecological ground-truthed mapping and habitat assessments conducted within the subject land.

The assessment matrix predicted when an impact was considered to be a residual adverse impact which is significant to a MNES species. The assessment methodology is detailed in Section 2 of this report.

1.3 Project background

1.3.1 Description of Project works

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

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

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

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

In 2015, Australian Rail Track Corporation (the proponent) developed a ten-year programme to deliver Inland Rail by 2025. ARTC was created in 1997 after the Australian and State governments agreed to the formation of a 'one stop shop' for all operators seeking access to the national interstate rail network. The proponent is seeking approval to construct and operate the North Star to NSW/QLD border section of Inland Rail (the proposal). The proposal consists of approximately 25 km of upgraded track between North Star and a greenfield deviation around Whalan Creek, and 5 km of new track between Whalan Creek and the NSW/QLD border. The proposal is a key component of the wider Inland Rail network between Melbourne and Brisbane.

1.1.1 Key project features

The proposal consists of the key features listed in **Table 1.1**. The construction phase of the proposal will also involve laydown areas, temporary access tracks, borrow bits, a mobile concrete batching plant, and a construction camp.

Table 1.1 Key features of the proposal

Aspect	Description
New track	■ Approximately 25 km of new track within the existing, non-operational Boggabilla rail corridor ■ Approximately 5 km of new track within a greenfield rail corridor
Crossing loop and turnouts	■ One crossing loop, designed to accommodate trains up to 1,800 m long, with provisions to accommodate trains up to 3,600 m long if required in the future ■ Turnouts will be provided on either end of the crossing loop to allow trains to be guided from one track to another
Bridges	■ Eleven new bridges ■ This includes an approximately 1.8 km long viaduct over the Macintyre River and Whalan Creek, which are major watercourses. The viaduct is located in both NSW and QLD; therefore, it will be assessed under *the NSW Environmental Planning and Assessment Act 1979* (EP&A Act) by this EIS, and under the *State Development and Public Works Organisation Act 1971* by the NSW/QLD border to Gowrie EIS. Approval from both States is required before construction of the viaduct can commence.
Drainage	■ Reinforced concrete pipe culverts and reinforced concrete box culverts. Scour protection measures will generally be installed around culverts to avoid erosion. ■ Embankment and catch drains adjacent to the proposed alignment to divert surface runoff the nearest bridge or culvert location
Level crossings	■ Work on new and existing level crossings ■ Signalling and communications infrastructure
Ancillary works	■ Ancillary infrastructure including signalling and communications infrastructure, signage, fencing and utilities.

1.3.2 Descriptions of key features of the proposal

Permanent footprint

The proposal is generally in accordance with the following parameters:

- Generally, aligns with the existing, non-operational Boggabilla rail corridor between North Star (Ch0 0.9 km) and the greenfield deviation (Ch 25.7 km)
- A strip of land at least 10 m wide has been allowed on either side of the earthworks footprint to accommodate track-side infrastructure such as fencing, drainage, etc.
- Encompasses the ultimate footprint of:
  - New track and associated earthworks
  - Bridge and drainage structures, including scour protection around culverts
  - Level crossings
  - Road realignments
  - Possible upgrades to adjacent roads and infrastructure
  - Rail maintenance access road, including access points, passing bays and turnarounds
  - Fencing and signage.

The width of the permanent footprint varies along the proposed alignment depending on the shape and size of the features listed above. A minimum width of 40 m has been adopted for the permanent footprint;

however, the width of the permanent footprint increases to approximately 200 m in the vicinity of the Bruxner Way realignment.

New track

Track within the existing, non-operational Boggabilla rail corridor is considered unsuitable for reuse. Therefore, the proposal consists of:

- Approximately 25 km of new, single line, standard gauge track within the existing, non-operational Boggabilla rail corridor, between North Star (Ch 0.9 km) and the greenfield deviation (Ch 25.7 km)
- Approximately 5 km of new, single line, standard gauge track within a greenfield rail corridor, between the greenfield deviation (Ch 25.7 km) and the NSW/QLD border (Ch 30.6 km).
- Key features of the new track include:
- Single line – trains travelling in both directions share the same track
- Standard gauge – gauge refers to how far apart the rails on a railway track are spaced. Standard gauge indicates that the rails will be spaced 1.435 m apart
- Greenfield rail corridor – this is a section of new track within a new rail corridor.

The track structure will consist of rails, fasteners, rail pads and concrete sleepers, which are laid on a trackbed of ballast. Collectively, these elements are referred to as ‘permanent way’.

The new track is designed to support 21 tonne axle load intermodal (i.e. container) trains up to 1,800 m long and 6.5 m high. Tonne axle load refers to the total weight felt by the track due to passing trains. Depending on the tonne axle load, train speeds will vary between 80 kilometres/hour (km/hr) and 115 km/hr.

Crossing loop and maintenance siding

The proposal includes one crossing loop, known as the Boonal crossing loop. As the proposal is for single line track, the Boonal crossing loop will allow trains travelling in opposite directions to pass each other.

The Boonal crossing loop is an approximately 2.2 km section of single line, standard gauge track, running roughly parallel to the main track. The optimised location of the crossing loop is between Ch 22.7 km and Ch 24.9 km. During the feasibility design phase, the location of the crossing loop was chosen on account of following factors:

- Operational modelling undertaken by ARTC for the wider Inland Rail Programme demonstrated that installing a crossing loop in this location would minimise train travel times in both directions
- Placing the crossing loop in this location minimises construction works as it is a relatively straight section of track, clear of structures and level crossings.

The Boonal crossing loop is able to accommodate trains up to 1,800 m long, with provisions to accommodate trains up to 3,600 m long if required in the future. It is connected to the main track at both ends via low-speed (80 km/hr) turn outs.

A one-ended, single line, standard gauge siding will be incorporated into the Boonal crossing loop for maintenance purposes. It is approximately 500 m long and will be connected to the southern end of the Boonal crossing loop via a low-speed (40 km/hr) turn out. Connecting to the southern end is preferred over the northern end due to the straighter, flatter alignment, and lower embankment heights.

Bridges

Bridges are required so that water, vehicles, and in some cases, stock and pedestrians may cross the proposed rail corridor. Two types of bridges are proposed:

- Rail over water

- Rail over road.

The type of bridge proposed depends on a range of factors, including the local topography, road usership, rail and road alignments at the crossing point, and access requirements. Bridges have been provided at all major watercourse crossings along the proposed alignment to minimise impacts to the local riverine system, and to avoid having to divert watercourses.

A total of 11 new bridges are proposed. An approximately length for each bridge is included in Table 1.2.

Table 1.2 Proposed bridges

Chainage of the southern-most end of the bridge (km)	Bridge	Approximate bridge length
Ch 5.7	Mobbindry Creek Rail Bridge	112 m
Ch 6.1	Mobbindry Floodplain Rail Bridge	182 m
Ch 8.1	Back Creek Rail Bridge	70 m
Ch 16.3	Forest Creek Rail Bridge	154 m
Ch 20.7	UT1 Forest Creek Rail Bridge	136 m
Ch 25.2	Melonenkamm Rail Bridge	160 m
Ch 25.7	Bruxner Way Rail Bridge	114 m
Ch 26.0	Whalan Floodplain #1 Rail	183 m
Ch 27.5	Whalan Floodplain #2 Rail	126 m
Ch 27.5	Whalan Floodplain #3 Rail	126 m
Ch 29.3	Macintyre River Viaduct	1,750 m

Macintyre River viaduct

The includes an approximately 1.8 km long viaduct that crosses Whalan Creek, Tucka Tucka Road and the Macintyre River. Approximately 1.2 km of the viaduct is located in NSW, while the remaining 0.5 km is located in Queensland, where the NSW/QLD border is defined by the centre point of the Macintyre River.

During the feasibility design phase, the design of the Macintyre River Viaduct was informed by geotechnical and flooding studies. Initially, three separate bridge structures were proposed over Whalan Creek, Tucka Tucka Road, and the Macintyre River. However, an iterative flood assessment of the design has resulted in a single viaduct structure that minimises upstream flooding impacts.

Culverts

Culverts are structures that allow water, whether in a watercourse or drainage line, to pass under the proposed alignment. During the feasibility design phase, proposed designs and locations for culverts were developed based on:

- Addressing hydrologic, hydraulic and geotechnical constraints associated with the proposal
- Minimising potential flooding impacts by:
- Locating culverts at low points along the proposed alignment in order to prevent upstream water ponding
- Ensuring that the inside base of culverts is level with the natural surface
- Designing culverts to withstand a 100-year flood event (i.e. 1% annual exceedance probability (AEP)
- Maintaining existing patterns of flow across the floodplain so as not to divert or concentrate flows.

Culverts associated with the proposal will be a mix of reinforced concrete pipe culverts and reinforced concrete box culverts. Scour protection measures will generally be installed around culverts, on disturbed stream banks, and around waterfront land to avoid erosion.

A total of 48 culvert locations were identified during the feasibility design phase. The number of culverts and their locations will be further refined during the detailed design phase in order to minimise potential impacts, especially flooding impacts.

Road rail interfaces

Road rail interfaces are points at which the proposed alignment intersects a road. Treatments for road rail interfaces can be categorised as grade separated crossings, level crossings or closures:

- **Grade separated crossings** – road and rail cross each other at different heights so that traffic flow is not affected. Grade separations are either road over rail, or rail over road.
- **Level crossings** – road and rail cross each other at the same level. Level crossings have either passive or active controls to guide road users:
- **Passive** – have static warning signs (e.g. stop and give way signs) that are visible on approach. This signage is unchanging with no mechanical aspects or light devices.
- **Active** – have static warning signs as well as flashing lights and automatic boom gates
- **Closure** – existing road rail interfaces may be closed, consolidated into fewer crossing points, relocated or diverted to where there is lower operational demand. Closures will only occur where the impact of diversions or consolidations is considered acceptable, or the existing location is not considered safe and cannot reasonably be made safe.

There are no existing signalling or communications systems within the proposed alignment. New signalling and communications infrastructure will be installed at the crossing loop and active level crossings, enabling active controls to tie into the wider Inland Rail network.

In the future, ARTC's Advanced Train Management System is proposed to manage signalling and communications for the wider Inland Rail network. Communication (voice and data) will occur between Network Control Centres and locomotives operating on the Inland Rail network.

Road realignments

The proposal involves a minor realignment of Bruxner Way. Bruxner Way is a Main Road pursuant to the *Roads Act 1993*. It is a two lane, two-way road with a posted speed limit of 100 km/hr.

In order to achieve flood immunity, the elevation of the proposal must be significantly higher than Bruxner Way at the point where the proposal intersects Bruxner Way. Therefore, a rail over road grade separation with a minimum vertical clearance of 5.4 m is proposed at the point of intersection.

At the point where the proposal intersects the existing Bruxner Way, the skew angle is approximately 75 degrees. Maintaining this skew angle would involve constructing a bridge with excessively long, non-standard spans.

A more practical skew angle is 45 degrees. To achieve a 45-degree skew angle, it is proposed to realign Bruxner Way to the east, and then back to the existing Bruxner Way on a slight curve.

As part of the reconfiguration, the elevation of Bruxner Way will be maintained or slightly increased. This will maintain or improve flood immunity at this location.

Earthworks

The proposed alignment traverses the Macintyre River floodplain for approximately 14 km. To achieve flood immunity, the majority of the proposal is elevated on a fill embankment. The embankment height is typically less than 2 m; however, around the realigned Bruxner Way and in the lead up to the Macintyre River Viaduct, the embankment height increases to approximately 7.5 m.

Embankments have been designed and constructed to minimise erosion during flood events. The steepness of embankments will be minimised as much as possible to encourage vegetation growth, which will further prevent erosion.

No significant cuttings (i.e. > 10 m deep) are proposed. However, where practicable, materials won from excavations and cuttings will be assessed for re-use as embankment fill. If unsuitable for reuse, this material may be formed into permanent spoil mounds within the rail corridor. Features of the spoil mounds include:

- Located as close as possible to the source of excavated material
- Maximum height of 2 m
- May be located on both sides of the track
- Would be stabilised as required
- Gaps in the spoil mounds would be provided to allow water to drain away from the track.

The exact location, sizing and design of spoil mounds will be determined during the detailed design phase, with consideration given to the results of hydraulic modelling and sight distances. Mounds would not be located in areas where they would impact on flooding or drainage.

1.3.3 Fencing and signage

The purpose of fencing is to protect the proposed alignment from trespass and prevent stock on adjoining properties from accessing the rail corridor. Standard rural fencing, consistent with the existing rural landscape, is proposed between the rail corridor and adjoining properties, generally located at the corridor boundary.

Fencing will generally be provided around culverts. Gates will be installed for accessing culverts for inspection and maintenance.

Fencing will continue to bridge abutments. However, to avoid locating fencing in major watercourses and floodplains, the rail corridor will not be fenced underneath bridges. In specific cases, fencing will be provided across waterways to prevent stock on adjoining private properties from accessing the rail corridor.

Signage is also proposed, especially at level crossings.

1.3.4 Operation of the proposal

Subject to approval of the proposal, construction of the proposal is planned to occur between early-2021 and mid-2023. The proposal will be managed and maintained by the proponent; however, train services will be provided by a variety of operators. Train services are expected to commence in 2023, once construction is complete. Significant increases in train numbers are not expected until all 13 sections of Inland Rail are complete, which is planned to be in 2015.

The proposal will be trafficked by an estimated 12 trains per day in 2025, increasing to an estimated 21 trains per day in 2040 (refer Figure 1.1). Annual freight tonnages will increase in parallel, from approximately 12 million tonnes per year in 2025 to 20 million tonnes per year in 2040.

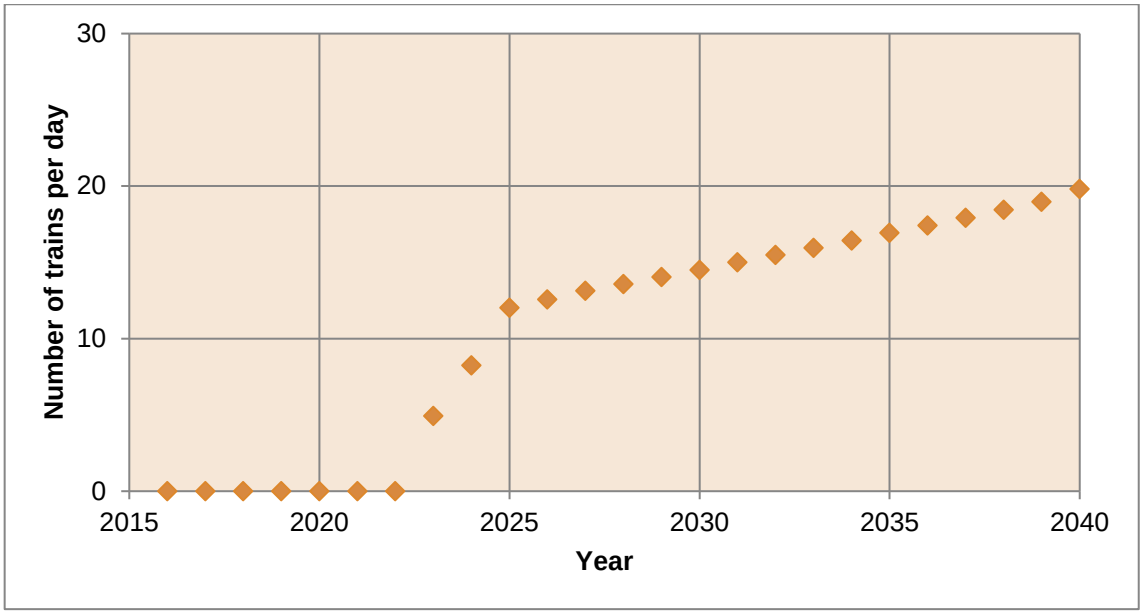


Figure 1.1 **Projected growth in train numbers for Inland Rail**

1.3.5 Maintenance of the proposal

During the operation phase standard maintenance activities will be undertaken, including:

- Bridge and culvert inspections
- Sleeper replacement
- Rail welding and grinding
- Ballast dropping and cleaning
- Track tamping and reconditioning

It is anticipated that pre-construction planning and land acquisition for the Project will occur from 2019 until late 2020. Construction of the Project is scheduled from 2020 to 2024, with operation in 2025.

The construction program defines a number of stages and activities. These comprise:

- Site preparation including:
  - Site clearance
  - Establishment of site compounds and facilities
  - Installation of temporary and permanent fencing
  - Installation of drainage and water management controls
  - Construction of site access including temporary haul roads
- Civil works including:
  - Bulk earthworks
  - Construction of cuts and embankments
  - Installation of permanent drainage controls
  - Bridge and watercourse crossing construction
  - Road works and rail interface crossings
- Track works including the installation of ballast, sleepers and rails

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

1.4 Environmental offset requirements

The 'EPBC Act Environmental Offsets Policy' (DSEWPaC 2012) states that 'environmental offsets' are measures that compensate for the **residual adverse impacts** of an action on the environment and defines **residual adverse impacts** as those impacts which remain after avoidance and mitigation measures have been implemented. The EPBC Act only requires residual adverse impacts to be offset if the impact is considered to be **'significant'** as defined by the 'Matters of National Environmental Significance – Significant Impact Guidelines Version 1.1' (DOTE 2013).

The potential impacts on EPBC Act listed threatened and migratory species habitats informed by the feasibility design are contained in the Project Biodiversity Technical Report. Impacts associated within the following habitat categories have been determined where relevant:

- Core habitat
- Essential habitat
- General habitat
- Unlikely habitat.

The assessment methodology presented in this report has been prepared to identify the potential **significant residual adverse impacts** to the MNES species and/or their habitat values based on the feasibility design included with the Project EIS.

The AIAM provides for the provision of a 'fatal flaw' trigger which identifies extreme risk factors that result in a significant residual adverse impact on the target species and/or their preferred habitat. The fatal flaw trigger captures scenarios were the level of risk to the species is high. Where a fatal flaw is triggered, there is a significant residual adverse impact and these have been outlined in the Project EIS as potential indicative areas where ARTC will be required to provide a suitable offset for this MNES. The location and management of the associated offset/s will be detailed within the Project offset strategy.

2 Assessment methodology

The EPBC Act Environmental Offsets Policy outlines the Commonwealth Government's approach to the use of offsets under the EPBC Act. The policy defines offsets as *measures that compensate for the residual adverse impacts of an action on the environment* (DSEWPaC 2012).

As discussed in Section 1.2, the purpose of this document is to identify areas within the subject land where the proposal's activities will (and will not) result in a significant residual adverse impact to MNES species populations and/or their associated habitat subject to the proposal's EPBC Act obligations. To identify such areas, an assessment ranking approach was used to develop an assessment matrix to provide a consistent, transparent and repeatable method by which impacts of the proposal to MNES species could be ranked and reflected in a GIS model. The structure and implementation of the assessment ranking approach and assessment matrix were influenced by risk assessment theory and application.

