Wilcannia Weir Replacement

Biodiversity Development Assessment Report

Final

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Water Infrastructure NSW

Wilcannia Weir Replacement

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Glossary of terms

Term	Definition
Biodiversity Assessment Method (BAM) (2020)	The Biodiversity Assessment Method (BAM) (DPIE, 2020) is the assessment manual that outlines how an accredited person assesses impacts on biodiversity at development sites (development site). It is a scientific document that provides: ▪ a consistent method for the assessment of biodiversity on a proposed development or major project, or clearing site, ▪ guidance on how a proponent can avoid and minimise potential biodiversity impacts, and ▪ the number and class of biodiversity credits that need to be offset to achieve a standard of 'no net loss' of biodiversity.
Biodiversity credits	Ecosystem-credits or species-credits.
Biodiversity credit report	The report produced by the Biodiversity Assessment Method Calculator (BAM-C) that sets out the number and class of biodiversity credits required to offset the remaining adverse impacts on biodiversity values at a development site.
Biodiversity offsets	Management actions that are undertaken to achieve a gain in biodiversity values on areas of land in order to compensate for losses to biodiversity values from the impacts of development.
Biodiversity Offsets Scheme	A NSW government framework which creates a transparent, consistent, and scientifically based approach to biodiversity assessment and offsetting for development that is likely to have a significant impact on biodiversity.
Biodiversity Offset Strategy	A strategy for offsetting residual impacts associated with a development.
Biodiversity Assessment Method Calculator (BAM-C)	The computer program that provides decision support to assessors and proponents by applying the BAM, and which calculates the number and class of biodiversity credits required to offset the impacts of a development.
Bioregion	Bioregions are relatively large land areas characterised by broad, landscape-scale natural features and environmental processes that influence the functions of entire ecosystems. They capture the large-scale geophysical patterns across Australia. These patterns in the landscape are linked to fauna and flora assemblages and processes at the ecosystem scale.
Cumulative impact	The impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. Refer to the project SEARs for cumulative impact assessment requirements.
Direct impact	An impact on biodiversity values that is a direct result of vegetation clearance and loss of habitat for a development. It is predictable, usually occurs at or near to the development site and can be readily identified during the planning, design, construction, and operational phases of a development.
Direct impact area	Native vegetation to be cleared for construction and areas of native vegetation in the weir pool which will be directly impacted through inundation at full supply level.
Development site	As defined by the BAM (2020) an area of land that is subject to a proposed development under the EP&A Act. The term development site is also taken to

Term	Definition
	include clearing site, except where the reference is to a small area development or a major project development. For the purpose of this assessment, the development site is the same as the construction footprint.
Ecosystem-credit	As defined by the BAM, a measurement of the value of EECs, CEECs and threatened species habitat for species that can be reliably predicted to occur with a plant community type (PCT). Ecosystem-credits measure the loss in biodiversity values at a development site (development site) and the gain in biodiversity values at a biodiversity stewardship site.
Ecosystem-credit species	A measurement of the value of threatened species habitat for species that can be reliably predicted to occur with a PCT.
Habitat	An area or areas occupied, or periodically or occasionally occupied, by a species, population, or ecological community, including any biotic or abiotic component.
Indirect impact	An impact on biodiversity values that occurs when development related activities affect threatened species, threatened species habitat, or ecological communities in a manner other than direct impact. Compared to direct impacts, indirect impacts often: ▪ occur over a wider area than just the site of the development ▪ have a lower intensity of impact in the extent to which they occur compared to direct impacts ▪ occur off site ▪ have a lower predictability of when the impact occurs ▪ have unclear boundaries of responsibility.
Local population	As defined by the BAM, the population that occurs in the study area. In cases where multiple populations occur in the study area and/or a population occupies part of the study area, impacts on the entirety of each population must be assessed separately.
MNES	A matter of national environmental significance (MNES) protected by a provision of Part 3 of the EPBC Act.
Mitigation	Action to reduce the severity of an impact.
Mitigation measure	Any measure that facilitates the safe movement of wildlife and/or prevents wildlife mortality.
NSW (Mitchell) landscape	Landscapes with relatively homogeneous geomorphology, soils, and broad vegetation types, mapped at a scale of 1: 250,000.
Patch	A patch is defined in the BAM as an area of intact native vegetation that occurs on the subject land. The patch may extend onto adjoining land beyond the development site of the subject land, and for woody ecosystems, includes native vegetation separated by less than or equal to100 metres from the next area of intact native vegetation. For non-woody vegetation, this gap is reduced to less than or equal to 30 metres.
Plant community type (PCT)	A NSW plant community type (PCT) is identified using the PCT classification system. The classification system is approved by the NSW Plant Community Type Control Panel and described in the BioNet Vegetation Classification database, which describes how to identify PCTs and TECs as per the NSW PCT classification, and details each PCT and its geographic distribution.

Term	Definition
Population	As defined by the BAM, a group of organisms, all of the same species, occupying a particular area.
Species-credits	As defined by the BAM, the class of biodiversity credits created or required for the impact on threatened species that cannot be reliably predicted to use an area of land based on habitat surrogates. Species that require species-credits are listed in the Threatened Biodiversity Data Collection.
Species-credit species	Threatened species that are assessed according to Section 6.4 of the BAM.
Subject land	As defined by the BAM, land to which the BAM is applied in Stage 1 to assess the biodiversity values of the land. For the purpose of this assessment, the 'subject land' is referred to as the 'development site'. Refer to **Section 1.2** for terminology and definitions used throughout in this report.
Study area	The development site and any other areas surveyed and assessed for biodiversity values which may be subject to indirect impacts. For the purpose of this assessment the study area includes the development site plus a 50 metre buffer.
Target species	A species that is the focus of a study or intended beneficiary of a conservation action or connectivity measure.
Threatened Biodiversity Data Collection	Part of the BioNet database, published by EESG and accessible from the BioNet website at www.bionet.nsw.gov.au.
Threatened species	A species listed under the BC Act, *Fisheries Management Act 1994* (FM Act) or *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).
Threatened ecological community	A community of different species associated with one another and sharing the same habitat, that is listed under the BC Act, FM Act and Commonwealth EPBC Act. Threatened ecological communities are listed as endangered or critically endangered under the BC Act, or may be listed as vulnerable, endangered, or critically endangered under the Commonwealth EPBC Act.
1,500-m landscape buffer	The assessment area surrounding the development site includes the area of land in the 1,500-m landscape buffer around the development site. The study area is situated within the 1,500-m landscape buffer. The landscape buffer is an assessment area used to identify landscape features surrounding the development site to provide site context and to inform the likely habitat suitability of the development site.

Abbreviations	
AHD	Australian Height Datum
BAM	Biodiversity Assessment Method 2020
BAM-C	Biodiversity Assessment Method Calculator
BC Act	*Biodiversity Conservation Act 2016* (NSW)
BC Regulation	*Biodiversity Conservation Regulation 2017* (NSW)
BDAR	Biodiversity Development Assessment Report
CEMP	Construction environmental management plan
DoAWE	Department of Agriculture, Water and the Environment (Commonwealth)
DPE	Department of Planning and Environment (NSW)
DPIE	Department of Planning, Industry and Environment (NSW) (former)
DPI	Department of Primary Industries (NSW)
EEC	Endangered ecological community
EESG	Environment, Energy and Science Group (NSW DPE)
EIS	Environmental impact statement
EP&A Act	*Environmental Planning and Assessment Act 1979* (NSW)
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth)
FM Act	*Fisheries Management Act 1994* (NSW)
IBRA	Interim Biogeographic Regionalisation for Australia
Left and right	Reference to left and right (of river) is with respect to the view in the downstream direction, in accordance with industry practice
MLD	Megalitres per day
MNES	Matters of National Environmental Significance
NSW	New South Wales
OEH	Office of Environment and Heritage (replaced by EESG)
PCT	Plant Community Type
River kilometre	Distance along the centreline of a river (i.e. not in a straight line), measured in kilometres
SEARs	Secretary's Environmental Assessment Requirements
TECs	Threatened Ecological Communities
TBDC	Threatened Biodiversity Data Collection (BioNet)
VIS	Vegetation information system (BioNet Vegetation Classification)
WINSW	Water Infrastructure NSW

Executive summary

Water Infrastructure NSW (WINSW) ('the proponent') is seeking approval to construct and operate a new weir on the Darling River (Baaka), and to partially remove and decommission the existing weir, next to the township of Wilcannia in western New South Wales (NSW) ('the proposal'). The proposal is located in the Central Darling Shire local government area and would provide a more reliable long-term town water supply for Wilcannia to meet community needs. The proposal is funded by a $30 million commitment from both the NSW and Commonwealth governments.

The proposal is declared State significant infrastructure under section 2.13 and Schedule 3 of the State Environmental Planning Policy (Planning Systems) 2021. The NSW Biodiversity Offsets Scheme applies to State significant infrastructure projects unless the Secretary of the Department of Planning and Environment and the Chief Executive of Environment, Energy and Science Group determine that the proposal is not likely to have a significant impact. This document is the Biodiversity Development Assessment Report (BDAR) for the proposal as required under the Biodiversity Assessment Method (BAM). This BDAR documents the methods and results of the biodiversity assessment undertaken for the proposal in line with the relevant State and Commonwealth environmental and threatened species legislation and policy. This BDAR addresses Stage 1 and Stage 2 of the BAM. A separate Aquatic Impact Assessment Report has been prepared to address potential impacts on listed aquatic species and communities.

The proposal comprises the construction and operation of a new weir and the partial removal and decommissioning of the existing weir on the Darling River (Baaka) in the township of Wilcannia in western NSW. The proposed new weir would be located on a reach of the Darling River (Baaka) downstream of Union Bend, about 4.92 river kilometres downstream of the existing weir, and about two road kilometres south of the Wilcannia township (refer to **Photo 2-1**). The crest of the five metre-high weir would be about five metres below the top of the river left bank (southern side) and 6.5 metres below the top of the river right bank (northern side) at this location.

Landscape

The proposal is located within a predominately natural landscape containing a diversity of habitats with high biodiversity value. The proposal is located in the Darling Riverine Plains Bioregion and within the Wilcannia Plains subregion. The Darling Riverine Plains Bioregion occupies most of the upper catchments of the Darling and Barwon Rivers in northern NSW and southern Queensland and includes the channels and floodplains of the lower reaches of these catchments.

Assessment methods

Ecological surveys have been undertaken for this BDAR in November 2020 in accordance with the BAM (Department of Planning, Industry and Environment (DPIE), 2020) including:

- Preliminary site visits and mapping
- Identification and detailed mapping of plant community types (PCTs) involving:
  - Stratification of PCTs in survey units (vegetation zones)
  - Plot based floristic vegetation survey and vegetation integrity (VI) assessment
- Threatened species habitat assessment
- Targeted threatened species surveys, including:
  - Parallel transects undertaken across suitable habitats within the proposal area for threatened flora species within prescribed survey periods (seasons)
  - Targeted fauna survey methods were employed including bird surveys, call broadcasting, spotlighting and timed area searches.

Native vegetation and habitats

Three PCTs were identified within the development site, and represented in different condition states from very poor to good condition as follows:

- PCT 36: River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion, low and good condition
- PCT 39: Coolabah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion, disturbed, low and good condition
- PCT 158: Old Man Saltbush - mixed chenopod shrubland of the semi-arid hot (persistently dry) and arid climate zones (north-western NSW), very poor and low condition.

A further three PCTs were also identified and mapped over the broader study area, within the surrounding floodplain adjacent to, but outside of the development site:

- PCT247: Lignum shrubland wetland on regularly flooded alluvial depressions in the Brigalow Belt South Bioregion and Darling Riverine Plains Bioregion
- PCT 38: Black Box low woodland wetland lining ephemeral watercourses or fringing lakes and clay pans of semi-arid (hot) and arid zones
- PCT153: Black Bluebush low open shrubland of the alluvial plains and sandplains of the arid and semi-arid zones.

PCT 39 corresponds with a threatened ecological community (TEC) listed under the NSW *Biodiversity Conservation Act 2016* (BC Act) and identified as Coolibah-Black Box Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain and Mulga Lands Bioregions (Endangered). The good condition areas of this PCT also correspond with the endangered ecological community listing in the Commonwealth *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC Act) referred to as Coolibah - Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions (Endangered).

The above listed PCTs correspond with four vegetation classes (Keith 2004) that represent different broad habitat types used to stratify fauna survey, including:

- Inland Riverine Forests
- North-west Floodplain Woodlands
- Riverine Chenopod Shrublands
- Inland Floodplain Shrublands.

Groundwater dependent ecosystems

The level of groundwater dependence of vegetation communities in the study area was identified using the *Atlas of Groundwater Dependent Ecosystems* (GDEs) (Bureau of Meteorology, 2017) and the *Risk Assessment Guidelines for Groundwater Dependent Ecosystems* released by the NSW DPI (Kuginis *et al.*, 2012). Within the development site and study area:

- PCT 36, PCT 39, PCT 158 and PCT 247 have high GDE potential and are likely proportional facultative GDEs (i.e. exhibit partial dependence on the subsurface presence of groundwater from a consistent source)
- PCT 38 and PCT 153 have medium GDE potential and are likely to be opportunistic facultative GDEs (i.e. partial dependence on the subsurface presence of groundwater when available.

Threatened species

Five threatened plant species were targeted in a survey of the development site. Each of these species is identified as known from the region and has potential to occur, however no threatened plant species were confirmed in the development site or study area during the surveys.

Fauna surveys identified the Red-tailed Black-Cockatoo (*Calyptorhynchus banksii samueli*) within the development site, and the Spotted Harrier (*Circus assimilis*) and Dusky Woodswallow (*Artamus cyanopterus cyanopterus*) from the study area.

Large, mature hollow-bearing trees are widespread across the study area and all along the Darling River (Baaka). These represent important microhabitat features and provide potential breeding sites for threatened bird species that have a high likelihood of occurring. This includes Major Mitchell Cockatoo (*Lophochroa leadbeateri*), Barking Owl (*Ninox connivens*) and Masked Owl (*Tyto novaehollandiae*). There were no confirmed breeding sites for these species reported during the survey.

The Square-tailed Kite (*Lophoictinia isura*), Black-breasted Buzzard (*Hamirostra melanosternon*), Little Eagle (*Hieraaetus morphnoides*), and White-bellied Sea Eagle (*Haliaeetus leucogaster*) were not found during the surveys although are considered to potentially occur. Three moderately-sized stick nests were located in trees in the development site, although there were no confirmed active nest sites for these threatened diurnal raptors reported during the survey.

Biodiversity impacts

The proposal will result in the direct removal of native vegetation to gain access to the river and facilitate construction of the new weir across the river channel. This will include upgrading of existing tracks for all weather access leading to the site for construction and operational maintenance, and removal of a narrow area of riparian vegetation on each bank and adjoining small areas of vegetation adjacent to the bank for construction of the weir. A small recreation area and car park of about 0.7 hectares will be established on the north bank of the weir at Union Bend, and this has been sensitively designed to avoid removal of vegetation, including existing trees, particularly large mature trees. The final stage of the proposal will involve access to and removal of the upstream existing weir, this will involve minimal disturbance due to the plan to use an existing access road from the south bank with a short extension.

The estimated area of vegetation and habitat removal required for construction and operation of the proposal equates to 10.14 hectares, which includes 1.49 hectares of riparian vegetation (1.5 metres either side of the river channel) between the existing weir and the new weir which will be subject to inundation at full supply level. There are no direct impacts to species credit species although the development site provides habitat features for a range of ecosystem credit fauna species and potential foraging habitat for several dual-credit fauna species.

Table ES.1-1 Summary of direct impacts to native vegetation from the proposal

Veg Zone	PCT ID	PCT name	Broad condition class	Threatened ecological community		Direct impact area (ha)	Current VI score	Future VI score
				BC Act	EPBC Act			
1	36	River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion	Good	Not a TEC	Not a TEC	0.95	75.4	0
2			Low	Not a TEC	Not a TEC	1.62	21.2	0
3	39	Coolabah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion	Moderate	Coolibah-Black Box Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain and Mulga Lands Bioregions	Coolibah - Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions	1.94	57.8	0
4			Low		Not a TEC	0.94	15	0
5			Poor		Not a TEC	0.05	0.9	0
6	158	Old Man Saltbush - mixed chenopod shrubland of the semi-arid hot (persistently dry) and arid climate zones (north-western NSW)	Moderate	Not a TEC	Not a TEC	1.94	63.4	0
7			Poor	Not a TEC	Not a TEC	0.71	3.5	0
8			Good	Not a TEC	Not a TEC	1.99	92.4	0
					Total	**10.14**		

In addition to the direct impacts the BDAR has also assessed indirect and prescribed impacts to biodiversity. Potential indirect impacts are able to be mitigated through stringent controls applied during construction and include:

- Potential inadvertent impacts on adjacent vegetation and habitat outside of the development site boundary
- Potential impact on water quality from sediment mobilised during construction
- Loss of potential foraging habitat for threatened and migratory birds in the weir pool
- Potential transport of weeds and plant and animal disease pathogens during construction
- Impact from noise and vibration, dust, and potential for contaminant spills during construction.

Prescribed impacts on biodiversity are less easy to identify and were assessed with respect to:

- The greater level of inundation expected at the weir pool and upstream reaches beyond the weir pool
- Changes to existing baseline flows downstream of the proposed new weir through greater water storage capacity of the new weir and its cutting of flows when entering a drought
- Changes to groundwater levels in proximity to the weir pool and the potential impact on groundwater dependent ecosystems.

Potential prescribed impacts can also be mitigated to a degree; however, monitoring will be required to inform if impacts are occurring as part of an adaptive management approach. Potential prescribed impacts include:

- Reduction of habitat connectivity associated with a newly created canopy gap along the riparian corridor. This is able to be mitigated, as to are other minor prescribed impacts such as increased risk of vehicle strike to fauna during construction and impact to any fauna using the existing weir structure (if present)
- Alteration to the natural flow regime of the river: The Darling River (Baaka) channel upstream and downstream of the weir pool was investigated and confirmed a lack of native in-stream and wetland vegetation and general fauna habitat in the river channel. Such habitats that are considered important for fauna, particularly waders and migratory bird species were found to be absent in the river channel and it is evident that the inundation upstream and the reduced flow downstream will not impact important habitats for these species, and not isolate or remove important wetland habitats for birds and frogs
- Potential alteration to groundwater salinity levels in areas immediately adjacent to the weir that may impact the long-term vegetation integrity of identified floodplain PCTs that are GDEs.

Avoidance, mitigation, and offsets

The approach to design development and preliminary construction planning undertaken to date has included a focus on avoiding and/or minimising, as far as practicable, the potential for impacts during all stages of construction. Direct impacts to vegetation have been minimised by using existing tracks to access the construction work sites and avoiding trees and other vegetation of significance as far as practicable. Staging and laydown areas have been situated to utilise more cleared areas where possible. The recreation reserve has been designed to avoid vegetation removal.

The impacts described are addressed in a mitigation strategy to be formalised into a construction environmental management plan (CEMP) and applied during the construction and operational phases.

Based on the anticipated new weir construction of 4.92 river kilometres downstream from Wilcannia, equilibrium groundwater levels are expected to rise to within five metres of the surface. Identified low-lying areas near to the Darling River (Baaka) where long-term groundwater levels are expected to be less than three metres below ground level, will experience salinization. While these levels of salinization will be similar to what has been experienced upstream from the existing weir the impact of this on the integrity of the PCTs surrounding the new town pool and downstream low-lying areas are uncertain.

A comprehensive monitoring program should be developed post-approval to assess any change in vegetation integrity for the PCTs that have been identified as GDEs. This would focus on PCTs immediately adjacent to the weir pool, and additional floodplain PCT sites immediately downstream of the weir. The results will inform the need for management actions or further indirect offsets should a negative change in vegetation integrity occur and be attributed to increase in soil salinity.

A credit requirement has been generated by the BAM-C for ecosystem credits associated with the direct impacts to three PCTs. Credits for indirect impacts have not been calculated. The strategy for meeting the proposal's credit obligation to offset residual impacts would be to firstly source any available like-for-like credits from the Biodiversity Offsets Public Register in accordance with clause 6.3 of the Biodiversity Conservation Regulation 2017. The table below shows a summary of the ecosystem credits required to offset each PCT impacted by the proposal and the options for sourcing like-for-like credits as provided by the BAM-C.

Table ES.1.2 Ecosystem credits obligation and like-for-like options

Credit type	Sum of credits required	Like-for-like credit retirement options			
		Class	Trading group	HBT[1]	IBRA
PCT 36: River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion	46	Inland Riverine Forests This includes PCTs: 9, 36, 78, 79, 112, 249, 356, 362	Inland Riverine Forests - ⩾ 50% - < 70% cleared group (including Tier 3 or higher threat status	Yes	Wilcannia Plains, Barnato Downs, Darling Depression, Louth Plains, Menindee, Paroo Overflow, Paroo-Darling Sands and Scopes Range. or Any IBRA subregion that is within 100 kilometres of the outer edge of the development site.
PCT 39: Coolabah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion	63	Coolibah-Black Box Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain and Mulga Lands Bioregions This includes PCTs: 37, 39, 40, 55	None (TEC)	Yes	
PCT 158: Old Man Saltbush - mixed chenopod shrubland of the semi-arid hot (persistently dry) and arid climate zones (north-western NSW)	153	Riverine Chenopod Shrublands This includes PCTs: 158, 159, 195	Riverine Chenopod Shrublands - ⩾ 70% - <90% cleared group (including Tier 2 or higher threat status).	No	

Notes
[1] Hollow bearing trees

The options available to satisfy the proposal offset liability would entail either one of or a combination of the following options:

- Payment directly to the Biodiversity Conservation Fund, managed by the Biodiversity Conservation Trust
- Purchasing credits from the open market
- Establishing a stewardship site.

In the case of this proposal, it is recommended that WINSW purchase credits from the market as the first option where available. Alternatively, WINSW could pay directly into the fund as it can be achieved within the shortest timeframe. A further recommendation is to undertake consultation with BCT to ascertain more information on the credits which are available.

Important note about this report

In preparing this report Jacobs has relied upon and presumed accurate any information, or confirmation of the absence thereof, provided by Water Infrastructure NSW (WINSW) and/or from other sources. Except as otherwise stated in the report, Jacobs has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate, or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

Jacobs derived the data in this report from information sourced from WINSW and/or available in the public domain at the time or times outlined in this report. The passage of time, manifestation of latent conditions or impacts of future events may require further examination of the proposal and subsequent data analysis, and re-evaluation of the data, findings, observations, and conclusions expressed in this report. Jacobs has prepared this report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to applicable standards, guidelines, procedures, and practices at the date of issue of this report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report, to the extent permitted by law.

This report should be read in full, and no excerpts are to be taken as representative of the findings. No responsibility is accepted by Jacobs for use of any part of this report in any other context.

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1. Introduction

1.1 Proposal overview

Water Infrastructure NSW (WINSW) ('the proponent') is seeking approval to construct and operate a new weir on the Darling River (Baaka), and to partially remove and decommission the existing weir, next to the township of Wilcannia in western New South Wales (NSW) ('the proposal'). The proposal is located in the Central Darling Shire local government area (LGA) and would provide a more reliable long-term town water supply for Wilcannia to meet community needs. The proposal is funded by a $30 million commitment from both the NSW and Commonwealth governments.

The proposal location is shown in **Figure 1-1**. The key features of the proposal are shown in **Figure 2-1**. A detailed proposal description is provided in **Section 2**.

The proposed new weir would provide 5,435 megalitres of water accessible for the town's water supply and exceed the town's unrestricted dry year extraction requirements by about 100 megalitres of water per year.

1.2 Terms and definitions

The following terms are discussed throughout this report and are defined as:

- The proposal: Refers to the preliminary concept design for the Wilcannia Weir replacement proposal
- Development site: The development site encompasses the extent of the design and construction footprint and includes the land required to accommodate the construction and operational activities associated with the proposed new weir and partial removal and decommissioning of the existing weir as described in **Section 2.2** and displayed on **Figure 4-1** and **Figure 4-2**. The development site includes a buffer of about 10 metres on existing access roads which will not be cleared and also includes cleared land required for access, work sites and stockpiles, that does not contain native vegetation to be cleared
- Direct impact area: This term is used to identify portions of the development site where native vegetation exists and will need to be cleared to allow construction of the weir. The direct impact will also include native vegetation currently located within the river channel and banks (within the future weir pool) which will be subject to inundation at full supply level (refer to **Figure 5-2**) and hence directly impacted
- Indirect impact area: The river channel upstream of Wilcannia to the upper limit of the weir pool extent that would be subject to periodic and temporary inundation. Indirect impacts are also described and assessed downstream of the weir, subject to changed hydrological regimes
- Study area: This term is used broadly to describe the combined development site, direct and indirect impact areas and any floodplain vegetation immediately surrounding the Darling River (Baaka) in proximity to the weir pool which has been assessed for prescribed impacts (refer to **Figure 4-1** and **Figure 4-2**)
- Landscape buffer: A 1500-metre buffer surrounding the subject land and used to assess and identify landscape features which are associated with the project in accordance with Subsection 3.1.3 of the BAM (refer to **Figure 4-2**)
- Bioregion: The proposal is located in the Darling Riverine Plains Interim Biogeographic Regionalisation for Australia (IBRA) Bioregion (Department of Agriculture, Water and the Environment (DoAWE), 2020). The Darling Riverine Plains Bioregion occupies most of the upper catchments of the Darling and Barwon Rivers in northern NSW and southern Queensland and includes the channels and floodplains of the lower reaches of these catchments (refer to **Figure 4-1** and **Figure 4-2**)
- Locality: This is defined as the IBRA subregion in which the development site is located; that is, the Wilcannia Plains subregion (DoAWE, 2020).

1.3 Purpose of this technical report

The proposal is declared to be State significant infrastructure and is subject to the provisions of Part 5 Division 5.2 of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

The proposal also requires assessment under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) as the referral to the Commonwealth Department of Agriculture, Water and the Environment has determined the proposal to be a controlled action. As a result of the referral decision, the proposal will be assessed under the Bilateral Agreement between the NSW and Commonwealth Governments.

This Biodiversity Development Assessment Report (BDAR) has been prepared in accordance with the Secretary's Environmental Assessment Requirements (SEARs) issued for the proposal on 28 August 2020 by the Planning Secretary of the NSW Department of Planning and Environment (DPE). A separate Aquatic Ecology Impact Assessment has been prepared to address potential impacts on listed aquatic species and communities.

The SEARs relevant to this technical report are presented in **Table 1-1.**

Table 1-1 Secretary's environmental assessment requirements – Biodiversity

SEARs		Section addressed
4. Biodiversity assessment		
Biodiversity impacts related to the proposed development are to be assessed in accordance with Section 7.9 of the *Biodiversity Conservation Act 2016*, the Biodiversity Assessment Method and documented in a Biodiversity Development Assessment Report (BDAR). The BDAR must include information in the form detailed in the *Biodiversity Conservation Act 2016* (s6.12), Biodiversity Conservation Regulation 2017 (s6.8) and Biodiversity Assessment Method.		This entire document is the Biodiversity Development Assessment Report (BDAR), which documents the biodiversity impacts of the Wilcannia Weir proposal in accordance with Section 7.9 of the *Biodiversity Conservation Act 2016* and the Biodiversity Assessment Method (Department of Planning, Industry and Environment (DPIE), 2020).
The BDAR must document the application of the avoid, minimise, and offset framework including assessing all direct, indirect, and prescribed impacts in accordance with the Biodiversity Assessment Method.		Avoidance and minimisation is detailed in **Section 8**. Offsetting is detailed in **Section 11** and **Section 12**. Direct, indirect, and prescribed impacts are detailed in **Section 9**.
The BDAR must include details of the measures proposed to address the offset obligation as follows:	▪ the total number and classes of biodiversity credits required to be retired for the project	The credits calculated for the proposal are detailed in **Section 12**.
	▪ the number and classes of like-for-like biodiversity credits proposed to be retired	The offset strategy is located in **Section 12.2**.
	▪ the number and classes of biodiversity credits proposed to be retired in accordance with the variation rules	
	▪ any proposal to fund a biodiversity conservation action	
	▪ any proposal to make a payment to the Biodiversity Conservation Fund	
If seeking approval to use the variation rules, the BDAR must contain details of the reasonable steps that have been taken to obtain requisite like-for-like biodiversity credits		

SEARs		Section addressed
The BDAR must:	▪ be submitted with all spatial data associated with the survey and assessment as per Appendix 11 of the BAM.	The spatial data collected as part of this BDAR is presented in the figures within this document and submitted to the NSW Biodiversity, Science and Conservation Directorate as part of the submission of the BAM-C.
	▪ be prepared by a person accredited in accordance with the Accreditation Scheme for the Application of the Biodiversity Assessment Method Order 2017 under s6.10 of the Biodiversity Conservation Act 2016.	Personnel involved in the development of this BDAR are listed in **Section 1.3**.
	▪ include an aquatic ecological assessment from above and below Wilcannia Weir replacement that addresses all direct, indirect, and prescribed impacts of the new weir on Key Fish Habitat and associated flora and fauna including threatened species, populations, and communities during construction and operation for the life of the storage.	The aquatic ecological assessment is located in the Aquatic Ecology Impact Assessment (**Technical Report 3** of the EIS).
	▪ include an assessment of the ecological impact of the Wilcannia Weir replacement upon the safe upstream and downstream passage of fish over the full range of weir operating conditions, including assessment of how the proposed operating rules of the weir may impact upon the safe fish passage as a result of the rules. The assessment must be performed in consultation with and having regard to the requirements of DPI Fisheries.	The aquatic ecological assessment is located in the Aquatic Ecology Impact Assessment (**Technical Report 3** of the EIS).
	▪ include an Aquatic Biodiversity Offsets Strategy that is consistent with relevant policy and guidelines and is adequately funded to mitigate and manage impacts of the Wilcannia Weir replacement during construction and subsequent operation, focusing on protecting and improving the biodiversity and conservation values of the Darling River, its biota, and associated riparian zones in the medium to long term.	The aquatic ecological assessment is located in the Aquatic Ecology Impact Assessment (**Technical Report 3** of the EIS).
	▪ details of the rehabilitation of the site and revegetation of disturbed areas are to be considered, with the manner of long-term management/security of the rehabilitation areas detailed. The Biodiversity Development Assessment Report should include details of stakeholder consultation where offsetting is proposed.	Recommendations for rehabilitation is located in the proposed mitigation measures in **Section 10.** Discussion on offsetting is provided in **Section 12.2**.

On 11 August 2020, the delegate of the Commonwealth Minister for the Environment determined that the Wilcannia Weir Replacement is a controlled action requiring approval under the Commonwealth EPBC Act. **Table 1-2** lists the key issues relating to EPBC Act listed biodiversity that are specified in Attachment A of the SEARs.

Table 1-2 EPBC Act assessment requirements

Key issue			Section addressed
Biodiversity (threatened species and communities)			
14. The EIS must identify each EPBC Act listed threatened species and community likely to be impacted by the action. For any species and communities that are likely to be impacted, the proponent must provide a description of the nature, quantum, and consequences of the impacts. For species and communities potentially located in the project area or in the vicinity that are not likely to be impacted, provide evidence why they are not likely to be impacted.			EPBC Act listed threatened ecological communities are discussed in **Section 7.3**, and threatened plants and animals discussed in **Sections 7.4** and **7.5**. Assessment of the nature, quantum and consequences of impacts on species and communities is discussed in **Sections 9.1** to **9.3** and Assessment of Significance for MNES in **Appendix D**.
15. For each of the EPBC Act listed threatened species and communities likely to be impacted by the action the EIS must provide a separate:	a)	description of the habitat (including identification and mapping of suitable breeding habitat, suitable foraging habitat, important populations, and habitat critical for survival), with consideration of, and reference to, any relevant Commonwealth guidelines and policy statements including listing advice, conservation advice and recovery plans;	**Sections 6.2** and **6.4**, and **7.3** to **7.5** provide a description of any habitat present for MNES, including mapping, with further assessment and information provided in **Appendix D**. Habitat assessment for threatened species is provided in **Section 6.**
	b)	details of the scope, timing and methodology for studies or surveys used and how they are consistent with (or justification for divergence from) published Australian Government guidelines and policy statements;	Details of survey methods are described in **Section 5** for communities and **Section 6** for threatened species.
	c)	description of the relevant impacts of the action having regard to the full national extent of the species or community's range; and	Impacts to EPBC Act listed biodiversity is detailed in **Sections 7.3** to **7.6** and Assessment of Significance included in **Appendix D**.
	d)	description of the specific proposed avoidance and mitigation measures to deal with relevant impacts of the action;	Avoidance measures from this project are described in **Section 8** and apply to MNES. Mitigation measures are detailed in **Section 10**.
	e)	identification of significant residual adverse impacts likely to occur after the proposed activities to avoid and mitigate all impacts are taken into account;	Impacts to EPBC Act listed biodiversity is described in **Sections 7.3** to **7.7** and **Sections 9.1** to **9.4**.
	f)	a description of any offsets proposed to address residual adverse significant impacts and how these offsets will be established.	Discussion on credit requirements for offsetting under the BAM is provided in **Section 12**, with proposed offsetting provided in **Section 12.2**.
	g)	details of how the current published NSW Biodiversity Assessment Method (BAM) has been applied in accordance with the objects of the EPBC Act to offset significant residual adverse impacts; and	Refer **Section 3** for context. Application of the BAM is described in **Sections 4** to **6** and **Sections 8** to **12**.
	h)	details of the offset package to compensate for significant residual impacts including details of the credit profiles required to offset the action in accordance with the FBA and/or mapping and descriptions of the extent and condition of the relevant habitat and/or threatened communities occurring on proposed offset sites.	The proposed offset strategy, including different options in accordance with the BAM are provided in **Section 12.2**. Note: It is assumed that the reference to "the FBA" here is intended to say, "the BAM".