To align with the EPBC Act controlled action, the assessment matrix which determines the nature of the Project's impact to each MNES species is an assessment of residual adverse impact. All assumptions and assessment criteria being used are based on scientific literature backed information.

To assess the nature (adverse or not adverse) and extent (significant or not significant) of a proposal impact on a MNES species, the following five key factors, or inputs, were identified:

- Habitat suitability
- Species resilience
- Habitat resilience
- Landscape attributes
- Disturbance nature.

The key factors above, have been ranked and modelled for this AIAM for the land in which the proposal is to occur.

The ranking system includes the provision of a 'fatal flaw' trigger. Fatal flaw triggers have been built into the assessment matrix to identify extreme risk factors that automatically result in a significant residual adverse impact on the target species and/or their preferred habitat.

To provide for rank standardisation, a number of fields and numerical values were assigned to each key factor subject to this AIAM to ensure robustness to the ranking system. To allow for a quantitative assessment output that could be modelled in GIS, numerical values were assigned to habitat suitability, species resilience, habitat resilience, landscape attributes and disturbance nature.

The numerical values which were allocated to the assessment are:

- 1 – Representing the low extremity of the key factors impact.
- 120 – Representing the high extremity of the key factors impact. This value was also allocated to represent a 'fatal flaw' trigger.
- 35 – Representing a moderate impact. The value 35 was chosen to provide for a wide values range to easily distinguish between ranking categories. To account for cumulative impacts and provide for a conservative measure of impact with respect to the precautionary principle which governs the EPBC Act, if three of the four key factors are attributed a moderate score, and the remaining attribute was allocated a low score (which would total 106), an adverse impact would still be triggered. Two moderate impact values when combined with two low values (72) is not considered to constitute an adverse impact with respect to the resilience represented in the balance of the remaining attributes which were allocated a low score.

A number of assessment scenarios were conducted to assess the outputs of the AIAM. The output scenarios were assessed by suitably qualified ecologists and included extensive reviews of scientific literature documenting the species ecological requirements. This review was done to determine if the resultant AIAM output values aligned with expert observation regarding the level of impact and the likelihood of species survival.

Following this detailed and extensive review process the combination of three moderate impact values when combined with one low value was considered the trigger for a significant residual adverse impact. Impacts to two key factors were not considered to have a significant residual adverse impact on the target species due to the resilience remaining in the other two factors. For example, moderate impacts to 'landscape attributes' (which represent attributes such as habitat connectivity and patch size) and 'habitat suitability', (e.g. an area of essential habitat where a species has been previously identified), were not considered to have a significant residual adverse impact on a highly resilient species (i.e. one with high mobility), which is associated with highly resilience habitat types.

However, scenarios also presented where impacts to three key factors were considered to have a significant residual adverse impact on the target species. For example, for an area of general habitat (i.e. 'habitat suitability' score of 1) for a moderately resilient species which is associated with a moderately resilient habitat type, with moderate impacts attributed to 'landscape attributes' was considered to be subject to significant residual adverse impacts. A precautionary approach was taken, with the assumption made that impacts to the combination of a moderately resilient species, moderately resilient habitat type and moderate impacts to the key landscape attributes (i.e. connectivity and patch size) would compromise the resilience of the system and therefore the species, to respond to disturbance.

The 'fatal flaw' trigger was built into the AIAM to capture factors which would have a significant residual adverse impact on a species, regardless of degree of impacts to the other key factors subject to the AIAM. For example, impacts to a low resilient species was considered to constitute a significant residual adverse impact regardless of the degree of impact to the species 'habitat suitability', 'habitat resilience' or 'landscape attributes'.

The application of the numerical values in the assessment process is discussed in further detail in the sections below, with a worked example of the assessment matrix for two species scenarios provided in Table 2.15.

The assessment matrix has been designed to determine whether a threshold for a key factor is likely to be triggered by activities related to the proposal, with a resultant consequence of a significant residual adverse impact. Section 5 of the EPBC Act Environmental Offsets Policy discusses the assessment stage which is implemented to determine whether an offset is necessary, one key step of which is the assessment of the residual adverse impacts to MNES and if the residual impacts are likely to constitute a 'significant impact' as defined in the 'Matters of National Environmental Significance – Guidelines Version 1.1' (DOTE 2013).

To acknowledge and reflect the EPBC Act significant impact assessment for MNES species in the assessment matrix outputs, the significant impact criteria contained in the guidelines were built into the assessment matrix inputs. Table 2.1 presents the DOTE (2013) significant impact criteria for critically endangered, endangered, vulnerable and migratory species, and notes how the criteria is reflected in the assessment.

Table 2.1 Incorporation of significant impact criteria for threatened and migratory species

Significant impact criteria	Assessment matrix input
Lead to a long term decrease in the size of a population	**Species resilience** (Q1 to Q12) – Provides for assessment of the species capacity to recover from disturbance **Habitat suitability** – Provides for assessment on species important habitat **Landscape attributes** – Provides for reference to impacts on local fauna assemblages
Reduce the area of occupancy of the species	**Habitat suitability** – Accounts for species area of occupancy by reflecting the category of habitat present for the species (i.e. 'core', 'essential', 'general')

Significant impact criteria	Assessment matrix input
Fragment an existing important population into two or more populations	**Landscape attributes** – The connectivity assessment conducted as part of the landscape attribute assessment provides for assessment of potential project impact on fragmentation **Species resilience** (Q5 – Q6) – Provides for assessment of the species capacity to colonise new areas and its reliance on habitat linkages
Adversely affect habitat critical to the survival of a species	**Species resilience** (Q1 to Q4) – Provides for assessment of species capacity to respond to disturbances to breeding and non-breeding habitat **Habitat resilience** – Accounts for the capacity of a species habitat to respond to disturbance **Habitat suitability** – Provides for assessment on species important habitat
Disrupt the breeding cycle of a population	**Species resilience** (Q8) to Provides for assessment of species resilience to breeding cycle disruptions
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	**Species resilience** (Q1 to Q4) – Provides for assessment of species capacity to respond to disturbances to breeding and non-breeding habitat **Habitat resilience** – Accounts for the capacity of a species habitat to respond to disturbance **Landscape attributes** – Provides for assessment of potential impacts on species habitat within proximity to the disturbance area by assessing project impacts on the size of habitat patch, connectivity and habitat availability.
Result in invasive species that are harmful to MNES species becoming established in the MNES species' habitat	**Species resilience** (Q10, Q12) – Assesses Project impact on invasive species and the species capacity to respond, including an assessment of the predation vulnerability of the target species
Introduce disease that may cause the species to decline	**Species resilience** (Q11) – Assesses Project impact on disease prevalence and the species capacity to respond
Interfere with the recovery of the species	**Species resilience** (Q1 to Q12) – Provides for assessment of the species capacity to recover from disturbance **Landscape attribute assessment** - Provides for assessment of the ability of the affected habitat patch to support the target species post disturbance
Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species	**Species resilience** (Q1 to Q4) – Provides for assessment of species capacity to respond to disturbances to breeding and non-breeding habitat **Habitat resilience** – Accounts for the capacity of a species habitat to respond to disturbance **Landscape attribute assessment** - Provides for assessment of potential impacts on regionally available habitat by assessing impacts on the size of habitat patch, connectivity and habitat availability
Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species	**Species resilience** (Q10, Q12) – Assesses Project impact on invasive species and the species capacity to respond, including an assessment of the predation vulnerability of the target species
Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species	**Species resilience** (Q1 to Q9) – Provides for assessment of species ability to disperse and its capacity to respond to disturbances to breeding and non-breeding habitat and resource fluctuations

Table 2.2 Incorporation of significant impact criteria for threatened ecological communities

Significant impact criteria	Assessment matrix input (refer Appendix B2 for detailed community descriptions and AIAM questions identified below)
Reduce the extent of an ecological community	**Habitat suitability** – Accounts for community's area of occupancy by reflecting the category of habitat present (i.e. 'general habitat') **TEC's resilience** (Q2) – Provides for assessment for a reduction in area as a result of the project
Fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines	**Landscape attributes** – The connectivity assessment conducted as part of the landscape attribute assessment provides for assessment of potential project impact on fragmentation **TEC's resilience** (Q5 – Q6) – Provides for assessment of the community's capacity to recolonise colonise following disturbance
Adversely affect habitat critical to the survival of an ecological community	**TEC's resilience** (Q1 – Q3) – Provides for assessment of community's capacity to respond to disturbances to habitat **Habitat resilience** – Accounts for the capacity of a species habitat to respond to disturbance **Habitat suitability** – Provides for assessment on species important habitat
Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns	**TEC's resilience** (Q1 – Q3, Q5) – Provides for assessment of the community's capacity to respond to disturbances to habitat and resource availability **Habitat resilience** – Accounts for the capacity of a species habitat to respond to disturbance **Landscape attributes** – Provides for an assessment of potential impacts on community's habitat within proximity to the disturbance area by assessing Project impacts on the size of habitat patch, connectivity and habitat availability.
Cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting	**TEC's resilience** (Q1, Q3, Q5, Q8) – Provides for assessment assesses Project impact on change including weed invasion and habitat disturbance **Landscape attributes** – Provides for an assessment of potential impacts on community's habitat within proximity to the disturbance area by assessing Project impacts on the size of habitat patch, connectivity and habitat availability. **Habitat resilience** – Accounts for the capacity of a species habitat to respond to disturbance habitat
Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to: (a) assisting invasive species, that are harmful to the listed ecological community, to become established, or (b) causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community	**TEC's resilience** (Q1 – Q3, Q5, Q7, Q8) – Provides for assessment of species capacity to respond to disturbances to habitat and weed invasion/disease **Habitat resilience** – Accounts for the capacity of a species habitat to respond to disturbance **Landscape attributes** – Provides for an assessment of potential impacts on community's habitat within proximity to the disturbance area by assessing Project impacts on the size of habitat patch, connectivity and habitat availability. **Habitat suitability** – Provides for assessment on species important habitat
Interfere with the recovery of an ecological community	**TEC's resilience** (Q1, Q2, Q3, Q7, Q8) – Provides for assessment of community's capacity to respond to disturbances to habitat **Landscape attributes** – Provides for an provides for an assessment of the ability of the affected habitat patch to support the target community post disturbance.

To ensure that the adversely impacted areas are captured, the assessment methodology assesses impacts of the proposal to the target species at the time of disturbance, which is the point in which the greatest impact to the species is anticipated (i.e. directly after habitat removal or modification).

The sections below discuss the assessment methodology in further detail and presents information regarding the species subject to the assessment, the five key factors; habitat suitability, species resilience, habitat resilience, landscape attributes and disturbance nature, by which the level of adverse impact was determined for each MNES fauna species and the ranking process by which the key factors were assessed.

2.1 Matters of national environmental significance species subject to assessment

The assessment was conducted for each MNES identified as having a high or greater level of impact significance as determined by initial impact assessment following the application of project mitigation measures. The species and communities, and their EPBC Act conservation status are defined in Table 2.3.

Table 2.3 Matters of national environmental significance species subject to the assessment

Species name	EPBC Act status
Threatened Fauna Species - 17	
Murray cod (*Maccullochella peelii*)	Vulnerable
Silver perch (*Bidyanus bidyanus*)	Critically endangered

2.2 Habitat suitability

'Habitat suitability' is the first key factor used in the assessment process to determine the nature of the proposals impact on MNES species. Habitat suitability is based on the habitat type present for the target species.

Habitat for MNES species was divided into four distinct categories based on habitat modelling, available scientific information, and expert advice contained within the biodiversity planning assessments (BPA) (DES 2018). The habitat categories include:

- Core habitat
- Essential habitat
- General habitat
- Unlikely habitat.

Table 2.4 defines each habitat category. A specific set of habitat assumptions for each MNES species subject to this assessment has been developed to categorise species habitat into categories defined in Table 2.4.

For the purposes of the assessment, each habitat category was assigned a ranking to reflect the ecological value of each habitat category to the target species (refer Table 2.4).

Core and essential habitat have been assigned a higher rating than general habitat to capture the greater risk to a species when areas of known habitat or habitat which supports key resources necessary for maintaining a population (i.e. potential breeding, roosting or foraging habitat) is affected by the proposal. The greater weighting ensures that habitat suitability is captured and reflected in the adverse impact assessment.

A 'fatal flaw' trigger was allocated to the habitat category core habitat to reflect the high ecological value of core habitat to the target species.

Areas of important habitat are captured in this adverse impact assessment as core habitat. Core habitat represents an area of habitat in which the target species is known, and the area of habitat is recognised under relevant recovery plans or other relevant plans/policies/regulations. Core habitat also captures populations that are limited geographically within the region. As areas of core habitat represent important habitat for the target species, core habitat is allocated a fatal flaw to reflect the high ecological value of the habitat area.

Table 2.4 Habitat category and ranking

Habitat category	Description[1]	Habitat suitability[#]
Unlikely habitat	Unlikely habitat areas are those areas that do not contain records of the particular species and contain no habitat values to support the presence or existence of resident or migratory individuals or populations of the species.	N/A = 0
General habitat	General habitat consists of areas or locations that are 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. General habitat also includes areas defined from known records or 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 species. As potential habitat for many species known or predicted to occur within the subject land include most of the vegetation communities of the New England North West region of NSW, the general habitat category restricts the habitat to a more limited and realistic set of environmental parameters that are supported by literature and field-based observation.	Low = 1
Essential habitat	Essential habitat is an area containing resources that are considered essential for the maintenance of populations of the species (e.g. potential habitat for breeding, roosting, foraging, shelter, for either migratory or non-migratory species). Essential habitat is defined from known records and/or expert advice (including the findings of pre-clearance surveys).	Moderate = 35
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. Also included within this category are populations that are limited geographically within the region.	High = 120** ***Fatal flaw***

Table notes:

1 As defined in the Predictive Habitat Modelling Procedure (Appendix A of the Biodiversity Technical Report)
The numerical values associated with the category ranks are described in further detail in Section 2
** Fatal flaw

2.3 Species/TEC resilience

The second key factor incorporated in the assessment was 'species resilience'. The resilience of a species was defined and ranked to reflect the nature of the species response to disturbance.

To provide for a transparent, consistent and repeatable approach to assess species resilience, a scoring system was developed to rank species in order of their resilience using a set of defined criteria. The scoring system was informed by the 'system for assessing vulnerability of species (SAVS)' (Bagne et al. 2011) which was developed to assess the relative vulnerability, or resilience, of a species to the potential effects of climate change. SAVS is a published methodology which has been previously adopted and implemented by the United States Department of Agriculture. However, in order to account for the specific requirements of Threatened ecological communities (TECs), augmentations to the above system have been made so to increase the applicability of this system to TECs.

The species/TEC resilience assessment provides an assessment of species/TEC resilience to proposal disturbances, including secondary impacts such as edge effects and weed proliferation, which may be associated with the proposal. The resilience assessment criteria provide a means of assessing a species/TEC resilience to both primary and secondary disturbances by considering influences and impacts such as a species response to habitat disturbance, resource fluctuations, increase risk from predation, reduced food/prey availability, etc.

A species resilience questionnaire (refer Table 2.5) or a TEC questionnaire (refer Table 2.6) is completed for each MNES species/TEC subject to the assessment matrix. The relevant resilience questionnaire contains thirteen questions (for species) and 8 questions (for TECs) which have been amended from the SAVS questionnaire to ensure they provided for an appropriate impact assessment for the nature of the proposal disturbance. Questions in the SAVS questionnaire pertaining to a species physiological and phonological (sounds or calls) response to climate change were not incorporated into the current methodology.

The species resilience scoring system contains thirteen (species) or eight (TECs) assessment criteria. Each predictive criterion corresponds to a single question which represents resilience. The results of each question feed into the scoring system which provides for a measure of species/TEC resilience.

The degree of vulnerability of the target species/TEC is captured in the assessments of species/TEC resilience to reflect the differing sensitivities that Endangered, Vulnerable or Migratory species have to disturbance. Criterion 1, threatening processes, provides for an assessment of potential impact on recognised threatening processes for the target species or TEC which have resulted in the species threatened status and subsequent decline.

If there is insufficient information to address any species resilience assessment criterion, the highest score attributable to that criterion is allocated to reflect uncertainties in the data and to provide for a conservative approach to the assessment of species resilience.

The score produced by the questionnaire is then applied to Table 2.7 to provide a ranking for resilience which is reflected in the assessment matrix.

A fatal flaw trigger was allocated to 'low' ranked species/TEC resilience to reflect the reduced ability of the species/TEC to tolerate, adapt or recover from disturbance.

The results of the resilience questionnaire for each species are provided in Appendix B2.