Key issue		Section addressed
	[Note: For the purposes of approval under the EPBC Act, it is a requirement that offsets directly contribute to the ongoing viability of the specific protected matter impacted by a proposed action and deliver an overall conservation outcome that improves or maintains the viability of the MNES 'like for like'. In applying the BAM, residual impacts on EPBC Act listed threatened ecological communities must be offset with Plant Community Type(s) (PCT) that are ascribed to the specific EPBC listed ecological community. PCTs from a different vegetation class will not generally be acceptable as offsets for EPBC listed communities.]	
16. Any significant residual impacts not addressed by the BAM may need to be addressed in accordance with the Environment Protection and Biodiversity Conservation Act 1999 Environmental Offset Policy. http://www.environment.gov.au/epbc/publications/epbc-act-environmental-offsets-policy.		All offsetting requirements for EPBC Act listed biodiversity are covered by the credit obligation detailed in **Section 12.**

1.4 Agency consultation

The Environment, Energy and Science Group (EESG) within DPE was consulted throughout the development of this BDAR. Discussion included the methods of assessing direct, indirect and prescribed impacts of the proposal to be consistent with the BAM. Consultation consisted of:

- 3 November 2020 – Preliminary meeting to discuss the proposal
- 15 December 2020 – Phone correspondence with Renee Shepherd (BCS) in regard to assessing downstream / prescribed impacts
- 15 September 2021 – Progress meeting to present results of surveys, identify the existing environment and discuss the preliminary outcomes of the BDAR.

The focus and outcomes of these discussions centred around identifying the biodiversity values to BCS and the condition present in the study area, with a view to seeking agreement on a proposed approach for assessing indirect impacts. This was particularly important given the type of indirect and sometimes uncertain impacts associated with water storage projects that need to be interpreted for adequate compliance with the BAM.

1.5 Personnel

The work to prepare this BDAR was undertaken by qualified and experienced ecologists identified in **Table 1-3** along with their roles and qualifications.

Table 1-3 Personnel, role, and qualifications

Name	Role	Qualifications
Chris Thomson	Principal Ecologist – Technical review and finalistion of BDAR.	Graduate Certificate in Natural Resources Bachelor of Applied Science Accredited BAM assessor (under Section 6.10 of the BC Act – No. BAAS18058)
Brenton Hays	Senior Ecologist – PCT identification and mapping, Vegetation Integrity Surveys, reporting and GIS	Bachelor of Environmental Science and Management (Hons) Accredited BAM assessor (under Section 6.10 of the BC Act – No. BAAS19068)

Name	Role	Qualifications
Sonia Croft	Senior Ecologist – PCT identification, Vegetation Integrity Surveys	PhD in Science Master of Environmental Science Bachelor of Applied Science in Natural Resources Management
Tim Maher	Ecologist – Vegetation Integrity Surveys and targeted plant searches, fauna surveys, reporting	Master of Research (Plant Ecology) Bachelor of Advanced Science (Biology)
Matt Consterdine	Ecologist – Vegetation Integrity Surveys and targeted plant searches, fauna surveys	Bachelor of Environmental Science and Management Accredited BAM Assessor (under Section 6.10 of the BC Act – No. BAAS20027)
Emma Weatherstone	Ecologist – fauna surveys	Bachelor of Environmental Science (Wildlife Conservation and Biology)
Julia Bayada	Graduate Ecologist – report	Bachelor of Environmental Science and Management

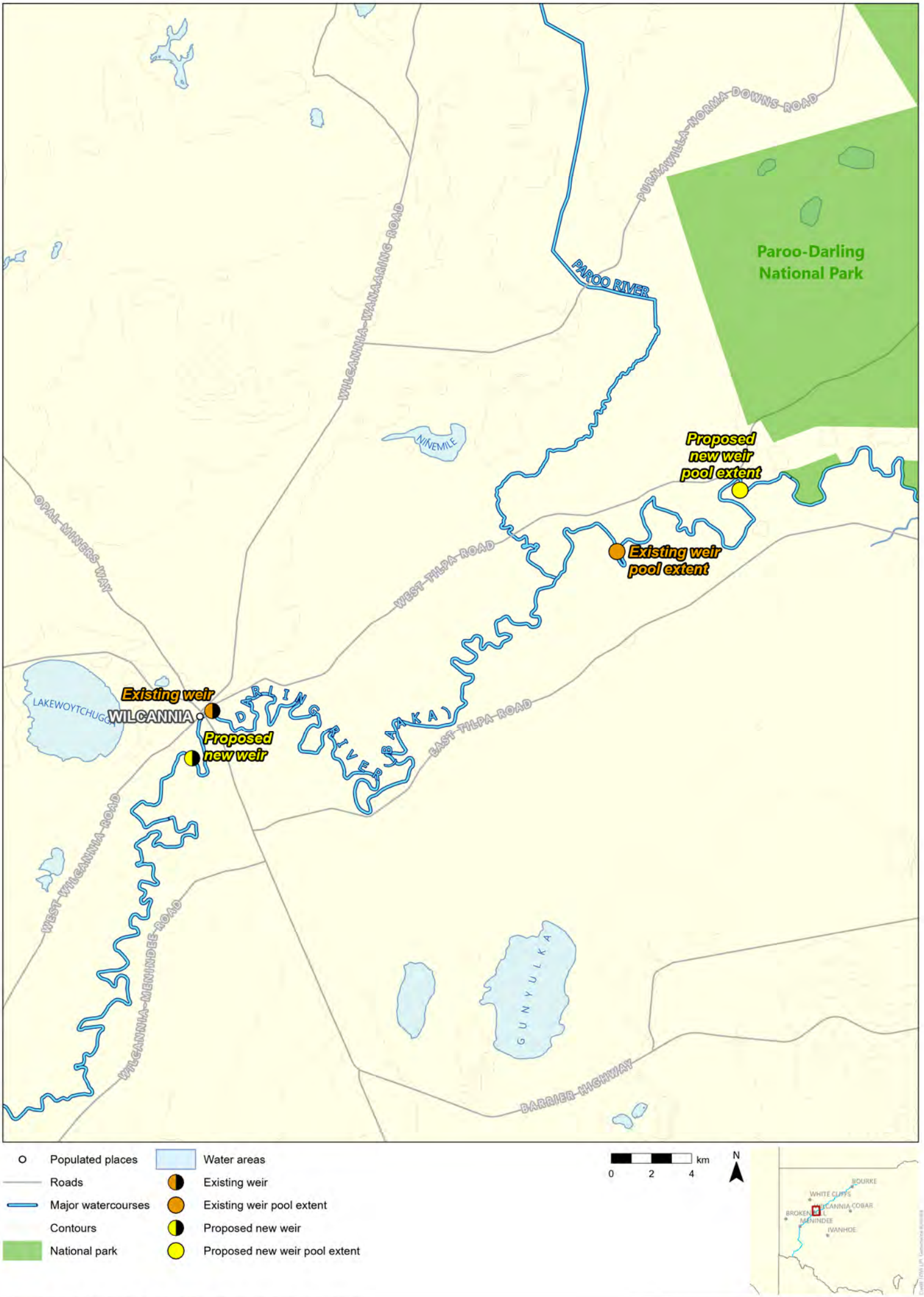

Figure 1-1: Proposal location and regional context

2. Description of the proposal

This section provides a description of the proposal including the design and activities associated with construction and operation of the proposal. Flexibility has been provided in the description of the proposal to allow for refinement during detailed design and in response to submissions received on this BDAR and/or if opportunities arise to minimise environmental impacts further. The final design may therefore vary from the preliminary concept design described in this section.

2.1 Proposal location and summary

The proposal comprises the construction and operation of a new weir and the partial removal and decommissioning of the existing weir on the Darling River (Baaka) adjacent to the township of Wilcannia in western NSW.

The proposed new weir structure would be located on a reach of the Darling River (Baaka) downstream of Union Bend, about 4.92 river kilometres downstream of the existing weir, and about two road kilometres south of the Wilcannia township (the site is shown in **Photo 2-1**). The crest of the five-metre-high weir would be about 4.7 metres below the top of the river left bank (southern side) and about 6.5 metres below the top of the river right bank (northern side) at this location and its construction will involve the removal of native vegetation from the design footprint.

Photo 2-1 The Darling River (Baaka) facing downstream from the right riverbank; the crest of the new weir would align with the clearing on the left riverbank visible on the right of the photo

2.2 Key features of the proposal

2.2.1 Construction

The key design features of the proposal are shown in **Figure 2-1** and include:

- A new weir with storage capacity of about 7,832 megalitres of water when the weir gates and fishway gates are closed. Maximum weir pool inundation area is about 340 hectares

- A fixed crest portion of the weir, about five metres high and 21.5 metres wide, next to the left bank (southern side) of the river
- A fishway about 120 metres long and 10.5 metres wide, next to the right bank (northern side) of the river to provide fish passage past the weir
- Remotely operated weir gates (with a manual function) to manage the storage, release and quality of water within the weir pool
- A small recreation area, known as a community river place, at Union Bend
- An upgraded unsealed access track (existing) about three kilometres long, between the Barrier Highway and the left side of the new weir (southern side), including three passing bays
- A new unsealed access track about 270 metres long, between Union Bend Road and the right side of the new weir (northern side)
- A permanent maintenance access track about 120 metres long, from the top of the right riverbank extending along the length of the fishway
- An electricity easement about 360 metres long and 20 metres wide, from the existing overhead powerlines on Union Bend Road to a new substation on the right side of the new weir. The substation would connect to a main switchboard installed within a prefabricated concrete switch room at the top of the right riverbank near the weir gate
- Conversion of an existing flow gauging station, located between the new and existing weirs, into a weir pool height gauging station
- Partial removal and decommissioning of the existing weir (see site in **Photo 2-2**).

Photo 2-2 The existing weir to be partially removed and decommissioned viewed from the left riverbank

In addition to the proposal features described above, the following temporary construction features would be required:

- Construction compounds and materials laydown areas on both sides of the river near the new weir
- A staging area on the left side of the river near the existing weir
- Access tracks down to the bed of the river from both sides of the river at the new weir

- An access track down to the bed of the river from the southern side of the river at the existing weir site (within the Victory Park Caravan Park)
- Cofferdams to create dry work areas within the river channel at both the new and existing weir sites.

2.2.2 Operation

The existing weir pool extends about 61.79 river kilometres along the Darling River (Baaka) upstream from the existing weir. The new weir would inundate about 4.92 river kilometres of the Darling River (Baaka) between the new weir and the existing weir, which is referred to as the 'new town pool'. This section of the river would be inundated to the same levels as the existing weir pool and has been assessed as direct impact.

The new weir would have dual modes of operation comprising a normal operation mode, where it would mostly operate at the existing full supply level (65.71 metres AHD) and a drought security operation mode, when it would mostly operate at a full supply level of 66.71 metres AHD (one metre above the existing full supply level). The temporary increase in the full supply level of one metre during drought security operation mode would result in the weir pool being one metre deeper and extending about 18.81 river kilometres further upstream than the existing weir pool, to create a weir pool that is about 85.52 river kilometres long.

When the gate of the new weir is closed, the weir pool would store an additional one metre of water above the level of the existing weir pool at full supply level. Additionally, in this drought security operation mode, a further 18.81 river kilometres of the Darling River (Baaka) upstream of the existing weir pool would be inundated by the one metre increase in the full supply level (refer to **Figure 2-2**). This has been assessed as an indirect impact.

The new weir would have dual modes of operation separated by transition phases:

- Normal operation mode — During normal operation mode the weir would mostly be operated at the same full supply level as the existing weir (65.71 metres AHD) except at times of increased inflows
- Drought security operation mode — During drought security operation mode the weir would mostly operate at a new full supply level of 66.71 metres AHD, one metre above the existing full supply level
- Filling phase — This is a transitional phase between normal operation mode and drought security operation mode, when the headwater level would be raised from the existing full supply level (65.71 metres AHD) to the drought full supply level (66.71 metres AHD)
- Reset phase — This is a transitional phase between drought security operation mode and normal operation mode when the headwater level would be lowered from the drought full supply level (66.71 metres AHD) to the normal full supply level (65.71 metres AHD).

2.2.2.1 Trigger levels for operating the weir and fishway gates

Preliminary trigger levels for transitions between the normal and drought security operation modes have been adopted based on the flow rate in the Darling River (Baaka) at the Bourke Town Weir, represented by the location of the Myandetta gauge (gauging station no. 425038 (Darling River at Myandetta)). The filling phase would be triggered by flows past Bourke Town Weir falling below 250 megalitres per day and the reset phase triggered by flows past Bourke Town Weir rising above 300 megalitres per day. Preliminary trigger levels based wholly on daily flows past Bourke Town Weir have been adopted for the purposes of storage behaviour modelling.

2.2.2.2 Operations plan

WaterNSW would operate the new weir in accordance with an operations plan approved by the Department of Planning and Environment (Water) (DPE Water). The operations plan will:

- Outline governance arrangements for operating the new weir including roles, responsibilities, accountabilities, risk management, and reporting requirements

- Define the operating rules for the normal and drought security operation modes and filling and reset phases
- Document the approvals process for any future amendments and updates to the operations plan, which will involve a consideration of the consistency of the proposed changes with the Water Sharing Plan for the Barwon-Darling Unregulated River Water Source 2012, planning approval conditions of consent, and requirement for additional consultation with relevant stakeholder agencies.

The operations plan for the new weir is being prepared in consultation with the DPE Water, Fisheries NSW, DPE (Environment and Heritage), the Murray-Darling Basin Authority and WaterNSW. The operations plan will continue to be developed with the stakeholder agencies.

An outline operations plan is provided in Appendix I of the EIS that shows the likely structure of the plan and the type of content that it is expected to contain. It is intended that the operations plan will be finalised prior to the approval of the proposal by the Minister for Planning.

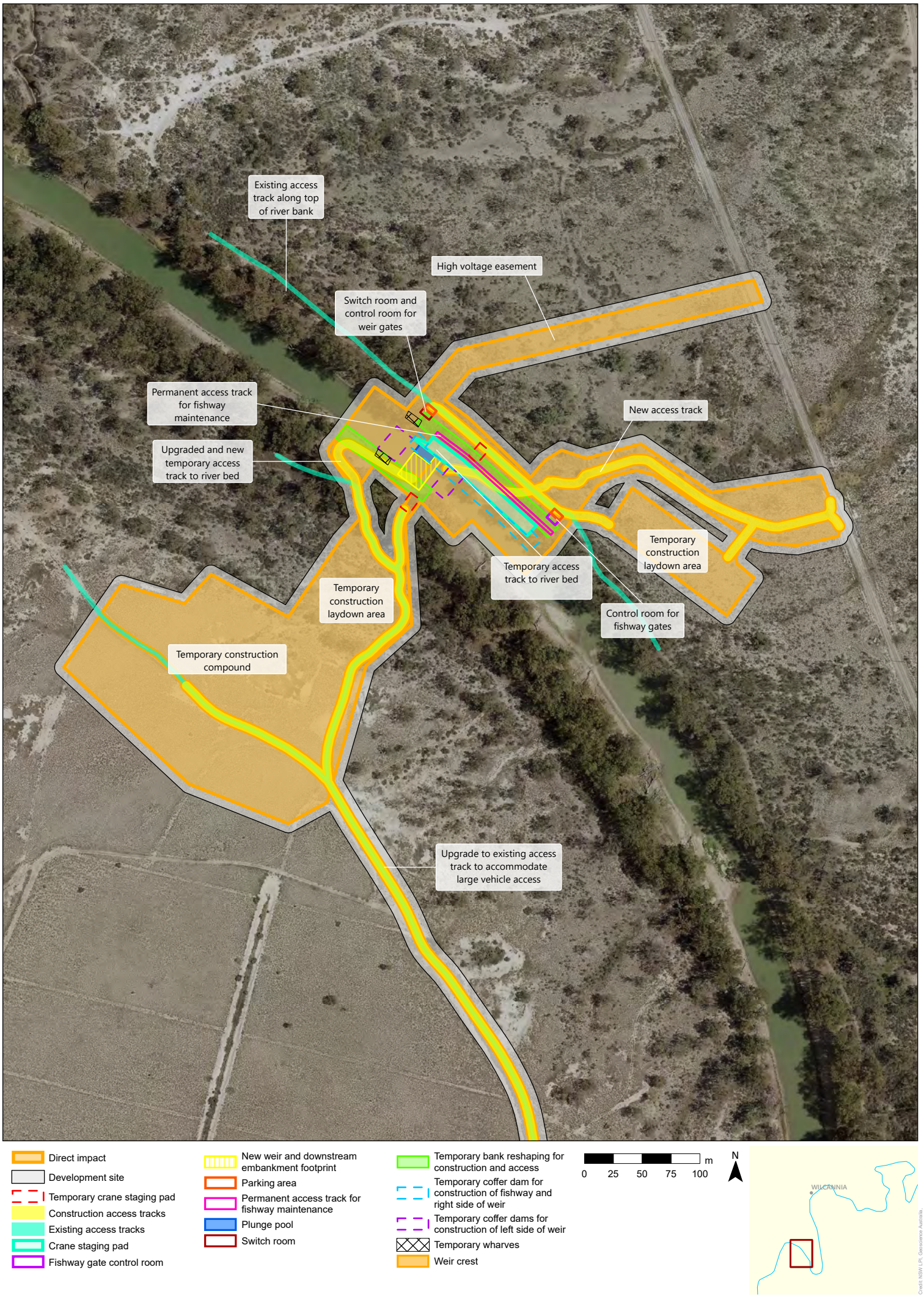

Figure 2-1: Key design features of the proposal – new weir site (detail)

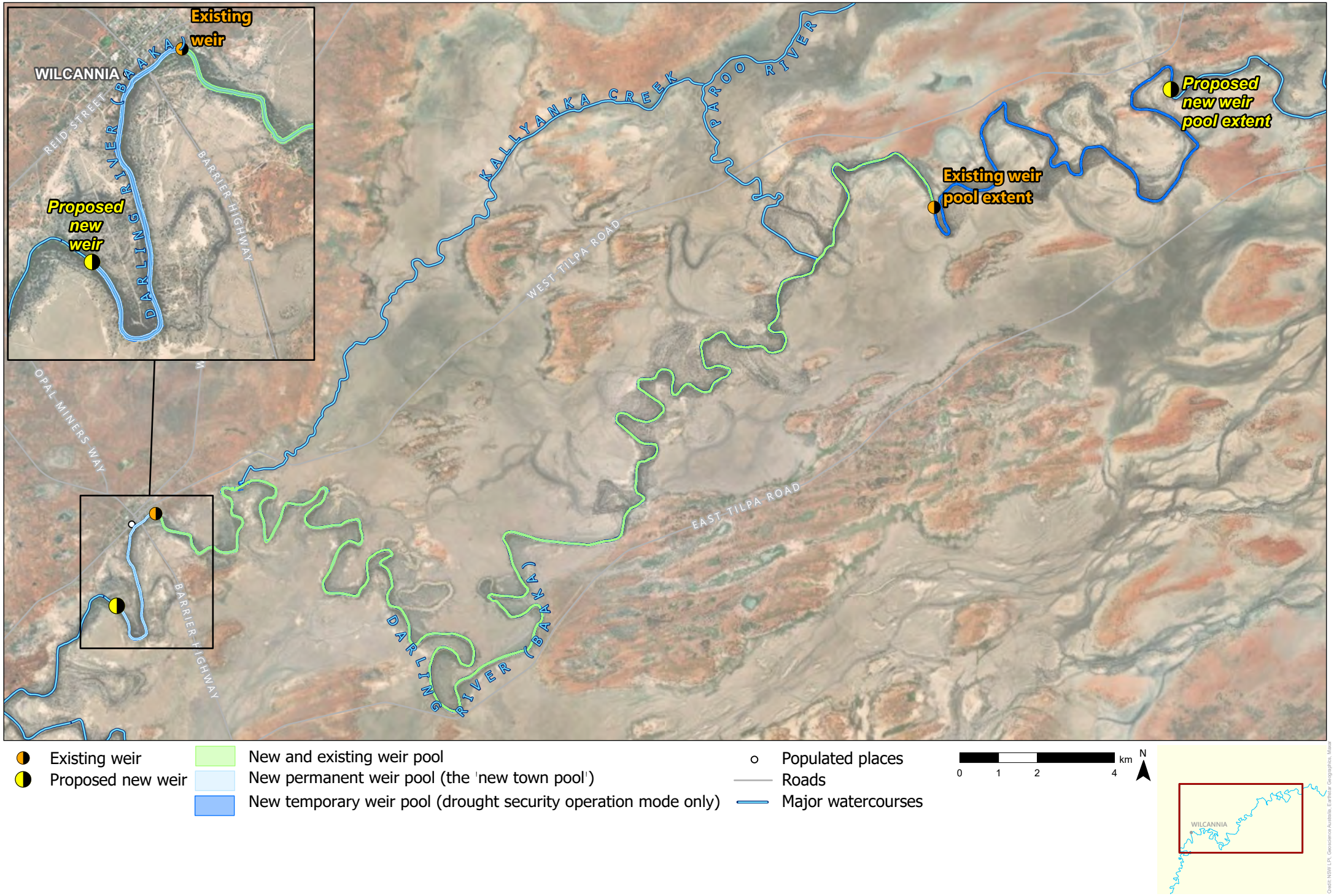

Figure 2-2 The new and existing weir pools

3. Legislation and policy

In accordance with Part 7.9 of the *Biodiversity Conservation Act 2016* (BC Act), an application for development consent under Division 5.2 of the EP&A Act to carry out State Significant Infrastructure must be accompanied by a BDAR unless the Planning Agency Head and the Environment Agency Head determine that the proposal is not likely to have any significant impact on biodiversity values. The SEARs issued for the proposal (**Section 1.2** of this report) have determined the need for a BDAR in accordance with Section 5.16 of the EP&A Act.

The Biodiversity Offsets Scheme applies to State significant infrastructure projects unless the Secretary of DPE and the Chief Executive of the EESG determine that the proposal is not likely to have a significant impact. This document is the BDAR for the proposal as required under the Biodiversity Assessment Method (BAM) (DPIE, 2020) and address the Biodiversity Offsets Scheme. This BDAR documents the results of the biodiversity assessment undertaken for the proposal in line with the relevant State and Commonwealth environmental and threatened species legislation and policy. This BDAR has been prepared by Brenton Hays (accreditation number BAAS19068) and Chris Thomson (accreditation number BAAS18058), who are accredited under Section 6.10 of the BC Act as Biodiversity Assessment Method Assessors to apply the BAM in connection with the preparation of Biodiversity Stewardship Site Assessment Reports, BDARs, and Biodiversity Certification Assessment Reports pursuant to Part 6 of the BC Act.

The BDAR has been prepared in compliance with the BAM (DPIE, 2020) and is structured around two primary stages:

- Stage 1 – Biodiversity assessment
- Stage 2 – Impact assessment (biodiversity values and prescribed impacts).

Biodiversity Assessment Method Calculator (BAM-C) case number 00022314/BAAS19068/20/00022315 is associated with this BDAR.

This BDAR also addresses potential impacts to biodiversity listed as Matters of National Environmental Significance (MNES) identified in the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). A separate Aquatic Ecology Impact Assessment has been prepared by to assess potential impacts to aquatic biodiversity listed under the NSW *Fisheries Management Act 1994* (FM Act) and EPBC Act.

An EPBC Act referral (2020/8703) was made to the DoAWE on 10 July 2020 to assess whether the proposal would be considered to be a controlled action. On 11 August 2020, the department determined the proposal to be a 'controlled' action (referral reference number 2020/8713) on the basis of potential impacts to the following MNES:

- Listed threatened species and communities (Section 18 and Section 18A).

The NSW Government confirmed the action would be assessed via the "Bilateral agreement made under Section 45 of the EPBC Act relating to environmental assessment between Commonwealth of Australia and the State of New South Wales" (Bilateral Agreement) (2015). This agreement accredits the assessment process under Division 5.2 of the EP&A Act. As the proposal is considered a controlled action, the Commonwealth Minister for the Environment would need to issue a separate approval for the proposal to DPE.

4. Landscape features

4.1 IBRA bioregion and subregion

The proposal is located in the Darling Riverine Plains Bioregion and within the Wilcannia Plains subregion (DoAWE, 2020). The Darling Riverine Plains Bioregion occupies most of the upper catchments of the Darling and Barwon Rivers in northern NSW and southern Queensland and includes the channels and floodplains of the lower reaches of these catchments. The upper catchment landscape is a series of overlapping, low gradient alluvial fans. The lower tract of the river is a narrow floodplain confined between bedrock landscapes, or by extensive sandplains and dune fields. Discharge from past and present streams control patterns of sediment deposition, soils, landscapes, and vegetation. The characteristic landforms of the Wilcannia Plains subregion encompass channel and floodplain features, and anabranch streams presenting feeding valley margin lakes. Soils typically consist of grey clays from channels to back plains and on lake beds. Additionally, red soils and patchy sands may represent alluvial terraces (NPWS, 2003).

4.2 BioNet NSW Landscapes (Mitchell landscapes)

The proposal primarily sits within the Mid-Darling Channels and Floodplains landscape, except for a small portion of the study area in the north, including the existing weir, which sits within the Mid-Darling Alluvial Plans landscape as mapped by the NSW National Parks and Wildlife Service (NPWS) (2002) and described by the NSW Department of Environment and Climate Change (2001) (refer to **Figure 4-1**).

The Mid-Darling Channels and Floodplains landscape includes parts of six land systems containing Acres Billabong, Budda, Hermidon, Long Meadow, Mid-Darling and Nelyambo. The primary landscape features include:

- An active floodplain with highly sinuous intermittently flowing anabranches with channels, and lateral floodouts, terrace patches with recent and ancient dunes
- Channels incised between ten to 15 metres
- Quaternary alluvium of heavy grey cracking clays with some sandy earths and sands within channel loops, terrace plains with sandy yellow texture-contrast, red or yellow sands in dunes.

The Mid-Darling Alluvial Plans landscape is characterised by alluvial flats and adjacent low terraces with occasional sand dunes in Quaternary sediments, in relief of one to ten metres. The floodplains are often treeless.

4.3 Rivers, streams, and estuaries

The proposal comprises the construction and operation of a new weir and the partial removal and decommissioning of the existing weir on the Darling River (Baaka) in the township of Wilcannia in western NSW. The subject section of river is located within the lower Darling catchment. The lower Darling River (Baaka) flows from the Menindee Lakes to its junction with the River Murray at Wentworth. The catchment is located on the semi-arid plains of south-western NSW, where most of the landscape has an elevation of less than 100 metres and rainfall of less than 300 milimetres.

The Darling River (Baaka) travels as a deep channel in the flat, dry floodplains of western NSW. Below the Menindee Lakes, the river has two large and distinct channels — its main channel, the lower Darling River, and its ancestral channel, the Great Darling Anabranch. The Great Darling Anabranch has a number of overflow lakes that can hold water for prolonged periods following a flood. It branches from the main channel of the river about 55 kilometres south of Menindee and joins the River Murray downstream of Wentworth. Flows can also reach the Great Darling Anabranch from the lakes system through Tandou Creek and several other minor creeks.

The climate of the lower Darling catchment is semi-arid and with one of the lowest rainfall regions of NSW. Average annual rainfall ranges between 220 and 280 millimetres across the catchment. The low rainfall and

high summer temperatures result in very high evaporation rates across the catchment – the wide and shallow Menindee Lakes are particularly affected. The river flows in the lower Darling result from seasonal rainfall and storms in the catchment and upper catchments. Floods generally occur as a result of high rainfall in the northern and eastern catchments of the northern Basin.

Tributary streams below Bourke are ephemeral and contribute little water or sediment to the mainstream. Downstream of Wilcannia the Darling breaks into several channels (anabranches) that flow on roughly parallel courses for up to 200 kilometres before joining the Murray. The Darling River (Baaka) is subject to extreme flow variation. River discharge declines downstream as water is lost through seepage and evaporation. The upper margins of the plain, especially in sandy soils, are part of the recharge area of the Great Australian Basin. The river may have zero discharge for several consecutive months, alternating with regional floods that may last nearly 12 months.

4.4 Wetlands

There are no Ramsar Wetlands or Important Wetlands as listed in the Directory of Important Wetlands of Australia located within the assessment area.

Three types of wetland are found in the Darling Riverine Plains bioregion: delta-like swamplands, terminal drainage basins and lakes, and overflow lakes filled by floodwaters that drain back to the river as the flood recedes. The Macquarie Marshes are the most important and extensive example of a throughflow delta-like swamp in the bioregion. Narran Lakes are an example of terminal basins at the end of the Narran River, a distributary channel of the Balonne. The Menindee Lakes complex are the overflow lakes. The Menindee Lakes are a naturally occurring series of shallow wetlands located along the Lower Darling River, about 200 kilometres upstream of the junction with the Murray River at Wentworth. Naturally ephemeral, that is, typically dry but filling with water for brief periods following rainfall.

4.5 Connectivity of habitat

According to the BAM, for development sites, the assessor must identify the connectivity of different areas of habitat that may facilitate the movement of threatened species across their range. The study area is located within a landscape that has been highly modified for agriculture and most areas have been cleared of remnant woody vegetation. The only high-quality habitat connectivity within the development site is within riparian zone along the Darling River (Baaka), which contains large remnant trees. Apart from the township of Wilcannia and large areas of cleared land, there are no barriers to movement.

4.6 Areas of geological significance and soil hazard features

Areas of geological significance generally include karst, caves, crevices, and cliffs. No areas of geological significance have been identified within the study area or immediate surrounds.

Soils and vegetation directly reflect past patterns of sedimentation and today's flooding regime, with some variation in plant species across the Darling Riverine Plains bioregion relating to summer or winter rainfall dominance. Sandy soils are found in linear belts along the older stream channels, sometimes with local source dunes on their border. Texture contrast soils, often badly eroded, are found marginal to channels of all ages, and most of the plains are dominated by deposits of heavy dark-coloured clays. Many clay areas have gilgai micro-relief patterns, most crack extensively, and others are more or less permanently wet in swamplands (DPIE, 2016).

The sandy soils have low nutrient levels and drain rapidly. The clay soils vary more depending on source rocks in the catchment, but all have only a limited amount of free water available to plants. Most soils contain high levels of calcium carbonate and some are saline. All lake beds consist of grey cracking clays and the eastern margins of most lakes have well-formed sandy beaches and crescent-shaped dunes or lunettes up to 25 metres high which are composed of fine cemented quartz sand with some layers of pelleted clay (DPIE, 2016).

The Soil Landscapes of Wilcannia 1:250,000 Geological series (Frenda, 1965) identifies the land on which the proposed new weir is located as consisting of quaternary residual soils (Qrs), characteristic of floodplains, outwash areas and drainage flats of black and red clayey silt and sand. The soils are predominantly vertosols, which are clay-rich soils of uniform texture, with potential for strong cracking and slickensides (Gray and Murphy, 2002). The grey cracking clays are in evidence on the proposed access route to the left bank and the proposed main construction compound. The soils are described as having high agricultural potential with high chemical fertility and water-holding capacity but requiring significant amounts of rain before water is available to plants. As such, gypsum and/or lime may be required to improve their structure. Heavy plastic clays can be difficult to cultivate especially when they are wet. Shrink-swell characteristics also create problems for foundations of buildings built on vertosol type soils (GHD, 2020).

A search of the NSW EPA Contaminated Land Register on 16 October 2020 did not identify any contaminated lands within the Central Darling Shire.

Overall, the landscape is flat with river channel and floodplain features dominant and the complexities of geomorphology and surface sediment distribution all reflect past climates and different river discharge regimes.

4.7 Areas of outstanding biodiversity value

Areas of declared critical habitat that were listed under the now repealed *Threatened Species Conservation Act 1995* have become declared areas of outstanding biodiversity value (AOBVs) in NSW with the commencement of the BC Act. AOBVs are special areas with irreplaceable biodiversity values that are important to the whole of NSW, Australia or globally. These are areas declared by the Minister for the Environment.

The Biodiversity Values Map spatial data (DPIE, 2020) identified an AOBV that occurs within the development site specified as 'Protected Riparian Land'. This land is associated with the Darling River (Baaka).

4.8 Native vegetation extent

To assess the current extent of native vegetation, a landscape buffer of 1500 metres was placed around the development site boundary. The 1500-metre landscape buffer is about 847 hectares in size and contains about 130 hectares of native vegetation (refer to **Figure 4-2**). This area was calculated using a combination of available resources including:

- Vegetation mapping prepared for this BDAR
- State Vegetation Type Map: Western Region Version 1.0. VIS_ID 4492 (Office of Environment and Heritage, 2019)
- High-definition aerial imagery taken of the site on 26 November 2020.

As much of the 1500-metre landscape buffer was not verified during surveys, regional vegetation mapping was the primary resource for mapping the extent of native vegetation. This results in a per cent native vegetation cover in the landscape of about 88 per cent. Therefore, native vegetation cover in the landscape is in the more than70 % cover class. These calculations are an approximation only and there are unsealed dirt roads and disturbed areas that exist throughout the 1,500 metre buffer that are included in the mapping as they have some level of native vegetation cover and could be assigned to a plant community type (PCT). The purpose of the percentage vegetation cover calculation is to create a figure of native vegetation cover that is used in the BAM-C to predict threatened species likely to occur or use habitat on a site. Minor adjustments to polygon boundaries will not affect the more than 70 per cent cover class present within the landscape buffer.

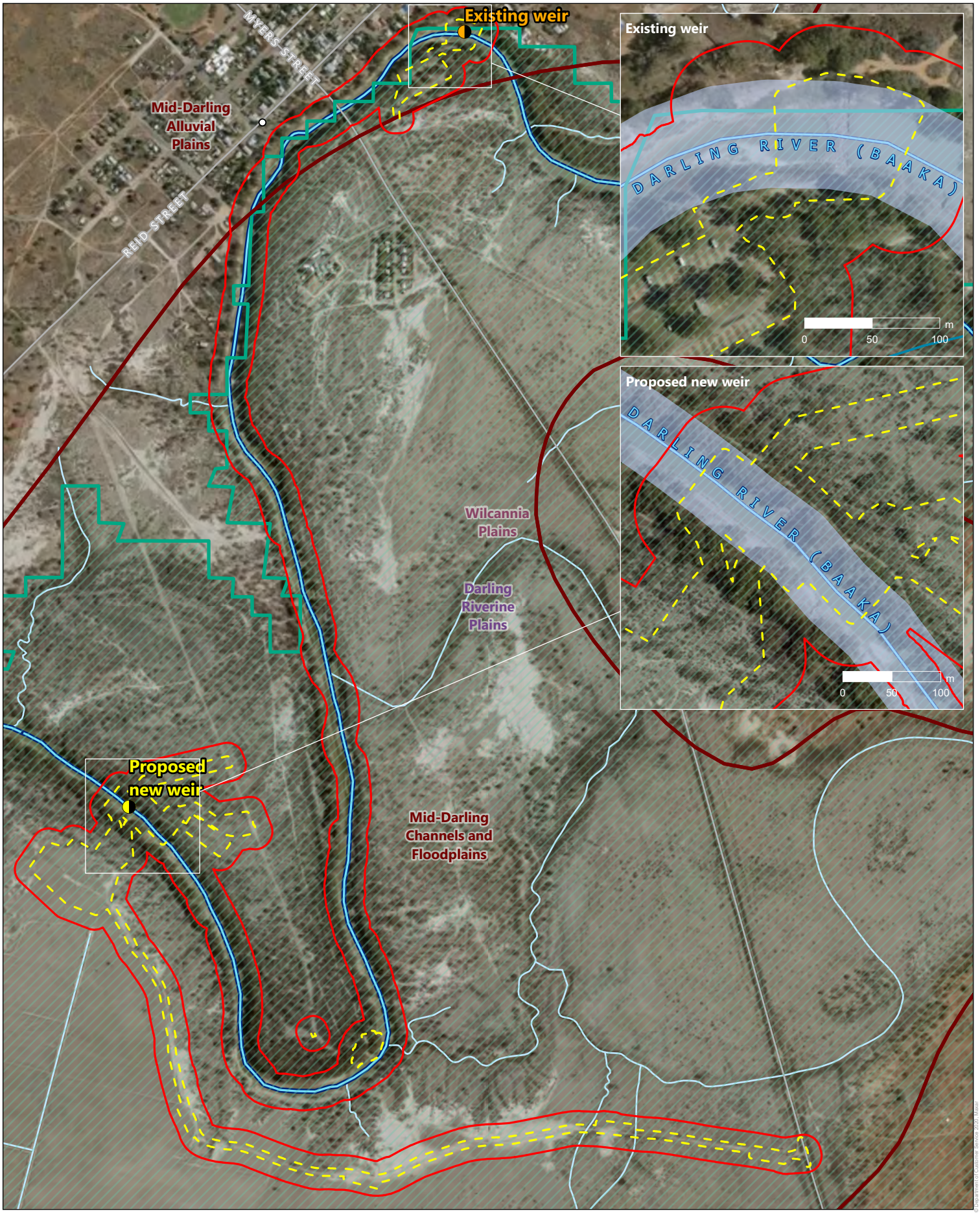

Figure 4-1: Site map

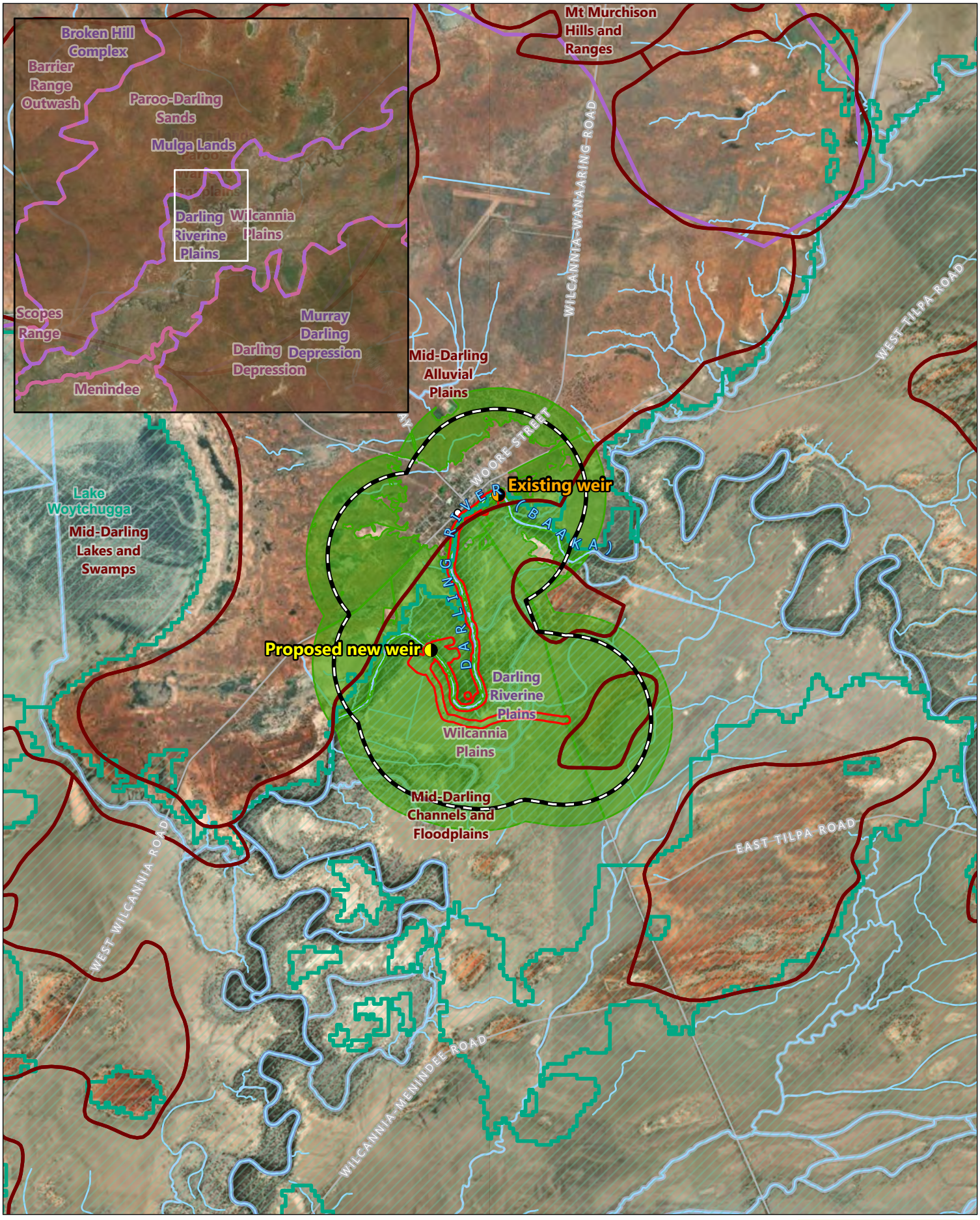

Figure 4-2: Location map

5. Native vegetation and vegetation integrity

5.1 Background research and data sources

A database search and literature review were completed as part of the desktop assessment of the study area prior to the commencement of field surveys. The review focused on database searches, relevant ecological reports pertaining to the survey area and relevant Geographic Information System (GIS) layers. The review was used to prepare a list of PCTs and potential Threatened Ecological Communities (TECs), to inform survey effort required for both native vegetation and threatened species assessment.

The following databases and information sources were consulted:

- NSW BioNet Vegetation Classification database – reviewed October and November 2020
- DoAWE Protected Matters Search Tool – searched 15 October 2020
- Bureau of Meteorology's Atlas of Groundwater Dependent Ecosystems (GDE) – searched 15 October 2020
- DoAWE Directory of Important Wetlands – reviewed 13 October 2020.

Regional vegetation mapping, geology and soil mapping projects were reviewed including:

- State Vegetation Type Map: Western Region Version 1.0. VIS_ID 4492 (Office of Environment and Heritage, 2019)
- Mitchell Landscapes Version V3.1 (NPWS, 2002)
- Soil Landscapes of Wilcannia 1:250,000 Geological series (Frenda, 1965)
- Australian Soil Classification (ASC) Soil Type map of NSW (State Government of NSW and Office of Environment and Heritage (OEH), 2012).

The EIS Scoping Report completed for the Wilcannia Weir Replacement (GHD, 2020) was reviewed and the results were used to inform the preparation of this BDAR.

Preliminary and provisional determinations to list species and ecological communities as threatened under the BC Act were viewed on the EESG NSW Threatened Species Scientific Committee website. At the time of writing, there are no preliminary or provisional listings of relevance to the proposal. The annual Final Priority Assessment List of nominated species and ecological communities that have been approved for assessment by the Minister responsible for the EPBC Act was last reviewed in September 2021.

5.2 Mapping extent of native vegetation

The extent of native vegetation in the study area was mapped using high-definition aerial imagery taken specifically for this proposal on 26 November 2020, regional vegetation mapping (VIS_ID 4492) and verified where possible by field surveys. Polygons were digitised using GIS software (ArcGIS 10.7.1) at a scale of between 1:1,000 and 1:5,000. The vegetation extent within the study area has been mapped in detail although due to the remoteness of the proposal location, much of the broader study area was not able to be accessed and some boundary errors may exist.

5.2.1 Definition of native vegetation

Under the BAM, native vegetation has the same meaning as in Section 1.6 of the BC Act which states that native vegetation and clearing native vegetation have the same meanings as in Part 5A of the *Local Land Services Act 2013*. Section 60B of the *Local Land Services Act 2013* defines the meaning of native vegetation as any of the following types of plants native to NSW:

a) Trees (including any sapling or shrub or any scrub)

b) Understorey plants

c) Groundcover (being any type of herbaceous vegetation)

d) Plants occurring in a wetland.

A plant is native to NSW if it was established in NSW before European settlement.

Some cleared areas within the study area mapped as 'not native vegetation' in VIS_ID 4492 do contain native, understorey plants, and groundcover species. While these areas are heavily disturbed and have been cleared in the past for cropping, they currently contain native vegetation. As such, these areas have been assigned to the most likely PCT as the original PCT can be determined with reasonable confidence based on adjacent PCTs and position in the landscape.

5.3 Plant community type identification

The types and distribution of PCTs within the study area were identified and mapped during the field survey undertaken from 17 November to 27 November 2020. The identification of PCTs presented here is consistent with the NSW PCT classification database as presented in the BioNet Vegetation Classification. Each PCT was assigned to the relevant corresponding TEC where applicable. PCTs were identified using data collected from floristic plots (20 x 20 metre) for the development site, and rapid assessment sites (n=40) were used across the study area, both upstream and downstream of the proposed weir site to record dominant species in each strata and general condition of the vegetation and identify the PCTs or most likely PCTs.

Some PCTs in the study area are currently poorly described in the BioNet Vegetation Classification, with few species identified in each structural layer. Other described PCTs provide a single broad definition of several seemingly distinct vegetation types. In many cases there is no distinct linear boundary to assist in determining the distribution of different PCTs within the development site. To aid in the identification of PCTs, existing vegetation mapping and classification relevant to the study area was reviewed. The detailed descriptions of vegetation units provided in the State Vegetation Type Map: Western Region Version 1.0. VIS_ID 4492 (Office of Environment and Heritage, 2019) was also used to aid PCT identification and mapping. This review of information informed the stratification of native vegetation for the survey design. Post- survey analysis of plot data was also used to validate PCT selection.

5.3.1 Stratification of native vegetation into survey units

Using existing regional vegetation mapping, prior to the fieldwork commencing, survey sites (plots/midlines) were randomly located within each area of mapped vegetation to provide a representative assessment of the vegetation. Plots were also positioned to provide a wide spatial coverage of the study area for assessment of prescribed impacts. Once the identification of PCTs had been finalised, each PCT was then divided into vegetation zones; each comprising an area of native vegetation in the development site that is the same PCT and has a similar broad condition state. The PCTs identified within the development site and the study area are described in detail in **Section 5.4**.

Each vegetation zone was assigned to either good, moderate, low or poor condition. Cleared tracks and highly disturbed areas with no native vegetation or very few native plants were not mapped were mapped as cleared and disturbed.

The field survey was able to provide good spatial coverage and survey effort for each PCT present within the development site, meeting the requirements of the BAM. The vegetation within the development site has been assigned to a PCT as listed in the BioNet Vegetation Classification database based on the observed species composition, vegetation structure, landscape position, and underlying geology and soils. In most cases the vegetation on site does not perfectly align with any PCT listed in the BioNet Vegetation Classification database so the vegetation has been allocated to the PCT with which it most closely aligns.

About 10.14 hectares of native vegetation occurs in the direct impact area and will be subject vegetation clearing or loss through inundation of the weir pool. This area was the focus of the vegetation integrity assessment. Additional VI plots were sampled adjacent to allow consideration of design changes, indirect and prescribed impacts.

5.3.2 Plot-based floristic vegetation survey and vegetation integrity assessment

A plot-based full floristic survey and vegetation integrity assessment was undertaken in accordance with the BAM using a series of 20 x 20 metre plots (or 400 metres square (equivalent area), each nested inside a 20 x 50 metre plot (or equivalent 1,000 metre square area). In some situations, along narrow PCT patches (such as edge of access track), 10 x 40 metre floristic plots were used. The location of each plot/mid-line completed during the survey is illustrated in **Figure 5-1**. Plots/mid-lines were established to provide a representative assessment of the vegetation integrity of the vegetation zone, accounting for the level of variation in the broad condition state of the vegetation zone. The emphasis was on identifying broad condition states within each PCT and no attempt was made at fine scale mapping in areas of variable vegetation density.

A summary of the survey effort completed in each vegetation is provided in **Table 5-1**. The minimum survey requirements for most vegetation zones, with the exception of very small vegetation zones, was generally exceeded so that the variation within each PCT could be adequately sampled. VI Plots were positioned to sample vegetation integrity within the direct impact area, although given the small area, some plots were positioned in immediately adjacent areas ensuring these were sampling the same vegetation zone (i.e. within the development site buffer).

Twenty-eight VI assessment plots were surveyed in total throughout the study area, this comprised:

- 21 plots from with the direct impact area and adjacent buffer (refer to **Table 5-1**)
- Additional five plots were sampled in PCTs and locations that will not be directly impacted, although are consistent with GDEs located within the study area, and therefore these PCTs may be subject to prescribed impacts (i.e. PCT247: Plot 23, 24, PCT 38: Plot 26, PCT 153: Plot 27 and PCT158: Plot 28)
- Additional two plots were sampled in upstream areas of the existing weir associated with PCT36 (plot 20 and 21) these were added to sample vegetation at the upper extent of the weir pool during drought security operation mode, and subject to indirect impacts through periodic inundation.

No VI plots were sampled immediately downstream of the proposed new weir, due to an absence of native vegetation in the river channel. The vegetation zones, their broad condition class and number of plots completed are provided in **Table 5-1**. Vegetation integrity plot data is provided in **Appendix C.**

Table 5-1 Vegetation zone area (development site and direct impact area), condition class and the number of plots completed

Vegetation Zone	PCT ID.	PCT name	Broad condition class	Direct impact area (ha)	Min no. plots required	No. plots completed
1	36	River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion	Good	0.95	1	4 (plots 1,7,13,15)
2			Low	1.62	1	6 (plots 3, 14,16,17,18, 19)
3	39	Coolabah – River Coobah – Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion	Moderate	1.94	1	4 (plots 2,6,9,10)
4			Low	0.94	1	2 (plots 4, 5)
5			Poor	0.05	1	1 (plot 22)
6	158		Moderate	1.94	1	1 (plot 12)

Vegetation Zone	PCT ID.	PCT name	Broad condition class	Direct impact area (ha)	Min no. plots required	No. plots completed
7		Old Man Saltbush – mixed chenopod shrubland of the semi-arid hot (persistently dry) and arid climate zones (north-western NSW)	Poor	0.71	1	1 (plot 25)
8			Good	1.99	1	2 (plots 8,11)
Total				**10.14 ha**	**8**	**21**