Table 2.5 Species resilience questionnaire for threatened and migratory species

Item	Question	Species response (score)
Q1.	Threatening processes – Are the threatening processes which have contributed to the decline and subsequent conservations status of the target species expected to change as a result of the projected changes?	Species threatening processes are expected to: ■ Increase in intensity as a result of the projected changes **(2)** ■ Unlikely to change as a result of the projected changes **(0)**
Q2.	Area and distribution – breeding: Is the area or location of the associated vegetation type used for breeding activities by this species expected to change?	Area used for breeding habitat expected to: ■ Decline or shift from current location **(2)** ■ Stay the same and in approximately the same location **(0)**
Q3.	Area and distribution – non-breeding: Is the area or location of the associated vegetation type used for non-breeding activities by this species expected to change?	Area used for non-breeding habitat expected to: ■ Decline or shift from current location **(2)** ■ Stay the same and in approximately the same location **(0)**
Q4.	Habitat components – breeding: Are specific habitat components required for breeding expected to change within the associated vegetation type?	Required breeding habitat components: ■ Expected to decrease or habitat components required for breeding unknown **(2)** ■ Unlikely to change **(0)**
Q5.	Habitat components – non-breeding: Are other specific habitat components required for survival during non-breeding periods expected to change within the associated vegetation type?	Required non-breeding habitat components: ■ Expected to decrease or habitat components required for non-breeding unknown **(2)** ■ Unlikely to change **(0)**
Q6.	Ability to colonise new areas: What is the potential for this species to disperse?	■ Low ability to disperse **(2)** ■ Mobile, but dispersal is sex-biased (only one sex disperses) **(1)** ■ Very mobile, both sexes disperse **(0)**
Q7.	Migratory or transitional habitats: Does this species require additional habitats during migration that are separated from breeding and non-breeding habitats?	■ Additional habitats required that are separated from breeding and non-breeding habitats (eg most migratory species) **(2)** ■ No additional habitats required that are separated from breeding and non-breeding habitats (eg most resident species and short-distance migrants) **(0)**

Item	Question	Species response (score)
Q8.	Survival during resource fluctuation: Does this species have alternative life history pathways to cope with variable resources or climate conditions?	Species has: ▪ Limited flexible strategies to cope with variable resources across multiple years **(2)** ▪ Flexible strategies to cope with variable resources across multiple years (eg alternative life forms, irruptive, explosive breeding, cooperative breeding) **(0)**
Q9.	Resilience to timing mismatch: Does this species have more than one opportunity to time reproduction to important events?	Species reproduces: ▪ Once per year or less **(2)** ▪ More than once per year **(0)**
Q10.	Food resources: Are important food resources for this species expected to change?	▪ Primary food source(s) are expected to be negatively impacted by projected changes **(2)** ▪ Species consumes variety of prey/forage species OR primary food resource(s) not expected to be impacted by projected changes **(0)**
Q11.	Predation: Is the species predation vulnerability expected to change?	▪ Species predation vulnerability: ▪ Is expected to increase as a result of the projected changes **(2)** ▪ Is not expected to be impacted by the projected changes **(0)**
Q12.	Disease: Is prevalence of diseases known to cause widespread mortality or reproductive failure in this species expected to change?	▪ Disease prevalence is expected increase with projected changes **(2)** ▪ No known effects of expected changes on disease prevalence (0)
Q13.	Competitors: Are populations of important competing species expected to change?	▪ Major competitor species are expected to be positively impacted by projected changes **(2)** ▪ Species has a variety of competitive relationships or no expected impacts of projected changes in major competitor species **(0)**

Table 2.6 TEC resilience questionnaire for threatened ecological communities

Item	Question	TECs response (score)
Q1.	Threatening processes – Are the threatening processes which have contributed to the decline and subsequent conservations status of the target community expected to change as a result of the projected changes?	Community's threatening processes are expected to: ▪ Increase in intensity as a result of the projected changes **(2)** ▪ Unlikely to change as a result of the projected changes **(0)**
Q2.	Area and distribution: Are areas or locations of the associated vegetation type associated with this community expected to change?	Area used for non-breeding habitat expected to: ▪ Decline or shift from current location **(4)** ▪ Stay the same and in approximately the same location **(0)**
Q3.	Habitat components: Are other specific habitat components required by this community expected to change?	Required habitat components: ▪ Expected to decrease or habitat components required for non-breeding unknown **(4)** ▪ Unlikely to change **(0)**
Q4.	Survival during resource fluctuation: Does this community have alternative strategies/ pathways to cope with variable resources or climate conditions?	Community has: ▪ Limited flexible strategies to cope with variable resources across multiple years **(3)** ▪ Flexible strategies to cope with variable resources across multiple years (eg alternative life forms, irruptive, explosive breeding, cooperative breeding) **(0)**
Q5.	Resources: Are important resources for this community expected to change?	▪ Primary resources are expected to be negatively impacted by projected changes **(4)** ▪ Primary resources are not expected to be impacted by projected changes **(0)**

Item	Question	TECs response (score)
Q6.	Susceptibility to negative impacts: Is the community's susceptibility to negative impacts expected to change?	■ Susceptibility to impacts: – Is expected to increase as a result of the projected changes **(4)** – Is not expected to be impacted by the projected changes **(0)**
Q7.	Disease: Is prevalence of diseases known to cause widespread mortality in this community expected to change?	■ Disease prevalence is expected increase with projected changes **(3)** ■ No known effects of expected changes on disease prevalence (0)
Q8.	Competitors: Are populations of important competing species expected to change?	■ Major competitor species are expected to be positively impacted by projected changes **(3)** ■ Species has a variety of competitive relationships or no expected impacts of projected changes in major competitor species **(0)**

Table 2.7 Species resilience and ranking

Questionnaire score^	Species resilience#
0 – 1	High = 1
2 – 15	Moderate = 35
≥ 16	Low = 120** *Fatal flaw*

Table notes:

^ The value ranges provided for 'questionnaire score' have been selected following review of species information and completion of species questionaries' (refer Appendix B2) as they are considered to provide for a suitable ranking which appropriately reflects the resilience of the species

The numerical values associated with the category ranks are described in further detail in Section 2.3

** Fatal flaw

2.4 Habitat resilience

The third key factor incorporated in the assessment was 'habitat resilience'. The resilience of species habitat was defined and ranked to reflect the species' habitat capacity to respond to disturbance.

The habitat resilience input provides for an assessment of the literature supported anticipated time required for an area of species habitat to naturally regenerate to a point where the appropriate microhabitat features to support the target species are re-established. The AIAM is subject to the MNES fauna species listed in Section 2.1 of this report and their habitat.

To define habitat resilience, the natural regeneration time of the key vegetation communities occurring within the subject land were noted. The results are summarised in Table 2.8.

It is important to note that the natural regeneration times indicated in Table 2.8 are provided as a guide only with natural regeneration times to vary between sites dependent upon surrounding factors such as landscape context, soil conditions and rainfall patterns.

To capture a species multiple habitat requirement, habitats which are used by each target species are mapped and provided for within the AIAM via the habitat suitability input. Using GIS, each area of species habitat which intersects with the disturbance area (i.e. the proposal) is assessed using the assessment methodology. As such, the variety of habitats which may be used by the target species within the disturbance area are captured in the assessment.

The areas of habitat which are determined to be adversely impacted by the proposal are identified and mapped. Development of a ranking system for habitat resilience for each of the habitats present within subject land was determined based on estimated recovery times following disturbance. For the purposes of ranking habitat resilience and to provide for a conservative approach, the longest natural regeneration time was used for ranking. Identified habitat types, estimate recovery times and habitat resilience ratings are provided in Table 2.9.

Table 2.8 Natural regeneration times for key Plant Community Types (PCTs) within the subject land

PCT ID	PCT Name	Natural regeneration time	Habitat resilience rating (refer Table 2.9)
1	Candidate grasslands	2 to 12 months Non-woody species capable of natural regeneration post disturbance Species sexual maturity reached within 2 months and generation times as short as 6 months	High (1)
27	Weeping Myall open woodland of the Darling Riverine Plains Bioregion and Brigalow Belt South Bioregion	50 years + Mature stands of *Acacia pendulosa* are likely to take greater that 50 years to develop into an open woodland	Low (120)
35	Brigalow - Belah open forest / woodland on alluvial often gilgaied clay from Pilliga Scrub to Goondiwindi, Brigalow Belt South Bioregion	100 years + Mature stands of Brigalow may take upwards of 100 years to develop	Low (120)
52	Queensland Bluegrass +/- Mitchell Grass grassland on cracking clay floodplains and alluvial plains mainly the northern-eastern Darling Riverine Plains Bioregion	2 to 12 months Non-woody species capable of natural regeneration post disturbance Species sexual maturity reached within 2 months and generation times as short as 6 months	High (1)
53	Shallow freshwater wetland sedgeland in depressions on floodplains on inland alluivial plains and floodplains	2 to 12 months Non-woody species capable of natural regeneration post disturbance	High (1)
55	Belah woodland on alluvial plains and low rises in the central NSW wheatbelt to Pilliga and Liverpool Plains regions.	100 years + Mature stands of Belah may take upwards of 100 years to develop	High (1)
56	Poplar Box - Belah woodland on clay-loam soils on alluvial plains of north-central NSW	100 years + Mature stands of Poplar box - Belah may take upwards of 100 years to develop	High (1)
98	Poplar Box - White Cypress Pine - Wilga - Ironwood shrubby woodland on red sandy-loam soils in the Darling Riverine Plains Bioregion and Brigalow Belt South Bioregion	100 years + Mature stands of Poplar Box - White Cypress Pine - Wilga - Ironwood shrubby woodland may take upwards of 100 years to develop	High (1)
147	Mock Olive - Wilga - Peach Bush - Carissa semi-evergreen vine thicket (dry rainforest) mainly on basalt soils in the Brigalow Belt South Bioregion	100 years + Mature stands of Mock Olive - Wilga - Peach Bush - Carissa semi-evergreen vine thicket may take upwards of 100 years to develop	High (1)
192	Silver-leaved Ironbark - Poplar Box +/- Ironwood shrub - grass woodland on rises in the north-western plains of NSW	100 years + Mature stands of Silver-leaved Ironbark - Poplar Box +/- Ironwood shrub - grass woodland may take upwards of 100 years to develop	High (1)

PCT ID	PCT Name	Natural regeneration time	Habitat resilience rating (refer Table 2.9)
244	Poplar Box grassy woodland on alluvial clay-loam soils mainly in the temperate (hot summer) climate zone of central NSW (wheatbelt).	100 years + Mature stands of Poplar Box grassy woodland may take upwards of 100 years to develop	High (1)
247	Lignum shrubland wetland on regularly flooded alluvial depressions in the Brigalow Belt South Bioregion and Darling Riverine Plains Bioregion	6-20 years Non-woody species capable of natural regeneration post disturbance. Regenerate rapidly following flooding however if root-stock is removed (i.e. during clearing) regeneration is slow (Wiltshire and Schmidt 1988)	Moderate (35)
418	White Cypress Pine - Silver-leaved Ironbark - Wilga shrub grass woodland of the Narrabri-Yetman region, Brigalow Belt South Bioregion	100 years + Mature stands of White Cypress Pine - Silver-leaved Ironbark - Wilga shrub grass woodland may take upwards of 100 years to develop	High (1)
628	Carbeen +/- Coolabah grassy woodland on floodplain clay loam soil on north-western NSW floodplains, mainly Darling Riverine Plain Bioregion	100 years + Mature stands of Carbeen +/- Coolabah grassy woodland may take upwards of 100 years to develop	High (1)
NNV	Non-native vegetation	2 to 12 months Non-woody species capable of natural regeneration post disturbance Species sexual maturity reached within 2 months and generation times as short as 6 months	High (1)

Table note:

1 The vegetation communities selected for inclusion in Table 2.8 are those outlined in the Appendix B: Biodiversity Technical Report document number: 2-0001-270-EAP-10-RP-0401

Table 2.9 Habitat resilience and ranking

Natural regeneration period^	Habitat resilience#
0 to 5 years	High = 1
6 to 30 years	Moderate = 35
31 years and greater	Low = 120** *Fatal flaw*

Table notes:

^ The natural regeneration period associated with each category rank has been defined by the natural regeneration times (refer Table 2.6) comparatively associated with communities (i.e. grasslands which are known to regenerate quickly, remnant communities which are the most complex in regard to structure and composition and thus have longer regeneration times and regrowth communities which act as the midpoint between non-remnant/grassland and remnant communities)

The numerical values associated with the category ranks are described in further detail in Section 2.0

** Fatal flaw

A habitat resilience layer was created for use in GIS to facilitate the assessment process. The natural regeneration times noted in Table 2.8 for the key vegetation communities present within the Project ecology study area were used to inform the series of assumptions which were used to create the habitat resilience GIS layer. The habitat resilience GIS layer was defined by three categories, including resilient habitat, moderately resilient habitat and non-resilient habitat. Habitat resilience was categorised by the natural regeneration time for the habitat type (refer Table 2.9), with respect to the following assumptions:

- **Resilient habitat** – Resilient habitat consists of non-remnant vegetation in addition to grassland dominated PCTs

- In a number of bioregions in NSW, some grassland dominant PCTs are analogous to native grassland TECs. These however, have also been included in the development of the habitat resilience GIS layer as they are characterised by non-woody species which are capable of quick regeneration post disturbance.
- **Moderately resilient habitat** – The moderately resilient habitat layer consists of all areas currently mapped as regrowth vegetation by the NSW Office of Environment and Heritage (OEH).
- **Non-resilient habitat** – The non-resilient habitat layer consists of remnant vegetation and all areas mapped as PCTs with the exclusion of those included in the resilient habitat layer.

A 'fatal flaw' trigger was allocated to low ranked habitat resilience to reflect the reduced ability of the habitat to recover from disturbance.

The habitat resilience layer is illustrated in Figure 2.1.

2.5 Landscape attributes

The fourth key factor incorporated in the adverse impact assessment methodology is 'landscape attributes'. The incorporation of landscape attributes allows for an assessment of impact on habitat function and provides a reference for impact assessment on available habitat within proximity to the disturbance area.

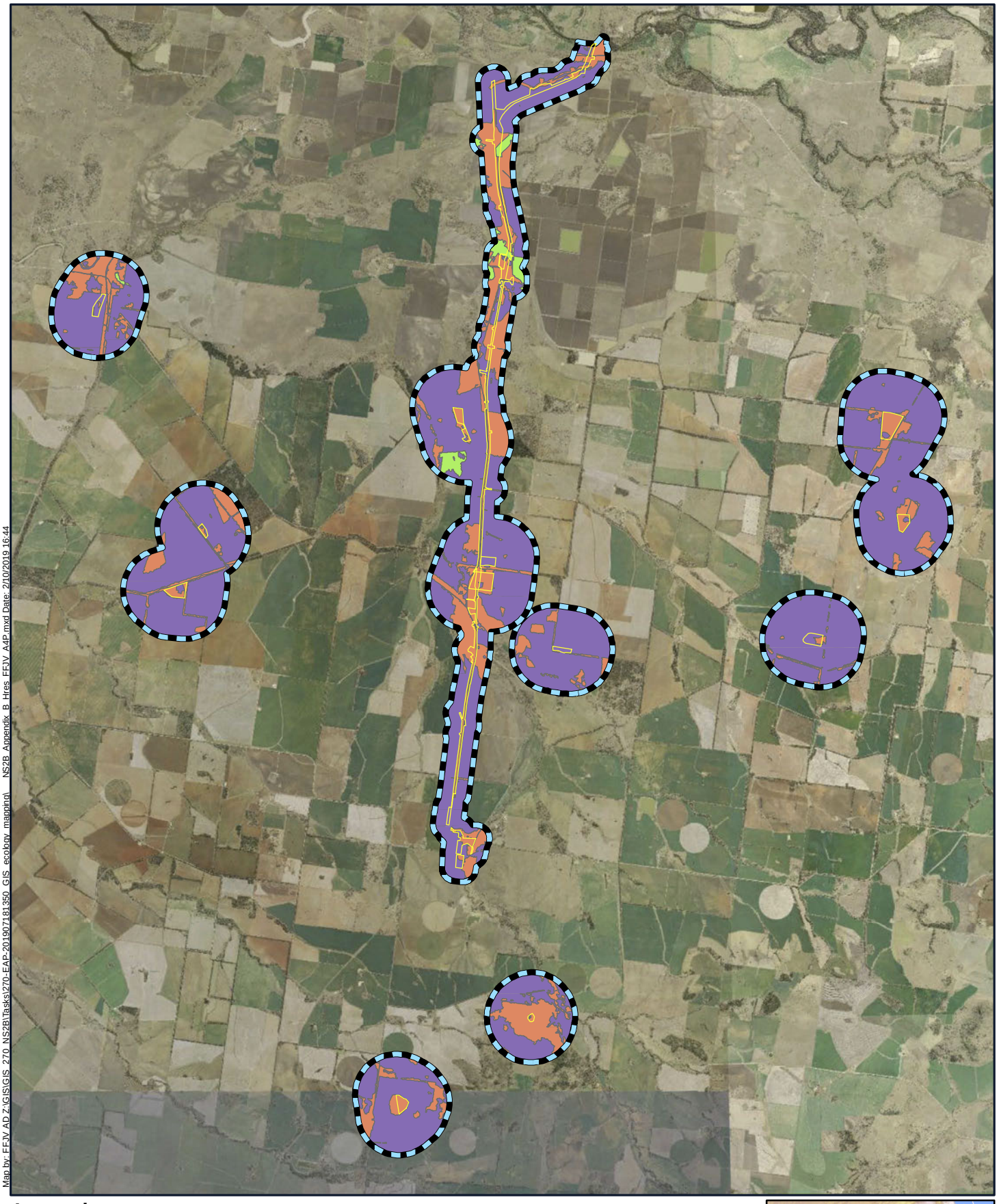
To provide for landscape context in the impact assessment process, the assessment of landscape-scale attributes from the *Biodiversity Assessment Methodology* (BAM) (OEH 2017) was adapted and included in the assessment. These attributes are relevant to terrestrial species and have no relevance to aquatic species.

The potential impact of the proposed disturbance on regionally availably habitat for each species was assessed using three key landscape attributes, including size of habitat patch, habitat connectivity and habitat context.

For the purposes of the landscape attribute assessment, the species habitat suitability layer was used. The species habitat suitability layer was developed using a combination of pre-clearance ground-truthed habitat data (which was collected for the disturbance footprint) and predictive habitat modelling (for areas within a 1 km radius of the disturbance area).

The habitat categories delineated in the habitat suitability layer were merged (i.e. core, essential and general) in recognition of the contribution all degrees of habitat have in increasing or maintaining biodiversity values, especially in highly modified landscapes (Bowen et al. 2007). A landscape attribute assessment was conducted for each species subject to the adverse impact assessment (that is those species detailed in Table 2.3).

Each landscape attribute is discussed in further detail below.



Map by: FFJV AD Z:\GIS\GIS_270_NS2B\Tasks\270-EAP-20190718\350_GIS_ecology_mapping_NS2B_Appendix_B_Hres_FFJV_A4P.mxd Date: 2/10/2019 16:44

Legend

Habitat Resilience

- High
- Moderate
- Low

- Subject land
- Study area

A4 scale: 1:190,000

0 0.75 1.5 3 4.5 6 7.5 Km

Future Freight
Integrating Community, Environment and Engineering

Date: 17/09/2019 Version: 1

Coordinate system: MGA56

North Star to QLD/NSW Border

Figure 2.1:
Habitat resilience within the study area

2.5.1 Size of habitat patch

The size of habitat patch factor is a measure of the size of the patch of species habitat in which the disturbance area is located. The scoring reflects the importance of smaller patches of habitat in which the disturbance area is located. Larger patches of habitat are considered less susceptible to ecological edge effects and are also less susceptible to propagule pressure from exotic pasture species such as Buffel grass (Eyre et al. 2009; Lindenmayer et al. 1999; McIntyre et al. 2000).

For the purposes of assessment, the habitat suitability layer was used to calculate size of habitat patch. The size of the habitat patch within which the disturbance area intersects was calculated and ranked with the ranking system outlined in Table 2.10.

Table 2.10 Size of habitat patch – Categorisation and ranking scores

Description	Category	Score
0 ha. The assessment area does not occur within a habitat patch.	Negligible	0*
Patch size is ≥ 200 ha	Very low	2
Patch size is ≥ 100 ha to 200 ha	Low	5
Patch size is ≥ 25 ha to 100 ha	Moderate	7
Patch size is ≥ 5 ha to 25 ha	High	10
Patch size is > 0 ha to 5 ha	Very high	12

Table note:

* Note that for species which were assessed to have a high species resilience (which captures factors such as high species mobility) the size of the habitat patch was considered to be negligible and allocated a score of 0. The species assessed as having a high resilience were not considered to be reliant on large patches of contiguous habitat, with the species considered to be highly mobile, not reliant on specific micro-habitat features and able to persist in mosaic vegetation.

2.5.2 Connectivity

Connectivity relates to the capacity species have to disperse through the landscape between suitable patches of habitat, and therefore has important implications for species persistence (With 2004).

As a landscape level attribute, connectivity aims to assess the degree to which the disturbance area is connected with areas of habitat for the species.

Using the species habitat suitability layer, the percentage of the disturbance areas perimeter which intersects with an area of species habitat was measured and ranked to assess potential impact on species connectivity. The ranking scores used to categorise connectivity are presented in Table 2.11.

Table 2.11 Connectivity – categorisation and ranking scores

Description	Category	Score
0%. The assessment unit is not connected to a habitat patch.	Negligible	0
> 0% to < 50% of the assessment unit's perimeter is connected to a habitat patch	Low	2
50% to 75% of the assessment unit perimeter is connected to a habitat patch	Moderate	4
> 75% of the assessment unit perimeter is connected to a habitat patch	High	5

2.5.3 Context

The context attribute refers to the amount of species habitat that is retained in the landscape proximal to the disturbance area. A 1 km radius buffer from the perimeter of the disturbance area was used to delineate a circular spatial extent. The scoring and ranking presented in Table 2.12 relates to the proportion of species habitat which is retained within the 1 km buffer landscape.

The ranking scores used to categorise context have been derived from the literature, which generally demonstrate that there is a 10 % to 30% threshold of habitat loss within a landscape below which species will be lost from the ecosystem (Andren 1994; McIntyre et al. 2000; Radford et al. 2005).

Table 2.12 Context – categorisation and ranking scores

Description	Category	Score
0%. There is no habitat within a 1 km buffer of the assessment unit	Negligible	0
> 75% of the assessment unit's 1 km buffer area contains habitat	Low	2
≥ 30% to 75% of the assessment unit's 1 km buffer area contains habitat	Moderate	4
< 30% of the assessment unit's 1 km buffer area contains habitat	High	5

2.5.4 Landscape attribute score

The scores which were produced following the landscape attribute assessment (i.e. size of patch, connectivity and context) were added and then applied to Table 2.13 to obtain a final score and provide a ranking for landscape attributes which is reflected in the assessment matrix.

Table 2.13 Landscape attribute ranking – Categorisation and ranking scores

Combined score	Category	Score
0 to 8	Low	1
9 to 14	Moderate	35
15 to 22	High	120

2.6 Disturbance nature

The final key factor by which the AIAM determines the nature of the proposal's impact on MNES species is disturbance nature. Disturbance nature is included in the AIAM to provide reference to the type of disturbances associated with the Project and their anticipated impact on individual MNES species and their preferred habitat.

2.7 Final impact

The assessment matrix presents a final impact score which states whether the proposal's impact on the target species is considered to be adverse or not adverse. The assessment matrix and associated reporting presents the assessment process by which the final impact score, including the categorisation of the key factors, is derived to ensure transparency, consistency and repeatability in the assessment process.

To arrive at the final impact score, the key factor inputs; including habitat suitability, species resilience, habitat resilience and landscape attributes are summed and ranked (as defined in Sections 2.2 to 2.5 of this report).

The scoring of the key factors includes the provision of a fatal flaw trigger which identifies extreme risk factors that result in a significant residual adverse impact on the target species and/or their preferred habitat. The fatal flaw trigger captures scenarios were the level of risk to the species is too high, automatically resulting in an adverse impact output, regardless of the final summed score of all key factors.

The scoring system developed to derive the final impact score is presented in Table 2.14.

The values presented in Table 2.14 were derived by examining the various value combinations which may be derived from the assessment matrix and categorising the values in a manner which reflects the nature, adverse or not adverse, of the impact.

Table 2.14 Final score ranking system

Score (sum of habitat suitability, species resilience and habitat resilience)	Final impact	Description
3 to 72	No adverse impact	Significant residual adverse impact to target species is anticipated to be not significant in nature, with the species and habitat considered resilient to the nature of the proposed disturbance and able to recover un-aided to the pre-works disturbance state
106 to 480	Adverse impact	Significant residual adverse impact to target species is anticipated to be significant in nature, with the species and habitat not considered to be resilient to the nature of the proposed disturbance or able to recover un-aided to the pre-works disturbance state
A fatal flaw is triggered (total score is not applicable in this event)		

The simplest scenario at which a not adverse impact may occur would be if each attribute is allocated the minimum score for its category, resulting in a score of 3.

A score of 106 is defined as the minimum score for an adverse impact. To account for cumulative impacts and provide for a conservative measure of impact with respect to the precautionary principle which governs the EPBC Act, if three of the four key factors are attributed a moderate score, and the remaining attribute was allocated a low score (which would total 106), an adverse impact would still be triggered.

Two moderate impact values when combined with two low values (72) is not considered to constitute an adverse impact with respect to the resilience represented in the balance of the remaining attributes which were allocated a low score.

As discussed in further detail in Section 2, the combination of three moderate impact values when combined with one low value was considered the trigger for an adverse impact following an extensive review process which involved running a number of assessment scenarios for different species through the AIAM to determine if the affected values would affect the species survival. The assessment scenarios were assessed by suitably qualified ecologists and included extensive reviews of scientific literature documenting the species ecological requirements.

The fatal flaw trigger was built into the AIAM to capture factors which would have a significant residual adverse impact on a species, regardless of the degree of impacts to the other key factors subject to the AIAM.

An adverse impact may occur via the trigger of a fatal flaw, with a fatal flaw allocated a score of 120, a score higher than the minimum score attributable to an adverse impact. Consequently, the maximum adverse impact score would occur in the event of four fatal flaws, with the resultant score totalling 480. Conversely, the highest score for an impact which is not adverse was defined at 72, which allows for no more than two moderate scored key factors.

The assessment matrix is derived and calculated in the Model Builder function of the GIS program ArcMap. For demonstrational purposes, Table 2.15 presents a worked example of the assessment matrix for two species scenarios. Appendix A2 provides an outline of the GIS model which was used to derive the final impact score.

The GIS model was designed to produce results in accordance with the assessment matrix which presents a final impact which states whether the proposal's impact on the target species is considered to be adverse or not adverse. The values of 1, 35, and 120 were used in the GIS model to represent the low, moderate, and high values from the assessment matrix. These particular numeric values were chosen so that the operational functions of the assessment matrix can be performed within the GIS model.

There are four parameters in the assessment matrix for any given area (i.e. habitat suitability, species resilience, habitat resilience and landscape attributes). Each of these parameters can have a value of low (1), moderate (35) or high (120). These values are combined to produce a total score. In accordance with the assessment matrix, one high value represents a fatal flaw and will result in a score of at least 120. Three moderate values and one low value also represent a fatal flaw and result in a score of 106 (3 x moderate [score 35] + 1 x low [score 1]). Once the four parameters are combined, each area that has a score of 106 or greater is classified as an adverse impact and areas with lower scores are classified as no adverse impact. This method and the values used enable the GIS model to produce results in accordance with the assessment matrix.

Numerical thresholds for final impact were derived by examining various value combinations which may be derived from the assessment matrix and categorising the values in a manner which reflects the nature, adverse or not adverse, of the impact. As such, the final ranking scores (refer Table 2.14) were selected based on theories of predicted outcomes from the interactions of each input. The numerical value attributed to each category (i.e. low, moderate and high) was an arbitrary selection to facilitate GIS modelling of the AIAM model outputs. The scores assigned to each input category were not designed to artificially inflate or supress outputs, rather, they were assigned to best represent each category value.

The model is checked by inputting known (or set) scenarios and ensuing that the outputs are consistent with the known outcomes.

The results of the assessment matrix are not over-ridden or altered and provide for a conservative, unaltered assessment which is informed by the SAVS assessment methodology and peer-reviewed scientific literature.

Following the adverse impact assessment, the results are reviewed to ensure that the areas of adversely impacted habitat are appropriate for the target species and capture the degree of proposal impacts on the areas of species habitat. During review, particular attention is given to MNES fauna species (particularly focussing on migratory species) to ensure that their mobility was captured.

Table 2.15 Modelled assessment matrix extract for demonstrational purposes

Species name Common (Scientific)	Species status EPBC Act	Habitat suitability		Species resilience [Section 2.3 and Appendix B2]	Habitat resilience Time until return to pre-disturbance state [Section 2.4]	Landscape attribute [Section 2.5]	Disturbance type/nature [Section 2.6]	Final score [Section 2.7]	Impact assessment [Section 2.7]
		Habitat category As occurs within the project area (defined by predictive habitat mapping within the Project area	Habitat suitability ranking [Section 2.2]						
A saltbush (*Atriplex infrequens*)	Vulnerable	General	High – 120**	Low – 120**	Low – 120**	High – 120**	Permanent	**480**	**Adverse (fatal flaw)**
Curlew sandpiper (*Calidris ferruginea*)	Critically endangered	General	Low – 1	High - 1	High - 1	Low - 1	Access track / Temporary	**4**	**No adverse impact (3 to 72)**

Table notes:

GIS input

** Fatal flaw

2.8 Limitations and assumptions

The assessment process and associated outputs of the AIAM are subject to a number of limitations and assumptions including, but not limited to the following:

- The quality and quantity of information varies for individual species
- The ranking system relies on expert ecological opinion (as in ecological field survey situations) and is subject to a number of assumptions and constraints
- Periods provided for the natural regeneration of vegetation communities are general estimates only and do not account for seed availability, climatic influences and natural variability between sites
- The species resilience questionnaire discussed in Section 2.3 was informed by the SAVS which was developed to assess species resilience in response to climate change. However, the SAVS provide for a relevant assessment of species resilience to proposed disturbances. The questions in the SAVS questionnaire which pertained to a species physiological response to climate change were not used in the species resilience questionnaire.
- The species resilience questionnaires do not account for seasonal and temporal species responses. To provide for a conservative approach to species resilience assessments, a static landscape which generates the greatest species response is assumed.
- The accuracy of the habitat disturbance calculations are limited to accuracy of the GIS input files.

3 Matters of national environmental significance habitat disturbance areas

3.1 Habitat disturbance areas for matters of national environmental significance species

Following assessments of species and habitat resilience, and the subsequent assessment process which has been outlined in the aforementioned sections of this document, the area of habitat proposed for disturbance for each MNES species which represents the significant residual adverse impact to the species and/or its habitat values is outlined in Table 3.1.

The calculations are accurate for habitat attributes within the subject land only and does not account for the required habitat attributes outside of the subject land or the size and resilience of the species population outside of the subject land. Due to the species range and population size, excluding those which are also Critically endangered, Endangered, Vulnerable, the proposal is not considered to have a significant residual adverse impact on any of the migratory listed species populations.

Appendix C2 illustrates the areas of species habitat present within the Project ecology study area for each MNES species. The figures also illustrate the areas of species habitat subject to an adverse impact and no adverse impact from the Project.

Species habitat associations have been determined via review of field investigation results, peer-reviewed literature and expert knowledge, as discussed in further detail in Appendix A of the Aquatic Biodiversity Technical Report.

Table 3.1 Matters of national environmental significance species habitat disturbance areas

Species name	Non-significantly impacted habitat disturbance area[2] (ha)	Significant residual adversely impacted habitat disturbance area[2] (ha) (supported by this document, specifically the assessment detailed in Section 2 and the additional research presented in Appendix B2)
Critically endangered species		
Silver perch (*Bidyanus bidyanus*)	0.36	1.15
Vulnerable species		
Murray cod (*Maccullochella peelii*)	0.36	1.15

Table 3.2 Matters of national environmental significance species habitat provided by habitat type units

Species name	Total impacted habitat disturbance area (ha)	PCT														Riparian zones	Waterbodies and ephemeral swamps	Watercourses	Aerial
		27	*35*	*36*	*52*	*53*	55	56	98	147	192	244	247	418	628				
Critically endangered species - 1																			
Silver perch (*Bidyanus bidyanus*)	1.51																	✓	
Vulnerable species - 1																			
Murray cod (*Maccullochella peelii*)	1.51																	✓	

Table note:

✓ Refer to Appendix B2 for further detail regarding species specific microhabitat requirements

4 References

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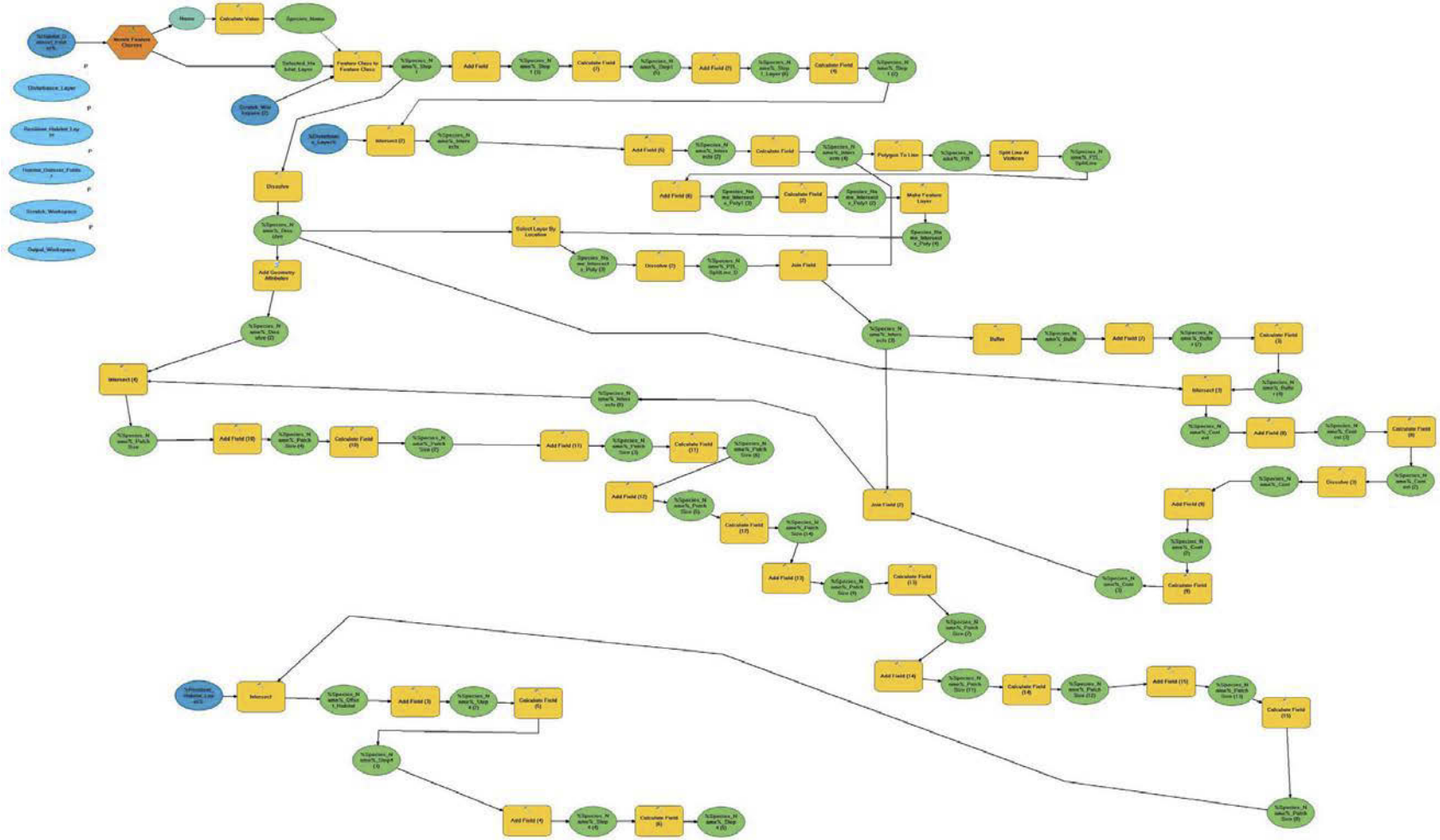
Appendix A

AIAM – GIS Model Script

Appendix A
AIAM – GIS Model Script



Appendix B

Species resilience questionnaires

Contents

1 Introduction

The following section presents the species resilience questionnaires which have been completed for each MNES subject to the EPBC Act controlled action approval.

A summary of the species resilience assessments for each aquatic fauna species subject to the EPBC Act controlled action approval is provided in Table 1.1

Table 1.1 Summary of species resilience assessments

Species name	EPBC Act status	Species resilience	
		Questionnaire score	Ranking
Fauna Species - 2			
Silver perch (*Bidyanus bidyanus*)	Critically endangered	6	Moderate
Murray cod (*Maccullochella peelii*)	Vulnerable	6	Moderate

2 Critically endangered fauna species

2.1 Silver perch (*Bidyanus bidyanus*)

2.1.1 Status

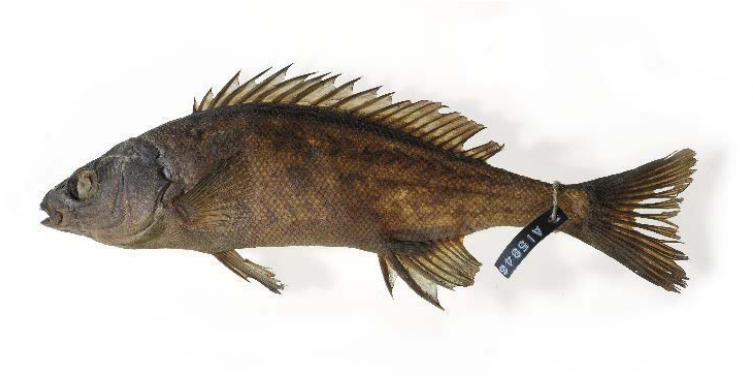
EPBC Act – Critically Endangered

BC Act – Vulnerable

2.1.2 Biology and ecology

Characteristics

A medium to large, fish with a body that becomes deeper and more laterally compressed with age. Maximum length ~500 mm and maximum weight 8 kg; usually 350 mm and 2 kg. The single dorsal fin has a higher, spinous anterior section and a lower, rayed section at the rear. They have a pointed head and snout and a relatively small mouth with equal jaws and narrow bands of very fine villiform (needle-like) teeth. The body colour is grey to grey-brown or dusky bronze with a lighter belly. The scales are much smaller than those on Golden or Macquarie perch. The tail is weakly forked. Very large specimens assume a slightly disproportionate appearance with a strongly humped forehead, strong lateral compression and a more distinctly pointed, almost beak-like head and snout. (Lintermans 2007, OEH 2019).



Photograph 2.1 Silver Perch (*Bidyanus bidyanus*)

Source: Michelle (2017)

Known distribution

Formerly widespread over much of the Murray-Darling Basin excluding the most upper reaches, Silver perch has declined over most of its range. Numbers moving through a fishway at Euston Weir on the Murray River declined by 93% between 1940 and 1990. Only nine Silver perch were recorded in a two-year survey of 40 randomly selected sites in the NSW portion of the Basin in the mid 1990s. The species is still patchily abundant in the mid-Murray. The ACT probably represented the upstream limit of distribution in the Murrumbidgee catchment, although the large spawning run of fish that occurred in summer from Lake Burrinjuck is unfortunately a thing of the past (Lintermands 2007,OEH 219).