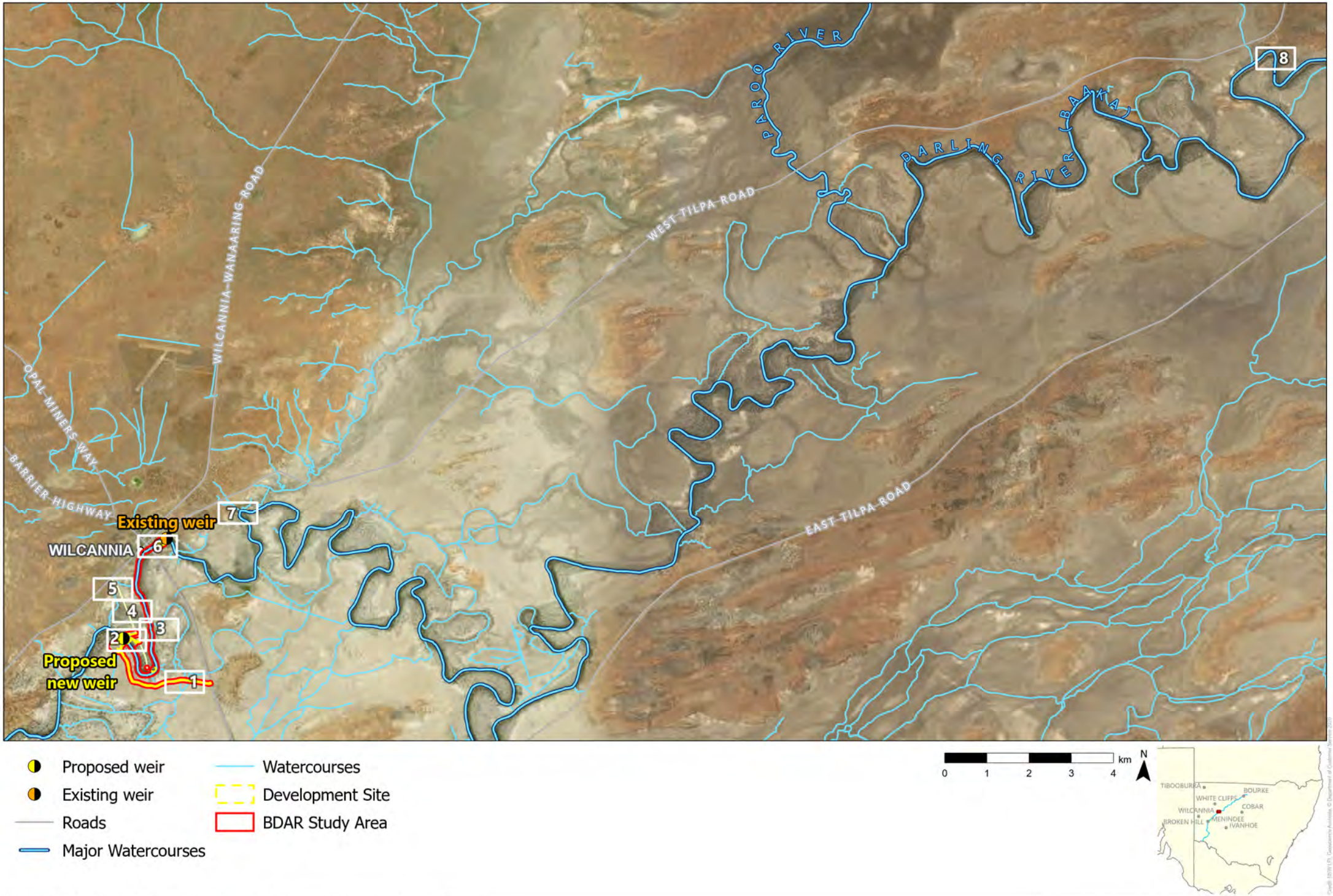

Figure 5-1: Vegetation integrity plot-based assessments - Overview

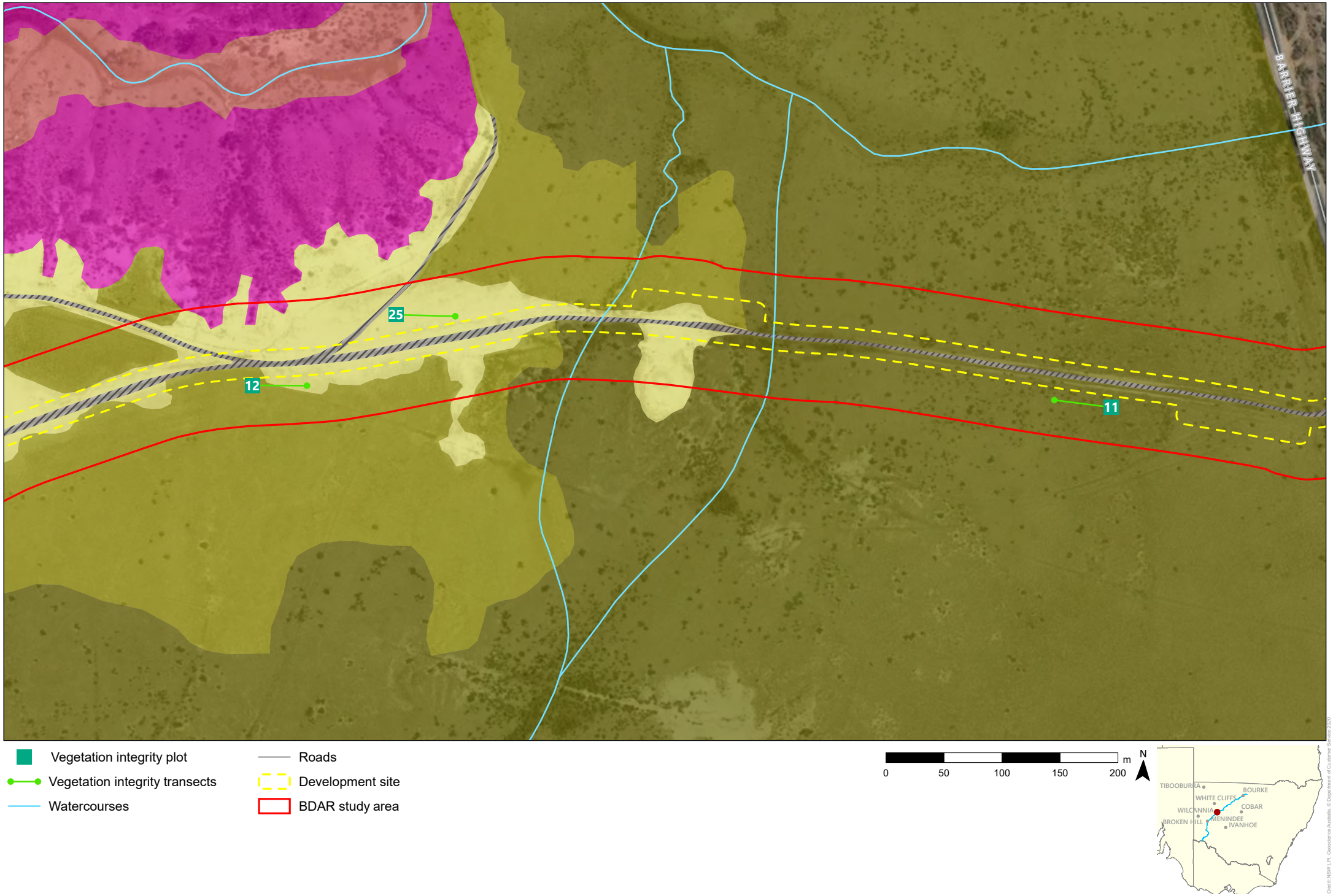

Figure 5-1: Vegetation integrity plot-based assessments - 1 of 8

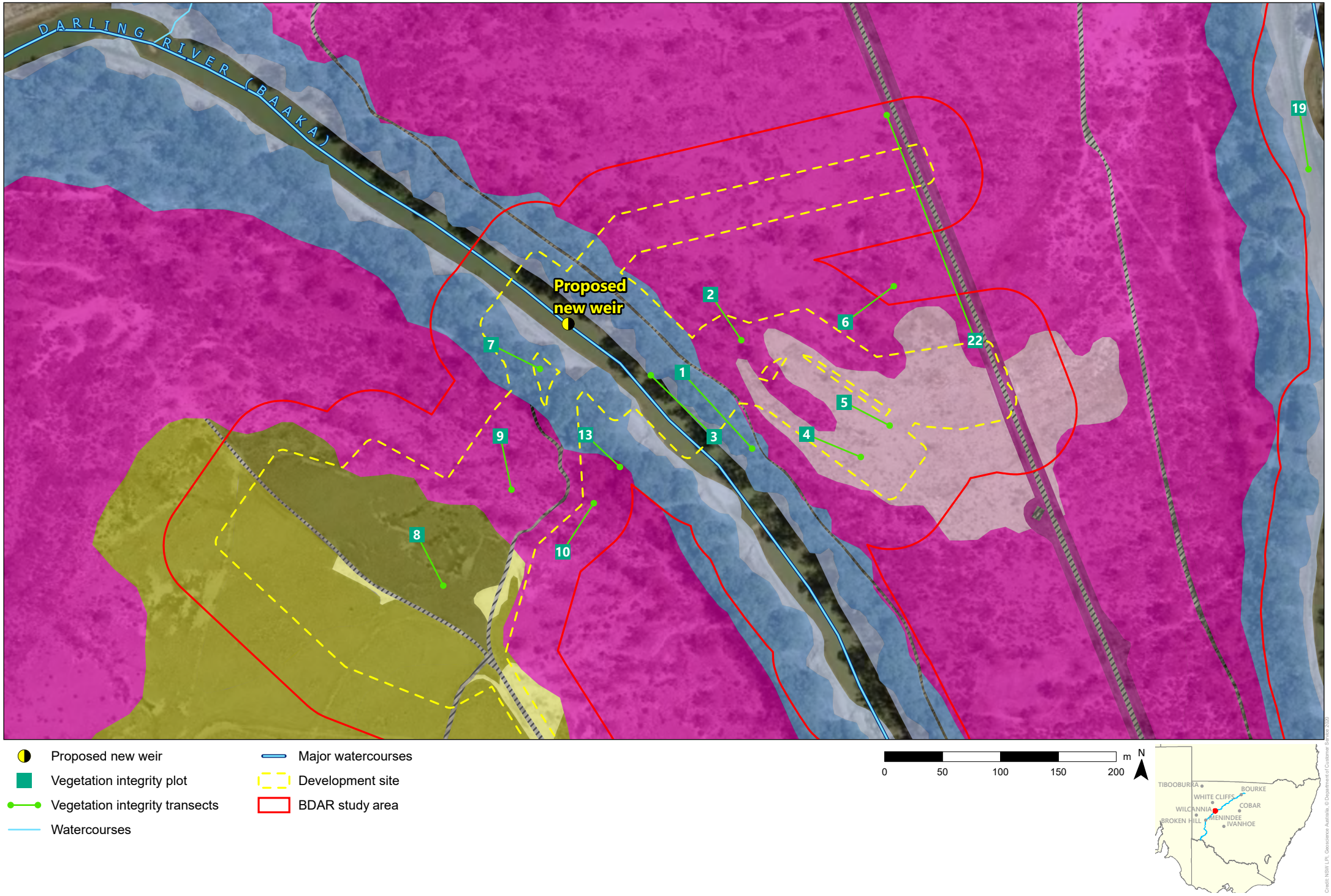

Figure 5-1: Vegetation integrity plot-based assessments - 2 of 8

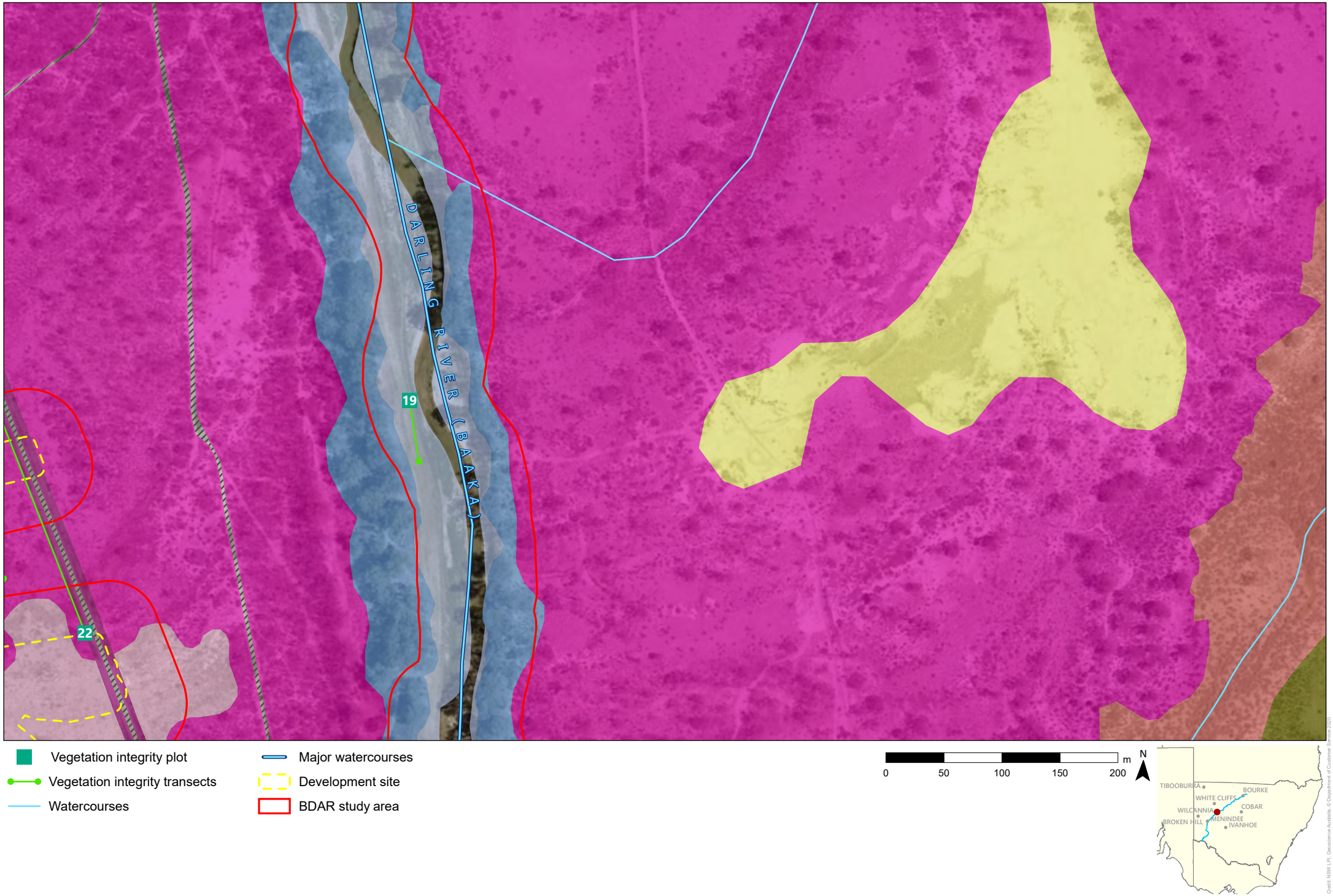

Figure 5-1: Vegetation integrity plot-based assessments - 3 of 8

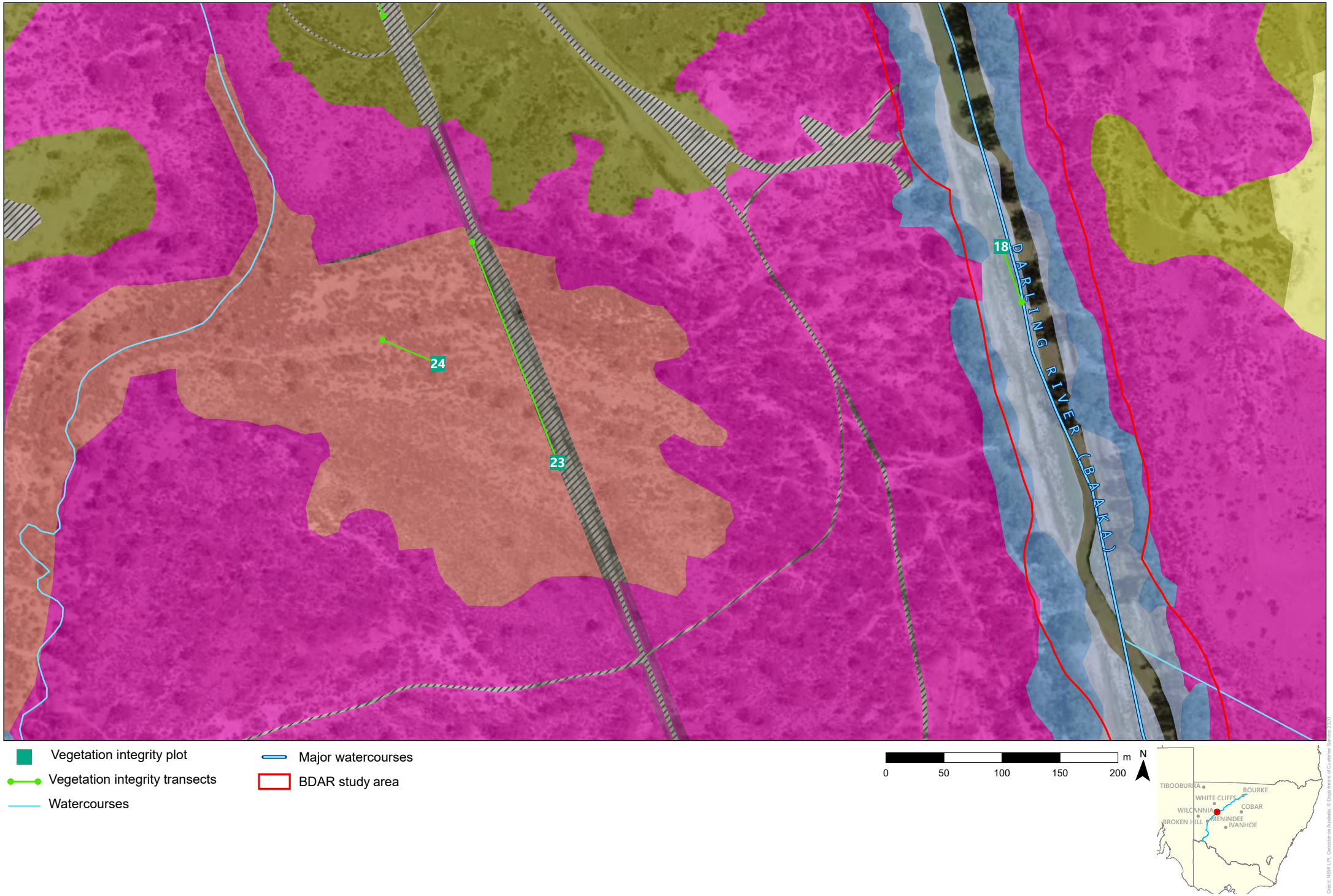

Figure 5-1: Vegetation integrity plot-based assessments - 4 of 8

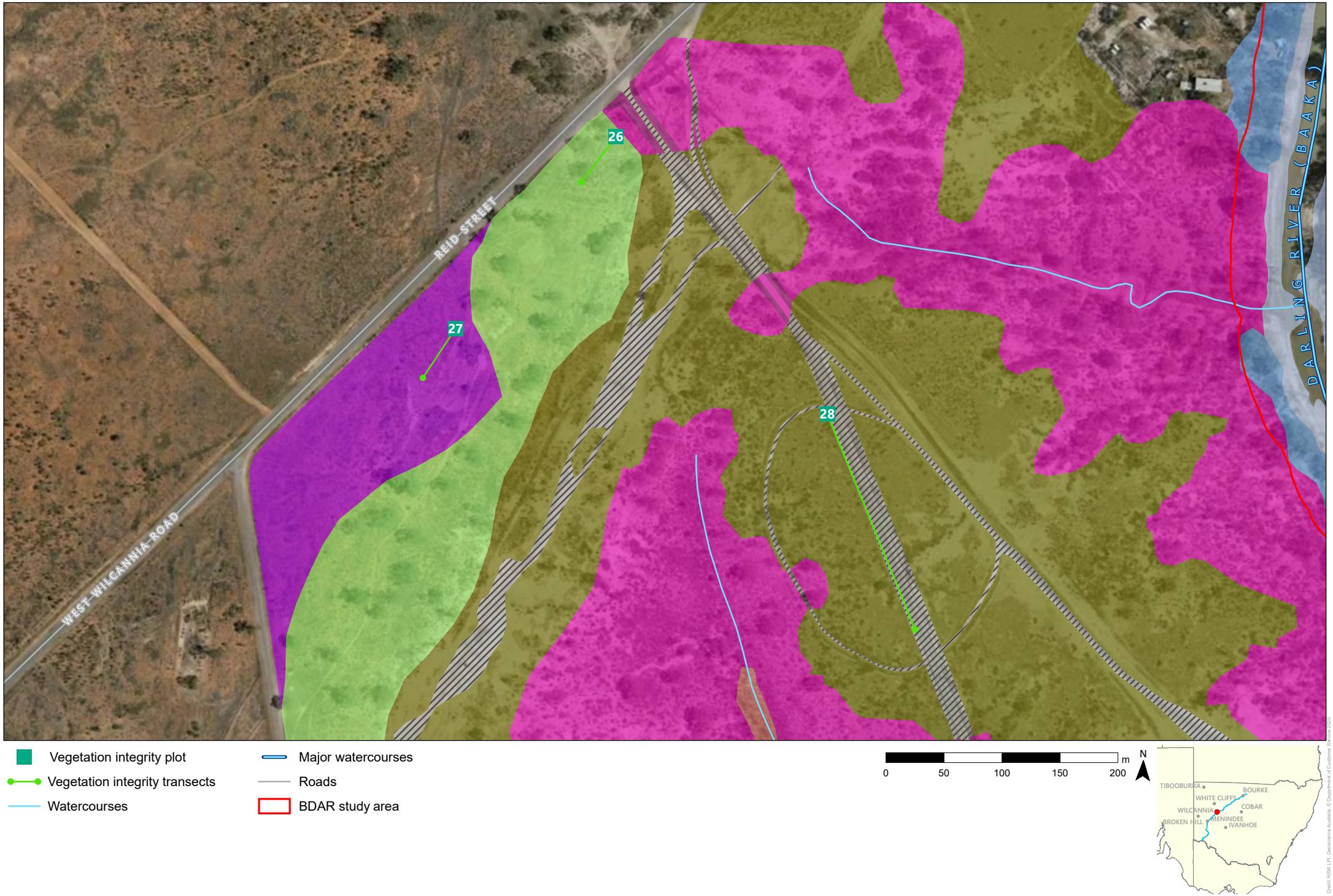

Figure 5-1: Vegetation integrity plot-based assessments - 5 of 8

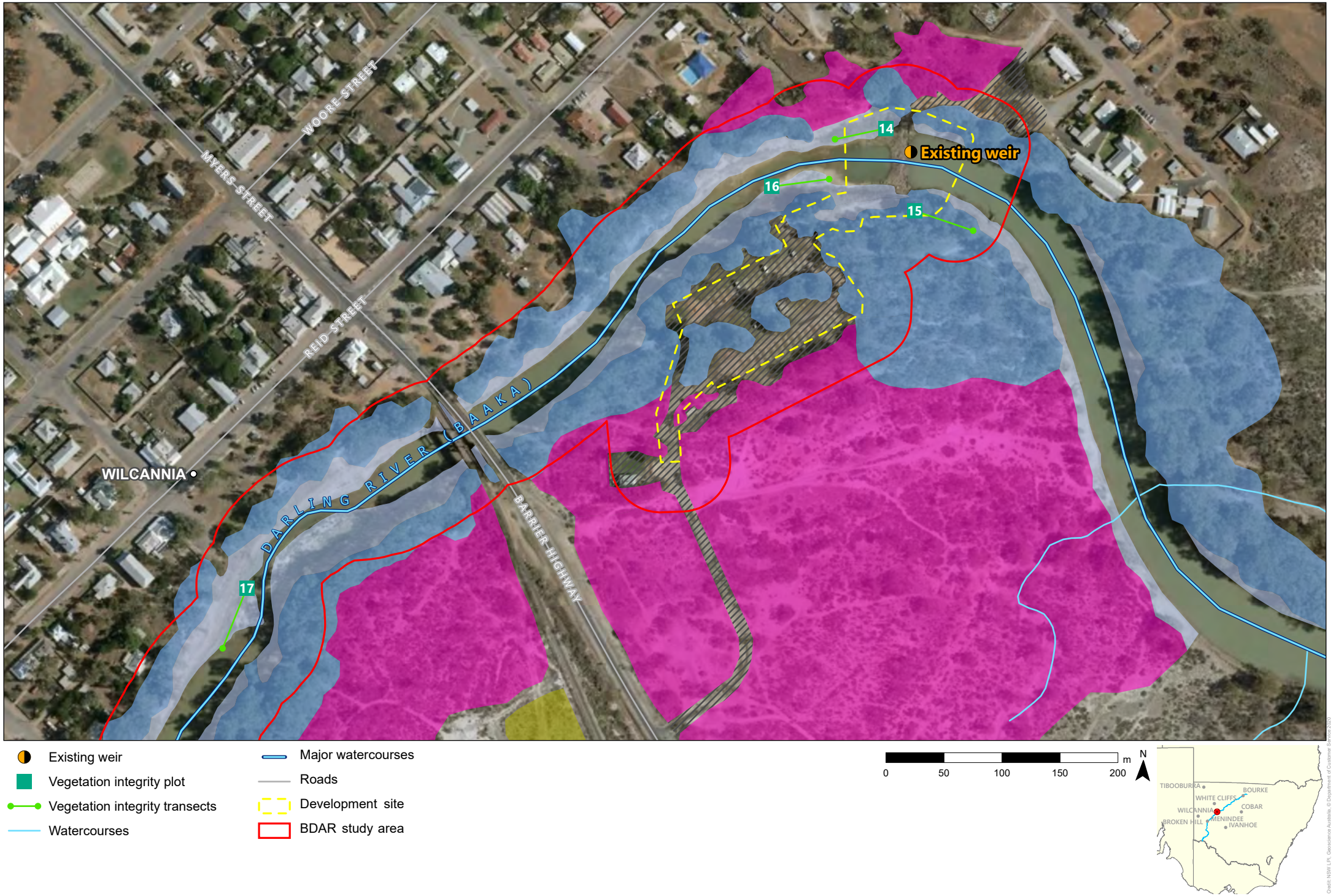

Figure 5-1: Vegetation integrity plot-based assessments - 6 of 8

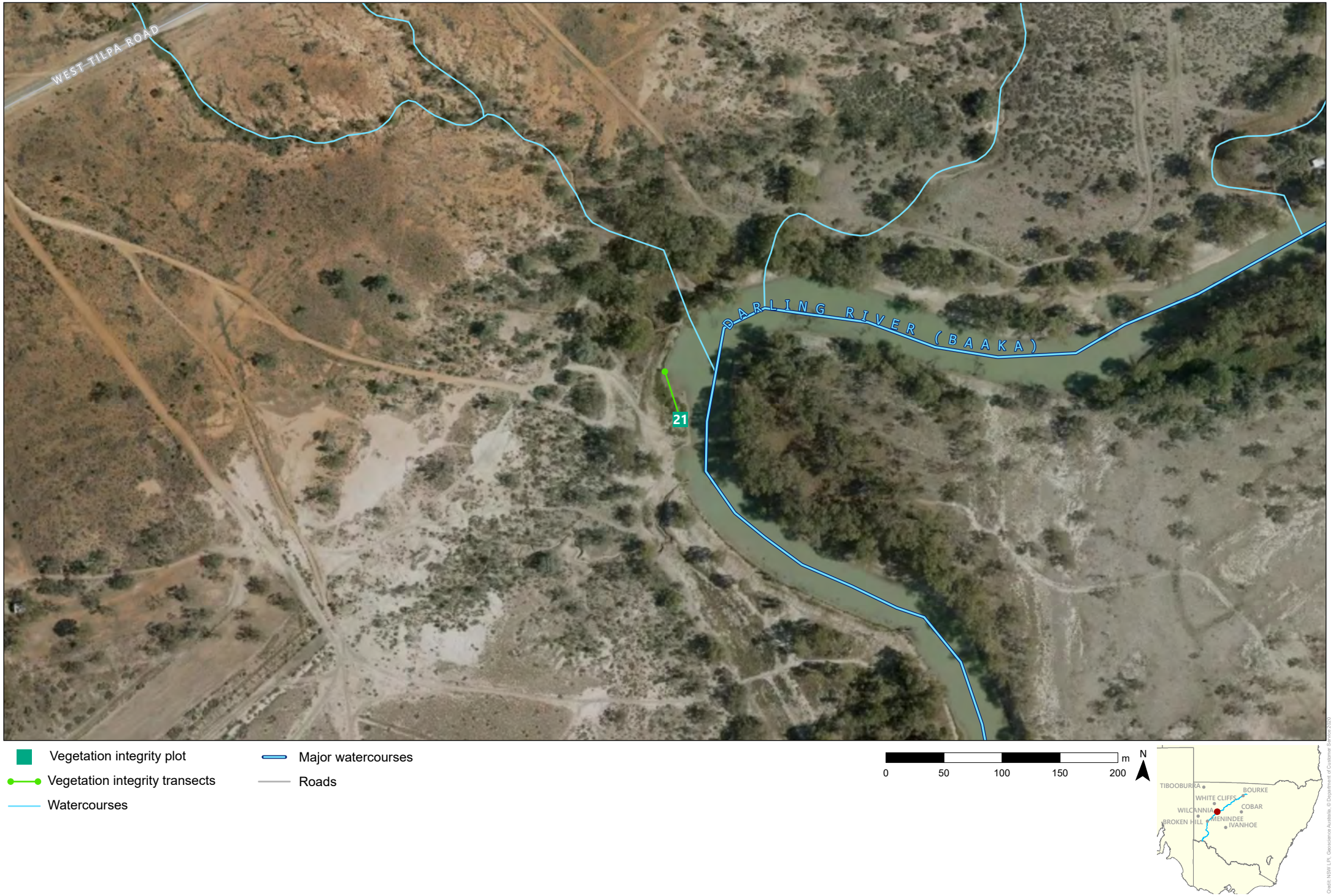

Figure 5-1: Vegetation integrity plot-based assessments - 7 of 8

Figure 5-1: Vegetation integrity plot-based assessments - 8 of 8

5.4 Plant community types

This BDAR describes PCTs in terms of their floristic composition, geological substrate, and relevant regional vegetation classification. The PCTs identified within the development site and study area are identified in **Table 5-2** and their distribution is illustrated in **Figure 5-2**. The PCTs within the direct impact area are the focus of calculating offset requirements. The identification and mapping of PCTs has also been extended to show the surrounding study area. This is to provide context to discussing potential indirect and prescribed impacts by showing the distribution of threatened ecological communities and GDEs.

Descriptions of the vegetation that occurs in the study area are provided in the following sections matched to the most likely PCT as described in the BioNet Vegetation Classification database. In most cases the vegetation on site does not perfectly align with any PCT listed in the BioNet Vegetation Classification database so the vegetation has been allocated to the PCT with which it most closely aligns.

Table 5-2 PCTs identified within the study area (including the development site) and the area to be directly impacted (development site and broader study area direct impact area)

PCT ID No.	PCT name	Vegetation formation	Vegetation class	TEC	Area in direct impact area (ha)
36	River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion	Forested Wetlands	Inland Riverine Forests	Not a TEC	2.57 ha
39	Coolabah – River Coobah – Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion	Semi-arid Woodlands (Grassy sub-formation)	North-west Floodplain Woodlands	Endangered BC Act Endangered EPBC Act (Good condition only)	2.94 ha
158	Old Man Saltbush – mixed chenopod shrubland of the semi-arid hot (persistently dry) and arid climate zones (north-western NSW)	Arid Shrublands (Chenopod sub-formation)	Riverine Chenopod Shrublands	Not a TEC	4.64 ha
247	Lignum shrubland wetland on regularly flooded alluvial depressions in the Brigalow Belt South Bioregion and Darling Riverine Plains Bioregion	Freshwater Wetlands	Inland Floodplain Shrublands	Not a TEC	Within study area – outside of direct impact area
38	Black Box low woodland wetland lining ephemeral watercourses or fringing lakes and clay pans of semi-arid (hot) and arid zones	Semi-arid Woodlands (Grassy sub-formation)	North-west Floodplain Woodlands	Not a TEC	Within study area – outside of direct impact area
153	Black Bluebush low open shrubland of the alluvial plains and sandplains of the arid and semi-arid zones	Arid Shrublands (Chenopod sub-formation)	Riverine Chenopod Shrublands	Not a TEC	Within study area – outside of direct impact area
				Total direct impact	**10.14 ha**

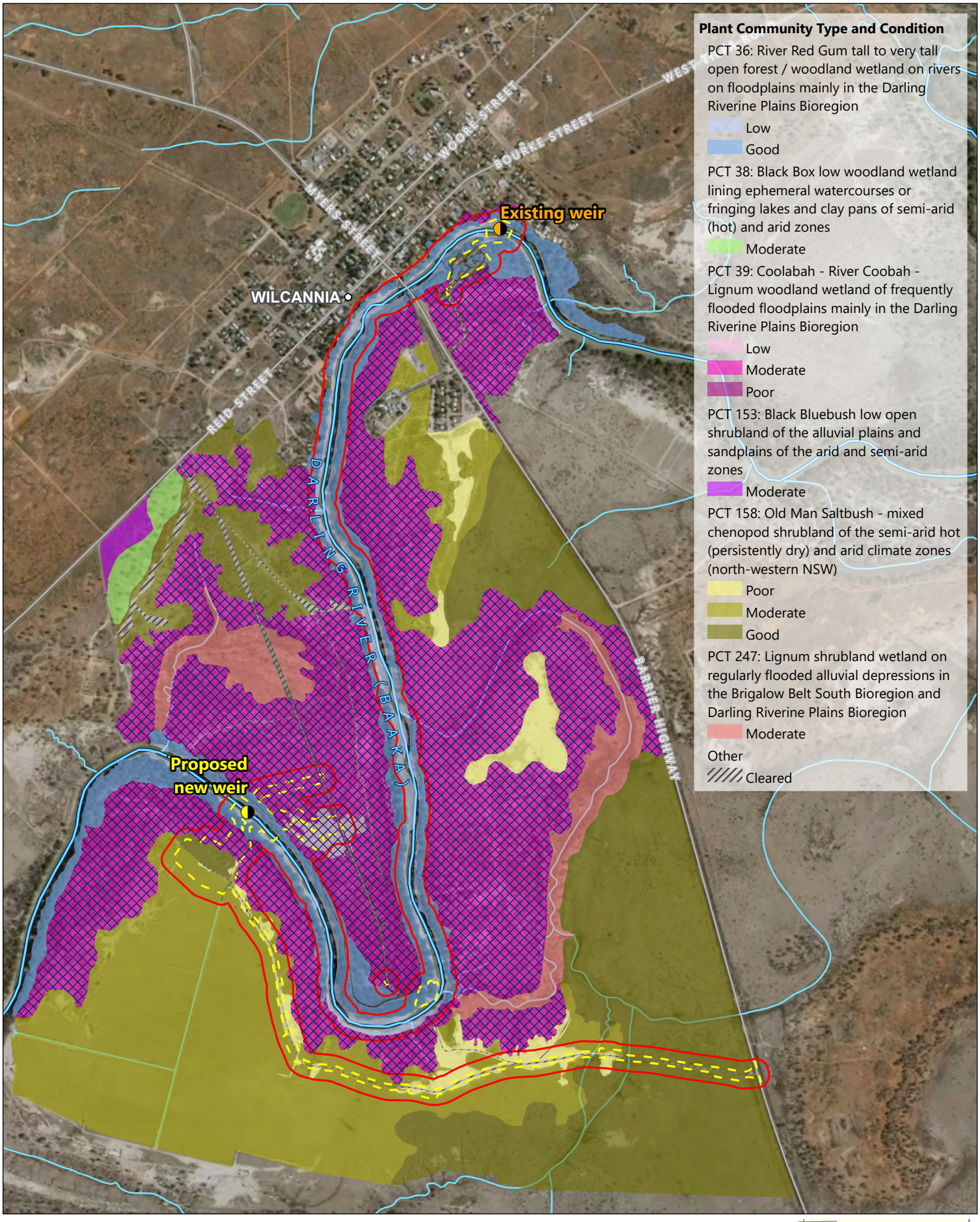

Figure 5-2: Plant community types, vegetation zones and threatened ecological communities

5.4.1 PCTs within direct impact area

5.4.1.1 River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion

Vegetation formation: Forested Wetlands

Vegetation class: Inland Riverine Forests **PCT ID:** 36

Threatened ecological community (BC Act and EPBC Act): Not a TEC

Vegetation zones (condition) and plots:

- Zone 1 (PCT 36 – Good): Plots 1, 7, 13, 15
- Zone 2 (PCT 36 – Low): Plots 3,14,16,17,18,19

The River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion PCT is described in the BioNet Vegetation Classification database as a very tall or tall open forest or woodland up to 30 metres high lining major watercourses dominated by *Eucalyptus camaldulensis* subsp. *Camaldulensis* (River Red Gum) sometimes with *Eucalyptus largiflorens* (Black Box) or *Eucalyptus coolabah* (Coolabah) with southern areas containing *Eucalyptus melliodora* (Yellow Box). Shrubs may be absent or if present are sparse including *Acacia salicina* (Cooba), *Acacia stenophylla* (River Cooba) and *Duma florulenta* (Lignum). The ground cover may be dense after rain or flooding and is dominated by native grass species including *Austrostipa ramosissima*, *Austrostipa 35obilization*, *Rytidosperma caespitosum*, *Paspalidium jubiflorum*, *Leptochloa digitata*, *Panicum decompositum* and *Cynodon dactylon*. Sedge species include *Cyperus gymnocaulos, Eleocharis pallens* and *Eleocharis plana*. Rushes such as *Juncus radula* be present. The fern *Marsilea drummondii* (Nardoo) is common in poorly drained sites. A range of forbs include *Pratia concolor*, *Centipeda cunninghamii*, *Rumex 35obiliz*, *Haloragis glauca*, *Boerhavia 35obili*, *Swainsona galegifolia*, *Alternanthera 35obilizatio* and *Goodenia fascicularis*.

Occurs on Quaternary alluvial grey cracking clay, loamy clays and sometimes sandy loam soils in the riparian zone of rivers (banks, levees, benches), ox-bow lakes and depressions on adjacent floodplains. A widely distributed community with large floristic variation depending on flooding regimes. Distributed on the floodplains of major rivers and creeks of central-northern western NSW mainly in the Darling Riverine Plains Bioregion extending into adjoining bioregions. A substantial proportion of this community has been cleared and/or adjoining vegetation has been cleared rendering this community susceptible to "edge" effects. Many areas are affected by trampling by stock and weed invasion by *Phyla canescens* or *Lycium ferocissimum*. Changed flooding regimes due to irrigation draw off is leading to a lack of regeneration of River Red Gum in some locations.

Within the study area, vegetation considered most likely to be representative of the River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion PCT occurs as a thin strip along the edges of the Darling River (Baaka). The canopy is dominated by *Eucalyptus camaldulensis* (River Red Gum) with occurrences of *Eucalyptus coolabah* (Coolabah). The canopy is generally intact, though past disturbance has cleared the canopy to a single strip of trees in some areas. The dominant midstorey species included *Acacia stenophylla, Chenopodium nitrariaceum* and *Swainsona greyana*. Soils on the top of the riverbanks are characterised by a layer of alluvial loam over top of grey-brown silty clay which is exposed on the bank slopes and river edges. The location of this vegetation within the study area is generally consistent with the mapped distribution of PCT 36 by the State Vegetation Type Map: Western Region Version 1.0. VIS_ID 4492 (Office of Environment and Heritage, 2019). Two condition classes of PCT 36 have been identified within the direct impact area:

- Good (zone 1): This is the most common condition class for PCT 36. The zone shows a level of disturbance, but diversity, structure and functional characteristics were intact. A canopy of large *Eucalyptus camaldulensis* (15-20 metres) is present, however the midstorey is absent in some areas

(including canopy regeneration) and a moderate cover of exotic groundcover (particularly *Sisymbrium erysimoides*) is common

- Low (zone 2): This is variant of PCT 36 that occurs along the steep banks and exposed sand bars of the Darling River (Baaka) that are subject to inundation during high flow. While trees are absent from the sloping bank, the vegetation was noted to contain regenerating *Eucalyptus camaldulensis* seedlings. The dominant native species are *Cyperus gymnocaulos* and *Lachnagrostis filiformis*. There is a high cover of exotic species, particularly *Xanthium occidentale* which was present in a regenerating state. Bare ground is also common along the banks.

Other PCTs known from the region that have *Eucalyptus camaldulensis* as a part of the canopy include River Red Gum – Lignum very tall open forest or woodland wetland on floodplains of semi-arid (warm) climate zone (mainly Riverina Bioregion and Murray Darling Depression Bioregion) (PCT 11). The assemblage of vegetation dominated by *Eucalyptus camaldulensis* in the study area is along the higher banks of the Darling River (Baaka) above the floodplain and therefore *Duma florulenta* is not abundant as is typical of PCT 11, which is described as occurring on drainage depressions and flood-outs of major water courses on the floodplains.

This vegetation is most likely to be representative of PCT 36 for the following reasons:

- The canopy is dominated by *Eucalyptus camaldulensis*. The small tree *Acacia stenophylla* is the dominant midstorey species
- Where present, the midstorey shrub layer is sparse to dense and is dominated by *Chenopodium nitrariaceum* and *Swainsona greyana*. *Duma florulenta* is also present in some areas
- The ground cover varies depending on canopy cover, though is comprised of a mixture of chenopods (*Sclerolaena* sp. And *Maireana* sp.) and forbs. In-stream sandbars and wetter areas fringing the Darling River (Baaka) contained a high cover of *Cyperus gymnocaulos* and *Lachnagrostis filiformis*
- The vegetation is located on the high banks the Darling River (Baaka) and does not extend far into the surrounding floodplain.

Vegetation on the sloping bank was also assigned to PCT 36 (Zone 2) acknowledging that the bank would experience different patterns of inundation to the upper riparian zone, and this would affect the presence - absence of species and the structure of the vegetation. This vegetation was assigned to PCT 36 rather than a sedgeland community due to the fact that it is inconsistent with the different instream and sedgeland type communities described in the region (e.g. PCT181, 182, 53 or 12). These are typically associated with a landscape position in the bed of the stream or edge of waterways. The riverbanks in the study area are higher and steeper than the instream wetland zone and are contiguous with PCT36 and not consistent with a sedgeland community.

A summary of the vegetation structure and floristics of PCT 36 is given below in **Table 5-3**. This list of species reflects the local variation gathered from multiple floristic plots undertaken within the study area.

Table 5-3 Floristic and structural summary of PCT 36 within the direct impact area

Vegetation layer	Dominant species
Tree canopy (upper stratum)	*Eucalyptus camaldulensis* with occasional *Eucalyptus coolabah*
Midstorey (mid-stratum)	The small tree *Acacia stenophyllum* and large shrubs *Chenopodium nitrariaceum, Duma florulenta,* Myoporum montanum, Eremophila bignoniiflora and *Swainsona greyana*
Groundcovers (ground stratum)	Small shrubs *Olearia pimeleoides, Enchylaena tomentosa, Sclerolaena 36obilizati, Sclerolaena muricata, Atriplex leptocarpa, Salsola australis, Chenopodium curvispicatum* Grass species including *Paspalidium jubiflorum, Austrostipa nodosa, Bromus catharticus, Eragrostis parviflora, Cynodon dactylon, Eriochloa crebra, Sporobolus mitchellii, Lachnagrostis filiformis*

Vegetation layer	Dominant species
	Sedge species *Juncus* sp., *Cyperus gymnocaulos, Bolboschoenus caldwellii, Juncus bufonius,* Forbs including *Oxalis perennans, Solanum esuriale, Rhodanthe floribunda, Asperula 37obiliz, Wahlenbergia fluminalis, Goodenia heteromera, Goodenia glauca, Tetragonia tetragonioides, Vittadinia cervicularis* var. *cervicularis, Calotis scapigera, Haloragis aspera, Xerochrysum bracteatum, Brachyscome ciliaris, Rumex crystallinus, Rumex 37obiliz, Euphorbia 37obilization37te* var. *queenslandica, Atriplex suberecta, Calotis scapigera, Alternanthera nodiflora, Senecio runcinifolius, Persicaria lapathifolia, Pseudognaphalium luteoalbum, Ethuliopsis cunninghamii, Centipeda cunninghamii, Leiocarpa websteri, Euchiton involucratus, Stemodia florulenta, Glinus lotoides, Nicotiana velutinella, Plantago drummondii* Species in the 'other' growth forms include *Cullen tenax*.
Exotic species	*Sisymbrium erysimoides, Xanthium occidentale, Centaurea melitensis, Sonchus oleraceus, Brassica tournefortii, Lactuca serriola, Solanum nigrum, Picris squarrosa, Lepidium africanum, Solanum nigrum, Melilotus indicus, Conyza bonariensis, Polygonum aviculare, Verbena officinalis, Polypogon monspeliensis, Spergularia brevifolia, Vicia* sp., *Heliotropium supinum, Centaurium tenuiflorum, Medicago* sp., *Verbena supina*
High Threat Weeds	None

Photo 5-1 Plot 1 showing vegetation zone 1 (PCT 36 – Good) with intact native midstorey

Photo 5-2 Plot 7 showing vegetation zone 1 (PCT 36 – Good) with open midstorey

Photo 5-3 Plot 3 showing vegetation zone 2 (PCT 36 – Low) at the proposed new weir site

Photo 5-4 Plot 14 showing vegetation zone 2 (PCT 36 – Low) in a weedy state at the existing weir

5.4.1.2 Coolabah – River Coobah – Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion

Vegetation formation: Semi-arid Woodlands (Grassy sub-formation)

Vegetation class: Upper Riverina North-west Floodplain Woodlands **PCT ID:** 39

Threatened ecological community (BC Act and EPBC Act): All vegetation zones meet the definition of Coolibah-Black Box Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain and Mulga Lands Bioregions (Endangered – BC Act) – refer to **Section 5.7.1**. Vegetation zone 3 meets the definition and condition threshold for listing under Coolibah – Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions (Endangered – EPBC Act) – refer to **Section 7.3.1**.

Vegetation zones (condition) and plots:

- Zone 3 (PCT 39 – Moderate): Plots 2, 6, 9, 10
- Zone 4 (PCT 39 – Low): Plots 4, 5
- Zone 5 (PCT 39 – Poor): Plot 22

The Coolabah – River Coobah – Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion PCT is described in the BioNet Vegetation Classification database as an open forest and woodland dominated by Coolabah (*Eucalyptus coolabah* subsp. *Coolabah*) often with River Red Gum (*Eucalyptus camaldulensis* subsp. *Camaldulensis*) with understorey thickets of Lignum (*Muehlenbeckia florulenta*), River Cooba (*Acacia stenophylla*) or Cooba (*Acacia salicina*). *Melaleuca tristachya* occurs on riverbanks in some areas. The ground cover contains tall tussock grasses such as *Leptochloa digitata* and *Paspalidium jubiflorum*, sedges such as *Cyperus concinnus* and *Cyperus victoriensis* and rushes (*Juncus* sp.). Coolabah occurs on areas slightly less flooded than River Red Gum. It also may adjoin Black Box communities that tend to occupy slightly higher ground. Lippia (*Phyla canescens*) and African Boxthorn (*Lycium ferocissimum*) are problem weeds in places. Occurs on alluvial silty clay soils with

neutral pH on floodplains of the major rivers mainly in the Darling Riverine Plain Bioregion but with outliers in other bioregions. This community is frequently flooded and may be subject to occasional prolonged inundation. Grades into a less frequently flooded Coolabah Open Woodland (PCT 40) that occurs distant from the channelised section of the floodplain. It has been extensively cleared in central northern NSW but stands remain in the Western Division in the Darling River (Baaka) system although clearing is extending into this region. Endangered due to the rate of its decline and long-term impacts from changed flooding regimes affecting its condition.

Within the study area, vegetation considered most likely to be representative of the Coolabah – River Coobah – Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion PCT occurs on the fringes of the Darling River (Baaka) riparian zone, within the floodplain. The canopy is dominated by *Eucalyptus coolabah* (Coolabah) and *Eucalyptus camaldulensis* (River Red Gum) and *Eucalyptus largiflorens* (Black Box), varying in abundance and cover depending on distance from the Darling River (Baaka) and previous disturbance. The dominant midstorey species included the small tree *Acacia stenophylla* and larger shrubs*, Myoporum montanum* and *Eremophila bignoniiflora*. The groundcover is dominated by *Chenopodium nitrariaceum*, *Duma florulenta* and a mixture of chenopods. Soils are characterised by a grey-brown silty clay, often cracking from recent inundation. This vegetation within the study area is generally consistent with the mapped distribution of PCT 39 by the State Vegetation Type Map: Western Region Version 1.0. VIS_ID 4492 (Office of Environment and Heritage, 2019). Three condition classes of PCT 39 were identified within the direct impact area:

- Moderate (zone 3): This zone contains all structural layers with a canopy of medium to large *Eucalyptus coolabah* and the occasional *Eucalyptus camaldulensis* and *Eucalyptus largiflorens* (10-15 metres) and a generally good midstorey and ground cover of native species. There appears to have been some disturbance throughout much of this vegetation in the past, particularly where it borders old agricultural areas. Branch lopping is common, and large open areas lacking canopy are common. It is difficult to determine where treeless areas are natural and where they are a result of disturbance. As such all vegetation has been lumped into the one zone and sampled by more plots than required to capture the variation
- Low (zone 4): Similar in floristic composition to zone 3, however this zone is largely missing the canopy. This may be from past disturbance, though the small patch is located within a very shallow depression, which may have limited tree growth
- Poor (zone 5): This zone occurs five metres either side of the access road on the north side of the Darling River (Baaka). It contains a selection of regenerating shrubs and forbs following clearing and ground disturbance for the construction of the track and powerline.

Other PCTs known from the region that have *Eucalyptus coolabah* as a part of the canopy include Coolabah open woodland wetland with chenopod/grassy ground cover on grey and brown clay floodplains (PCT 40). The assemblage of vegetation dominated by *Eucalyptus coolabah* in the study area is immediately adjacent to the Darling River (Baaka) and therefore contains *Eucalyptus camaldulensis* instead of drier canopy and midstorey species such as *Eucalyptus populnea*, *Casuarina cristata* and *Alectryon oleifolius* typical of PCT 40, which is described as occurring on higher floodplains more distant from watercourses.

This vegetation is most likely to be representative of PCT 39 for the following reasons:

- This canopy is dominated by *Eucalyptus coolabah* with scattered *Eucalyptus coolabah* and *Eucalyptus camaldulensis*. The small tree Acacia stenophylla is the dominant midstorey species. Some areas contain a very sparse canopy and midstorey where the PCT intergrades into shrublands
- The lower shrub layer is sparse to dense and is dominated by *Chenopodium nitrariaceum* and *Duma florulenta*, depending on the level of disturbance and proximity to low-lying areas (i.e. drainage lines)
- The ground cover is comprised of a mixture of chenopods (*Sclerolaena* sp. And *Maireana* sp.) and grasses
- The vegetation is located on the fringes of River Red Gum riparian woodland (PCT 36) along the Darling River (Baaka).