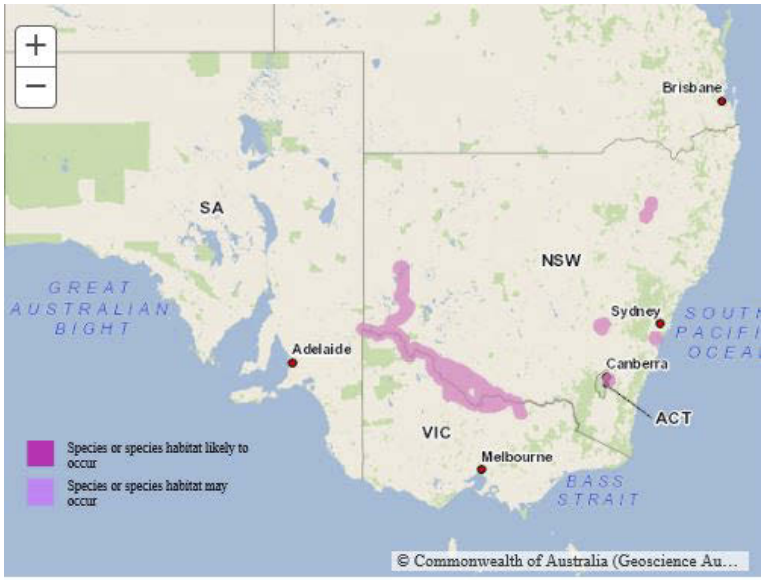


Figure 2.1 Distribution range of Silver Perch

Source: DoEE (2019)

Biology and reproduction

Silver perch display sexual dimorphism, with females growing to a larger size. Growth varies between individual fish and is affected by the productivity of environments. Male fish reach sexual maturity at three years of age, and female fish reach sexual maturity at four to five years of age. Growth slows dramatically in both sexes after sexual maturity. Mallen-Cooper and Stuart (2003) estimated a mean maximum size for Murray River silver perch of 422 mm for female fish and 377 mm for male fish. They spawn in spring and summer after an upstream migration, when large schools often form. Spawning occurs in late afternoon, dusk or just after nightfall. Spawning occurs in shoals at or near the surface, involves simultaneous release of milt (sperm) and eggs by male and female fish respectively, and is often accompanied by thrashing at the surface (Lake, 1967a; Merrick and Schmida, 1984; Clunie and Koehn, 2001). Merrick and Schmida (1984) reported that spawning occurs where water flows over a gravel or rock rubble substrate. Whilst spawning can occur during nonflood conditions, spawning activity was significantly increased during a flood and environmental water release in 2005 in the mid-Murray River. Lake (1967b) found that fertilised, water-hardened eggs were 2.7–2.8 mm in diameter, and hatched in 30–31 hours at temperatures of 26–27°C. Silver perch eggs spawned at cooler temperatures had longer hatching times. Importantly, Lake (1967b) noted that silver perch eggs are semi-pelagic and will sink to the bottom in the absence of current; he also noted the propensity for the chorion (‘outer covering’) of silver perch eggs to adsorb very fine suspended sediment. The cumulative evidence indicates that silver perch reproduction is flexible in terms of flow conditions and temperature; reproduction can occur in both within-channel flows and floods and at relatively cool water temperatures. Surveys found that silver perch across the Murray-Darling Basin failed to recruit during 2008–2010 drought conditions and that its current low densities may heighten the risk from extended recruitment failure in the future (Davies et al., 2012).

Silver perch are omnivorous. The diet contains aquatic plants, snails, shrimps, zooplankton and aquatic insect larvae.

This species is bred artificially in a number of government and commercial hatcheries and widely stocked into farm dams and reservoirs. While significant numbers of silver perch are bred and grown in aquaculture facilities for human consumption in Australia and Asia, these aquacultured fish are not considered meaningful to the long-term survival of silver perch in the wild, as they are highly domesticated both in the behavioural and the genetic sense (Rowland, 2009). Similarly, large numbers of hatchery-bred silver perch are stocked, usually in impoundments, but these stocked silver perch appear to make little improvement to the conservation situation of wild silver perch (Davies et al., 2008; Rowland, 2009; Davies et al., 2012).

2.1.3 Habitat

Silver perch are found in similar habitats to Murray cod and Golden perch, i.e. lowland, turbid and slow-flowing rivers. However, numerous reliable accounts exist of silver perch penetrating to Cooma (~ 800 metres ASL) on the Murrumbidgee River in large-scale upstream migrations in summer in the early and mid 1900s. Silver perch are consistently reported by anglers and researchers to show a general preference for faster-flowing water, including rapids and races, and more open sections of river, throughout the Murray-Darling Basin (Clunie and Koehn, 2001). In the upper Murrumbidgee River during the 1960s and 1970s, the species was renowned for migrating into clear fast-flowing rapids in summer, in which anglers observed and targeted them (Pratt, 1979). Silver perch are a highly migratory freshwater fish. The extensive migration of adults, particularly during flooding, has long been recognised and is considered to be part of their spawning behaviour, likely a strategy to offset the downstream drift of eggs and larvae (Cadwallader, 1977; Reynolds, 1983; Mallen-Cooper et al., 1995). Reynolds (1983) tagged and then recovered a small number of tagged adult silver perch in the lower Murray River; most moved about 40 km upstream, while one fish moved 110 km and another 570 km upstream in 19 months.

2.1.4 Threatening processes

River regulation has severely affected this species through disruption of migration and reproductive behaviour. It is estimated there are 4000 barriers to fish movement in the Murray-Darling Basin in the form of dams, weirs and other structures (Lintermans, 2007), the vast majority of which do not have fishways. Between 2001 and 2013, the Sea to Hume Dam Fish Passage Program provided purpose-built fishways to give native fish passage past 15 weirs and barrages on the Murray River between the river's mouth and Hume Dam at Albury (Lintermans, in prep., 2013), thereby ameliorating the impacts of weirs on the movement of juvenile and adult native fish, including silver perch in the middle and lower Murray River (but not necessarily native fish eggs and larvae).

Thermal pollution In the upper Murray system, large dams release cold water from their base, below the lower thermal limits for hatching and growth of native fish eggs and larvae, and disrupting cues for movement by juvenile and adult fish (e.g. Astles et al., 2003). Thermal pollution typically takes several hundred kilometres for water temperatures to be restored to normal (summarised in Clunie and Koehn, 2001).

Blackwater events - Blackwater is water containing high levels of dissolved organic carbon which gives it a characteristic dark colour. Blackwater results from flood waters inundating floodplains or dry river channels, in the process leaching carbon compounds from inundated plant material. The dissolved organic carbon in blackwater encourages rapid bacterial growth which consumes dissolved oxygen and can reduce dissolved oxygen levels to very low levels that are fatal to fish and other aquatic organisms. While the extraction of dissolved organic carbon by floodwaters is a natural phenomenon, severe blackwater events are at least partially a result of river regulation, which has reduced the frequency and extent of floodplain inundation, and thus increased stores of dissolved organic carbon yielding plant material (Gerkhe et al., 1993; King et al., 2012).

Habitat degradation - It is widely recognised that Murray-Darling habitats have been degraded by desnagging, increased turbidity and salinity, loss of submergent macrophytes ('water weed'), and loss of riparian vegetation and associated siltation due to land clearing and a variety of poor farming practices including cattle grazing and trampling river banks (summarised in Clunie and Koehn, 2001). While all of these forms of habitat degradation have affected silver perch, key impacts are likely to be (1) loss of submergent macrophytes, which may be important nursery areas for juvenile silver perch and important sites for feeding for all life stages, and (2) siltation, which can smother silver perch eggs that sink to the substratum in the absence of current.

Alien pathogens - There are many pathogens and parasites present in Murray-Darling waterways capable of affecting silver perch. Almost all are introduced ('alien'), having been brought into Australia with imports of live alien fish. Diverse evidence suggests alien pathogens and parasites may have had greater impacts on native fish species than realised in the past, and ongoing impacts in the present. The key alien pathogens and parasites are of concern are EHNV, Saprolegnia and Aphanomyces, Chilodonella, Ichthyophthirius, Lernaea and Asian fish tapeworm.

Interactions with alien species (Carp, Brown and Rainbow trout, *Gamubzia holbrooki* and Redfin perch) are also suspected to be a threat.

2.1.5 Species resilience

Determination of species resilience is presented in Table 2.1.

2.1.6 References

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Table 2.1 Species resilience questionnaire – Silver perch (*Bidyanus bidyanus*)

Item	Question	Criteria	Species response	Score
Q1.	Threatening processes – Are the threatening processes which have contributed to the decline and subsequent conservations status of the target species expected to change as a result of the projected changes?	Species threatening processes are expected to: ■ Increase in intensity as a result of the projected changes **(2)** ■ Unlikely to change as a result of the projected changes **(0)** ■ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Key threats to this species include: ■ River regulations ■ Black water events ■ Habitat degradation ■ Alien pathogens ■ Alien fish Project works which require clearing are unlikely to increase threatening processes for this species	0
Q2.	Area and distribution - breeding: Is the area or location of the associated vegetation type used for breeding activities by this species expected to change?	Area used for breeding habitat expected to: ■ Decline or shift from current location (3) ■ Stay the same and in approximately the same location **(0)** ■ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Area used for breeding habitat expected to: Stay the same and in approximately the same location	0
Q3.	Area and distribution - non-breeding: Is the area or location of the associated vegetation type used for non-breeding activities by this species expected to change?	Area used for non-breeding habitat expected to: ■ Decline or shift from current location **(2)** ■ Stay the same and in approximately the same location **(0)** ■ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Area used for non-breeding habitat expected to Stay the same and in approximately the same location	0
Q4.	Habitat components - breeding: Are specific habitat components required for breeding expected to change within the associated vegetation type?	Required breeding habitat components: ■ Expected to decrease or habitat components required for breeding unknown (3) ■ Expected to decrease or habitat components required for breeding unknown (3) ■ Unlikely to change **(0)** ■ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	No breeding habitat components will be changes as part of the project related activities	0

Item	Question	Criteria	Species response	Score
Q5.	Habitat components - non-breeding: Are other specific habitat components required for survival during non-breeding periods expected to change within the associated vegetation type?	Required non-breeding habitat components: ■ Expected to decrease or habitat components required for non-breeding unknown **(2)** ■ Unlikely to change **(0)** ■ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species* ***(120)***	Non-breeding habitat components will remain largely unchanged as a result of the project activities	0
Q6.	Ability to colonise new areas: What is the potential for this species to disperse?	Low ability to disperse **(2)** ■ Mobile, but dispersal is sex-biased (only one sex disperses) **(1)** ■ Very mobile, both sexes disperse **(0)** ■ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species* ***(120)***	This is aquatic and has a low ability to disperse	2
Q7.	Migratory or transitional habitats: Does this species require additional habitats during migration that are separated from breeding and non-breeding habitats?	■ Species migratory habitats will be adversely affected **(2)** ■ Species migratory habitats will not be adversely affected **(0)** ■ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species* ***(120)***	Species migratory patterns are not likely to be altered in response to the project activities	0
Q8.	Survival during resource fluctuation: Does this species have alternative life history pathways to cope with variable resources or climate conditions?	Species has: ■ Limited flexible strategies to cope with variable resources across multiple years **(2)** ■ Flexible strategies to cope with variable resources across multiple years (eg alternative life forms, irruptive, explosive breeding, cooperative breeding) **(0)** ■ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species* ***(120)***	This species is limited flexible strategies to cope with variable resource availability	2
Q9.	Resilience to timing mismatch: Does this species have more than one opportunity to time reproduction to important events?	Species reproduces: ■ Once per year or less **(2)** ■ More than once per year **(0)** ■ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species* ***(120)***	Only a brood single offspring is produced each year	2

Item	Question	Criteria	Species response	Score
Q10.	Food resources: Are important food resources for this species expected to change?	▪ Primary food source(s) are expected to be negatively impacted by projected changes **(2)** ▪ Species consumes variety of prey/forage species OR primary food resource(s) not expected to be impacted by projected changes **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	This species feeds on a variety of invertebrates and vertebrates. Important food resources are not expected to change as a result of the project.	0
Q11.	Predation: Is the species predation vulnerability expected to change?	Species predation vulnerability: ▪ Is expected to increase as a result of the projected changes **(2)** ▪ Is not expected to be impacted by the projected changes **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Increased levels of predation and the species vulnerability is not expected to be impacted by the project activities	0
Q12.	Disease: Is prevalence of diseases known to cause widespread mortality or reproductive failure in this species expected to change?	▪ Disease prevalence is expected increase with projected changes **(2)** ▪ No known effects of expected changes on disease prevalence (0) ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	The nature of works is unlikely to introduce disease that may cause species decline	0
Q13.	Competitors: Are populations of important competing species expected to change?	▪ Major competitor species are expected to be positively impacted by projected changes **(2)** ▪ Species has a variety of competitive relationships or no expected impacts of projected changes in major competitor species **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	There are no major competitors recognised as a key threating process to this species. No change is expected.	0
Total score				6
Species resilience				**Moderate**

3 Vulnerable fauna species

3.1 Murray cod (*Maccullochella peelii*)

3.1.1 Status

EPBC Act – Vulnerable

BC Act – Not listed

3.1.2 Biology and ecology

Characteristics

The Murray cod (*Maccullochella peelii*) is the largest freshwater species of fish in Australia, measuring up to 1.8 m in length and weighing about 10 kg although some records indicate the species may reach over 100 kg in weight. The Murray cod has a broad head, rounded snout, equal length jaws and has a concaved facial profile. The light olive to dark green scales of the fish has mottled pattern, with a white ventral colouration. The pectoral fins of the fish are rounded and large with soft dorsal, anal and caudal fins with distinctive red or white edging (DoEE 2019) (refer Photograph 3.1).

Photograph 3.1 Murray cod (*Maccullochella peelii*)

Source: flagstaffotos (2006)

Known distribution

The Murray cod was once a widespread species and abundant in the lower and mid reaches of the Murray-Darling Basin between Queensland and South Australia (refer Figure 3.1). However, the distribution of the species has now reduced to several bioregions between Queensland and Victoria, including the Brigalow Belt South Bioregion (National Murray Cod Recovery Team 2010, DoEE 2019).

Figure 3.1 Distribution range of Murray cod

Source: ALA (2019)

Biology and reproduction

Due to the size of the Murray cod, it is considered the apex predator of the Murray-Darling river system and known to ambush its prey. The demersal species is known to hunt from sunset to sunrise, feeding on spiny crayfish and shrimp as well as reptiles and other fish species including cod (DoEE 2019).

The Murray cod has relatively low fertility compared to many other freshwater fish with the species generally reaching sexual maturity, which is heavily dependent on size, at 5 years of age. Male Murray cod, who are known to guard and fan the eggs during incubation, mature at a larger size than females with the species breeding as a pair. A female cod weighing 3 kg can produce up to 10,000 eggs often laid in logs or snags after developing them through winter until spawning, which is triggered by an increase in temperature and day length (DoEE 2019).

Upon hatching larvae tend to remain clustered in their nest for up to 11 days with the male continually providing protection before the larvae leave the nest to drift downstream and feed on zooplankton as well as aquatic insects (DoEE 2019).

3.1.3 Habitat

The habitat of the species is diverse, ranging from clear rocky streams to slow-flowing, turbid lowland rivers or billabongs where the fish is found frequently in the main channel. Due to the species preferred breeding environment, it is often found in streams containing large rock, snags, overhanging vegetation, stumps or other woody structures (DoEE 2019).

The species is known to take long distance journeys prior to spawning travelling up to several hundred kilometres upstream despite their naturally sedentary nature (Koehn et al. 2009).

3.1.4 Threatening processes

The following have been identified as potentially threatening processes to the Murray cod:

- Impoundment of streams and altered water flow
- Loss of riparian vegetation
- Habitat removal, modification and degradation (DoEE 2019).

3.1.5 Species resilience

Determination of species resilience is presented in Table 3.1.