A summary of the vegetation structure and floristics of PCT 39 is given below in **Table 5-4**. This list of species reflects the local variation gathered from multiple floristic plots undertaken within the study area.

Table 5-4 Floristic and structural summary of PCT 39 within the direct impact area

Vegetation layer	Dominant species
Tree canopy (upper stratum)	*Eucalyptus coolabah* with *Eucalyptus camaldulensis* and *Eucalyptus largiflorens*
Midstorey (mid-stratum)	The small tree *Acacia stenophyllum* and large shrubs *Chenopodium nitrariaceum, Duma florulenta, Myoporum montanum, Eremophila bignoniiflora* and *Atriplex nummularia*
Groundcovers (ground stratum)	Small shrubs *Olearia pimeleoides, Enchylaena tomentosa, Portulaca oleracea, Sclerolaena stelligera, Sclerolaena 41obilizati, Sclerolaena diacantha, Sclerolaena muricata, Sclerolaena brachyptera, Dissocarpus paradoxus, Atriplex leptocarpa, Atriplex semibaccata, Atriplex pseudocampanulata, Neobassia proceriflora, Salsola australis* Grass and grass like species including *Eriochloa crebra, Lachnagrostis filiformis, Chloris 41obiliza, Austrostipa scabra, Panicum decompositum, Paspalidium jubiflorum* Forbs including *Calotis scapigera, Plantago drummondii, Plantago turrifera, Bulbine semibarbata, Leiocarpa websteri, Leiocarpa brevicompta, Boerhavia 41obili, Brachyscome ciliaris, Brachyscome melanocarpa, Oxalis perennans, Rhodanthe floribunda, Rhodanthe corymbiflora, Teucrium racemosum, glauca, Tetragonia tetragonioides, Euphorbia 41obilization41te* var. *queenslandica, Phyllanthus lacunarius, Sida cunninghamii, Solanum esuriale, Atriplex suberecta, Alternanthera nodiflora, Senecio glossanthus, Euchiton* sp., *Einadia nutans* Species in the 'other' growth forms include *Convolvulus erubescens*.
Exotic species	*Sisymbrium erysimoides, Hordeum leporinum, Rostraria pumila, Medicago minima, Centaurea melitensis, Sonchus oleraceus, Lepidium africanum, Silene apetala, Polygonum aviculare*
High Threat Weeds	*Carrichtera annua, Schismus barbatus*

Photo 5-5 Plot 2 showing vegetation zone 4 (PCT 39 – Moderate)

Photo 5-6 Plot 9 showing vegetation zone 3 (PCT 39 – Moderate)

Photo 5-7 Plot 5 showing vegetation zone 4 (PCT 39 – Low)

Photo 5-8 Plot 22 showing vegetation zone 5 (PCT 39 – poor)

5.4.1.3 Old Man Saltbush – mixed chenopod shrubland of the semi-arid hot (persistently dry) and arid climate zones (north-western NSW)

Vegetation formation: Arid Shrublands (Chenopod sub-formation)

Vegetation class: Riverine Chenopod Shrublands **PCT ID:** 158

Threatened ecological community (BC Act and EPBC Act): Listed in BioNet Vegetation Classification as Artesian Springs Ecological Community in the Great Artesian Basin (Endangered – BC Act). However, this vegetation is not located within an area recognised as an artesian spring and therefore does not meet the definition of this TEC (refer to **Section 5.7** for discussion).

Vegetation zones (condition) and plots:

- Zone 6 (PCT 158 – Moderate): Plot 12
- Zone 7 (PCT 158 – Poor): Plot 25
- Zone 8 (PCT 158 – Good): Plots 8,11.

The Old Man Saltbush – mixed chenopod shrubland of the semi-arid hot (persistently dry) and arid climate zones (north-western NSW) PCT is described in the BioNet Vegetation Classification database as a tall shrubland to two metres high, dominated by *Atriplex nummularia* (Old Man Saltbush), often with *Chenopodium nitrariaceum* (Nitre Goosefoot), *Maireana pyramidata* (Black Bluebush) with *M. astrotricha* in far western areas and *Duma florulenta* (Lignum) with a lower shrub layer composed of copperburrs (*Sclerolaena* sp.) and other *Atriplex* species. The ground layer varies but typically is composed of forbs such as *Rhodanthe* sp., *Tetragonia eremaea*, *Bulbine alata*, *Centipeda minima* var. *minima*, and *Plantago cunninghamii* and grasses such as *Chloris 43obiliza* and *Sporobolus actinocladus*. In some areas the shrubland may be restricted in height and very sparse. Occurs in restricted patches on grey clay or texture contrast sandy clay soils on periodically inundated alluvial plains and rises on or adjacent to floodplains in the upper Darling, Paroo and Bulloo Rivers and other rivers in north western NSW. Also occurs on heavy clays

on the beds of pans between dunes in dunefield country along with *Eragrostis australasica* (Canegrass) – for example in the Bulloo Overflow. Southern-most occurrence is near Wilcannia where it has apparently been severely reduced in extent. Also occurs along drainage lines in Bladder Saltbush communities. Prior to European settlement, and the introduction of stock and feral animals, this community would have covered large areas. Continuous grazing has eliminated a most of the Old Man Saltbush particularly from its eastern range in the northern NSW wheatbelt. This shrubland often grades into and becomes an understorey of Black Box or Coolabah communities – for example along the Macquarie River in the east and on the floodplain of the Darling River (Baaka) to the west. Over the last few decades, the species Old Man Saltbush has been planted in restoration projects including in parts of the previously denuded landscape surrounding the Broken Hill mines. It is also planted on properties for fodder and as a means of reducing rising saline water-tables – including in parts east of its previous known range. In assessing its status, it is important to exclude these planted areas. Due to its reduction in extent, this community is considered to be a threatened community and as of 2005 it is poorly represented in protected areas. Contains some species in common with the Old Man Saltbush shrubland in the Riverina and Murray Darling Depression Bioregions (PCT 159).

Within the study area, vegetation considered most likely to be representative of the Old Man Saltbush – mixed chenopod shrubland of the semi-arid hot (persistently dry) and arid climate zones (north-western NSW) PCT occurs in the open floodplain bordering Coolabah woodland (PCT 39). The vegetation consists of a low shrubland dominated by *Atriplex nummularia* and, to a lesser extent, *Chenopodium nitrariaceum*. Scattered *Eucalyptus coolabah* are present at very low abundance, mostly close to woodland edges. The groundcover is dominated by a mixture of chenopods. Soils are characterised by a grey-brown silty clay. The location of this vegetation within the study area is generally consistent with the mapped distribution of PCT 158 by the State Vegetation Type Map: Western Region Version 1.0. VIS_ID 4492 (Office of Environment and Heritage, 2019). Three condition classes of PCT 158 were identified within the direct impact area:

- Moderate (zone 6): This zone occurs either side of the access road in the east adjacent to the Barrier Highway on the south side of the Darling River (Baaka). It consists of low shrubland and mixture of chenopods. A small area also occur in the disturbance site on south side of the river at proposed weir construction area
- Poor (zone 7): This zone occurs in highly and consistently disturbed areas along tracks on the south side of the Darling River (Baaka) and along the southern access track. These areas are predominately bare ground, though a varying and low cover of shrubs and forbs are present
- Good (zone 8): This zone occurs five metres either side of the access road on the south side of the Darling River (Baaka). It contains a selection of regenerating shrubs and forbs following clearing and ground disturbance for the construction of the track and powerline.

Other PCTs known from the region that have a low shrub layer dominated by *Atriplex nummularia* include Old Man Saltbush shrubland mainly of the semi-arid (warm) climate zone (south western NSW) (PCT 159), however this PCT is described as only occurring in the south-west of NSW.

This vegetation is most likely to be representative of PCT 158 for the following reasons:

- The shrub layer is dominated by *Atriplex nummularia* with *Chenopodium nitrariaceum*
- The ground cover is comprised of a mixture of chenopods (*Dissocarpus paradoxus*, *Sclerolaena muricata*, *Atriplex holocarpa*), grasses and forbs.

A summary of the vegetation structure and floristics of PCT 158 is given below in **Table 5-5.** This list of species reflects the local variation gathered from multiple floristic plots undertaken within the study area.

Table 5-5 Floristic and structural summary of PCT 158 within the direct impact area

Vegetation layer	Dominant species
Tree canopy (upper stratum)	*Eucalyptus coolabah*

Vegetation layer	Dominant species
Midstorey (mid-stratum)	Dominated by *Atriplex nummularia* with *Chenopodium nitrariaceum*
Groundcovers (ground stratum)	Small shrubs *Portulaca oleracea, Sclerolaena tricuspis, Sclerolaena 45obilizati, Sclerolaena muricata, Sclerolaena brachyptera, Sclerolaena 45obilizati, Dissocarpus paradoxus, Dissocarpus biflorus, Sida cunninghamii, Atriplex leptocarpa, pseudocampanulata, Neobassia proceriflora, Malacocera tricornis* Grass and grass like species including *Eriochloa crebra, Panicum decompositum, Sporobolus mitchellii, Austrostipa nitida, Rytidosperma setaceum, Dactyloctenium radulans* Forbs including *Atriplex lindleyi, Atriplex holocarpa, Rhodanthe corymbiflora, Leiocarpa websteri, Leiocarpa brevicompta, Podolepis jaceoides, Swainsona swainsonioides, Pycnosorus globosus, Plantago turrifera, Minuria* spp.*, Brachyscome* spp.*, Sida cunninghamii, Bulbine semibarbata, Euphorbia 45obilization45te* var. *queenslandica, Abutilon* sp.*, Vittadinia cuneata*
Exotic species	*Sonchus oleraceus, Rostraria pumila, Melilotus indicus, Hordeum leporinum, Lactuca serriola, Melilotus indicus*
High Threat Weeds	*Carrichtera annua, Schismus barbatus*

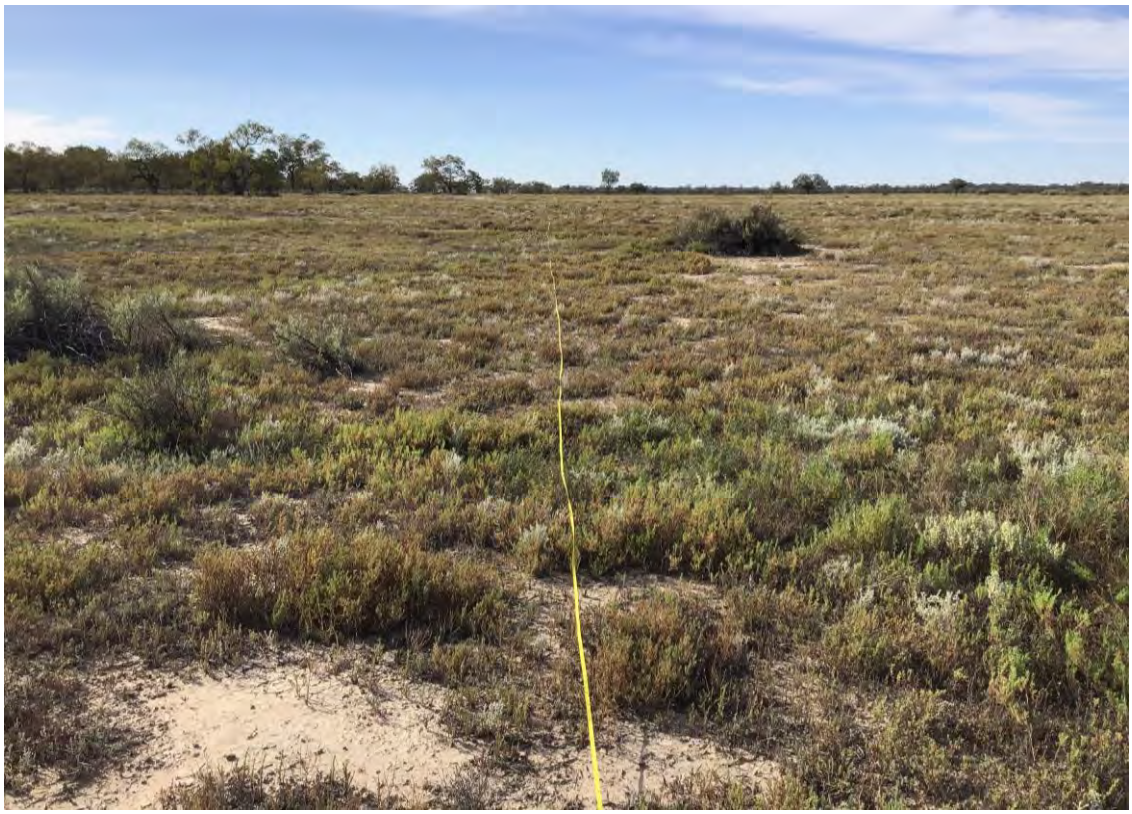

Photo 5-9 Plot 8 showing zone 8 (PCT 158 – Good)

Photo 5-10 Plot 25 showing zone 7 (PCT 158 – Poor)

5.4.2 PCTs within the study area

The following PCTs occur in the study area surrounding the river and are outside of the development site and area of direct impact, however, have been identified for assessing prescribed impacts.

5.4.2.1 Lignum shrubland wetland on regularly flooded alluvial depressions in the Brigalow Belt South Bioregion and Darling Riverine Plains Bioregion

Vegetation formation: Freshwater Wetlands

Vegetation class: Inland Floodplain Shrublands **PCT ID:** 247

Threatened ecological community (BC Act and EPBC Act): Listed in BioNet Vegetation Classification as Artesian Springs Ecological Community in the Great Artesian Basin (Endangered – BC Act). However, this vegetation is not located within an area recognised as an artesian spring and therefore does not meet the definition of this TEC (refer to **Section 5.7** for discussion).

Not a vegetation zone as occurs outside direct impact area: Plot 23, 24

The Lignum shrubland wetland on regularly flooded alluvial depressions in the Brigalow Belt South Bioregion and Darling Riverine Plains Bioregion PCT is described in the BioNet Vegetation Classification database as a tall shrubland or open shrubland usually to 2 metres high dominated by *Duma florulenta* (Lignum). Other shrub species that may be present include *Eremophila bignoniiflora*, *Eremophila 46obiliza*, *Rhagodia spinescens* and *Chenopodium nitrariaceum*. Scattered trees may be present with less than 10 per cent canopy cover including *Eucalyptus camaldulensis*, *Eucalyptus largiflorens* and *Eucalyptus coolabah*. The ground cover may be dense after rains or inundation but very sparse during drought. The scrambler *Einadia nutans* subsp. *Nutans* may be present along with copperburr shrubs such as *Sclerolaena muricata* and *Sclerolaena 46obilizati*. Grass species include *Paspalidium jubiflorum*, *Panicum decompositum*, *Chloris 46obiliza*, *Enteropogon acicularis* and *Sporobolus mitchellii*. Forbs include *Persicaria hydropiper*, *Alternanthera*

47obilizatio, *Eclipta platyglossa*, *Haloragis glauca*, *Pratia concolor*, *Sida fibulifera*, *Boerhavia 47obili* and *Solanum esuriale*. Sedges may be common and include *Eleocharis plana*, *Eleocharis pusilla*, *Carex inversa* and *Cyperus* sp. The rush *Juncus aridicola* is often present. *Marsilea drummondii* is abundant. Occurs on deep, self-mulching alluvial grey clays (and rarely black earth) that are often gilgaied, in depressions on floodplains or as narrow bands near watercourses that are subject to regular inundation. Distributed within the temperate (hot summer), dry sub-tropical and eastern semi-arid (hot) climate zones which corresponds with the Darling Riverine Plain Bioregion extending eastwards to the Liverpool Plains where small stands occur on the edge of Lake Goran. Grades into Lignum (PCT 17) in south western NSW and Lignum in far north western NSW (PCT 25). Compared to those other Lignum communities, this community is more restricted and threatened. Most of its original extent has been cleared and reduced flooding threatens many stands over the long term.

Within the study area, vegetation considered most likely to be representative of the Lignum shrubland wetland on regularly flooded alluvial depressions in the Brigalow Belt South Bioregion and Darling Riverine Plains Bioregion PCT occurs in depressions and drainage lines on the floodplain around the Darling River (Baaka). It is characterised by a moderate to high cover of *Duma florulenta* and *Chenopodium nitrariaceum* in the midstorey over a sparse ground layer of chenopods and forbs. The community is relatively treeless, though contains scattered *Eucalyptus coolabah* and *Acacia stenophylla* around the drier edges. Soils are characterised by a grey-brown silty clay. This vegetation within the study area is generally consistent with the mapped distribution of PCT 247 by the State Vegetation Type Map: Western Region Version 1.0. VIS_ID 4492 (Office of Environment and Heritage, 2019). PCT 247 occurs within the study area in moderate condition and disturbed condition.

5.4.2.2 Black Box low woodland wetland lining ephemeral watercourses or fringing lakes and clay pans of semi-arid (hot) and arid zones

Vegetation formation: Semi-arid Woodlands (Grassy sub-formation)

Vegetation class: North-west Floodplain Woodlands **PCT ID:** 38

Threatened ecological community (BC Act and EPBC Act): Not a TEC

Not a vegetation zone as occurs outside direct impact area: Plot 26

The PCT Black Box low woodland wetland lining ephemeral watercourses or fringing lakes and clay pans of semi-arid (hot) and arid zones is described in the BioNet Vegetation Classification database as low open woodland to 10 metres high dominated by Black Box (*Eucalyptus largiflorens*) with a sparse cover of shrubs including *Myoporum montanum*, *Eremophila* spp., *Chenopodium* spp. And Lignum (*Muehelnbeckia florulenta*). The ground cover is mid-dense after rain but very sparse in dry times and is composed of annual chenopods including Atriplex spp., ephemeral forbs and summer grasses. Common ground species include the small shrubs *Enchylaena tomentosa*, *Teucrium racemosum*, *Sclerolaena 47obilizat*, *Salsola tragus* subsp. *Tragus*, *Atriplex holocarpa* and *Atriplex eardleyae*; forbs such as *Tetragonia eremaea*, *Pratia darlingensis*, *Mimulus repens*, *Stemodia florulenta*, *Osteocarpum acropterum* var. *acropterum* and *Polycalymma stuartii*; grasses such as *Sporobolus mitchellii*, *Eragrostis falcata*, *Eragrostis parviflora*, *Triraphis mollis* and *Tragus australianus* and the sedge *Cyperus gymnocaulos*.

Occurs on brown and grey cracking clays or sandy loams fringing ephemeral lakes, pans and watercourses among the sandplains of the Cobham Land System in the Channel Country Bioregion, Paroo and Warrego River regions of the Mulga Lands Bioregion and in the Strzelecki Desert dunefields to the west extending into South Australia. This community merges with Canegrass and Lignum communities in low lying depressions and *Acacia 47obiliza* shrubland (ID124) on sand dunes. While not extensively cleared, it has been degraded by grazing by domestic stock and feral animals that use the Black Box trees as shade.

5.4.2.3 Black Bluebush low open shrubland of the alluvial plains and sandplains of the arid and semi-arid zones

Vegetation formation: Arid Shrublands (Chenopod sub-formation)

Vegetation class: Riverine Chenopod Shrublands **PCT ID:** 153

Threatened ecological community (BC Act and EPBC Act): Listed in BioNet Vegetation Classification as Artesian Springs Ecological Community in the Great Artesian Basin (Endangered – BC Act). However, this vegetation is not located within an area recognised as an artesian spring and therefore does not meet the definition of this TEC (refer to **Section 5.7** for discussion).

Not a vegetation zone as occurs outside direct impact area: Plot 27

The Black Bluebush low open shrubland of the alluvial plains and sandplains of the arid and semi-arid zones, PCT 153, is described in the BioNet Vegetation Classification database as a mid-high open shrubland generally less than one meter high dominated by Black Bluebush (*Maireana pyramidata*) which may be dominant. Scattered low trees of Black Oak (*Casuarina pauper*) or Western Rosewood (*Alectryon oleifolius* subsp. *Canescens*) may be present. Tall shrubs are rare or absent and may include *Eremophila sturtii*. Other chenopod shrub species include Thorny Saltbush (*Rhagodia spinescens*), bluebushes such as *Maireana georgei*, *Maireana sedifolia* and *Maireana appressa*, Bladder Saltbush (*Atriplex vesicaria* sens lat), *Atriplex lindleyi* and *Atriplex pumillio*, Cannonball (*Dissocarpus paradoxus*), Ruby Saltbush (*Enchylaena tomentosa*) and copperburrs such as *Sclerolaena obliquicuspis*, *Sclerolaena patenticuspis*, *Sclerolaena brachyptera*, *Sclerolaena lanicuspis*, *Sclerolaena 48obilizati*, Sclerolaena tricuspis and Sclerolaena diacantha.

Grass species include the cork-screw grasses *Austrostipa nitida*, *Austrostipa scabra* and *Austrostipa nodosa* and wallaby grass *Austrodanthonia caespitosa*. *Eragrostis dielsii* and *Enneapogon avenaceus* occur in northern areas. Forbs include *Calotis hispidula*, *Tetragonia tetragonioides*, *Goodenia pinnatifida*, *Plantago varia*, Minuria integerrima, *Senecio runcinifolius*, *Brachyscome lineariloba*, *Brachyscome ciliaris* var. *ciliaris*, *Calandrinia eremaea*. Bladder Saltbush may have been more common prior to stock grazing. Weeds include *Hordeum* spp., *Heliotropium europaeum*, *Salvia verbenaca*, *Medicago* spp. And *Salvia verbenacea*. Occurs on red-brown duplex soils with textures of clay loam, sandy-loam or light clay on low sandy rises, undulating sandplains, drainage depressions and prior stream levees in the semi-arid and arid zones of far western NSW extending into South Australia and northern Victoria.

In NSW, Black Bluebush tends to be more common than Pearl Bluebush (ID154). It occurs on soils where the surface sandy layer is deep and contains medium to low levels of lime, whereas Pearl Bluebush tends to dominate areas with lime-rich soils. However, both species commonly co-exist. Black Bluebush is widespread on the transition zone between the eolian sandsheets and the riverine plain in far south-western NSW but also occurs to the north on sandplains and on the Darling River (Baaka) floodplain.

5.5 Vegetation zones and vegetation integrity score

A description of the vegetation zones identified within the direct impact area and the corresponding vegetation integrity (VI) score developed from the BAM Calculator is presented in **Table 5-6.** The VI survey plot data is provided in **Appendix B** and **Appendix C**.

Table 5-6 Vegetation zones directly impacted and vegetation integrity score

Vegetation Zone	PCT ID	PCT name	Broad condition class	PCT area directly impacted (ha)	VI score
1	36	River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains	Good	0.95	75.4
2			Low	1.62	21.2

Vegetation Zone	PCT ID	PCT name	Broad condition class	PCT area directly impacted (ha)	VI score
		mainly in the Darling Riverine Plains Bioregion			
3	39	Coolabah – River Coobah – Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion	Moderate	1.94	57.8
4			Low	0.94	15
5			Poor	0.05	0.9
6	158	Old Man Saltbush – mixed chenopod shrubland of the semi-arid hot (persistently dry) and arid climate zones (north-western NSW)	Moderate	1.94	63.4
7			Poor	0.71	3.5
8			Good	1.99	92.4

5.6 Patch size

A patch is defined in the BAM as an area of intact native vegetation that occurs on the subject land. The patch may extend onto adjoining land beyond the footprint of the development site, and for woody ecosystems, includes native vegetation separated by less than or equal to100 metres from the next area of intact native vegetation. For non-woody vegetation, this gap is reduced to less than or equal to 30 metres. Patch size for each vegetation zone located in the development site was mapped in accordance with Subsection 4.3.2 of the BAM using the following steps:

1) Identify vegetation zones that will be included in the same patch
2) Identify the boundary of any adjoining intact native vegetation which extends beyond the limit of the development site
3) Digitise each patch in a GIS using separate polygons where multiple patches exist
4) Calculate the area of each patch in hectare in a GIS.

The patch was then allocated to a patch size class (<5 ha, 5–24 ha, 25–100 ha or >100 ha). Patch size class is used as a filter in the BAM-C to predict threatened species likely to occur or use habitat on development site.

There are no barriers that break apart vegetation within the riparian corridor. The Darling River (Baaka) itself is not wide enough to separate each side as a separate patch. However, based on aerial imagery and regional vegetation mapping, the patches of riparian woodland either side of the Darling River (Baaka) are contiguous for large distances which create patches greater than 100 hectares in size. As such, the vegetation zones entered in the BAM-C are all contiguous with a maximum patch size class of greater than100 hectares.

5.7 Threatened ecological communities

There are five threatened ecological communities (TECs) listed under the BC Act that could potentially occur in the study area, based on database searches and the regional PCT mapping. These TECs are:

- Coolibah-Black Box Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain and Mulga Lands Bioregions
- Artesian springs ecological community in the Great Artesian Basin
- Myall Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain, Murray-Darling Depression, Riverina and NSW South Western Slopes bioregions
- Acacia loderi shrublands
- Acacia melvillei Shrubland in the Riverina and Murray-Darling Depression bioregions.

The assessment concludes that only one of these TECs (Coolibah-Black Box Woodland) occurs in the development site. Discussion and justification for this conclusion is provided below.

5.7.1 Coolibah-Black Box Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain and Mulga Lands Bioregions

The BioNet Vegetation Classification database lists Coolabah – River Coobah – Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion (PCT 39) as being a part of the listed endangered ecological community named Coolibah-Black Box Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain and Mulga Lands Bioregions.

The 'Coolibah-Black Box Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain and Mulga Lands Bioregions – endangered ecological community listing' (NSW Scientific Committee 2012) describes the endangered ecological community as being found on the grey, self-mulching clays of periodically waterlogged floodplains, swamp margins, ephemeral wetlands, and stream levees. The structure of the community may vary from tall riparian woodlands to very open 'savanna like' grassy woodlands with a sparse midstorey of shrubs and saplings. *Eucalyptus coolabah* (Coolibah) is typically the dominant or subdominant tree species, and it may occur with or without *Acacia stenophylla* (River Cooba), *Acacia salicina* (Cooba), *Casuarina cristata* (Belah), *Eremophila bignoniiflora* (Eurah), *Eucalyptus largiflorens* (Black Box), *Eucalyptus camaldulensis* (River Red Gum) and *Eucalyptus populnea* subsp. *Bimbil* (Bimble Box). The distribution of this TEC is limited to the Darling Riverine Plains and Brigalow Belt South bioregions.

The occurrence of PCT 39 in the development site meets the description of this TEC (refer to **Section 5.4.1.2**), as it is generally dominated by *Eucalyptus coolabah* with some of the listed accompanying species and it is located on grey, alluvial clays of the Darling River (Baaka) floodplain. There are no condition thresholds described in the TEC listing advice (NSW Scientific Committee 2012), therefore all vegetation zones (condition classes) within the development site are included in the TEC listing.

This TEC is not recognised as a serious and irreversible impact (SAII) entity (refer to **Section 6.4.3** for discussion of SAII).

5.7.2 Artesian springs ecological community in the Great Artesian Basin

Three PCTs identified within the study area (PCT 158, PCT 247 and PCT 153) are listed in the BioNet Vegetation Classification database as being associated (in part) with the Artesian springs ecological community in the Great Artesian Basin TEC, listed as endangered under the BC Act.

The 'Artesian Springs Ecological Community in the Great Artesian Basin – critically endangered ecological community listing' (NSW Scientific Committee 2015) describes the endangered ecological community as being naturally restricted to artesian springs at the southern and western margins of the Great Artesian Basin in north western NSW. The springs are characterised by mounds of sediment and salts deposited as water evaporates or may be depressions.

Wilcannia sits just outside the mapped boundary of the Great Artesian Basin. No artesian springs were identified within the study area. The occurrences of PCT 153, PCT 158 and PCT 247 are within the floodplain of the Darling River (Baaka) and likely predominately influenced by flooding. Therefore, these PCTs do not meet the requirements to be classed under the Artesian springs ecological community listing.

5.7.3 Myall Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain, Murray-Darling Depression, Riverina and NSW South Western Slopes bioregions

The 'Myall Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain, Murray-Darling Depression, Riverina and NSW South western Slopes bioregions – Determination to make a minor amendment to Part 3 of Schedule 1 of the Threatened Species Conservation Act' (NSW Scientific Committee 2011a) describes the Myall Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain,

Murray-Darling Depression, Riverina and NSW South western Slopes as a low woodland and low open woodland to low sparse woodland or open shrubland, with a tree layer up to a height of about ten metres and invariably includes *Acacia pendula* (Weeping Myall or Boree) as one of the dominant species or the only tree species present.

There were no vegetation communities meeting this description that occurred within or around the study area.

5.7.4 Acacia loderi shrublands

The 'Acacia loderi Shrublands – Determination to make a minor amendment to Part 3 of Schedule 1 of the Threatened Species Conservation Act' (NSW Scientific Committee 2011b) describes this TEC as a plant community that is dominated by the tall shrub/small tree *Acacia loderi*, with other tree species that may occur in association including *Acacia aneura*, *Acacia oswaldii*, *Callitris gracilis*, *Casuarina pauper* and *Flindersia maculosa*.

There were no vegetation communities meeting this description that occurred within or around the study area.

5.7.5 Acacia melvillei Shrubland in the Riverina and Murray-Darling Depression bioregions

The 'Acacia melvillei Shrubland in the Riverina and Murray-Darling Depression bioregions – endangered ecological community listing' (NSW Scientific Committee 2008) describes this TEC as a plant community that is dominated by *Acacia melvillei* and typically occupies sandhills and undulating sandplains in south-western NSW.

There were no vegetation communities meeting this description that occurred within or around the study area.

5.8 Groundwater dependent ecosystems

The level of groundwater dependence of vegetation communities in the study area has been identified using the National GDE Atlas – Atlas of Groundwater Dependent Ecosystems (GDEs) (Bureau of Meteorology, 2020) and the Risk Assessment Guidelines for Groundwater Dependant Ecosystems released by the NSW DPI (Kuginis *et al.*, 2012).

There are three types of GDEs generally recognised and these are as listed on the National GDE Atlas:

- **Aquatic ecosystems** that rely on the surface discharge of groundwater – including surface water ecosystems which may have a groundwater component, such as rivers, wetlands and springs
- **Terrestrial ecosystems** that rely on the subsurface presence of groundwater – including forests and riparian vegetation
- **Subterranean ecosystems** – including caves and aquifer ecosystems.

Potential aquatic and terrestrial GDEs have been identified on the national database in the study area:

- **Aquatic GDEs:** Darling River (Baaka) and the encompassing floodplains have been identified as having a high potential for groundwater dependence based on national assessment.
- **Terrestrial GDEs**: floodplain PCTs surrounding the Darling River (Baaka) have been identified as having as known and high potential for groundwater dependence based on regional studies, this includes downstream of the proposed weir as shown in **Plate 5-1**. The National Atlas identifies most of the study area and surrounding floodplain areas of the Darling River (Baaka) as containing moderate to high potential groundwater dependent terrestrial vegetation. The National Atlas dataset uses the same polygons as the State Vegetation Type Map: Western Region Version 1.0. VIS_ID 4492 (Office of Environment and Heritage, 2019) which has been shown to be moderately accurate.

The PCTs identified in the study area (including the development site) and the area to be directly impacted (development site and broader study area direct impact area) that correspond with terrestrial GDE mapping are shown in **Table 5-7**.