3.1.6 References

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Table 3.1 Species resilience questionnaire – Murray cod (*Maccullochella peelii*)

Item	Question	Criteria	Species response	Score
Q1.	Threatening processes – Are the threatening processes which have contributed to the decline and subsequent conservations status of the target species expected to change as a result of the projected changes?	Species threatening processes are expected to: ■ Increase in intensity as a result of the projected changes **(2)** ■ Unlikely to change as a result of the projected changes **(0)** ■ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Key threats to this species include: ■ Impoundment of streams and altered water flow ■ Loss of riparian vegetation ■ Habitat removal, modification and degradation (DoEE 2019). Project works which require clearing are unlikely to increase threatening processes for this species	0
Q2.	Area and distribution - breeding: Is the area or location of the associated vegetation type used for breeding activities by this species expected to change?	Area used for breeding habitat expected to: ■ Decline or shift from current location (3) ■ Stay the same and in approximately the same location **(0)** ■ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Area used for breeding habitat expected to: Stay the same and in approximately the same location	0
Q3.	Area and distribution - non-breeding: Is the area or location of the associated vegetation type used for non-breeding activities by this species expected to change?	Area used for non-breeding habitat expected to: ■ Decline or shift from current location **(2)** ■ Stay the same and in approximately the same location **(0)** ■ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Area used for non-breeding habitat expected to Stay the same and in approximately the same location	0
Q4.	Habitat components - breeding: Are specific habitat components required for breeding expected to change within the associated vegetation type?	Required breeding habitat components: ■ Expected to decrease or habitat components required for breeding unknown (3) ■ Expected to decrease or habitat components required for breeding unknown (3) ■ Unlikely to change **(0)** ■ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	No breeding habitat components will be changes as part of the project related activities	0

Item	Question	Criteria	Species response	Score
Q5.	Habitat components - non-breeding: Are other specific habitat components required for survival during non-breeding periods expected to change within the associated vegetation type?	Required non-breeding habitat components: ■ Expected to decrease or habitat components required for non-breeding unknown **(2)** ■ Unlikely to change **(0)** ■ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species* ***(120)***	Non-breeding habitat components will remain largely unchanged as a result of the project activities	0
Q6.	Ability to colonise new areas: What is the potential for this species to disperse?	Low ability to disperse **(2)** ■ Mobile, but dispersal is sex-biased (only one sex disperses) **(1)** ■ Very mobile, both sexes disperse **(0)** ■ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species* ***(120)***	This is aquatic and has a low ability to disperse	2
Q7.	Migratory or transitional habitats: Does this species require additional habitats during migration that are separated from breeding and non-breeding habitats?	■ Species migratory habitats will be adversely affected **(2)** ■ Species migratory habitats will not be adversely affected **(0)** ■ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species* ***(120)***	Species migratory patterns are not likely to be altered in response to the project activities	0
Q8.	Survival during resource fluctuation: Does this species have alternative life history pathways to cope with variable resources or climate conditions?	Species has: ■ Limited flexible strategies to cope with variable resources across multiple years **(2)** ■ Flexible strategies to cope with variable resources across multiple years (eg alternative life forms, irruptive, explosive breeding, cooperative breeding) **(0)** ■ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species* ***(120)***	This species is limited flexible strategies to cope with variable resource availability	2
Q9.	Resilience to timing mismatch: Does this species have more than one opportunity to time reproduction to important events?	Species reproduces: ■ Once per year or less **(2)** ■ More than once per year **(0)** ■ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species* ***(120)***	Only a brood single offspring is produced each year	2

Item	Question	Criteria	Species response	Score
Q10.	Food resources: Are important food resources for this species expected to change?	▪ Primary food source(s) are expected to be negatively impacted by projected changes **(2)** ▪ Species consumes variety of prey/forage species OR primary food resource(s) not expected to be impacted by projected changes **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	This species feeds on a variety of invertebrates and vertebrates. Important food resources are not expected to change as a result of the project.	0
Q11.	Predation: Is the species predation vulnerability expected to change?	Species predation vulnerability: ▪ Is expected to increase as a result of the projected changes **(2)** ▪ Is not expected to be impacted by the projected changes **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	Increased levels of predation and the species vulnerability is not expected to be impacted by the project activities	0
Q12.	Disease: Is prevalence of diseases known to cause widespread mortality or reproductive failure in this species expected to change?	▪ Disease prevalence is expected increase with projected changes **(2)** ▪ No known effects of expected changes on disease prevalence (0) ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	The nature of works is unlikely to introduce disease that may cause species decline	0
Q13.	Competitors: Are populations of important competing species expected to change?	▪ Major competitor species are expected to be positively impacted by projected changes **(2)** ▪ Species has a variety of competitive relationships or no expected impacts of projected changes in major competitor species **(0)** ▪ *Due to species sensitivities, any impact on this value is expected to have an adverse impact on the species **(120)***	There are no major competitors recognised as a key threating process to this species. No change is expected.	0
Total score				6
Species resilience				**Moderate**

Appendix C

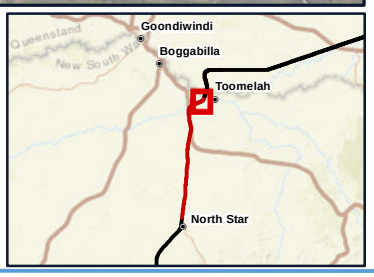
AIAM outputs

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

Map by: RB/MF/DTH/MF Z:\GIS\GIS_270_NS2B\Tasks\270-EAP-20200701227_Aquatic_tech_report\270-EAP-20200701227_NS2B_FFJV_Appendix_C_A4P_Aquatic_AIAMs.mxd Date: 13/07/2020 10:14

Legend

- Major roads
- Watercourses
- Study area
- Subject land
- Adversely impacted habitat
- Not adversely impacted habitat



A4 scale: 1:25,000
0 0.1 0.2 0.3 0.4 0.5 km

Future Freight
Integrating Community, Environment and Engineering

Date: 09/07/2020 Version: 3
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix C AIAMs output: Murray cod (*Maccullochella peelii*)

APPENDIX

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Aquatic Biodiversity Technical Report

Appendix C Aquatic Fauna Habitat and Likelihood of Occurrence

NORTH STAR TO NSW/QUEENSLAND BORDER ENVIRONMENTAL IMPACT STATEMENT

Appendix C

Aquatic fauna habitat and likelihood of occurrence

Table C1 Aquatic Fauna summary

Scientific name	Common name	Legislative status		Habitat requirements and likelihood to occur in the proposal study area
		FM Act	EPBC Act	
Threatened species				
Notopala sublineata	Darling river snail	CE	-	**Possible** Once widely distributed in the Murray-Darling basin in flowing rivers it now has a restricted population distribution and is now known from a limited number of irrigation pipes in southern NSW. No recent records of the species were identified on BioNet search (DPI 2018). Habitats within the creeks crossed by the rail corridor are unlikely to support populations of the species due to the extent of the drought and lack of water in the waterbodies. The Macintyre may support the species however there are no recent records or observations of the species during the site inspections. No additional surveys required but impacts on the species should be considered for the crossing of the Macintyre River.
Bidyanus bidyanus	Silver perch	V	CE	**Unlikely** Silver Perch were once widespread throughout the Murray Darling basin across a range of habitats. They are more commonly encountered in rapids, runs and faster flowing sections of waterways but are also found in larger open water bodies (DPI 2017). They are sometimes found in large schools and were once commercially harvested. The species undertakes large spawning migrations. No records were found of Silver Perch during the BioNet search and all of the waterways inspected, excluding the Macintyre River are unlikely to support Silver perch. While there are no records of Silver perch the Macintyre River provides suitable habitat to support the species and the habitat is mapped as suitable habitat. While no further assessment is recommended the proposed construction techniques and particularly spawning migration (Spring – summer) timing should avoid obstructing fish passage.
Mogurnda adspersa	Southern purple spotted gudgeon	E	-	**Possible** The Southern purple spotted gudgeon is a small benthic species that was once widespread throughout the Murray Darling basin however the western population now has a very restricted distribution and is known from a few isolated populations including the Gwydir and Border Rivers Catchments (DPI 2017a). No individual records for Southern purple spotted gudgeon were found during the BioNet search. DPI mapping indicates that they may be present or suitable habitat is present in the Macintyre River, Whalan Creek and one unnamed waterway. The habitat in the unnamed creek is unlikely to support the species as it is ephemeral. Whalan Creek at the sites surveyed and the proposed crossing location is dry due to the drought conditions but could provide suitable habitat when wet. The Macintyre River does provide suitable habitat for the species, however there is no records from the survey area. Depending on the proposed construction techniques for the Macintyre River crossing additional mitigation measures may be required.

Scientific name	Common name	Legislative status		Habitat requirements and likelihood to occur in the proposal study area
		FM Act	EPBC Act	
Maccullochella peelii	Murray cod	-	V	**Known** Murray Cod occurs in the waterways of the Murray Darling basin over a wide range of habitats. It is a long-lived species that has faced extensive population declines in the 1920's and again in the 1950's. The species now has a patchy distribution and abundance across the basin (Lintermans 2007). The species is generally found in deep holes and prefers habitats with instream cover including, snags and undercut banks. Murray cod also undertake upstream spawning migrations in late winter and early spring to spawn in spring and summer (Lintermans 2007). While the BioNet search returned no data for Murray cod the Macintyre River provides good habitat for Murray cod and is likely to support the species and the construction methods used will need to consider the biology and behaviour of the species. The other waterways inspected area unlikely to provide habitat for Murray cod.
Threatened populations				
Tandanus tandanus – Murray – Darling population	Eel-tailed catfish	E	-	**Possible** Eel-tailed catfish were once widespread and abundant throughout the Murray-Darling basin with the exception of the cooler southern tributaries (DPI 2015). NSW populations have declined dramatically since the 1970's and their distribution has reduced significantly in Victoria and NSW since. The species is found in a wide range of habitats it is more commonly found in still or slow flowing waters over a range of substrates including mud, sand - gravel and rock. No individual records for Eel-tailed catfish were found during the BioNet search. Waterways crossed by the rail corridor are mapped as suitable habitat that may support the species. The Macintyre River is the most likely waterway to support Eel-tailed catfish while the other waterways identified (Mobbindry and Back Creek) are to provide less critical habitat to the species as a result of intermittent flows and connectivity. The species is not known to occur in the rail corridor and no additional assessment is required, however construction techniques on the Macintyre River should consider measures to minimise impacts on Eel-tailed catfish.
Ambassis agassizii – western population	Western olive perchlet	E	-	**Possible** The western population of the Olive perchlet, also known as Agassiz's glassfish was once widespread throughout the Murray-Darling basin. The population is now found in limited sites in the Darling River drainage and an isolated population in the central Lachlan catchment (DPI 2013). Olive Perchlet inhabits rivers, creeks, ponds and swamps in still or slow flowing water. They prefer sheltered areas including overhanging vegetation, macrophyte beds, snags and rouble/rocks. No record of the Olive perchlet was found on the BioNet search. DPI mapping indicates the Macintyre River still supports the species. While no further assessments are required, the construction technique for the crossing of the Macintyre River should consider impacts to the species. The other waterways in the rail corridor are unlikely to support the Olive perchlet because of the current drought conditions and the intermittent nature of flows in the waterways and poor connectivity.

APPENDIX

S

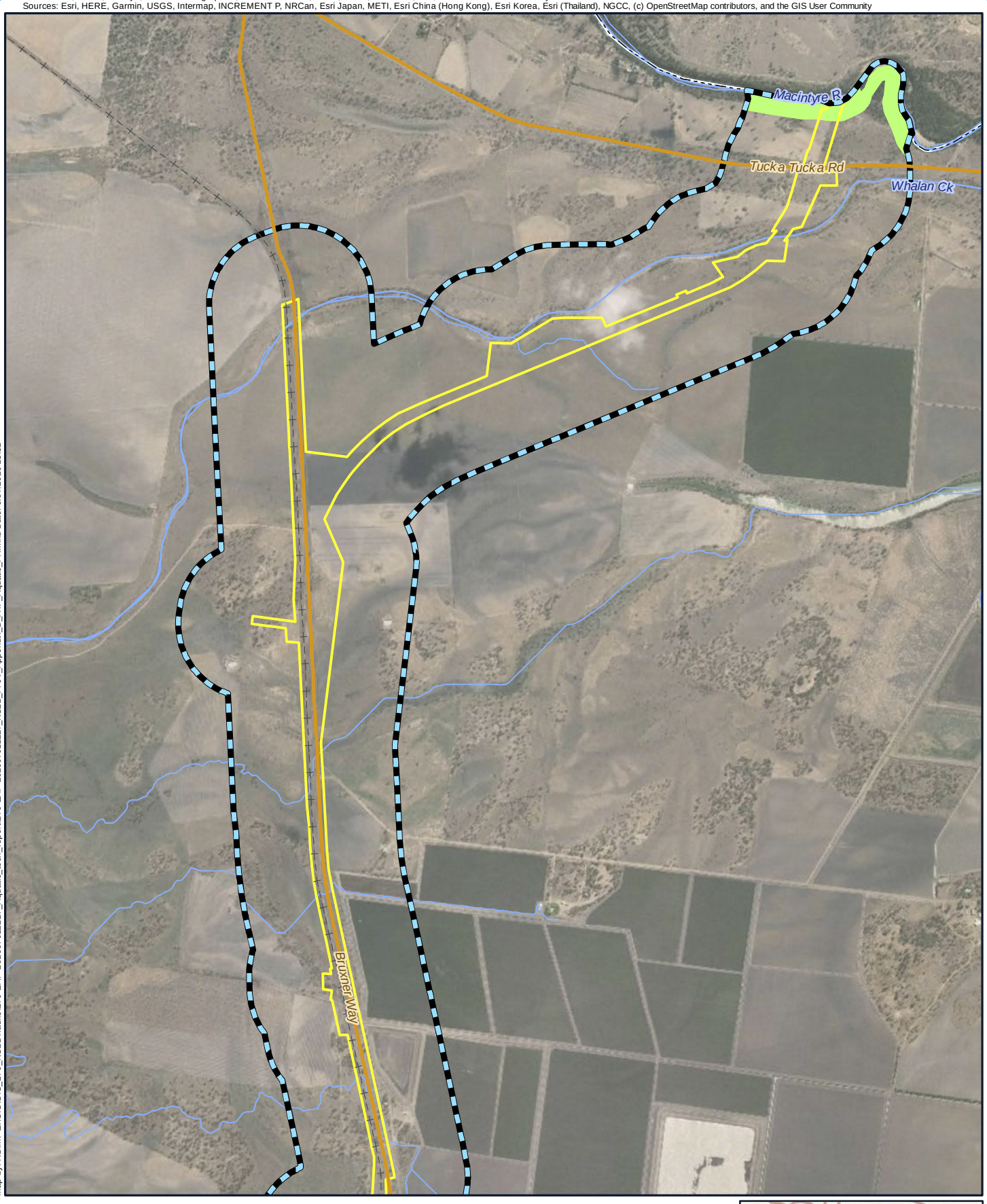
Aquatic Biodiversity Technical Report

Appendix D Matters of National Environmental Significance Predictive Mapping Outputs

NORTH STAR TO NSW/QUEENSLAND BORDER ENVIRONMENTAL IMPACT STATEMENT

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

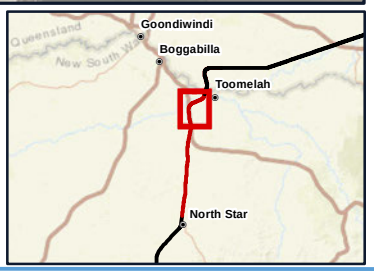
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the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



Map by: RBMF Z:\GIS\GIS_270_NS2B\Tasks\270-EAP-20200701227_Aquatic_tech_report\270-EAP-20200701227_NS2B_FFJV_Appendix_D_A4P_Aquatic_PH.mxd Date: 9/07/2020 13:32

Legend

- Existing rail (non-operational)
- Major roads
- Watercourses
- NSW/QLD border
- Study area
- Subject land
- General habitat



A4 scale: 1:35,000

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Future Freight
Integrating Community, Environment and Engineering

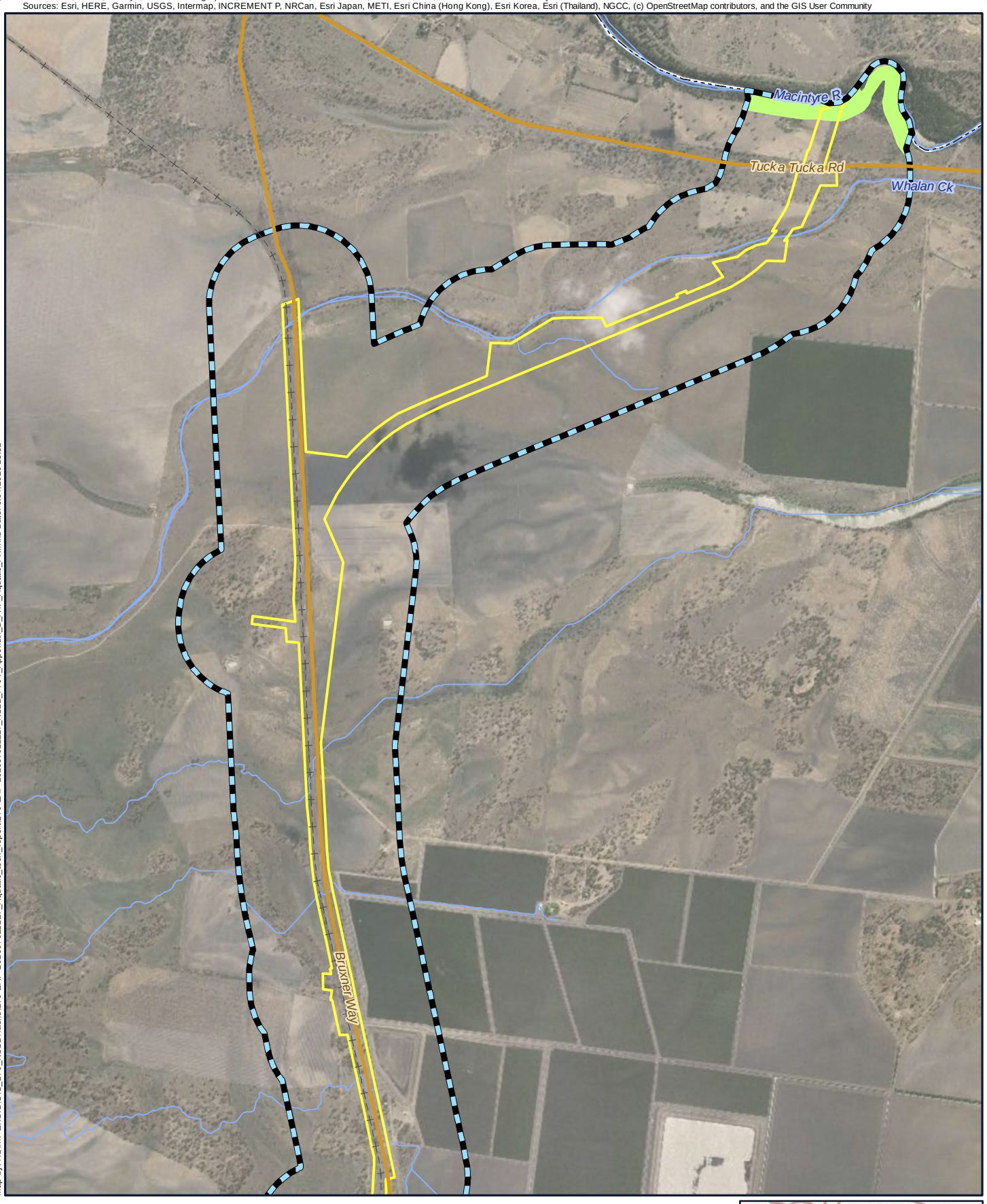
Date: 08/07/2020 Version: 2

Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix D Predicted habitat:
Bidyanus bidyanus (Silver perch)

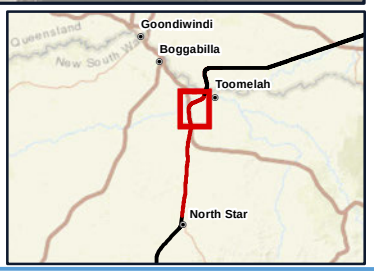
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the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



Map by: RBMF Z:\GIS\GIS_270_NS2B\Tasks\270-EAP-20200701227_Aquatic_tech_report\270-EAP-20200701227_NS2B_FFJV_Appendix_D_A4P_Aquatic_PH.mxd Date: 9/07/2020 13:32

Legend

- Existing rail (non-operational)
- Major roads
- Watercourses
- NSW/QLD border
- Study area
- Subject land
- General habitat



A4 scale: 1:35,000
0 0.2 0.4 0.6 0.8 1km

Future Freight
Integrating Community, Environment and Engineering

Date: 08/07/2020 Version: 2
Coordinate System: GDA 1994 MGA Zone 56

North Star to NSW/QLD border

Appendix D Predicted habitat:
Maccullochella peelii (Murray cod)