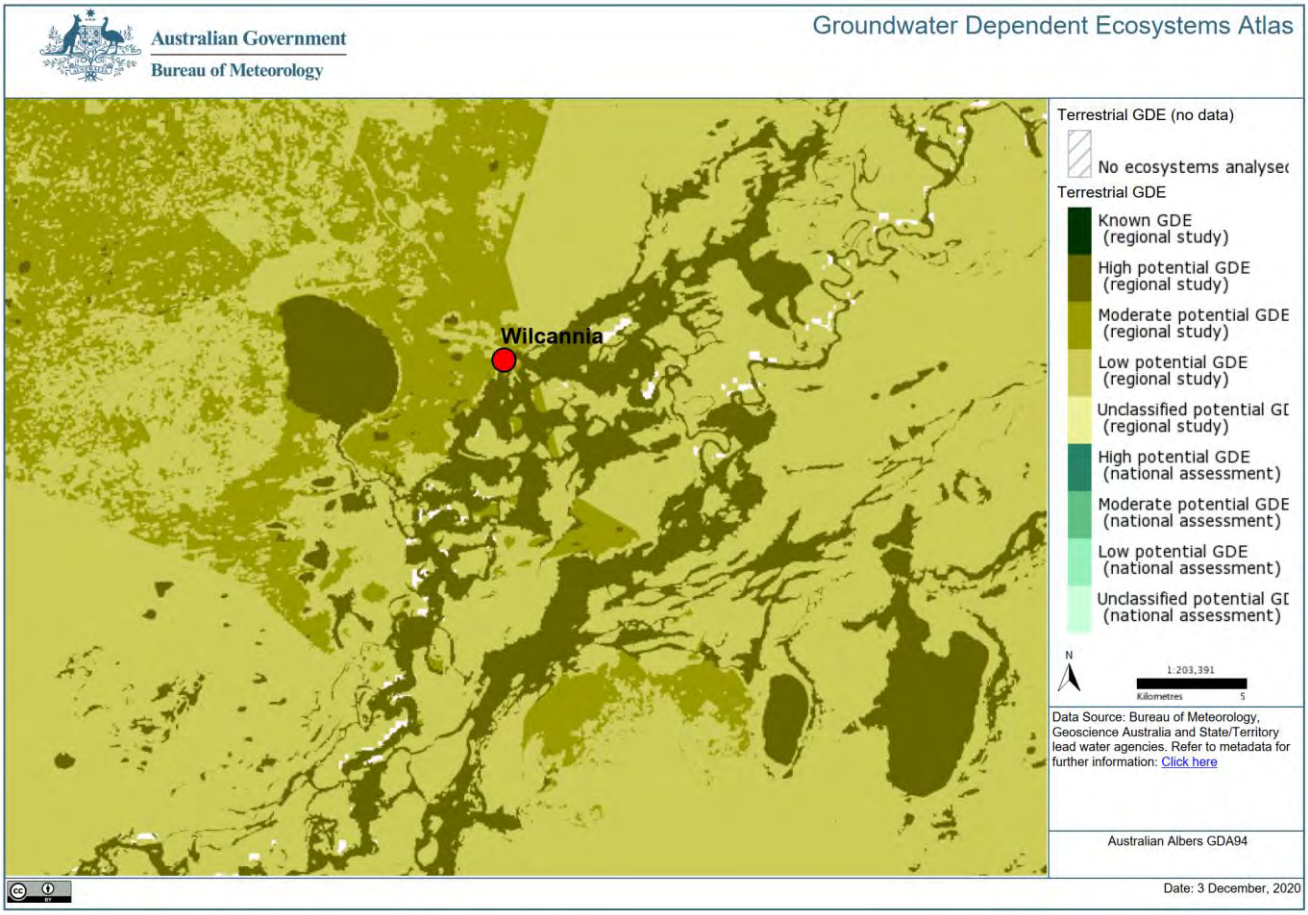

Plate 5-1 Terrestrial GDE's in broader locality surrounding the development site (BoM, 2020)

Table 5-7 Groundwater dependent ecosystems in the study area (including the development site) and the area to be directly impacted (development site and broader study area direct impact area)

GDE potential*	Associated PCT	GDE type**	**Area within study area (ha)**	**Area in direct impact area (ha)**
High	River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion (PCT 36)	Proportional facultative	70.0	2.57
	Coolabah – River Coobah – Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion (PCT 39)	Proportional facultative	282.0	2.94
	Old Man Saltbush – mixed chenopod shrubland of the semi-arid hot (persistently dry) and arid climate zones (north-western NSW) (PCT 158)	Proportional facultative	352.3	4.64
	Lignum shrubland wetland on regularly flooded alluvial depressions in the Brigalow Belt South Bioregion and Darling Riverine Plains Bioregion (PCT 247)	Proportional facultative	31.3	Outside of direct impact area

GDE potential*	Associated PCT	GDE type**	**Area within study area (ha)**	**Area in direct impact area (ha)**
Medium	Black Box low woodland wetland lining ephemeral watercourses or fringing lakes and clay pans of semi-arid (hot) and arid zones (PCT 38)	Opportunistic facultative	6.0	Outside of direct impact area
	Black Bluebush low open shrubland of the alluvial plains and sandplains of the arid and semi-arid zones (PCT 153)	Opportunistic facultative	2.9	Outside of direct impact area

**GDE potential as recognised by the Atlas of GDEs (Bureau of Meteorology, 2020)*

***GDE type determined using Risk Assessment Guidelines for Groundwater Dependant Ecosystems released by the NSW DPI (Kuginis et al., 2012).*

Using the Risk Assessment Guidelines for Groundwater Dependant Ecosystems released by the NSW DPI (Kuginis *et al.*, 2012), it is unlikely that the PCTs shown in **Table 5-7** have a total reliance on groundwater. However, being located within the floodplain PCT 36, PCT 39, PCT 158 and PCT 247 are likely to be proportional facultative GDEs that depend on the subsurface presence of groundwater (often accessed via the capillary fringe – subsurface water just above the water table) for a proportion of their water requirements in some locations but not in others, particularly where an alternative source of water (rainfall) cannot be accessed to maintain ecological function. PCT 38 and PCT 153, being located on the edges of the alluvial soils, are likely to be opportunistic facultative, using groundwater when available. These facultative GDEs may use groundwater during periods of low flow or drought.

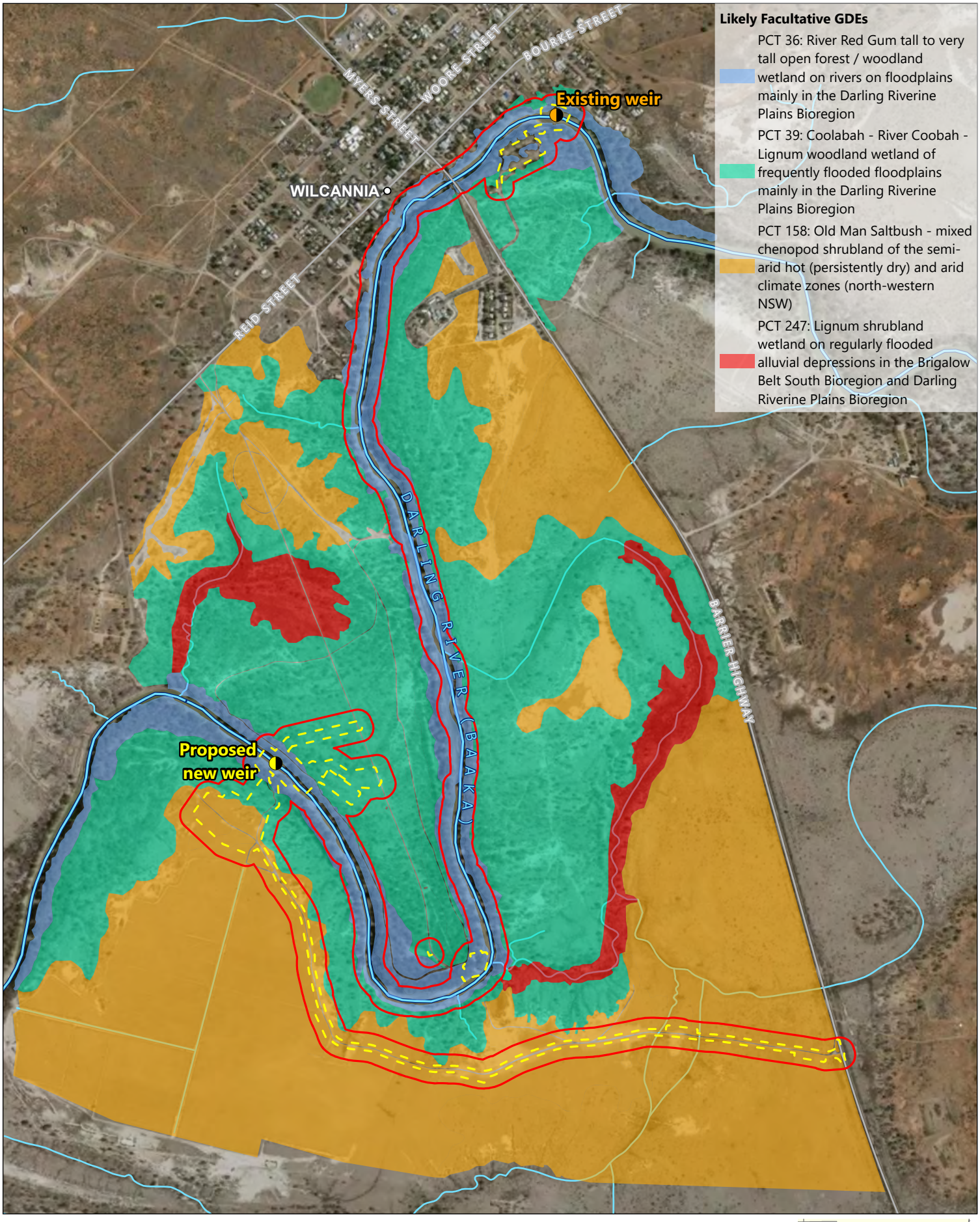

Figure 5-3: Groundwater dependent ecosystems

5.9 Survey limitations

The desktop assessment and field survey undertaken for this BDAR provide a limited view into the ecological values of the study area. The diversity of flora and fauna species recorded from this study should not be seen to be comprehensive. It is unlikely that every species present within the study area has been recorded. The field survey aimed to sample the study area and a comprehensive inventory of species was not made. A period of several seasons or years is often needed to identify all the species present in an area, especially as some species are only apparent at certain times of the year (orchids or migratory birds) and require specific weather conditions for optimum detection (breeding and flowering periods). The conclusions of this report are therefore based upon available data and are indicative of the environmental condition of the development site at the time of the survey. It should be recognised that site conditions, including the presence of threatened species, can change with time. To address this limitation, the assessment has aimed to identify the presence and suitability of the habitat for threatened species. All surveys have been conducted in accordance with the BAM and best practice guidelines.

In many cases there are no clear lines defining the transition between PCTs, so the vegetation mapping provided in this BDAR is supported by on ground floristic surveys and observations of potential ecotones. Plant communities are naturally variable and the boundaries between different PCTs on this site overlap considerably with a gradual transition from one community to another. However, a choice must be made to map and assign a PCT to an area of the site. As mapping necessitates that a hard boundary is drawn to separate PCTs, boundaries of PCTs and vegetation zones have been mapped as best as possible based on observations made during the field survey and based on patterns observed on aerial photography. It is likely that the boundaries of PCTs and vegetation zones will change with time and in response to long-term variation in biophysical conditions on the site such as rainfall and surface drainage patterns.

While conditions in floodplain areas are subject to distinct patterns of inundation and drying, and this is known to effect species presence-absence, the field surveys for this assessment were conducted following a period of four months of above average rainfall, with October 2020 recording 53.4 millimetres, nearly double the monthly average. **Table 5-8** shows 2020 experienced a high rainfall year, recording a total of 341.2 millimetres against an annual average of 264.7 millimetres. Compared to previous years where this region was considered to be in drought, the conditions preceding the field survey were good and likely to have been sufficient to provide a realistic representation of the condition of biodiversity values within the study area. This information adds confidence to the field survey data collected.

Table 5-8 Monthly rainfall data from 2017 to 2020 recorded at Wilcannia (Reid St) weather station 46043 (Bureau of Meteorology 2020)

Year	Rainfall (mm)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2017	27	-	3.2	22.6	4.8	5.4	13.6	9.2	0	-	8.2	58.2
2018	3.6	0.8	14.2	-	1.4	5.4	0	3.6	1.8	14.8	14.7	10.8
2019	20.2	0.4	9.8	78.4	23.2	7.4	25.4	0	0	-	23.2	3
2020	42	1.8	64.2	58.8	5.2	0.8	22	27.8	38.4	53.4	6.2	20.6
Average	**26.1**	**25.6**	**24.5**	**18.1**	**23.4**	**22.5**	**18.1**	**17.6**	**16.5**	**24.8**	**20.5**	**25.8**

Key – Red cells signify below monthly average rainfall and green cells signify above monthly average rainfall.

6. Threatened species

6.1 Background research and data sources

The Biodiversity Assessment Calculator (BAM-C) was used to derive the initial list of candidate species for this assessment by entering likely PCTs based on regional vegetation mapping (VIS_ID 4492). The results were also supplemented with database searches and recent work (GHD, 2020), including a review of the Threatened Biodiversity Data Collection, to identify the threatened species that have been recorded by previous surveys or are considered likely to occur in the locality and the study area. Due to the remoteness of the study area, the BioNet and Protected Matters Search Tool (PMST) databases were searched for records of threatened species with a 20-kilometre buffer.

The following databases and information sources were reviewed to prepare a list of potential threatened and migratory species for survey:

- Biodiversity Assessment Calculator (BAM-C) – case number 00022314/BAAS19068/20/00022315
- BioNet – the website for the Atlas of NSW Wildlife and Threatened Species Profile Database – searched 15 October 2020
- DoAWE Protected Matters Search Tool (PMST) – searched 15 October 2020
- NSW Biodiversity Values Map and Threshold Tool – reviewed 12 October 2020
- Important Area Maps – reviewed 12 October 2020
- State Vegetation Type Map: Western Region Version 1.0. VIS_ID 4492 (Office of Environment and Heritage, 2019).

The EIS Scoping Report completed for the Wilcannia Weir Replacement (GHD, 2020) was reviewed and the results were used to inform the preparation of this BDAR.

Preliminary and provisional determinations to list species and ecological communities as threatened under the BC Act were viewed on the EESG NSW Threatened Species Scientific Committee website. At the time of writing, there are no preliminary or provisional listings of relevance to the proposal. The annual Final Priority Assessment List of nominated species and ecological communities that have been approved for assessment by the Minister responsible for the EPBC Act was last reviewed in September 2021.

6.2 Threatened species habitat assessment

This section describes the process of assessing the habitat types within the development site and broader study area and the habitat suitability assessment for threatened species as outlined in Section 5 of the BAM.

6.2.1 Habitat types

The broad habitat types identified within the study area, including the development site, along with the corresponding PCT, are outlined in **Table 6-1**. Four vegetation classes (Keith, 2004) recognised as four broad habitat types were identified, three of which occur within the direct impact area, all habitats are well represented in adjacent vegetation and the locality.

The four habitat types include:

- Inland Riverine Forests (see **Photo 6-1**) – this habitat is typically an open eucalypt forest with a dense to patchy, species-rich, herbaceous groundcover interspersed with bare ground and scattered shrubs. It occurs on fertile alluvium subject to frequent flooding on the sandy banks of major inland rivers and the beds of intermittent streams, billabongs and channelled floodplains. Within the study area, the riparian vegetation along the Darling River (Baaka) (PCT 36) falls into this habitat type and contains very large

(one to two metre DBH) *Eucalyptus camaldulensis* with a high density of hollows. Leaf litter is thick under dense canopy cover and large woody debris is abundant

- North-west Floodplain Woodlands (see **Photo 6-2**) – typically a Eucalypt woodland, this habitat has an open but variable shrub stratum and semi-continuous groundcover of perennial and ephemeral grasses and forbs. It occurs on heavy texture soils on active channel floodplains of the upper Darling and tributaries receiving less than 500 millimetres of annual rainfall. Within the study area, this habitat occurs on the floodplain around the Darling River (Baaka) and consists of PCT 38 and PCT 39. Large trees (to one metre) with hollows are common in this habitat type in the study area
- Riverine Chenopod Shrublands (see **Photo 6-3**) – this habitat is a treeless, open chenopod shrubland with groundcover of forbs and grasses. It occurs on Extensive level or depressed alluvial plains and dry lake beds, often semi-saline, with deep grey-brown clays on semi-arid floodplains. Within the study area, this habitat occurs on the floodplain around the Darling River (Baaka) and consists of PCT 158 and PCT 153
- Inland Floodplain Shrublands (see **Photo 6-4**) – this habitat is a treeless, closed to open shrubland up to two metre tall with a groundcover of graminoids and forbs. It occurs on occasionally inundated depressions near active watercourses, often in narrow strips below river levees, on semi-arid floodplains. This habitat occurs just outside of the study area, in depressions and drainage lines on the floodplain around the Darling River (Baaka) and consists of PCT 247.

Figure 6-1 shows the location of the habitat types within the development site and study area.

Table 6-1 Extent of broad habitat types and corresponding PCTs within the study area (including the development site) and the area directly impacted (direct impact area)

PCTs	Vegetation formation (Keith, 2004)	Vegetation class (Keith, 2004) / habitat type	Area directly impacted (ha)	Extent in study area (ha)
PCT 36	Forested Wetlands	Inland Riverine Forests	2.57	70.0
PCT 38 PCT 39	Semi-arid Woodlands (Grassy sub-formation)	North-west Floodplain Woodlands	2.93	288.0
PCT 158 PCT 153	Arid Shrublands (Chenopod sub-formation)	Riverine Chenopod Shrublands	4.64	355.2
PCT 247	Freshwater Wetlands	Inland Floodplain Shrublands	n/a	31.3

Photo 6-1 An example of the Inland Riverine Forests habitat type (PCT 36) within the study area

Photo 6-2 An example of the North-west Floodplain Woodlands habitat type (PCT 39) within the study area

Photo 6-3 An example of the Riverine Chenopod Shrublands habitat type (PCT 158) within the study area

Photo 6-4 An example of the Inland Floodplain Shrublands habitat type (PCT 247) within the study area

1 of 4

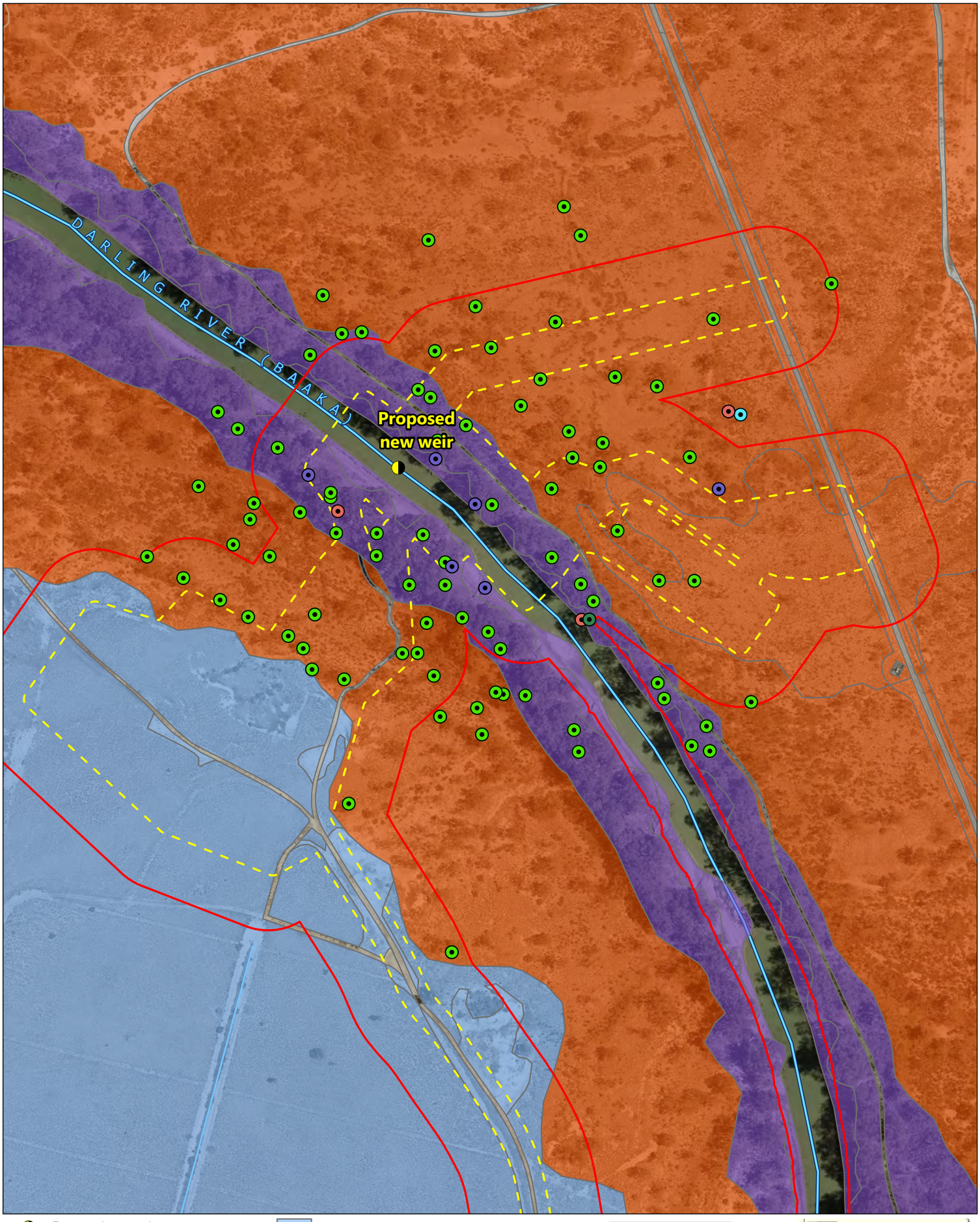

Figure 6-1: Terrestrial habitat types and habitat features within the study area - 1 of 4

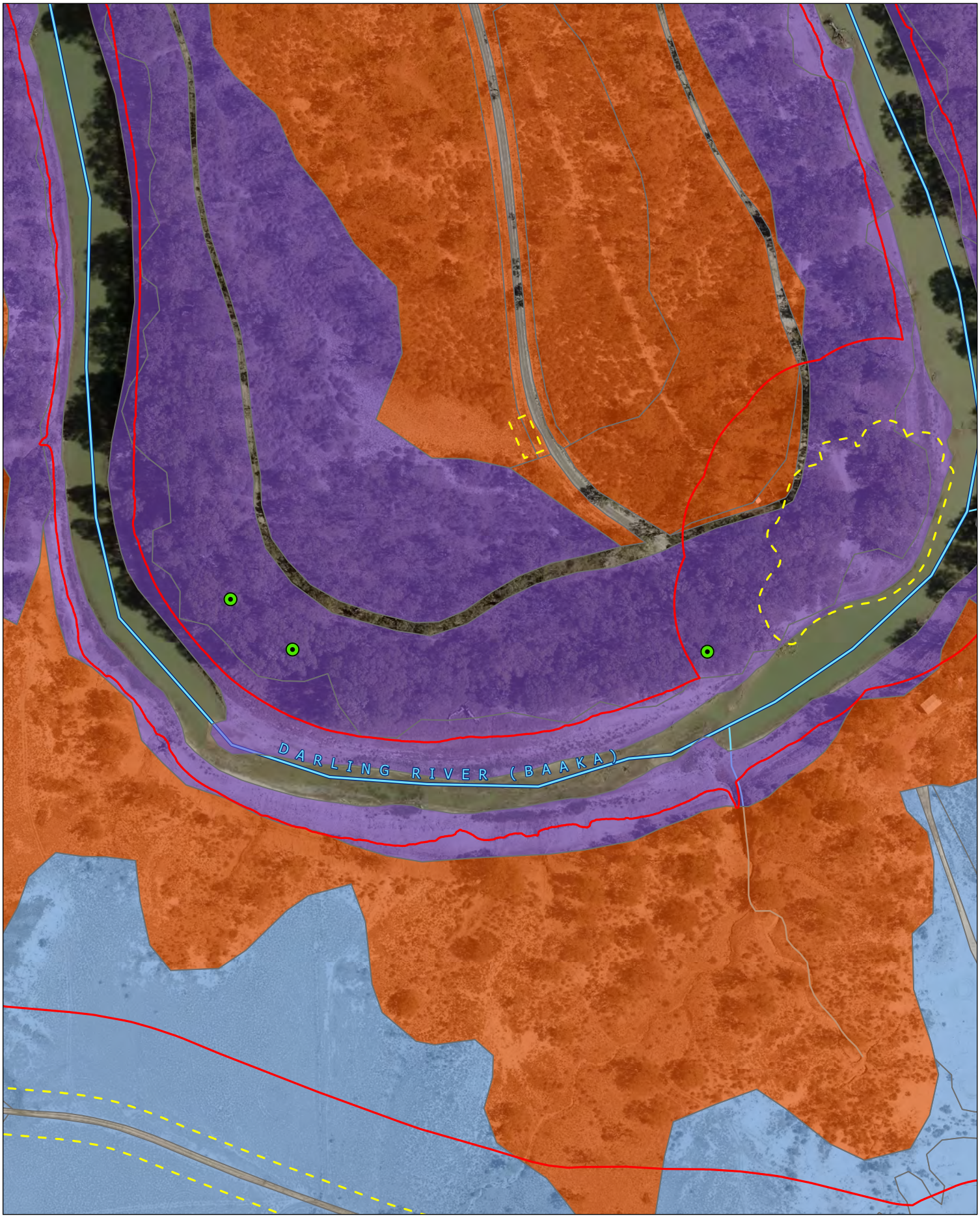

Figure 6-1: Terrestrial habitat types and habitat features within the study area - 2 of 4

Figure 6-1: Terrestrial habitat types and habitat features within the study area - 3 of 4

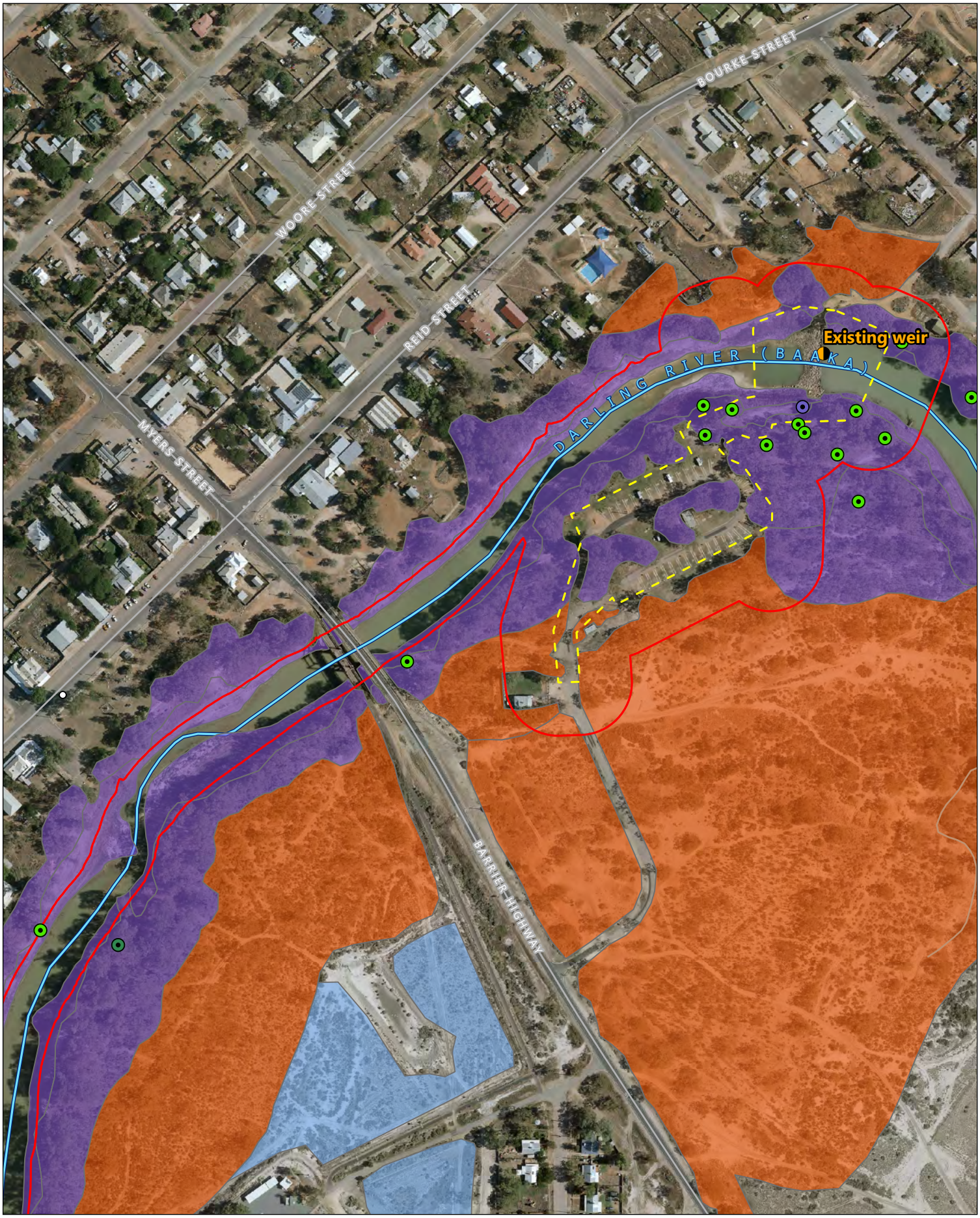

Figure 6-1: Terrestrial habitat types and habitat features within the study area - 4 of 4

6.2.2 Habitat suitability for species that can be predicted by habitat surrogates (ecosystem-credit species)

Ecosystem credit species are those threatened species where the likelihood of occurrence of a species or elements of the species' habitat can be predicted by vegetation surrogates and landscape features, or for which targeted survey has a low probability of detection. Ecosystem credit threatened species have been assessed in conjunction with information about site context (Section 1 and Chapter 3 of the BAM), PCTs and vegetation integrity attributes (Chapter 4 of the BAM), and data from the Threatened Biodiversity Data Collection (TBDC).

The BAM-C was used to generate a list of the predicted threatened species that met the criteria outlined in Section 5.2.1 of the BAM. The results of the BioNet Atlas search and the federal DoAWE PMST, and the EIS Scoping Report (GHD, 2020) were also used to inform development of the species list.

The initial list of predicted ecosystem-credit species is provided in **Table 6-2**. The full threatened species habitat suitability assessment is provided in **Appendix A**. Note that the justification for inclusion / exclusion included in **Table 6-2** is an assessment of potential habitat availability for each ecosystem-credit species and does not necessarily align with the likelihood of that species occurring in the development site, as detailed in **Appendix A**.

Once the initial list of predicted ecosystem-credit species was generated, the geographic limitations of each species (where applicable) were examined to see if they were met. Geographic limitations usually relate to altitude or topographic features and different geographic limitations can be described for different IBRA bioregion and subregions across a species' distribution. Where the development site is not within the geographic limitation described for a species, the species was removed from the predicted list of threatened species and no further assessment was undertaken. However, no geographic limitations were identified for any of the species listed in **Table 6-2**.

In accordance with Section 5.2.2 (Step 2) of the BAM, an onsite assessment was undertaken to determine the presence of any habitat constraints or microhabitats for the threatened species predicted to occur on the development site. Most species do not have any identified habitat constraints, in which case this step was not undertaken. As shown in **Table 6-2**, four ecosystem-credit species were identified as having habitat constraints.

- The development site contains waterbodies and is therefore suitable for the Australasian Bittern and White-bellied Sea-Eagle
- There are no mapped important areas within or near the development site for the Black-tailed Godwit. The BAM-C identifies this as a habitat constraint for the ecosystem-credit component for this species (given it is a dual credit species), however the TBDC states that mapped important areas constitute the Black-tailed Godwit's species-credit component. The BAM-C and TBDC do not align with this information. This species has been included as an ecosystem-credit species
- The Painted Honeyeater requires mistletoes present at a density of greater than five mistletoes per hectare for foraging. The development site contains a moderate density of dead mistletoes, however only several live plants were identified across the entire study area and did not match the density requirements. This species was therefore excluded.

Under the BAM, targeted survey is not required for ecosystem-credit species. In some circumstances, the TBDC may identify that a species requires assessment for ecosystem-credits and species-credits (a dual credit species). This occurs where part of the habitat is assessed as a species-credit (breeding habitat, or mapped locations identified as important area that is used by a species). The remaining part of the habitat is assessed as an ecosystem-credit (foraging habitat, unmapped locations used by a species). Therefore, some species (Black-tailed Godwit) are listed in both **Table 6-2** and **Table 6-3** as an ecosystem-credit species and a species-credit species.

Table 6-2 Predicted ecosystem-credit species identified by the BAM-C

Species name	Common name	EPBC Act	BC Act	Habitat constraints and geographic limitations	Justification for inclusion / exclusion	Sensitivity to gain class
Birds						
Artamus cyanopterus cyanopterus	Dusky Woodswallow	-	V	None	Included for all zones. Habitat for this species is widespread in the study area.	Moderate
Botaurus poiciloptilus	Australasian Bittern	E	E	Habitat constraints: ▪ Waterbodies ▪ Brackish or freshwater wetlands	Included for PCT 36, and PCT 39, excluding zones of low and disturbed condition.	Moderate
Calyptorhynchus 65obiliz samueli	Red-tailed Black-Cockatoo (inland subspecies) (foraging)	-	V	None	Included for PCT 36 and PCT 39, excluding zones of low and disturbed condition.	High
Certhionyx variegatus	Pied Honeyeater	-	V	None	Included for PCT 36 and PCT 39, excluding zones of low and disturbed condition.	Moderate
Circus assimilis	Spotted Harrier	-	V	None	Included for all zones.	Moderate
Daphoenositta chrysoptera	Varied Sittella	-	V	None	Included for PCT 36 and PCT 39, excluding zones of low and disturbed condition.	Moderate
Epthianura albifrons	White-fronted Chat	-	V	None	Included for all zones of PCT 158.	Moderate
Falco hypoleucos	Grey Falcon	V	E	None	Included for all zones.	Moderate
Falco subniger	Black Falcon	-	V	None	Included for all zones.	Moderate
Grantiella picta	Painted Honeyeater	V	V	Habitat constraints: ▪ Mistletoes present at a density of greater than five mistletoes per hectare	Excluded. Vegetation in the development site did not contain the required density of mistletoes.	Moderate
Grus rubicunda	Brolga	-	V	None	Included for all zones.	Moderate
Haliaeetus leucogaster	White-bellied Sea-Eagle (foraging)	M	V	Habitat constraints: ▪ Within 1km of a rivers, lakes, large dams or creeks, wetlands	Included for all zones.	High

Species name	Common name	EPBC Act	BC Act	Habitat constraints and geographic limitations	Justification for inclusion / exclusion	Sensitivity to gain class
				and coastlines		
Hamirostra melanosternon	Black-breasted Buzzard (foraging)	-	V	None	Included for all zones.	Moderate
Hieraaetus morphnoides	Little Eagle (foraging)	-	V	None	Included for all zones.	Moderate
Limosa limosa	Black-tailed Godwit (foraging)	M	V	Habitat constraints: ▪ As per mapped areas	Included for PCT 39, excluding zones of low and disturbed condition. There are no mapped important areas within or near the development site. The BAM-C identifies this as a habitat constraint for the ecosystem-credit component for this species, however the TBDC states that important areas constitute the Black-tailed Godwit's species-credit component. The BAM-C and TBDC do not align with this information. This species has been included as an ecosystem-credit species.	High
Lophochroa leadbeateri	Major Mitchell's Cockatoo (foraging)	-	V	None	Included for PCT 36, PCT 39 and 158, excluding zones of low and disturbed condition.	Moderate
Lophoictinia isura	Square-tailed Kite (foraging)	-	V	None	Included for all zones.	Moderate
Melanodryas cucullata	Hooded Robin (south-eastern form)	-	V	None	Included for PCT 36 and PCT 39, excluding zones of low and disturbed condition.	Moderate
Ninox connivens	Barking Owl (foraging)	-	V	None	Included for PCT 36, and PCT 39.	High
Phaps histrionica	Flock Bronzewing	-	E	None	Included for PCT 158.	Moderate
Pomatostomus temporalis	Grey-crowned Babbler (eastern subspecies)	-	V	None	Excluded. This western extent of this subspecies is described as being the western plains reaching as far as Louth and Balranald. Wilcannia is west of these locations so is presumable outside of the	Moderate

Species name	Common name	EPBC Act	BC Act	Habitat constraints and geographic limitations	Justification for inclusion / exclusion	Sensitivity to gain class
					range of the eastern subspecies.	
Pyrrholaemus brunneus	Redthroat	-	V	None	Included for all zones of PCT 158.	Moderate
Rostratula australis	Australian Painted Snipe	E	E	None	Included for PCT 36, and PCT 39, excluding zones of low and disturbed condition.	Moderate
Stagonopleura guttata	Diamond Firetail	-	V	None	Included for PCT 36, and PCT 39.	Moderate
Stictonetta naevosa	Freckled Duck	-	V	None	Included for PCT 36.	Moderate
Tyto novaehollandiae	Masked Owl (foraging)	-	V	None	Included for PCT 36, and PCT 39.	High
Mammals						
Antechinomys laniger	Kultarr	-	E	None	Included for PCT 39, PCT 158.	High
Chalinolobus picatus	Little Pied Bat	-	V	None	Included for all zones.	High
Leggadina forresti	Forrest's Mouse	-	V	None	Included for PCT 158.	High
Phascolarctos cinereus	Koala (foraging)	V	V	None	Included for PCT 36 and PCT 39 excluding zones of low and disturbed condition.	High
Rattus villosissimus	Long-haired Rat	-	V	None	Included for PCT 158.	High
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	-	V	None	Included for all zones.	High
Sminthopsis macroura	Stripe-faced Dunnart	-	V	None	Included for all zones.	High
Reptiles						
Pseudonaja modesta	Ringed Brown Snake	-	E	None	Included for PCT 39 and PCT 158.	Moderate

Key: E = Endangered, V = Vulnerable, M = Migratory

6.2.3 Habitat suitability for species that cannot be predicted by habitat surrogates (species-credit species)

Habitat suitability is identified as the degree to which the habitat needs of threatened species are present at a particular site. Species credit species have been assessed in conjunction with information collected about the context of the development site (Section 3 of the BAM), on PCTs and vegetation integrity attributes in (Section 4 of the BAM), and data obtained from the TBDC (Section 5.2 of the BAM).