APPENDIX

S

Aquatic Biodiversity Technical Report

Appendix E Desktop Search Results

NORTH STAR TO NSW/QUEENSLAND BORDER ENVIRONMENTAL IMPACT STATEMENT

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

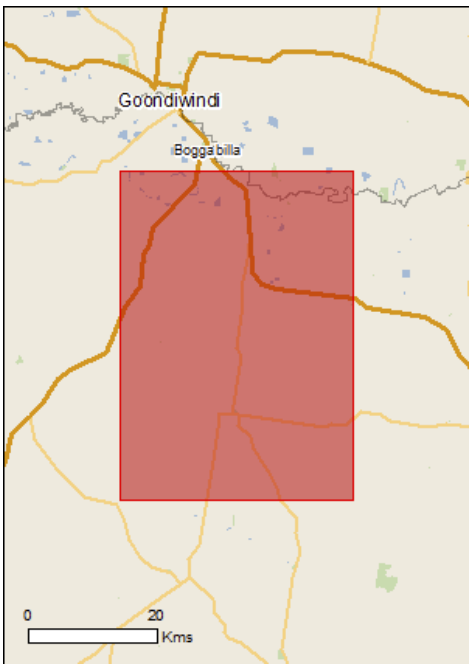
EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

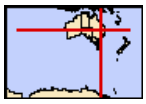
Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 05/08/19 14:34:54



Coordinates
Buffer: 10.0Km



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	3
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	7
Listed Threatened Species:	28
Listed Migratory Species:	11

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	3
Commonwealth Heritage Places:	None
Listed Marine Species:	18
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	1
Regional Forest Agreements:	None
Invasive Species:	30
Nationally Important Wetlands:	1
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Wetlands of International Importance (Ramsar) [Resource Information]

Name	Proximity
Banrock station wetland complex	1000 - 1100km
Riverland	1000 - 1100km
The coorong, and lakes alexandrina and albert wetland	1200 - 1300km

Listed Threatened Ecological Communities [Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Name	Status	Type of Presence
Brigalow (Acacia harpophylla dominant and co-dominant)	Endangered	Community known to occur within area
Coolibah - Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions	Endangered	Community likely to occur within area
Natural grasslands on basalt and fine-textured alluvial plains of northern New South Wales and southern Queensland	Critically Endangered	Community likely to occur within area
Poplar Box Grassy Woodland on Alluvial Plains	Endangered	Community may occur within area
Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar Bioregions	Endangered	Community likely to occur within area
Weeping Myall Woodlands	Endangered	Community likely to occur within area
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	Critically Endangered	Community may occur within area

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Anthochaera phrygia Regent Honeyeater [82338]	Critically Endangered	Foraging, feeding or related behaviour may occur within area
Botaurus poiciloptilus Australasian Bittern [1001]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Erythrotriorchis radiatus Red Goshawk [942]	Vulnerable	Species or species habitat likely to occur within area
Geophaps scripta scripta Squatter Pigeon (southern) [64440]	Vulnerable	Species or species habitat may occur within area
Grantiella picta Painted Honeyeater [470]	Vulnerable	Species or species habitat known to occur within area

Name	Status	Type of Presence
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat may occur within area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat may occur within area
Rostratula australis Australian Painted-snipe, Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area
Fish		
Maccullochella peelii Murray Cod [66633]	Vulnerable	Species or species habitat known to occur within area
Mammals		
Chalinolobus dwyeri Large-eared Pied Bat, Large Pied Bat [183]	Vulnerable	Species or species habitat likely to occur within area
Dasyurus maculatus maculatus (SE mainland population) Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population) [75184]	Endangered	Species or species habitat may occur within area
Nyctophilus corbeni Corben's Long-eared Bat, South-eastern Long-eared Bat [83395]	Vulnerable	Species or species habitat likely to occur within area
Petauroides volans Greater Glider [254]	Vulnerable	Species or species habitat may occur within area
Phascolarctos cinereus (combined populations of Qld, NSW and the ACT) Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) [85104]	Vulnerable	Species or species habitat known to occur within area
Pteropus poliocephalus Grey-headed Flying-fox [186]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Plants		
Androcalva procumbens [87153]	Vulnerable	Species or species habitat likely to occur within area
Cadellia pentastylis Ooline [9828]	Vulnerable	Species or species habitat likely to occur within area
Dichanthium setosum bluegrass [14159]	Vulnerable	Species or species habitat likely to occur within area
Homopholis belsonii Belson's Panic [2406]	Vulnerable	Species or species habitat may occur within area
Swainsona murrayana Slender Darling-pea, Slender Swainson, Murray Swainson-pea [6765]	Vulnerable	Species or species habitat may occur within area
Thesium australe Austral Toadflax, Toadflax [15202]	Vulnerable	Species or species habitat likely to occur within area
Tylophora linearis [55231]	Endangered	Species or species habitat may occur within area
Westringia parvifolia [4822]	Vulnerable	Species or species

Name	Status	Type of Presence
		habitat likely to occur within area
Reptiles		
Anomalopus mackayi Five-clawed Worm-skink, Long-legged Worm-skink [25934]	Vulnerable	Species or species habitat may occur within area
Delma torquata Adorned Delma, Collared Delma [1656]	Vulnerable	Species or species habitat may occur within area
Furina dunmalli Dunmall's Snake [59254]	Vulnerable	Species or species habitat may occur within area
Uvidicolus sphyrurus Border Thick-tailed Gecko, Granite Belt Thick-tailed Gecko [84578]	Vulnerable	Species or species habitat may occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat likely to occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat may occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Commonwealth Land [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Name
Commonwealth Land - Australian Telecommunications Commission
Commonwealth Land - Commonwealth Bank of Australia
Commonwealth Land - Telstra Corporation Limited

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat known to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Chrysococcyx osculans Black-eared Cuckoo [705]		Species or species habitat known to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat may occur within area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species

Name	Threatened	Type of Presence
		habitat may occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat likely to occur within area
Pandion haliaetus Osprey [952]		Species or species habitat may occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat may occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat may occur within area

Extra Information

State and Territory Reserves [Resource Information]

Name	State
Planchonella	NSW

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Acridotheres tristis Common Myna, Indian Myna [387]		Species or species habitat likely to occur within area
Alauda arvensis Skylark [656]		Species or species habitat likely to occur within area
Anas platyrhynchos Mallard [974]		Species or species habitat likely to occur within area
Carduelis carduelis European Goldfinch [403]		Species or species habitat likely to occur within area
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area
Streptopelia chinensis Spotted Turtle-Dove [780]		Species or species habitat likely to occur within area
Sturnus vulgaris Common Starling [389]		Species or species habitat likely to occur within area
Frogs		
Rhinella marina Cane Toad [83218]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Mammals		
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Capra hircus Goat [2]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Feral deer Feral deer species in Australia [85733]		Species or species habitat likely to occur within area
Lepus capensis Brown Hare [127]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Sus scrofa Pig [6]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Anredera cordifolia Madeira Vine, Jalap, Lamb's-tail, Mignonette Vine, Anredera, Gulf Madeiravine, Heartleaf Madeiravine, Potato Vine [2643]		Species or species habitat likely to occur within area
Asparagus africanus Climbing Asparagus, Climbing Asparagus Fern [66907]		Species or species habitat likely to occur within area
Asparagus asparagoides Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473]		Species or species habitat likely to occur within area
Lycium ferocissimum African Boxthorn, Boxthorn [19235]		Species or species habitat likely to occur within area
Opuntia spp. Prickly Pears [82753]		Species or species habitat likely to occur within area
Pinus radiata Radiata Pine Monterey Pine, Insignis Pine, Wilding Pine [20780]		Species or species habitat may occur within area
Rubus fruticosus aggregate Blackberry, European Blackberry [68406]		Species or species habitat likely to occur

Name	Status	Type of Presence
		within area
Salix spp. except S.babylonica, S.x calodendron & S.x reichardtii Willows except Weeping Willow, Pussy Willow and Sterile Pussy Willow [68497]		Species or species habitat likely to occur within area
Senecio madagascariensis Fireweed, Madagascar Ragwort, Madagascar Groundsel [2624]		Species or species habitat likely to occur within area
Tamarix aphylla Athel Pine, Athel Tree, Tamarisk, Athel Tamarisk, Athel Tamarix, Desert Tamarisk, Flowering Cypress, Salt Cedar [16018]		Species or species habitat likely to occur within area

Nationally Important Wetlands

[Resource Information]

Name	State
Morella Watercourse / Boobera Lagoon / Pungbougal Lagoon	NSW

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-28.63379 150.23647,-28.63379 150.56056,-29.0356 150.56056,-29.0356 150.23647,-28.63379 150.23647

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

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KingdomName	ClassName	FamilyName	ScientificName	CommonName	NSWStatus	CommStatus
Fauna	Aves	Acanthizidae	*Chthonicola sagittata*	Speckled Warbler	V,P	
Fauna	Aves	Accipitridae	*Circus assimilis*	Spotted Harrier	V,P	
Fauna	Aves	Accipitridae	*Haliaeetus leucogaster*	White-bellied Sea-Eagle	V,P	C
Fauna	Aves	Accipitridae	*Hieraaetus morphnoides*	Little Eagle	V,P	
Fauna	Aves	Accipitridae	*Lophoictinia isura*	Square-tailed Kite	V,P,3	
Fauna	Aves	Apodidae	*Hirundapus caudacutus*	White-throated Needletail	P	C,J,K
Fauna	Aves	Ciconiidae	*Ephippiorhynchus asiaticus*	Black-necked Stork	E1,P	
Fauna	Aves	Climacteridae	*Climacteris picumnus victoriae*	Brown Treecreeper (eastern subspecies)	V,P	
Fauna	Aves	Meliphagidae	*Grantiella picta*	Painted Honeyeater	V,P	V
Fauna	Aves	Neosittidae	*Daphoenositta chrysoptera*	Varied Sittella	V,P	
Fauna	Aves	Petroicidae	*Melanodryas cucullata cucullata*	Hooded Robin (south-eastern form)	V,P	
Fauna	Aves	Pomatostomidae	*Pomatostomus temporalis temporalis*	Grey-crowned Babbler (eastern subspecies)	V,P	
Fauna	Aves	Scolopacidae	*Gallinago hardwickii*	Latham's Snipe	P	C,J,K
Fauna	Aves	Threskiornithidae	*Plegadis falcinellus*	Glossy Ibis	P	C
Fauna	Insecta	Lycaenidae	*Jalmenus eubulus*	Pale Imperial Hairstreak	E4A,2	
Fauna	Mammalia	Emballonuridae	*Saccolaimus flaviventris*	Yellow-bellied Sheathtail-bat	V,P	
Fauna	Mammalia	Macropodidae	*Macropus dorsalis*	Black-striped Wallaby	E1,P	
Fauna	Mammalia	Phascolarctidae	*Phascolarctos cinereus*	Koala	V,P	V
Flora	Flora	Cyperaceae	*Cyperus conicus*		E1	
Flora	Flora	Poaceae	*Dichanthium setosum*	Bluegrass	V	V
Flora	Flora	Poaceae	*Homopholis belsonii*	Belson's Panic	E1	V

APPENDIX

S

Aquatic Biodiversity Technical Report

Appendix F Aquatic Receptor Assessment—Fisheries Management Act 1991

NORTH STAR TO NSW/QUEENSLAND BORDER ENVIRONMENTAL IMPACT STATEMENT

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

Appendix F

Aquatic receptor assessment –Fisheries Management Act

The aquatic assessment utilises impact assessment determinations under the FM Act for the *Determination of whether proposed development or activity likely to significantly affect threatened species, population or ecological community* as per FM Act. Each receptor (relevant to the FM Act) as MSES are assessed under matters identified under particulars contained within the FM Act.

Bidyanus bidyanus - Silver Perch

Silver Perch were once widespread and abundant throughout most of the Murray-Darling river system. They have now declined to low numbers or disappeared from most of their former range. Only one remaining secure and self sustaining population occurs in NSW in the central Murray River downstream of Yarrawonga weir, as well as several anabranches and tributaries.

(a) in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,

There is only one known self sustaining population within NSW which is on the NSW Victorian border over 400 km south west of the proposed development site.

(b) in the case of an endangered population, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,

Not applicable

(c) in the case of an EEC or critically endangered ecological community (CEEC), whether the proposed development or activity:

Not applicable

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,

(d) in relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and

The silver perch prefer to live in fast flowing waters which include rapids and races, these habitat features are not found within the proposed development study area. Therefore the proposed works are not expected to impact upon the habitat for this species.

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and

The proposed works have been designed not to fragment or isolate areas of the floodplain or riverbed. The area of habitat to be disturbed is approximately four sections of 9 m square within the river bank and beds, excluding the floodplain.

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the threatened species, population or ecological community in the locality,

The works associated with the proposal are over 400km overland from the only known self-sustaining population. Given the size of the disturbance and its distance from that populations it is considered highly unlikely the works will have any impact upon the long-term survival of the species.

(e) whether the proposed development or activity is likely to have an adverse effect on any critical habitat (either directly or indirectly),

The works associated with the proposal are over 400km overland from the only known self-sustaining population. The species prefer fast flowing water which contains rapids and races none of which are found within or adjacent to the proposed works.

(f) whether the proposed development or activity is consistent with a Priorities Action Statement, the proposed development is not at odds with the Priorities Actions Statement.

(g) whether the proposed development constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

Of the 8 key threatening processes within the FM Act the proposed works have the potential to trigger two: 'Installation and operation of instream structures and other mechanisms that alter natural flow regimes of rivers and streams', and 'Degradation of native riparian vegetation along NSW watercourses'. At the time of writing this report the most recent design drawings show works within the Macintyre River and its floodplain in both NSW and QLD consists of the development of 75 piers which will support a bridge 1.8 km long designed specifically not to impede the flow of the Macintyre River or its floodplains. Degradation to existing riparian vegetation is considered relatively minimal in the wider context of the Macintyre River.

As such, no significant impact on a population of Silver perch is considered likely as a result of the proposal.

References

Department of Primary Industries – Threatened Species Lists – Silver Perch (Bidyanus bidyanus) viewed on 16/9/2019 at **https://www.dpi.nsw.gov.au/fishing/fish-species/species-list/silver-perch**

Department of Primary Industries – Threatened Species Lists – Silver Perch (Bidyanus bidyanus) Priorities Action Statement viewed on 16/9/2019 at **https://www.dpi.nsw.gov.au/fishing/fish-species/species-list?a=560820**

Department of Primary Industries. 2017. Silver Perch – *Bidyanus bidyanus.* Available online at **https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0009/635778/Silver-Perch-Bidyanus-bidyanus.pdf**

Lintermans,M. 2007. Fishes of the Murray-Darling Basin – An introductory guide. Murray Darling Basin Commission.

Notopala sublineata - Darling River snail

(a) in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,

The Darling river snail has not been recorded within northern NSW in over ten years and are reported by the DPI (2018) as being virtually extinct throughout their natural range. The most recent records of the species are from within irrigation pipes in southern NSW. Given the likely extent of the species and the proposed works within the Macintyre River no impact is expected to occur which may have an adverse effect of the lifecycle of the species.

(b) in the case of an endangered population, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,

Not applicable

(c) in the case of an EEC or CEEC, whether the proposed development or activity:

Not applicable

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,

(d) in relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and

The proposed works will not remove or greatly modify the habitat of the Darling river snail. Recent research has shown that the species now only survive within irrigation pipes in the south of NSW. Additional structures within the river system may provide more habitat rather than less for the growth of microbial organisms which the snails feed upon should they be present.

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and

The proposed works will not fragment or isolate any part of the Macintyre river from its existing connections.

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the threatened species, population or ecological community in the locality,

The species has only been recorded from southern NSW in the last ten years and is not expected to occur within the proposed works area. No individuals of the species have ever been recorded within BioNet or ALA within a 100km radius of the proposed works. The proposed works have been designed not to fragment or isolate areas of the floodplain or riverbed. The area of habitat to be disturbed is approximately four sections of 9 m square within the river bank and beds, excluding the floodplain.

(e) whether the proposed development or activity is likely to have an adverse effect on any critical habitat (either directly or indirectly),

The species has only been recorded from southern NSW in the last ten years and is not expected to occur within the proposed works area. No individuals of the species have ever been recorded within BioNet or ALA within a 100km radius of the proposed works.

(f) whether the proposed development or activity is consistent with a Priorities Action Statement,

The proposed works are not at odds with the Priorities Action Statement. Any sightings or potential sightings of the species will be reported to the DPI.

(g) whether the proposed development constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

Of the 8 key threatening processes within the FM Act the proposed works have the potential to trigger two: 'Installation and operation of instream structures and other mechanisms that alter natural flow regimes of rivers and streams', and 'Degradation of native riparian vegetation along NSW watercourses'. At the time of writing this report the most recent design drawings show works within the Macintyre River and its floodplain in both NSW and QLD consists of the development of 75 piers which will support a bridge 1.8 km long designed specifically not to impede the flow of the Macintyre River or its floodplains. Degradation to existing riparian vegetation is considered relatively minimal in the wider context of the Macintyre River.

As such, no significant impact on a population of Darling River snail is considered likely as a result of the proposal.

References

Department of the Environment and Energy – Species Profile and Threats Database - Notopala sublineata — Darling River Snail SPRAT Profile viewed on 19/6/2019 at **http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=68490**

Department of Primary Industries - Threatened species – Darling River Snail viewed on 16/9/2019 at **https://www.dpi.nsw.gov.au/fishing/threatened-species/what-current/critically/river-snail**

Department of Primary Industries 2007 Recovery plan for the endangered River Snail (Notopala sublineata). Available online at http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0020/184241/Recovery-plan-for-the-endangered-river-snail-Notopala-sublineata---June-2007.pdf

Fisheries Scientific Committee (2016) Notopala sublineata – Darling River Snail as a critically endangered species.

Ponder, W. F., Hallan, A., Shea, M. and Clark, S. A. 2016. Australian Freshwater Molluscs. http://keys.lucidcentral.org/keys/v3/freshwater_molluscs/

Department of Primary Industries – Priority Action Statement – Actions for the River Snail viewed 16 /9/2019 at https://www.dpi.nsw.gov.au/fishing/threatened-species/what-current/critically/river-snail/priorities-action-statement-actions-for-the-river-snail

Mogurnda adspersa - Southern purple spotted gudgeon

Southern Purple Spotted Gudgeon occurs in inland drainages of the Murray-Darling basin as well as coastal drainages of northern NSW and Queensland. The western population of the Southern Purple Spotted Gudgeon was previously widespread in the Murray, Murrumbidgee and Lachlan River systems and tributaries of the Darling but has experienced a significant decline in recent times. Southern Purple Spotted Gudgeons are now extremely rare in inland NSW, having been recorded from this area only once since 1983. The species is reported to prefer slow moving or still waters or creeks, rivers, wetlands and billabongs and prefers slower flowing, deeper habitats. Most remnant populations occur within small to medium sized streams.

(a) in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,

Based on the current known distribution of the species it does not seem likely that the proposed activities within the Macintyre River will impact the lifecycle of the species such that it would be placed at risk of extinction. Should the species be present at the site it is considered reasonably mobile and would be able to move up or down stream during proposal construction activities. Instream works will be managed in such as way as to reduce risk of an increase in downstream sediment loads.