Threatened species for which the likelihood of occurrence of the species (or elements of suitable habitat for the species) cannot be confidently predicted by vegetation surrogates and landscape features, and which can be reliably detected by survey, are identified in the TBDC as species-credit species. Based on the assessment

of habitat in the study area, and review of databases and published information, the species-credit species outlined in **Table 6-3** are considered 'candidate species' for the assessment. The full threatened species habitat suitability assessment is provided in **Appendix A**.

Table 6-3 Candidate species-credit species identified by the BAM-C

Species name	Common name	EPBC Act	BC Act	Sensitivity to gain class
Plants				
Atriplex infrequens	A saltbush	V	V	High
Convolvulus tedmoorei	Bindweed	-	V	High
Phyllanthus maderaspatensis	*Phyllanthus maderaspatensis*	-	E	High
Swainsona murrayana	Slender Darling Pea	V	V	High
Birds				
Ardeotis australis	Australian Bustard	-	E	High
Burhinus grallarius	Bush Stone-curlew	-	E	High
Calyptorhynchus 68obiliz samueli	Red-tailed Black-Cockatoo (inland subspecies) (breeding)	-	V	High
Haliaeetus leucogaster	White-bellied Sea-Eagle (breeding)	Marine	V	High
Hamirostra melanosternon	Black-breasted Buzzard (breeding)	-	V	Moderate
Hieraaetus morphnoides	Little Eagle (breeding)	-	V	Moderate
Limosa limosa	Black-tailed Godwit (breeding)	M	V	High
Lophochroa leadbeateri	Major Mitchell's Cockatoo (breeding)	-	V	High
Lophoictinia isura	Square-tailed Kite (breeding)	-	V	Moderate
Ninox connivens	Barking Owl (breeding)	-	V	High
Tyto novaehollandiae	Masked Owl (breeding)	-	V	High
Mammals				
Phascolarctos cinereus	Koala (breeding)	V	V	High
Reptiles				
Antaresia stimsoni	Stimson's Python	-	V	High

Key: CE = Critically Endangered, E = Endangered, V = Vulnerable, M = Migratory

6.2.3.1 Identifying geographic and habitat constraints

Once the initial list of predicted candidate species-credit species was generated, the geographic limitations of each species (where applicable) were examined to see if they were met. Where the development site is not within the geographic limitation described for a species, the species was removed from the predicted list of threatened species and no further assessment was undertaken. In accordance with Section 5.2.2 (Step 2) of the BAM, an onsite assessment was undertaken to determine the presence of any habitat constraints or microhabitats for the threatened species predicted to potentially occur on the development site. A habitat assessment within the study area was used to identify the habitat elements listed in **Table 6-4** for each species. Some species do not have any identified habitat constraints, in which case this step was not undertaken. The species included or excluded based on geographic or habitat constraints are outlined below in **Table 6-4.**

Table 6-4 Candidate species-credit species identified by the BAM-C with geographic limitations or habitat constraints

Species name	Common name	EPBC Act	BC Act	Sensitivity to gain class	Habitat constraint	Geographic limitation	Assessment
Plants							
Phyllanthus maderaspatensis	-	-	E	High	Floodplains and/or clay soils	None	Included – Habitat constraint present in development site.
Birds							
Burhinus grallarius	Bush Stone-curlew	-	E	High	Fallen/standing dead timber including logs	None	Included – Habitat constraint present in development site.
Calyptorhynchus 69obiliz samueli	Red-tailed Black-Cockatoo (inland subspecies) (breeding)	-	V	High	Living or dead tree with hollows greater than 15 centimetres diameter and greater than five metres above ground	None	Included – Habitat constraint present in development site.
Haliaeetus leucogaster	White-bellied Sea-Eagle (breeding)	M	V	High	Living or dead mature trees within suitable vegetation within one kilometre of rivers, lakes, large dams or creeks, wetlands and coastlines	None	Included – Habitat constraint present in development site.
Hamirostra melanosternon	Black-breasted Buzzard (breeding)	-	V	Moderate	Land within 40m of riparian woodland on inland watercourses / waterholes containing dead or dying eucalypts	None	Included – Habitat constraint present in development site.
Hieraaetus morphnoides	Little Eagle (breeding)	-	V	Moderate	Nest trees – live (occasionally dead) large old trees within vegetation	None	Included – Habitat constraint present in development site.
Lophochroa leadbeateri	Major Mitchell's Cockatoo (breeding)	-	V	High	Living or dead tree with hollows greater than 10 centimetres diameter	None	Included – Habitat constraint present in development site.
Lophoictinia isura	Square-tailed Kite (breeding)	-	V	Moderate	Nest trees	None	Included – Habitat constraint present in development site.
Ninox connivens	Barking Owl (breeding)	-	V	High	Living or dead trees with hollows greater than 20 centimetres diameter and greater than four metres above the ground	None	Included – Habitat constraint present in development site.

Species name	Common name	EPBC Act	BC Act	Sensitivity to gain class	Habitat constraint	Geographic limitation	Assessment
Tyto novaehollandiae	Masked Owl (breeding)	-	V	High	Living or dead trees with hollows greater than 20 centimetres diameter	None	Included – Habitat constraint present in development site.
Mammals							
Phascolarctos cinereus	Koala (breeding)	V	V	High	Areas identified via survey as important habitat	None	Included – Habitat constraint present in development site.
Reptiles							
Antaresia stimsoni	Stimson's Python	-	V	High	Areas within 500 metres of rocks or gibber	None	Excluded – No rocky areas within 500 metres of development site.

Key: CE = Critically Endangered, E = Endangered, V = Vulnerable, M = Migratory

6.2.3.2 Candidate species removed from the assessment

According to Section 5.2.3 (Step 3) of the BAM, a candidate species credit species is considered unlikely to occur on the subject land if one of the following applies:

a. After carrying out a field assessment:

   i. the assessor determines that microhabitats required by a species are absent from the subject land (or specific vegetation zone). This must be based on evidence such as published literature, or

   ii. the assessor determines that the habitat constraints or microhabitats are degraded to the point that the species is unlikely to use the subject land (or specific vegetation zones)

b. An expert report states that the species is unlikely to be present on the subject land or specific vegetation zones.

A field habitat assessment was undertaken to determine whether the habitats within the development site were substantially degraded to the point that a candidate species is unlikely to 70obiliz the development site (or specific vegetation zones). There were a number of threatened species returned from the calculator that are species-credit species if breeding habitat would be impacted. The development site does not contain potential breeding habitat for any of these identified species as follows:

- Stimson's Python requires rocky areas, i.e. surface rock (bedrock or boulder) clearly visible on imagery, possibly as diurnal retreat sites (McDonald *et al.,* 2011). The development site does not contain any rocky areas and is not within 500 metres of any rocky areas. Therefore, this species was removed from the candidate species list
- The Black-tailed Godwit is a dual-credit migratory species that does not breed in Australia. The species-credit component of this species listing is mapped important areas. There are no mapped important areas within or near the development site. This species was removed from the candidate species list
- Despite the presence of habitat features (River Red Gum) there are no known Koala breeding colonies in or near the development site. Targeted survey for this species did not confirm presence of individuals or faecal pellets (scats) further supporting the absence of koalas from the disturbance area. Consequently, the Koala was removed from the candidate species list.

6.2.3.3 Candidate species added to the assessment

The following list of threatened species-credit species were not identified by the BAM-C, though are considered to have a moderate potential of occurring in the development site based on suitable habitat and/or database review of recorded sightings:

- *Solanum karsense* – This species is restricted to the far south-western plains, extending up the Darling River (Baaka) to the Menindee and Wilcannia districts. Mainly restricted to the area between the Darling and Lachlan Rivers. Localities include Kars Station, Lake Tandou, Lake Cawndilla, Oxley area, between Broken Hill and Menindee, and the Darling River (Baaka). It has been recorded from Kinchega National Park and Nearie Lake Nature Reserve. *Solanum karsense* grows in occasionally flooded depressions with heavy soil, including level river floodplains of grey clay with Black Box and Old Man Saltbush, and open treeless plains with solonized brown soils. Habitats are generally lake beds or floodplains of heavy grey clays with a highly self-mulching surface. Also found on sandy floodplains and ridges and in calcareous soils, red sands, red-brown earths and loamy soils. The TBDC does not identify any PCTs within the development site as associated habitat for *Solanum karsense*, however based on the described habitat requirements, parts of the development site may offer suitable habitat for this species. *Solanum karsense* was identified by the PMST and the EIS scoping report (GHD, 2020). As such, it was added to the assessment and targeted during surveys of the development site.
- Squatter pigeon (southern subspecies) – Found from north Queensland to the North West Slopes of NSW and extending down to the Liverpool Plains and Dubbo. Today they are very rare in the southern parts of their range. Found in grassy woodlands and plain, preferring sandy areas and usually close to water. Not associated with the PCTs in the development site but considered to potentially occur given presence of other suitable habitats in the broader study area. Squatter Pigeon was identified by the PMST. As such, it was added to the assessment and targeted during surveys of the development site.

6.2.3.4 Identifying candidate species for further assessment

The list of species retained for further assessment are shown in **Table 6-5.**

Table 6-5 Summary of candidate species-credit species for further assessment

Species name	Common name	EPBC Act	BC Act	Sensitivity to gain class	Potential SAII*	Associated habitat in development site (TBDC)
Plants						
Atriplex infrequens	A saltbush	V	V	High	No	PCT 39, PCT 158
Convolvulus tedmoorei	Bindweed	-	V	High	Yes	PCT 158
Phyllanthus maderaspatensis	Phyllanthus maderaspatensis	-	E	High	No	PCT 36, PCT 39
Solanum karsense	Menindee Nightshade	V	V	Moderate	No	No associated habitat in development site.
Swainsona murrayana	Slender Darling Pea	V	V	High	No	PCT 158
Birds						
Ardeotis australis	Australian Bustard	-	E	High	No	PCT 39, PCT 158
Burhinus grallarius	Bush Stone-curlew	-	E	High	No	PCT 36, PCT 39
Calyptorhynchus 72obiliz samueli	Red-tailed Black-Cockatoo (inland subspecies) (breeding)	-	V	High	No	PCT 36, PCT 39, PCT 158
Geophaps scripta	Squatter Pigeon (southern subspecies)	V	CE	High	Yes	PCT 36, PCT 39
Haliaeetus leucogaster	White-bellied Sea-Eagle (breeding)	Marine	V	High	No	PCT 36, PCT 39, PCT158
Hamirostra melanosternon	Black-breasted Buzzard (breeding)	-	V	Moderate	No	PCT 36, PCT 39, PCT 158
Hieraaetus morphnoides	Little Eagle (breeding)	-	V	Moderate	No	PCT 36,PCT 39, PCT 158
Lophochroa leadbeateri	Major Mitchell's Cockatoo (breeding)	-	V	High	No	PCT 36,PCT 39, PCT 158
Lophoictinia isura	Square-tailed Kite (breeding)	-	V	Moderate	No	PCT 36,PCT 39
Ninox connivens	Barking Owl (breeding)	-	V	High	No	PCT 36, PCT 39
Tyto novaehollandiae	Masked Owl (breeding)	-	V	High	No	PCT 36, PCT 39
Mammals						
Phascolarctos cinereus	Koala (breeding)	V	V	High	No	PCT 36, PCT 39

Note: SAII = Serious and Irreversible Impact Entity as identified by the BAM-C.*

6.3 Targeted threatened species surveys

After the candidate species list had been developed (refer to **Section 6.2**), targeted threatened species surveys were undertaken. The surveys undertaken for candidate threatened species of plants and animals are outlined in the following sections.

6.3.1 Threatened plant surveys

After the PCTs and finer scale habitats within the study area had been identified, and the threatened species habitat assessment had been undertaken, threatened plant surveys were undertaken targeted to the following candidate species:

- *Atriplex infrequens*

- *Convolvulus tedmoorei*
- *Phyllanthus maderaspatensis*
- *Solanum karsense*
- *Swainsona murrayana.*

The threatened flora surveys were guided by the methodology and effort described in the *Surveying threatened plants and their habitats – NSW survey guide for the Biodiversity Assessment Method* (Department of Planning, Industry and Environment, 2020). The application of the described guidelines is not mandatory, but they provide an indication of the effort that is likely required. The main method adopted was walking parallel search transects (about 10-20 metre spacing between observers) and with reference to the species prescribed survey timing in the BioNet TBDC. This approach was used to adequately cover the large areas of potential habitat for the above listed species. Given the vegetation on site was sparse, surveyors had a good line of site and were able to adopt 10-20 metre transect spacing to search for small herbs and sub-shrub species.

To identify habitats that were potentially suitable for the target species identified above, transects were walked through areas of suitable habitat, with a focus on the areas likely to be directly impacted. A description of potential habitat within the study area for each species is detailed below:

- *Atriplex infrequens* has been recorded in Wilcannia and is confined to the NSW far western plains. It is associated with broad drainage tracts, clay flats and possibly inundated habitats. The study area contains habitat that meets the description for this species, which includes all vegetation zones, though less likely in disturbed areas. Therefore, searches for *Atriplex infrequens* were undertaken across the entire development site. Associated habitat listed for *Atriplex infrequens* in the TBDC includes PCT 39, PCT 158, PCT 153 and PCT 38
- *Convolvulus tedmoorei* has been recorded from northern inland areas of South Australia, south-western Queensland and western NSW. There are few known records from NSW, including two areas on the Murrumbidgee and Darling River (Baaka) floodplains in central-western NSW and two other records from east of Broken Hill to Wilcannia, and from the Menindee Road, Scarsdale. The study area is located on grey-brown silty clay alluvium on the Darling River (Baaka) Floodplain, which correlates with the known habitat where the species has been recorded. Associated habitat listed for *Convolvulus tedmoorei* in the TBDC includes PCT 158, which was targeted during surveys, however the surveys were conducted in November which is outside the recorded flowering period for this species (June to September) which is a limitation. As a persistent perennial forb species and given the optimal rainfall conditions experienced for four months prior to the survey, there is a high likelihood that the species would have been detected if present, despite not flowering at the time. Furthermore, this species most closely resembles *Convolvulus clementii* but it can be distinguished by its more prostrate and fleshy habit, its coarse stems and its larger capsules and seeds. The seed surface structure is also a distinguishing character, as is the lack of a wing on the seed (Johnson, 2001). It is likely the species would still have been in seed during the November survey
- *Phyllanthus maderaspatensis* has been recorded within the Brewarrina and Collarenebri districts in the north-western plains of NSW. This species tends to inhabit floodplain areas with heavy soils and may rely on intermittent rainfall and flooding events. It is often associated with open grasslands and eucalypt woodlands in or near creek beds, and grassy flats and levees near watercourses. Associated habitat listed for *Phyllanthus maderaspatensis* in the TBDC includes PCT 36, PCT 38, PCT 39 and PCT 247, which were targeted during surveys for this species
- *Solanum karsense* is a species endemic to NSW which is restricted to the far south-western plains, extending up the Darling River (Baaka) to the Menindee and Wilcannia districts. It inhabits within occasionally flooded depressions with heavy soil, including level river floodplains of grey clay with Black Box and Old Man Saltbush, and open treeless plains with solonized brown soils. Habitats are generally lake beds or floodplains of heavy grey clays with a highly self-mulching surface. Associated habitat listed for *Solanum karsense* in the TBDC only includes PCT 153, however all open vegetation types on the floodplain were targeted for this species

- *Swainsona murrayana* is found throughout NSW. It has been recorded in the Jerilderie and Deniliquin areas of the southern riverine plain, the Hay plain as far north as Willandra National Park, near Broken Hill and in various localities between Dubbo and Moree. The species inhabits a variety of vegetation types including bladder saltbush, black box and grassland communities on level plains, floodplains and depressions and is often found with Maireana species. Associated habitat listed for *Swainsona murrayana* in the TBDC includes PCT 38, PCT 158 and PCT 247, which were targeted during surveys for this species. Only PCT158 4.64 ha) will be directly impacted. Surveys were conducted in November outside of the required survey period for this species (September), this limitation is addressed in **Section 6.4.1.2**.

About 24.7 kilometres was walked during the November 2020 flora surveys by a team of two ecologists. A summary of the survey effort based on the area of habitat for each target plant species is provided in **Table 6-6**. The location of tracks walked during the threatened plant surveys are illustrated in **Figure 6-2**. The development site has been adjusted and refined since the November 2020 surveys, and as a result flora transects were carried out over a larger extent than the current development site (**Figure 6-2**). Whilst some small areas of the refined development site were not surveyed or have noticeable gaps between transects, these unsurveyed patches were mostly within areas of degraded PCT 158 (almost bare ground) and the caravan park grounds at the existing weir (containing driveways and exotic grass beneath River Red Gum canopy). Habitat in these areas is likely unsuitable for the target flora species. Furthermore, the large survey effort in areas now deducted from the development site (in the same PCTs and similar landscape positions) would bolster the survey for threatened plants.

Table 6-6 Summary of survey effort for threatened plant species

Species name	Common name	EPBC Act	BC Act	Required survey period (TBDC)	Associated PCT area directly impacted*	Survey guideline**	Approx. effort (November 2020)
Atriplex infrequens	A saltbush	V	V	November – February	Associated PCTs: PCT 39: 2.9 ha PCT 158: 4.6 ha	PCT 39: 3 km PCT 158: 3 km	PCT 39: 7.2 km PCT 158: 7.9 km
Convolvulus tedmoorei	Bindweed	-	E	June – September	Associated PCTs: PCT 158: 4.6 ha	PCT 158: 3 km	PCT 158: 7.9 km
Phyllanthus maderaspatensis	-	-	E	September – March	Associated PCTs: PCT 36: 2.6 ha PCT 39: 2.9 ha	PCT 36: 3 km PCT 39: 3 km	PCT 36: 9.7 km PCT 39: 7.2 km
Solanum karsense	Menindee Nightshade	V	V	September – November	No associated PCTs All open floodplain vegetation targeted	-	PCT 36: 9.7 km PCT 39: 7.2 km PCT 158: 7.9 km
Swainsona murrayana	Slender Darling Pea	V	V	September	Associated PCTs: PCT 158: 4.6 ha	PCT 158: 3 km	PCT 158: 7.9 km

* Associated PCTs for each species are taken from their profile on the BioNet Threatened Biodiversity Data Collection database.
** The number of required survey kms is taken from the *Surveying threatened plants and their habitats – NSW survey guide for the Biodiversity Assessment Method* (Department of Planning Industry and Environment, 2020).

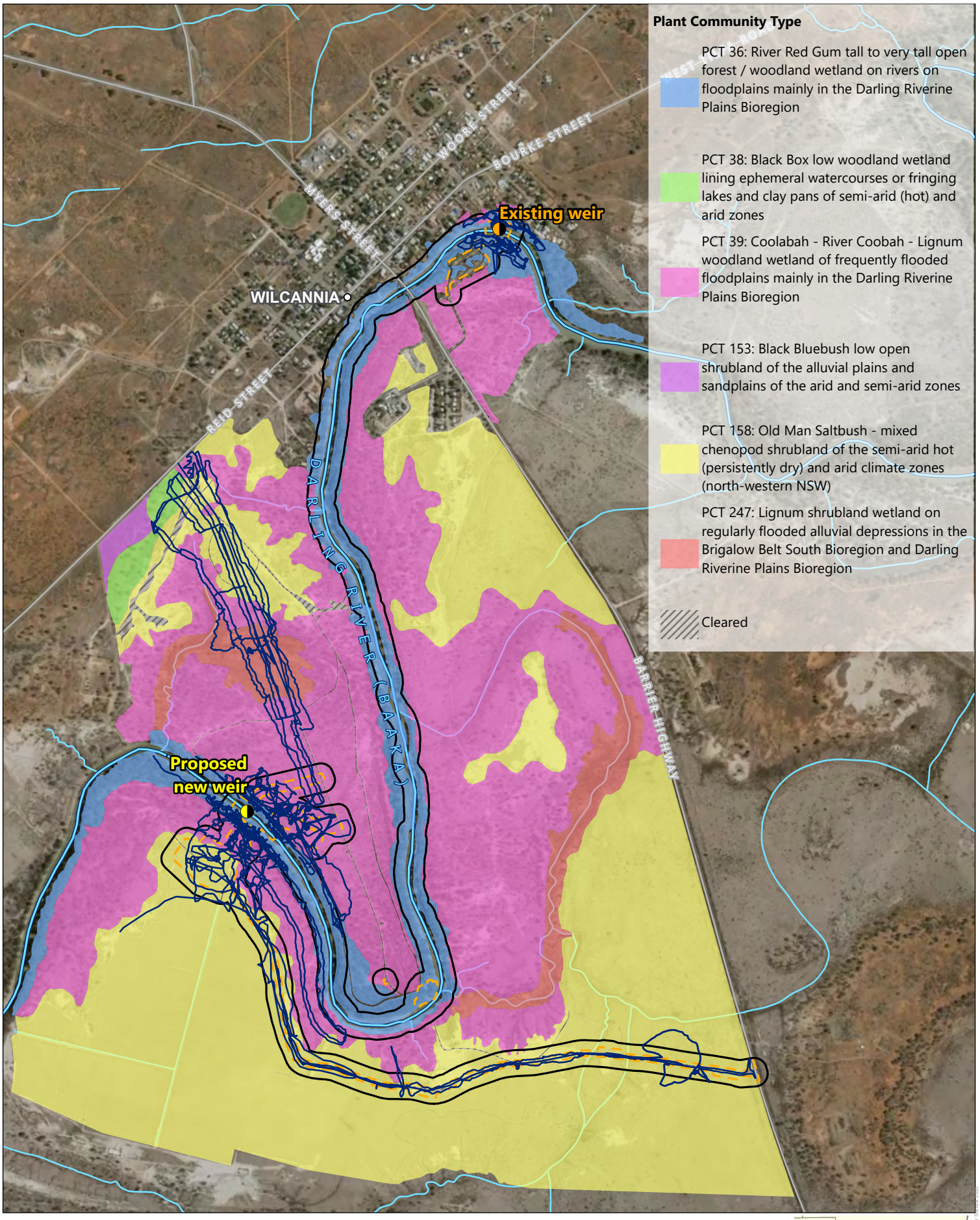

Figure 6-2: Threatened plant surveys

6.3.2 Threatened animal surveys

Targeted threatened species surveys were undertaken for animals that had potential habitat within the study area and locality. The primary focus was on targeting threatened species identified as candidate species-credit species, however survey data was collected for all species. Surveys included diurnal and nocturnal effort using a stratified sampling approach that aimed to sample the range of habitats present. Opportunistic observations of threatened species were also recorded during survey activities and generally while present in the study area. Surveys were focused on areas within the development site and where possible also occurred in adjacent habitats that extended beyond the development site which may be indirectly impacted by the proposal.

Surveys were conducted during the 2020 spring season (November) using a combination of sampling techniques based on the required survey period and techniques detailed for each species in the BioNet TBDC and methodology and effort as outlined in the document Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities (Department of Environment and Conservation, 2004) and later guidelines including:

- Survey Guidelines for Australia's Threatened Birds (Department of the Environment Water Heritage and the Arts, 2010)
- Survey Guidelines for Australia's Threatened Mammals (Department of the Environment Water Heritage and the Arts, 2011a)
- Survey Guidelines for Australia's Threatened Reptiles (Department of the Environment Water Heritage and the Arts, 2011b).

Details of the specific survey techniques and effort applied is outlined in this section of the BDAR and described in relation to the habitat types sampled for the target species.

6.3.2.1 Weather conditions

Fauna surveys were conducted over a total of six days (18 to 23 November 2020). A summary of the daily temperatures and rainfall preceding each day are provided in **Table 6-7**.

Conditions during the survey were mostly clear skies and hot, with still/calm early mornings becoming windy through the hottest part of the day. Evenings were mostly calm with clear skies. Scattered showers were only recorded on 23 November during the survey, representative of low rainfall experienced in November 2020 across the region (refer to **Table 5-8** for monthly rainfall totals).

Table 6-7 Weather and rainfall conditions during fauna surveys (Wilcannia Aerodrome AWS 046012)

Date	Min temp (°C)	Max temp (°C)	Wind (3pm)	Rainfall (24 hours)	Total rainfall in 7 days prior	Moon phase (visibility)
18/11/2020	12.2	35	ENE – 9 km/h	0 mm	8.0 mm	Waxing crescent (15%)
19/11/2020	12.5	40.4	WSW – 13 km/h	0 mm	8.0 mm	Waxing crescent (24%)
20/11/2020	17	42	SSE – 13 km/h	0 mm	0 mm	Waxing crescent (33%)
21/11/2020	21.7	41.4	NNW – 24 km/h	0 mm	0 mm	First quarter (43%)
22/11/2020	26.3	41.2	NNW – 31 km/h	0 mm	0 mm	First quarter (53%)
23/11/2020	23.3	33.2	S – 20 km/h	0.2 mm	0 mm	First quarter (63%)

6.3.2.2 Diurnal birds

The survey for diurnal birds focused on two groups of species:

- Australian Bustard and Squatter Pigeon (southern subspecies)

- Birds that may breed / nest in the study area – Red-tailed Black-Cockatoo (inland subspecies), White-bellied Sea-Eagle, Black-breasted Buzzard, Little Eagle, Major Mitchell's Cockatoo and Square-tailed Kite.

The Painted Honeyeater was also included as it was identified from the EPBC Act search. Other threatened bird species listed as ecosystem credit species were also noted when encountered and their locations mapped.

The diurnal bird surveys were undertaken by using the standard technique of timed area searches. All birds observed or heard were recorded in areas of one hectare over a 20-minute period. Sixteen timed searches were undertaken within the study area. The timed area searches were undertaken within two hours of dawn and dusk. Target species were also noted while moving through the vegetation undertaking other activities.

For dual credit species (i.e. where just the identification of an individual does not constitute the species-credit component), breeding habitat was also surveyed in accordance with the general notes for each species listed in the TBDC (**Table 6-8**).

Potential breeding habitat for raptors including the White-bellied Sea-Eagle, Black-breasted Buzzard, Little Eagle and Square-tailed Kite were searched for while moving through the habitats across the study area. Observers searched for any large stick nests (current or old) in the top of the canopy of large trees in the River Red Gum Forest habitat. The surveys were within the breeding habitat survey period for all species except the Little Eagle (August to October). The location of large stick nests (i.e. greater than 50 centimetres diameter) were recorded and revisited each day following identification. The ground below trees with nests was also surveyed for evidence of occupation (scat whitewash and animal remains).

Potential breeding habitat for hollow-dependent fauna (i.e. Red-tailed Black-Cockatoo and Major Mitchell's Cockatoo) was surveyed by the identification and mapping of hollow-bearing trees across the study area. Hollows were assessed as breeding habitat based on the survey notes for each species (**Table 6-8**).

Table 6-8 Notes for the identification of breeding habitat for dual credit species (diurnal species)

Species name	Common name	EPBC Act	BC Act	Notes for identifying breeding habitat (TBDC)
Calyptorhynchus 77obiliz samueli	Red-tailed Black-Cockatoo (inland subspecies) (breeding)	-	V	Breeding habitat is living or dead tree with hollows greater than 15 centimetres diameter and greater than five metres above ground. Paddock trees with hollows greater than 12 centimetres diameter and greater than two metres above the ground AND any trees within riparian zones. Breeding will be identified by the presence of suitable habitat AND 1. Presence of nest OR 2. Pairs exhibiting courtship behavior; OR 3. Observing/hearing begging juveniles.
Haliaeetus leucogaster	White-bellied Sea-Eagle (breeding)	Marine	V	Breeding habitat is live large old trees within one kilometre of a rivers, lakes, large dams or creeks, wetlands and coastlines AND the presence of a large stick nest within tree canopy; or an adult with nest material; or adults observed duetting within breeding period. Due to the similarities in nest structure and use of the same nests by White-bellied Sea Eagles and Wedge-tailed Eagles, where a nest is observed without a bird present, searches for prey remains/feathers below the structure should be undertaken. The differing diets of both species and distinctive adult feathers, should provide evidence of nest use, however; where prey items/feathers are absent, repeat visits to the nest until a bird is observed should be undertaken.
Hamirostra melanosternon	Black-breasted Buzzard (breeding)	-	V	The species is known to breed in sites with cropping, but also requires retained vegetation.

Species name	Common name	EPBC Act	BC Act	Notes for identifying breeding habitat (TBDC)
Hieraaetus morphnoides	Little Eagle (breeding)	-	V	Breeding habitat is live (occasionally dead) large old trees within suitable vegetation AND the presence of a male and female; or female with nesting material; or an individual on a large stick nest in the top half of the tree canopy.
Lophochroa leadbeateri	Major Mitchell's Cockatoo (breeding)	-	V	Breeding habitat is living or dead tree with hollows greater than 10 centimetres diameter. The species breeds from August to November, foraging may be present all year.
Lophoictinia isura	Square-tailed Kite (breeding)	-	V	Breeding habitat is live large old trees within suitable vegetation AND the presence of a male and female; or female with nesting material; or an individual on a large stick nest in the top half of the tree canopy.

Commonwealth survey guidelines for Squatter Pigeon suggest a survey requirement for 15 hours of bird surveys over three days (five hours per day) for sites less than 50 hectares in size and eight hours over four days (two hours per day) for raptor nest searches for sites less than 50 hectares. The survey undertaken for this BDAR does not meet the recommended survey effort for Squatter Pigeon, with six days and about ten hours of timed areas searches undertaken in November 2020. However, the guidelines are for sites less than 50-hectares and considering the development site is only c.16 hectares in size (impact area is 8 hectares), the survey effort undertaken is considered appropriate. Nest searches were undertaken throughout the entire survey period. A summary of the survey effort undertaken for threatened birds is provided in **Table 6-9**.

Table 6-9 Summary of survey effort for threatened diurnal birds

Species name	Common name	EPBC Act	BC Act	Survey period limitation	Survey timing	No. survey sites	No. people	Survey effort
Ardeotis australis	Australian Bustard	-	E	All year	18-23 November 2020 (6 days)	16 x 20 timed searches Opportunistic observation throughout survey period Observation to locate large stick nests undertaken throughout survey period	Two observers	Timed searches = about 10.6 person hours About 61 kilometres of ground was covered during the survey, walking and driving, during which time all large trees with stick nests examined and and note. The survey focuse don
Calyptorhynchus 78obiliz samueli	Red-tailed Black-Cockatoo (inland subspecies) (breeding)	-	V	May – July and Sept – Dec				
Geophaps scripta scripta	Squatter Pigeon (southern subspecies)	V	CE	All year				
Grantiella picta	Painted Honeyeater	V	V	Sept – Jan				
Haliaeetus leucogaster	White-bellied Sea-Eagle (breeding)	Marine	V	July – Dec (breeding habitat survey)				
Hamirostra melanosternon	Black-breasted Buzzard (breeding)	-	V	Sept- Nov Black-breasted Buzzard				
Hieraaetus morphnoides	Little Eagle (breeding)	-	V	Aug – Oct (breeding				

Species name	Common name	EPBC Act	BC Act	Survey period limitation	Survey timing	No. survey sites	No. people	Survey effort
				habitat survey)				identifying large stic nests, which may have been active or 79obiliz
Lophochroa leadbeateri	Major Mitchell's Cockatoo (breeding)	-	V	Sept– Dec(breeding habitat survey)				
Lophoictinia isura	Square-tailed Kite (breeding)	-	V	Sept– Jan (breeding habitat survey)				No smaller nests or active breeding pairs in tree hollows recorded

Note: The main fauna survey period was conducted outside of the breeding survey period for the Little Eagle so the survey for this species focused on locating large stick nests in the top of tree canopies.