(b) in the case of an endangered population, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,

Not applicable

(c) in the case of an EEC or CEEC, whether the proposed development or activity:

Not applicable

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

Not applicable

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,

Not applicable

(d) in relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and

The proposed works within the Macintyre and its floodplain currently consists of the development of 75 piers which will support a bridge 1.8km long designed specifically not to impede the flow of the Macintyre River or its floodplains. At the time of writing this report there were 4 piers designed to be placed within the streambed of the Macintyre River. Specific instream sediment management mitigation measures will be put in place to reduce any downstream impacts.

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and

The proposed works do not involve the damming or diversion of the Macintyre River so are not considered likely to fragment or isolate any part of the existing habitat.

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the threatened species, population or ecological community in the locality,

The species has not been recorded from the area however it has been mapped as likely to occur within the Macintyre River. Should the species be present there will be no removal or fragmentation of the habitat and modifications are likely only to occur during construction works. Specific instream sediment management mitigation measures will be put in place to reduce any downstream impacts which should reduce the risk of any potential long term impacts upon the species.

(e) whether the proposed development or activity is likely to have an adverse effect on any critical habitat (either directly or indirectly),

The species has not been recorded within or adjacent to the proposed works therefore the area is not considered to be critical habitat for the species. However, following the precautionary principal specific instream sediment management mitigation measures will be put in place to reduce any downstream impacts which should reduce the risk of any potential impacts upon the species.

(f) whether the proposed development or activity is consistent with a Priorities Action Statement,

The Priorities Action Statement states that there should be a collation and review of existing information about the species and data collection on the presence/absence during incidental surveys. To date one round of trapping has occurred within the Macintyre River with no individuals captured. This data is available to the department to add to their records. The proposed works are not at odds with the Priorities Action Statement.

(g) whether the proposed development constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process

Of the 8 key threatening processes within the FM Act the proposed works have the potential to trigger two: 'Installation and operation of instream structures and other mechanisms that alter natural flow regimes of rivers and streams', and 'Degradation of native riparian vegetation along NSW watercourses'. At the time of writing this report the most recent design drawings show works within the Macintyre River and its floodplain in both NSW and QLD consists of the development of 75 piers which will support a bridge 1.8 km long designed specifically not to impede the flow of the Macintyre River or its floodplains. Degradation to existing riparian vegetation is considered relatively minimal in the wider context of the Macintyre River.

As such, no significant impact on a population of Southern purple-spotted gudgeon is considered likely as a result of the proposal.

References

Department of Primary Industries. 2017. Primefact Southern purple spotted gudgeon (*Mogurnda adspersa*) available online at: **https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0007/635290/Primefact-1275-Southern-Purple-Spotted-Gudgeon-Mogurnda-adspersa.pdf**

Department of Primary Industries - Threatened species – Southern purple spotted gudgeon (*Mogurnda adspersa*) viewed on 16/9/2019 at **https://www.dpi.nsw.gov.au/fishing/threatened-species/what-current/critically/river-snail**

Department of Primary Industries – Priority Action Statement – Actions for the Southern purple spotted gudgeon (*Mogurnda adspersa*) viewed 16 /9/2019 at **https://www.dpi.nsw.gov.au/fishing/threatened-species/what-current/endangered-species/purple-spotted-gudgeon/priorities-action-statement-actions-for-the-purple-spotted-gudgeon**

Eel-tailed catfish (*Tandanus tandanus*) population in the Murray Darling basin

Eel Tailed Catfish are naturally distributed throughout the Murray-Darling Basin and in the Eastern drainages NSW north of Newcastle. Eel Tailed Catfish numbers in the Murray-Darling Basin have declined due to a range of impacts including invasive species, habitat degradation, cold water pollution and fishing pressures and are now virtually absent from the Murray, Murrumbidgee and Lachlan catchments. "*The species inhabits a diverse range of freshwater environments including rivers, creeks, lakes, billabongs and lagoons. It prefers clear, sluggish or still waters, but can also be found in flowing streams with turbid waters. Substrates range from mud to gravel and rock*" DPI 2015. A report produced by DPI published in 2017 maps the species as 'Disappeared' along the Macintyre River approximately 11.6 km upstream of the proposed works. The species is reported as being sedentary in that it will not travel greater than 5 km from where is originates therefore natural reintroduction, from either up or down stream, to areas currently devoid of the species is not likely. A breeding population was recorded from within the Macintyre River at Inverell approximately 140 km south east in a direct line, this does not imply that there are not breeding populations closer to the site however none have been recorded/reported within over 100km in the data reviewed for this assessment.

(a) in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,

Not applicable

(b) in the case of an endangered population, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,

The species has previously been recorded within the Macintyre River however a recent (2017) report indicates it is no longer present in the lower reaches near the proposal area. Given the nature of the works and the design mitigation measures being put in place is not considered likely that the construction and operation of the bridge or viaduct will place the population at any greater risk of extinction than currently exists.

The proposed works are being designed not to impact upon the flow patterns and flooding regimes of the Macintyre River or increase siltation rates all of which may impact the species ability to breed successfully. Provided these design principles are sound there should not be an adverse impact upon the life cycle of the species should they choose to breed there in the future.

(c) in the case of an EEC or CEEC, whether the proposed development or activity:

Not applicable

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,

(d) in relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and

It is acknowledged that there will be some modification of the vegetation along the banks of the Macintyre River and some clearing of the grasslands in the adjacent floodplain to enable the development of the viaduct and bridge. The development of specific management plans will enable the detailed management of any potential instream impacts. The proposed works consist of 75 piers to support the bridge and viaduct four of which (Piers 41 to 44) will be located within the Macintyre River bed and banks. Each pier will be approximately 9 m squared once the structures are in place no further modification is expected to occur.

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and

The proposed works have been specifically designed not to fragment or isolate any sections of the Macintyre River.

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the threatened species, population or ecological community in the locality,

The species prefer an environment with low daily flow, a high level of submerged macrophytes and a incidence of cobbles and gravels within nonbreeding areas and a high incidence of boulders and gravel within the stream bed within breeding areas. While the substrate of the river at the proposed crossing is not known by this assessor, recent evidence suggests there is no longer a breeding population of eel-tailed catfish within this section of the Macintyre River. The proposed works will consist of some clearing of riverbank vegetation and the construction of four piers within the Macintyre River bed and banks. Mitigation measure will be put in place to reduce the movement of any sediment created during the instream and banks works. The species are mobile and are expected to move outside of the construction area while works are occurring should they be present. Once works have been completed there will be no impediment for the population to return to the area.

(e) whether the proposed development or activity is likely to have an adverse effect on any critical habitat (either directly or indirectly),

The critical habitat for the species is the presence of cobbles, gravels and boulders within an area with high submerged macrophyte cover. The proposed works may reduce the number of macrophytes within the immediate vicinity of the construction but mitigation measures around sediment control is designed to reduce this impact and the instream vegetation should return to return to preconstruction levels.

(f) whether the proposed development or activity is consistent with a Priorities Action Statement,

The proposed development is not at odds with the Priorities Action Statement. Any decrease in water quality levels during construction will be short term and managed through a site-specific management plan to reduce any impacts downstream of the works.

(g) whether the proposed development constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

Of the 8 key threatening processes within the FM Act the proposed works have the potential to trigger one: ‘Installation and operation of instream structures and other mechanisms that alter natural flow regimes of rivers and streams’. The proposed works have been specifically designed so as not to impede water flow over the floodplains and into the Macintyre River, thus causing the smallest amount of modification to the existing flow regimes.

As such, no significant impact on a population of Eel-tailed catfish is considered likely as a result of the proposal.

References

Department of Primary Industries – Threatened Species Lists – Eel-tailed catfish (*Tandanus tandanus*) viewed on 16/9/2019 at **https://www.dpi.nsw.gov.au/fishing/threatened-species/what-current/endangered-populations/eel-tailed-catfish**

Department of Primary Industries – Threatened Species Lists – Eel-tailed catfish (*Tandanus tandanus*) Priorities Action Statement viewed on 16/9/2019 at **https://www.dpi.nsw.gov.au/fishing/threatened-species/what-current/endangered-populations/eel-tailed-catfish/priorities-action-statement-actions-for-murray-darling-population-of-eel-tailed-catfish**

Department of Primary Industries. 2018. Protecting Eel-tailed Catfish in Western NSW – a guide for fishers and land managers. Available online at **https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0006/832875/ProtectingEelTailedCatfish.pdf**

Lintermans,M. 2007. Fishes of the Murray-Darling Basin – An introductory guide. Murray Darling Basin Commission.

Ambassis agassizii - Western olive perchlet (western population)

Olive Perchlets are a small native fish that occur in both eastern (coastal) and western (Murray-Darling) drainages. The western population of the Olive Perchlet was once widespread throughout the Murray-Darling system of South Australia, Victoria, western New South Wales and southern Queensland. This population has suffered a serious decline and is extinct in Victoria and has not been found in South Australia since 1983. The remaining known populations is now found only at a few sites in the Darling River drainage. The species feed is carnivorous and prefer to live in areas with little or no flow such as backwaters. They are found in sheltered areas such as overhanging vegetation, logs, dead branches and boulders during the day and disperse to feed at night.

(a) in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,

At the time of reporting the most recent design drawings show works within the Macintyre River and its floodplain in both NSW and QLD consisting of the construction of 75 piers which will support a bridge 1.8 km long designed specifically not to impede the flow of the Macintyre River or its floodplains. Instream works within the Macintyre include the placement of four piers during which time there is likely to be an increase in localised sedimentation and destruction of some instream vegetation. The sedimentation will be managed in accordance with the site management plan and the instream vegetation is expected to recover. As construction methodology is not currently available detailed mitigations have not been developed at this time. Given the localised nature of the proposed works and the mobility of the species these works are not considered likely to place the local population of the species at risk of extinction.

(b) in the case of an endangered population, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,

At the time of reporting the most recent design drawings show works within the Macintyre River and its floodplain in both NSW and QLD consisting of the construction of 75 piers which will support a bridge 1.8 km long designed specifically not to impede the flow of the Macintyre River or its floodplains. Instream works within the Macintyre include the placement of four piers during the instream works there is likely to be an increase in localised sedimentation and destruction of some instream vegetation. The sedimentation will be managed in accordance with the site management plan and the instream vegetation is expected to recover. As construction methodology is not currently available detailed mitigations have not been developed at this time. Given the localised nature of the proposed works and the mobility of the species these works are not considered likely to place the local population of the species at risk of extinction.

(c) in the case of an EEC or CEEC, whether the proposed development or activity:

Not applicable.

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,

(d) in relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and

The preferred habitat for the species includes slow flowing or still waters which provide sheltering such as overhanging vegetation and aquatic macrophyte beds. The proposed works are likely to impact an area of approximately 20 m wide on the bank and four individual pier construction sites of around 9 m square within the bank and beds. This is likely to cause short term displacement due to construction noise but not likely to impact the preferred habitat of the species long term.

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and

The construction of the piers is not considered likely to fragment or isolate any areas of existing habitat outside of construction timeframes.

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the threatened species, population or ecological community in the locality,

There is no mapping of areas of importance for this species, Given the location and relatively small impact area it is not considered likely that this area is highly important for the survival of the species and the impact is not expected to be long-term.

(e) whether the proposed development or activity is likely to have an adverse effect on any critical habitat (either directly or indirectly),

There is no mapping of areas of importance for this species however it is reported as preferring slow flowing or backwaters, given the location and relatively small impact area it is not considered likely that this area is highly important for the survival of the species and the impact is not expected to be long-term. Based on this knowledge it is not considered likely that the proposed development will have an adverse effect on habitat which is critical for the species.

(f) whether the proposed development or activity is consistent with a Priorities Action Statement,

The proposed development is not at odds with the Priorities Actions Statement for the species.

(g) whether the proposed development constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

Of the eight key threatening processes within the FM Act the proposed works have the potential to trigger two: 'Installation and operation of instream structures and other mechanisms that alter natural flow regimes of rivers and streams', and 'Degradation of native riparian vegetation along NSW watercourses'. At the time of writing this report the most recent design drawings show works within the Macintyre River and its floodplain in both NSW and QLD consists of the development of 75 piers which will support a bridge 1.8 km long designed specifically not to impede the flow of the Macintyre River or its floodplains. Degradation to existing riparian vegetation is considered relatively minimal in the wider context of the Macintyre River.

As such, no significant impact on a population of Western olive perchlet is considered likely as a result of the proposal.

References

Department of Primary Industries – Threatened Species Lists – Olive Perchlet (*Ambassis agassizii*) viewed on 16/9/2019 at **https://www.dpi.nsw.gov.au/fishing/threatened-species/what-current/endangered-populations/olive-perchlet**

Department of Primary Industries – Threatened Species Lists – Olive Perchlet (Ambassis agassizii) Priorities Action Statement viewed on 16/9/2019 at **https://www.dpi.nsw.gov.au/fishing/threatened-species/what-current/endangered-populations/olive-perchlet/priorities-action-statement-actions-for-western-population-of-olive-perchlet**

Department of Primary Industries. 2014. PrimeFact - Olive Perchlet (western population) – *Ambassis agassizii.* Available online at https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0008/635876/PUB12-10-Primefact-176-Western-Olive-Perchlet-Ambassis-agassizii.pdf

Lintermans,M. 2007. Fishes of the Murray-Darling Basin – An introductory guide. Murray Darling Basin Commission.

Aquatic ecological community in the natural drainage system of the lowland catchment of the Darling River (Endangered ecological community)

The Darling River endangered ecological community encompasses all aquatic fauna including fish and invertebrates occurring within the ecological systems. The system encompasses all natural creeks, streams, rivers and associated lagoons, lakes, billabongs and floodplains of the Darling River in NSW. The ecological community in relation to the Project includes the border rivers which encompass the MacIntyre River below Graman Weir, Severn River downstream of Pindari Dam and the Damaresq River downstream of the junction with Mole River (DPI 2020). Since European settlement the Darling River endangered ecological community has undergone significant modification as a result of river regulation, agriculture, introduction of invasive species and over-fishing. Aquatic habitats within this endangered ecological community have become degraded and the species that occupy it undergone serious decline, some of which are now listed as threatened species. Threats to this endangered ecological community means there is a real risk that the system will become extinct (DPI 2007). Causing harm or modification of species or habitat within the Darling River endangered ecological community can result in severe legal implications including penalties. As such, potential impact to the system must be considered during the development application process (DPI 2007).

(a) in the case of a threatened species, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,

Not applicable

(b) in the case of an endangered population, whether the proposed development or activity is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,

Not applicable

(c) in the case of an EEC or CEEC, whether the proposed development or activity:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

At the time of reporting the most recent design drawings show works within the Macintyre River and its floodplain in both NSW and QLD consisting of the construction of 75 piers which will support a bridge 1.8 km long designed specifically not to impede the flow of the Macintyre River or its floodplains. Instream works within the Macintyre include the placement of four piers during the instream works there is likely to be an increase in localised sedimentation and destruction of some instream vegetation. Implementation of effective erosion control measures has been identified as a key recovery action. The sedimentation will be managed in accordance with the site management plan and the instream vegetation is expected to recover. Degradation of riparian habitat has been identified as a key threatening process to the Darling River EEC. The construction of the Project will require the permanent removal of riparian habitat however the impact will be localised and impacts will also be managed in accordance with the site management plan.

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,

At the time of reporting the most recent design drawings show works within the Macintyre River and its floodplain in both NSW and QLD consisting of the construction of 75 piers which will support a bridge 1.8 km long designed specifically not to impede the flow of the Macintyre River or its floodplains. Instream works within the Macintyre include the placement of four piers during the instream works there is likely to be an increase in localised sedimentation and destruction of some instream vegetation. Instream works also has the potential to displace faunal assemblages at a local scale during the installation of piers due to construction noise and disturbance. These impacts will be temporary and managed in accordance with the site management plan. As such, the Project associated instream works are not likely to substantially and adversely modify the composition of the ecological community to the point that it will likely be placed at risk of extinction.

(d) in relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and

Species associated with this ecological community may occupy areas which provide important shelter such as overhanging vegetation in riparian areas and aquatic macrophyte beds. The proposed works are likely to impact an area of approximately 20 m wide on the bank and four individual pier construction sites of around 9 m square within the bank and beds. The permanent removal of riparian vegetation will result in the permanent modification of riparian habitat where construction will occur along the riverbank. This impact, although permanent, will be localised. Displacement of aquatic fauna due to construction noise will be temporary and not likely to impact the preferred habitat of species within the ecological community in the long term.

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and

The construction of the piers is not considered likely to fragment or isolate any areas of existing habitat outside of construction timeframes. The piers will be designed specifically as to not impede the MacIntyre River or its floodplains.

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the threatened species, population or ecological community in the locality,

The Border Rivers, including the MacIntyre River, has been mapped as area within the Darling River endangered ecological community. As such, the Border Rivers could be considered as an area of importance for threatened species occurring within the system. Given the relatively small impact area project associated disturbance is not likely to impact the long-term survival of the ecological community or the threatened species occurring within it locally.

(e) whether the proposed development or activity is likely to have an adverse effect on any critical habitat (either directly or indirectly),

The construction of instream structures has to potential to cause direct and indirect localised impacts to this ecological community. However, given the relatively small impact area, project associated disturbance is not likely to have an adverse impact on critical habitat within the ecological community.

(f) whether the proposed development or activity is consistent with a Priorities Action Statement,

The proposed development does not conflict with conservation and recovery actions outlined in the *DPI 2007 Endangered ecological communities in NSW Lowland Darling River aquatic ecological community prime facts* document. Priority actions include:

- Adequate allocation and management of water flows to mitigate impacts of unseasonal flow and water temperature
- Implement management, protection and restoration of riparian habitat along with implementation of effective sediment control
- Cold water pollution mitigation from impoundment release
- Development and implementation of control programs for introduced species

- Restore woody debris and natural instream structures providing micro habitat
- Ensure fishing activities are managed sustainably
- Installation of fishways or removal of barriers for fish passage.

(g) whether the proposed development constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

Of the eight key threatening processes within the FM Act the proposed works have the potential to trigger two: 'Installation and operation of instream structures and other mechanisms that alter natural flow regimes of rivers and streams', and 'Degradation of native riparian vegetation along NSW watercourses'. At the time of writing this report the most recent design drawings show works within the Macintyre River and its floodplain in both NSW and QLD consists of the development of 75 piers which will support a bridge 1.8 km long designed specifically not to impede the flow of the Macintyre River or its floodplains. Degradation to existing riparian vegetation is considered relatively minimal in the wider context of the Macintyre River.

As such, no significant impact on the Darling River endangered ecological system is considered likely as a result of the proposal.

References

Department of Primary Industries. 2007. Endangered ecological communities in NSW – Lowland Darling River aquatic ecological community. Available from: **http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0006/171573/Lowland-Darling-River-aquatic-ecological-community.pdf**. Accessed: July 2020

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