6.3.2.3 Nocturnal birds

The survey for nocturnal birds focused on the Barking Owl, Masked owl and Bush Stone-curlew. Survey effort included spotlighting transects, stag-watching potential nest trees, call playback and habitat assessment (refer to **Figure 6-3**).

The survey period was still within the breeding period for Barking owl (May to December) but not for Masked owl (May to August). Therefore, it was not possible to positively identify an active nest site for Masked Owl. However, surveys for Masked Owl were still undertaken to determine if a resident pair and recent fledgling were present to assess if the study area was part of a core breeding territory. The likelihood of breeding habitat being present was determined by the presence of suitable habitat (PCTs) firstly, and as a precautionary measure, followed by the identification and mapping of large hollow bearing trees, that met the criteria as described in the TBDC (refer to **Table 6-10**). Evidence of previous occupancy (owl pellets, scat whitewash, animal remains) was searched for beneath large hollow bearing trees (potential nest and roost sites), when encountered.

Spotlighting was undertaken throughout the study area within contiguous habitats over five nights from 18-22 November. Spotlighting involved mostly walking transects undertaken by teams of two to four ecologists using 500-lumen headlamps (Ledlenser H5R) and 5000-lumen handheld torches (Ledlenser X21R). The network of existing tracks through woodland vegetation along the Darling River (Baaka) around the development site also allowed for vehicle-based surveys. A total of 11 medium to large hollow-bearing trees were stag-watched for about one hour at dusk on two separate nights.

Call playback for Barking Owl, Masked owl and Bush Stone-curlew was completed at seven different locations. Call broadcast occurred twice at each site. Where possible call playback sites were established near suitable habitat features (i.e. large hollow bearing trees). Calls were played intermittently for each target species followed by a 10-minute listening period. Spotlights were turned off during call broadcast to avoid spooking birds. Call playback was followed by a 10-minute spotlight of the canopy in the vicinity of the call playback site in an attempt to detect any birds attracted to the calls. All birds observed or heard were recorded. A summary of survey effort for threatened owls is provided in **Table 6-11**.

Table 6-10 Notes for the identification of breeding habitat for dual credit species

Species name	Common name	EPBC Act	BC Act	Notes for identifying breeding habitat (TBDC)
Burhinus grallarius	Bush Stone-curlew	-	E	Species is mainly found in western slopes and plains and the Riverina, smaller numbers on Central and North Coast with increasing numbers in Tweed Valley. It may be easier to detect during breeding season (spring-summer), possibly calls all year, but it is unclear how well it responds to playback. The species was allocated to a species credit as experts determined that it cannot be predicted to occur at a site based on vegetation surrogates but can be detected reliably from survey
Ninox connivens	Barking Owl (breeding)	-	V	Breeding habitat is living or dead trees with hollows greater than 20 centimetres diameter and greater than four metres above the ground. Where there are no known nest trees on site (known from existing data, studies or other documented evidence), assessors should apply the following process. 1. Look for SIGNS OF BREEDING on site as follows; suitable habitat AND (a) presence of male and female OR (b) calling to each other (duetting) OR (c) find nest. 2. Where signs of breeding on site are present, POTENTIAL NEST TREES should be identified. Potential nest trees are living or dead trees with hollows greater than 20 centimetres diameter and greater than four metres above the ground. 3. Where potential nest trees are identified on site then, night monitoring at the identified potential nest locations for a minimum of two nights should be undertaken to detect the presence of any owl of this species using a potential nest tree or demonstrating behavior focused on a potential nest tree (investigating the hollow or roosting within 10 metres). DPE is currently developing survey guidance for threatened bird species. In the interim, assessors must undertake species surveys using best practice methods that can be replicated for repeat surveys (as per the BAM threatened species survey requirements).
Tyto novaehollandiae	Masked Owl (breeding)	-	V	Breeding habitat is living or dead trees with hollows greater than 20 centimetres diameter. Patch size selected is based on that fact that the species will use areas that are quite small, especially as foraging habitat but also as roosting habitat and occasionally as breeding habitat. In Tasmania and Victoria. Masked owls have been recording nesting in paddock trees. Note that the species has been found to nest in caves in Tasmania (and maybe the Nullarbor) but there is no evidence to suggest that this occurs in NSW. Dead stags are especially popular for roosting/breeding habitat and are a limited resource due to natural attrition. DPE is currently developing survey guidance for threatened bird species. In the interim, assessors must undertake a species survey using best practice methods that can be replicated for repeat surveys (as per the BAM threatened species survey requirements).

Table 6-11 Summary of survey effort for threatened nocturnal birds

Common name	Species name	EPBC Act	BC Act	Survey period limitation	Survey timing	No. survey sites / technique	No. nights	Survey effort
Burhinus grallarius	Bush Stone-curlew	-	E	All year	18 November to 23 November 2020 (6 days and 5 nights)	7 call playback locations 14 spotlighting transect sites <u>Owls:</u> 11 hollows stag-watched over two nights Transects undertaken to identify large hollow-bearing trees. Owl pellets, scat whitewash and animal remains searched for beneath large trees.	14 survey nights spotlighting	About 30 person hours spotlighting About 23 kilometres of ground was covered during the survey (this is an under-estimate as not all surveyors were carrying GPS tracking units during surveys).
Ninox connivens	Barking Owl (breeding)	-	V	May – December (breeding habitat survey)				
Tyto novaehollandiae	Masked Owl (breeding)	-	V	May – August (breeding habitat survey)				

Note: The main fauna survey period was conducted outside of the breeding survey period for the Masked Owl. The survey aimed to detect presence of this species and identify any large trees with large hollows >20cm diameter that may be suitable breeding habitat.

6.3.2.4 Arboreal mammals

Targeted survey for arboreal mammals was focussed on the Koala and targeted the Inland Riverine Forests (PCT 36) and North-west Floodplain Woodlands (PCT 39) habitat types. Survey effort included spotlighting transects, call playback and scat surveys (refer to **Figure 6-3**). Scat searches were focused underneath suitable food tree species (*Eucalyptus camaldulensis* and *Eucalyptus coolabah*). A rapid assessment method was used as described in Woosnam-Merchez *et al* (2012) whereby sites were surveyed to sample the range of habitat types and biophysical attributes within the study area. The survey method is called the Scat Assessment Technique (SAT). The observers tracked to each waypoint and completed a dedicated scat search up to five metres around the base of the nearest tree and continued searching trees radiating out from the waypoint until a minimum of 20 trees were searched at each site. Trees were also examined for scratch marks to indicate use. A total of six dedicated SAT sites were undertaken (120 trees in total), in addition to opportunistic searches underneath large trees along the Darling River (Baaka) between the proposed new weir and existing weir, and both upstream and downstream of the development site at each of the general assessment locations (refer to **Figure 9-1**). Koalas were also targeted by call playback and spotlighting within the development site and contiguous habitats (refer to **Figure 6-3**).

Commonwealth survey guidelines for threatened mammals recommend spotlighting survey effort is two 200-metre transects per five-hectare site. The guidelines also recommend call playback be undertaken on two nights per sampling location, and two sampling locations per 200-hectare stratification unit. A summary of the overall survey effort is provided in **Table 6-12.**

Table 6-12 Summary of survey effort for arboreal mammals

Common name	Species name	EPBC Act	BC Act	Survey period limitation	Survey timing	No. survey sites	No. nights / people	Survey effort
Koala	*Phascolarctos cinereus*	V	V	All year	18- 23 November 2020 (six days and five nights)	Seven call playback locations 14 spotlighting transect sites Six SAT survey locations	14 survey nights spotlighting	About 30 person hours spotlighting About 23 kilometres of ground was covered during the survey (this is an under-estimate as not all surveyors were carrying GPS tracking units during surveys).

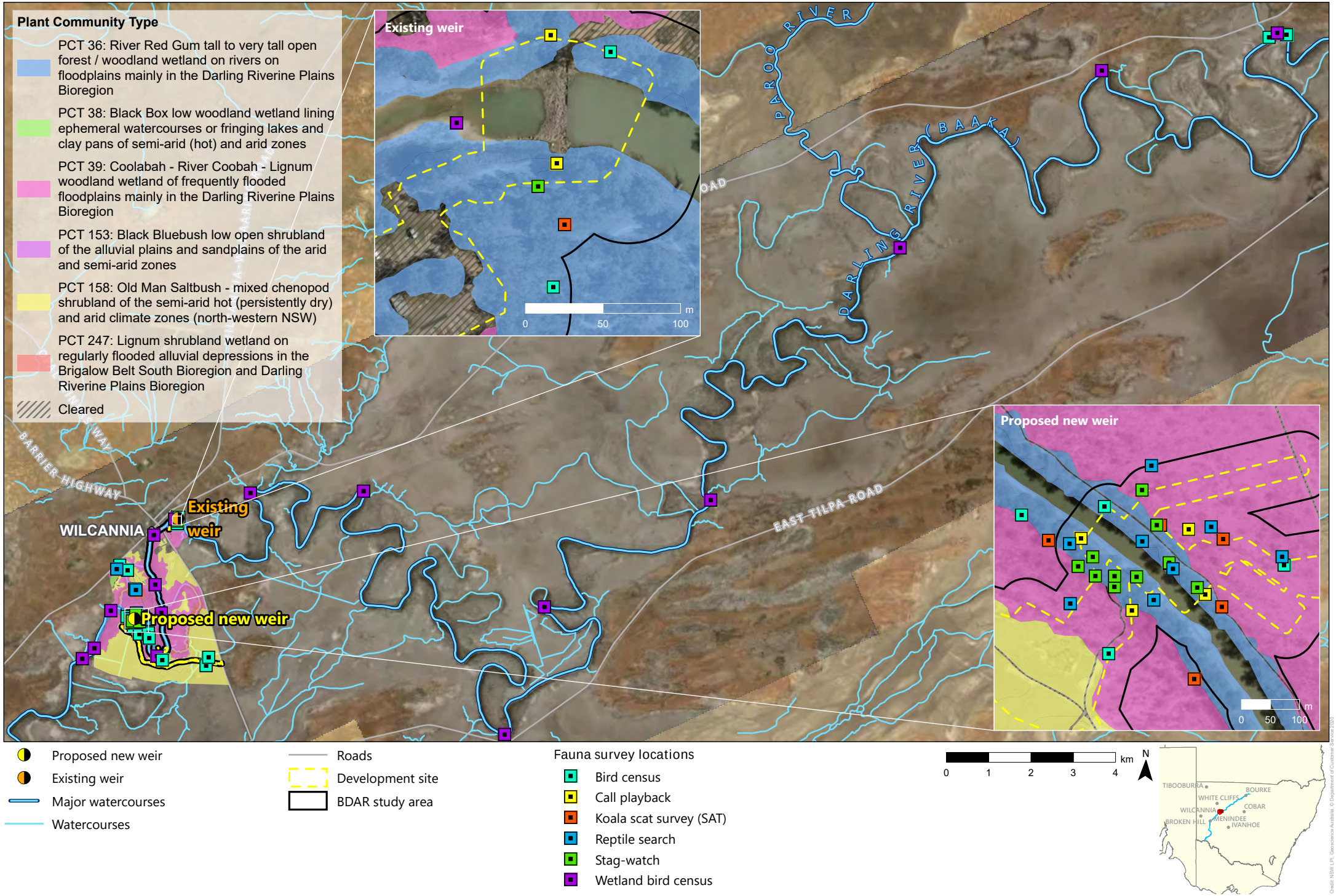

Figure 6-3: Threatened animal surveys

6.4 Threatened species survey results

6.4.1 Threatened plant species

Five threatened plant species were targeted during surveys of the development site. No threatened plant species were found in the development site or study area during the surveys.

To determine the presence of a candidate species-credit species, Subsection 5.2.4 of the BAM allows an assessor to consider several options. To determine presence, the assessor must:

a) assume the species is present, or

b) conduct a threatened species survey, as per Section 5.3 of the BAM, or

c) obtain an expert report, or

d) for candidate species including dual credit species, where the TBDC indicates that an important habitat map identifies the species credit component, the assessor must confirm whether the subject land is within an area identified on the important habitat map

Surveys were conducted in November 2020, which satisfies the requirements detailed in Section 5.3 of the BAM for all species except for *Convolvulus tedmoorei* and *Swainsona murrayana,* as the surveys were undertaken outside of the required survey season these two species. This assessment must therefore assume presence of these two species or demonstrate that the habitats are degraded to the point that the species is unlikely to be present within the development site.

6.4.1.1 Convolvulus tedmoorei

Surveys undertaken in November 2020 only identified one *Convolvulus* species; *Convolvulus remotus*. *Convolvulus remotus* was distinguished from *Convolvulus tedmoorei* by its narrower leaves, and seeds with wings.

Convolvulus tedmoorei is only known from a few locations in NSW, two areas on the Murrumbidgee and Darling River (Baaka) floodplains in central-western NSW (from Toganmain Station, Darlington Point, and from a locality eight kilometres north-west of Louth); and two other records from east of Broken Hill on the road to Wilcannia, and from the Menindee Road, Scarsdale. Wilcannia sits roughly between the records around Broken Hill and the records from Louth. It is unknown what survey effort has been undertaken across the region to identify further occurrences of this species. Little data exists to describe the conditions and habitat at these locations, however the *Convolvulus tedmoorei* BioNet profile states that the species may require periodic flooding of its habitat to maintain the wet conditions suitable for seed set and germination.

As a persistent and perennial species, and given the optimal rainfall conditions experienced for four months prior to the survey, there is a high likelihood that the species would have been detected if present, despite not flowering at the time. The targeted transect survey and spacing of observors was targeted at detection of this species. Furthermore, this species most closely resembles *C.clementii* (which was also not found to be present) but it can be distinguished by its more prostrate and fleshy habit, its coarse stems and its larger capsules and seeds. The seed surface structure is also a distinguishing character, as is the lack of a wing on the seed (Johnson, 2001). It is likely *Convolvulus tedmoorei* would have been in seed during the November survey. Given the small impact area of c.3 ha and walked survey effort, there is a reasonable expectation that the species would have been detected if present. The species is considered unlikely to occur. About 1.3 hectares of the potential habitat identified occurs along the road edge of the southern access road and is low condition.

6.4.1.2 Swainsona murrayana

The survey period occurred in November and was outside the main flowering period and the prescribed survey month of September for this species. Surveys undertaken in November 2020 identified two other

Swainsona species; *Swainsona greyana* and *Swainsona swainsonioides*. It is acknowledged that *Swainsona murrayana* dieback after flowering in September, however it is possible that plant remains would have still been identifiable during the November 2020 survey considering the high rainfall in the months preceding the survey (refer to **Table 5-8**). *Swainsona greyana* was flowering and very common along the Darling River (Baaka) in PCT 36. It is a large species (up to 1.5 metres high) and easily distinguishable from *Swainsona murrayana*. *Swainsona swainsonioides* was identified flowering in good/moderate and poor condition vegetation zones of PCT 158. Apart from the presence of flowers, *Swainsona swainsonioides* differs from *Swainsona murrayana* primarily by having basifixed rather than medifixed hairs, an incomplete circular keel, wider leaflets, sparsely hairy rather than densely hairy stems and a hairless, rather than hairy calyx.

The TBDC identifies associated habitat for *Swainsona murrayana* as PCT158, PCT247 and PCT38. Of these habitats about 4.6 hectares of PCT158 would be impacted on the south bank of the river. The other two PCTs are not directly impacted. This species has bene considered unlikely to occur.

6.4.2 Threatened animal species

Targeted surveys were undertaken for the candidate species listed in **Table 6-5**. The Red-tailed Black-Cockatoo was the only candidate threatened species identified in the study area. Surveys also identified Dusky Woodswallow and Spotted Harrier in the broader study area. No threatened fauna species were identified within the development site (refer to **Figure 6-4**).

Brown Treecreepers were commonly observed in riparian vegetation around the Darling River (Baaka), however they do not qualify for inclusion under the eastern subspecies listing as the western boundary of the range of *Climacteris picumnus victoriae* runs approximately through Corowa, Wagga Wagga, Temora, Forbes, Dubbo and Inverell.

6.4.2.1 Red-tailed Black-Cockatoo (inland subspecies)

This species was observed in large family groups (up to 20 individuals) at three locations, including the inside bend of the river one kilometre upstream of the new weir, one location 15 kilometres upstream of the new weir and another location at the end of the new weir pool extent (refer to

Figure 6-4). A small group of birds were also observed feeding in Old Man Saltbush (PCT 158) near the southern access track to the new weir. The birds in this location appeared to be feeding on the fruits of the native chenopod shrub; *Dissocarpus paradoxus*.

No evidence of breeding was observed in any of these locations (i.e. birds in hollows, courtship behavior or the sound of chicks in a hollow). Suitable breeding hollows are highly abundant all along the Darling River (Baaka), with a high prevalence of large hollow-bearing trees. Considering the presence of family groups, it is possible that this species breeds around these observed locations. No Red-tailed Black-Cockatoos were observed within the development site. As such, no species polygon has been developed for this species.

6.4.2.2 Major Mitchell's Cockatoo (breeding)

No Major Mitchell's Cockatoos were identified during surveys. Hollow-bearing trees potentially suitable for breeding are widespread across the study area and all along the Darling River (Baaka). The Atlas of Living Australia shows many recorded sightings of Major Mitchell's Cockatoos in the locality, some within the last couple of years. The abundance of hollow availability in the study area is representative of all areas that were surveyed along the Darling River (Baaka) from about 30 kilometres downstream to about 90 kilometres upstream of the proposed new weir (refer to **Figure 9-1**). Therefore, breeding habitat for this species is likely to be widespread. This species may use the development site on occasion for foraging, though considering no birds were observed and no breeding habitat was identified, it is unlikely that this species is currently breeding in the development site. As such, no species polygon was developed for this species.

6.4.2.3 Nest-building raptors

None of the threatened raptors listed in **Table 6-5** (i.e. White-bellied Sea-Eagle, Black-breasted Buzzard, Little Eagle and Square-tailed Kite) were observed to be present within the development site and study area during the survey period. One Spotted Harrier was seen flying over the Darling River (Baaka) near the end of the current weir pool extent. The bird landed in a nearby tree briefly before flying away. No nests were observed in this location.

Three moderately-large sized sitck nests (all about 50-80 centimetres in diameter) were identified in trees within the study area, however these are not within the development site or direct impact footprints (refer to **Figure 6-1**). No raptors were observed using these nests, which were checked every day following initial identification (i.e. the nest closest to the development site) was identified on 18 November and checked for nesting birds each day for the following five days). The ground beneath the nests contained no evidence of recent use (i.e. feeding remains). Given these results, it is likely that none of the species-credit raptor species listed in **Table 6-5** were currently breeding in the development site during the assessment period.

6.4.2.4 Barking Owl and Masked Owl

No Barking Owl or Masked Owls were heard or observed in the study area during the five night survey period. River Red Gum riparian forest in the study area contains a moderate abundance of large hollows that may represent potential nest sites for Barking Owl and Masked Owl, however no nesting Barking Owls were recorded, and no evidence of recent occupation around these trees was identified (i.e. pellets and scat whitewash). The abundance of hollows in the development site is representative of all areas that were surveyed along the Darling River (Baaka) from about 30 kilometres downstream to about 90 kilometres upstream of the proposed new weir (refer to **Figure 9-1**) indicting that potential nesting sites are common and widespread within the region.

Recorded sightings of the two species in the locality are limited, particularly for the Masked Owl, which is considered rare in north-west NSW. There is one recorded sighting on the Atlas of Living Australia (but not in BioNet Atlas) of a Barking Owl from the Warrawong campground in 2015. The record may be a false identification (the Southern Boobook looks very similar and has commonly recorded in the locality), or there may be a low-density population with a large range that uses riparian woodland along the Darling River (Baaka). The closet records of Masked Owl are about 100 kilometres upstream of Wilcania on the Darling River (Baaka). Interestingly, these records were from December 2000 of a resident pair and a fledgling (begging) and shows evidence that resident pairs can remain active in the breeding territory for more than three months after the nesting period.

The results of the surveys demonstrate that potential nesting habitat is indeed present in the study area and would be associated with the River Red gum floodplain habitat, however no nest trees were identified and there were no owls present in the development site or the direct impact area and both species are considered a very low likelihood of breeding in this location at the time of the surveys. As such, no species polygons have been developed for the Barking Owl or the Masked Owl.

6.4.2.5 Squatter Pigeon (southern subspecies)

No Squatter Pigeons (southern subspecies) were identified during surveys. Formerly widespread and abundant in NSW, this species has disappeared from the southern extent of its range and is currently only known from Narrabri north to Boggabilla and east to near Glen Innes. It is highly unlikely that a population of Squatter Pigeon (southern subspecies) is present within the development site.

6.4.2.6 Bush Stone-curlew

No Bush Stone-curlews were identified during surveys. The development site and study area does contain hollow logs and dead standing/fallen timber that meets the habitat requirements of this species. There are scattered records on the Atlas of Living Australia of this species across north-western NSW, however most are

either "historical records" or greater than 30 years old, possibly attributing to the fact that this species has been declining in the region. The five nights and six days of survey for this assessment in November 2020 is likely to have identified this species if it was present in the development site.

6.4.2.7 Koala

No koalas or evidence of recent occupation was identified during surveys. There are no known populations in the locality and reported sightings in far western NSW are rare. There are two records just north of Wilcannia from 1994, both near the Wilcannia-Wanaaring Road. At least one of these records probably corresponds with the recorded sighting detailed in Ellis *et al.* (1997). The observational paper describes the koala as being a young (about two years old) male travelling widely in its dispersal phase trying to establish a new territory. Ellis *et al.* (1997) recognizes the importance of riparian corridors with feed trees (such as the Darling River (Baaka)) as movement and connectivity corridors. These records represent the most western records in north-west NSW. There are a small cluster of records upstream of the development site on the Darling River (Baaka) near Bourke, including a recent record from 2019. The next closest records to the development site are a small cluster of six records located around Ivanhoe from the late 1960s and 1970s.

It is possible that the development site may at some point provide habitat for travelling individuals, however the surveys confirmed that there was no evidence of a resident koala population in the study area during the survey period. The development site therefore does not constitute important habitat for this species and a species polygon has not been developed.

6.4.3 Serious and irreversible impact entities

The concept of serious and irreversible impacts (SAII) is fundamentally about protecting threatened entities that are most at risk of extinction from potential development. The Biodiversity Offsets Scheme recognises that there are some types of serious and irreversible impacts that the community expects will not occur except where the consent authority considers that this type of impact is outweighed by the social and economic benefits that the proposal will deliver to the state. The principles for determining SAII are outlined in clause 6.7 of the Biodiversity Conservation Regulation 2017 (BC Regulation).

The BC Act permits the Minister for Planning to give consent to or approve State Significant Infrastructure which is likely to have serious or irreversible impacts. The Minister must take those impacts into consideration and determine whether there are any additional and appropriate measures that will minimise those impacts if consent or approval is to be granted.

Two threatened species that were included in the assessment are identified by the BAM-C as SAII entities:

- *Convolvulus tedmoorei* – *Convolvulus tedmoorei* was targeted by dedicated transect searches, however these were conducted in November, about 4-5 weeks past the documented flowering period (August-September). The species was not recorded and was removed from the assessment. This is due to the perennial and non-cryptic nature of the species which is considered likely to be detected even when not flowering. Another Convolous species was recorded (*C.remotus*) which was not floweing and does not resemble *C.tedmoorei*.
- Squatter Pigeon (southern subspecies) – this species is critically endangered, therefore impacts on the species from development could be potentially serious and irreversible. The Squatter Pigeon (southern subspecies) was surveyed for in accordance with the BAM and is considered unlikely to be present on the development site.

Therefore, these two SAII entities are considered unlikely to be impacted by the development and additional impact assessment provisions in accordance with Section 9.1.2 of the BAM have not been undertaken. On this basis the proposal is unlikely to result in serious and irreversible impacts.

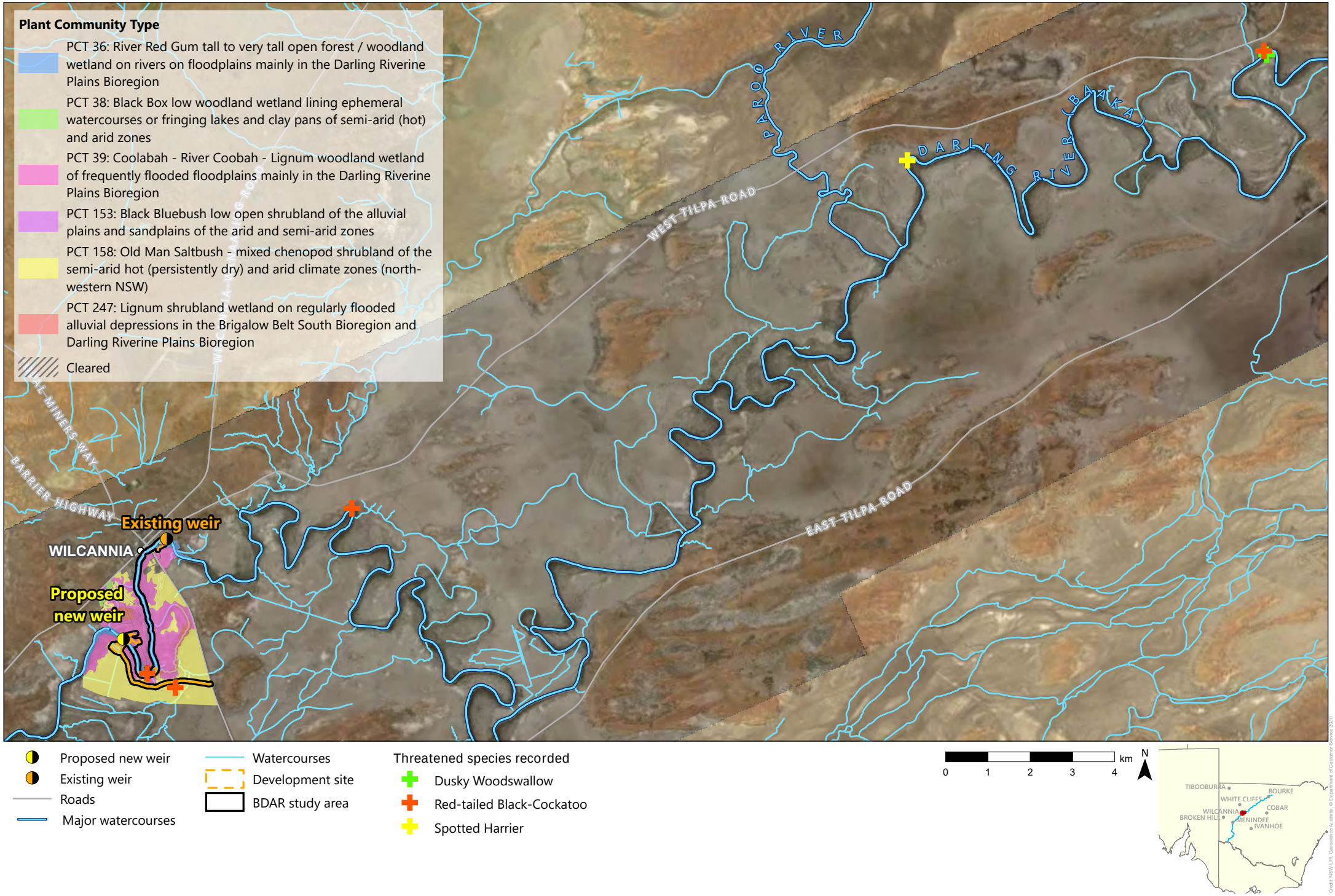

Figure 6-4: Threatened species recorded

7. Matters of national environmental significance

The EPBC Act provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places – defined as matters of national environmental significance as follows (as applicable to the proposal):

- World heritage properties
- National heritage places
- Wetlands of international importance (often called 'Ramsar' wetlands after the international treaty under which such wetlands are listed)
- Nationally threatened species and ecological communities
- Migratory species.

For EPBC Act listed matters identified or considered to have potential habitat within the study area, or considered moderately likely to occur, significance assessments have been completed in accordance with the EPBC Act Policy Statement 1.1 Significant Impact Guidelines (Department of Environment, 2013) (see **Appendix D**) where these species have not already been assessed in accordance with the BC Act. Assessments have been included for some species where non-detection may not mean absence (Squatter Pigeon). Whether or not an action is likely to have a significant impact depends upon the sensitivity, value, and quality of the environment that is affected, and upon the intensity, duration, magnitude and geographic extent of the impacts (Department of Environment, 2013). Importantly, for a 'significant impact' to be 'likely', it is not necessary for a significant impact to have a greater than 50 per cent chance of happening; it is sufficient if a significant impact on the environment is a real or not remote chance or possibility (Department of Environment, 2013). This advice has been considered while undertaking the assessments.

7.1 World heritage properties and national heritage places

The study area contains no World Heritage Properties or National Heritage Places according to the PMST.

7.2 Wetlands of international importance

The study area does not contain any wetlands of international importance (Ramsar). However, the PMST returned three wetlands of international importance within 600 kilometres of the proposal:

- Banrock Station Wetland complex 300 – 400 kilometres upstream
- Riverland 200 – 300 kilometres upstream
- The Coorong and Lakes Alexandrina and Albert Wetland 500 – 600 kilometres upstream.

The PMST places the wetlands upstream from the proposal, however, they are in fact located downstream from the proposal. Any changes to hydrological flows of the Darling River (Baaka) from the proposal to downstream wetlands would be minor. The Darling River (Baaka) floodplain has a history of agriculture, which has overtime modified and/or diverted the hydrological flows of the floodplain. Significant downstream flows into the River Murray are only likely to occur during large rainfall events, which would not be affected by the construction and operation of the new weir. Temporary impacts may result from changes in operation (when switching from normal operation mode to drought security operation mode and vice versa), however the overall reduction in hydrological flow would be insignificant.

7.3 Threatened ecological communities

According to the Protected Matters Search Tool (PMST) the following EPBC Act listed TECs have been identified as may occur or likely to occur within the study area:

- Buloke Woodlands of the Riverina and Murray-Darling Depression Bioregions (endangered) – may occur within area
- Coolibah – Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions (endangered) – likely to occur within area.

There is no vegetation in the study area which meets the description of the Buloke Woodlands of the Riverina and Murray-Darling Depression Bioregions TEC. One vegetation zone (zone 3) associated with PCT 39 is of significant condition to correspond with the listed Coolibah – Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions (Table 7-1), as described below. The distribution of the Coolibah – Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions TEC within the development site is shown in **Figure 7-1**. Remaining areas of PCT39 (0.97 ha) are of low and poor condition and do not meet the condition criteria for the listed TEC.

Table 7-1 EPBC Act listed threatened ecological communities in the development site and the extent directly impacted by the proposal (direct impact area)

Vegetation Zone	PCT name	Broad condition class	TEC (EPBC Act)	Extent in direct impact area (ha)
3 (PCT39_Moderate)	Coolabah – River Coobah – Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion (PCT39)	Moderate (VI = 57.8)	Coolibah – Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions (endangered)	1.94 ha

7.3.1 Coolibah – Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions

The Commonwealth listing advice for the Coolibah – Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions TEC (listed as endangered under the EPBC Act), describes this community as representing occurrences of one type of semi-arid to humid subtropical woodland where *Eucalyptus coolabah* subsp. *Coolabah* (Coolibah) and/or *Eucalyptus largiflorens* (Black Box) are the dominant canopy species and where the understorey tends to be grassy (Threatened Species Scientific Committee, 2011). The ecological community is associated with the floodplains and drainage areas of the Darling Riverine Plains and the Brigalow Belt South bioregions. References to the NSW TEC listing advice (NSW Scientific Committee, 2012) in the Commonwealth listing advice demonstrates that the BC Act and EPBC Act listings align closely. As described in **Section 5.7.1**, vegetation in the development site recognised as Coolabah – River Coobah – Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion (PCT 39) meets the key diagnostic characteristics of this EPBC Act listed TEC.

However, unlike the BC Act listed TEC, the Commonwealth listing advice (Threatened Species Scientific Committee, 2011) contains four condition thresholds which vegetation must meet in order to be included in this EPBC Act TEC listing. **Table 7-2** provides an analysis of the vegetation zones associated with PCT 39 and present within the development site against the condition thresholds for this TEC. All four condition thresholds must be met to be included in the TEC listing. Based on the general absence of a canopy layer in lower condition vegetation zones (zone 4 and zone 5), only vegetation zone 3 (PCT39_Moderate) meets the criteria for listing under the EPBC Act TEC. The distribution of the Coolibah – Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions TEC within the study area is shown in **Figure 7-1**.

Table 7-2 Analysis of PCT 39 vegetation zones against listed condition thresholds for Coolibah – Black Box Woodlands EPBC Act TEC

Condition thresholds	Vegetation zone (PCT 39)		
	Zone 3	Zone 4	Zone 5
Patch size: ▪ the minimum patch size is 5 ha. This may include areas of native vegetation that may be naturally open or contain regrowth	All vegetation zones are contiguous with a patch size greater than 5 ha.		
AND			
Tree canopy layer: ▪ the crown cover of trees in the patch must be ≥8 % **AND** ▪ Coolibah and/or Black Box in the tree canopy must be present in the patch that are either: - mature trees with a main stem that has a dbh of ≥30 cm; **OR** - hollow-bearing trees (live or dead); **OR** - coppiced trees with a main stem that has a dbh of ≥20 cm	Plot data from Zone 3 (Plots 2, 6, 9 and 10) shows an average canopy cover of 16 % consisting of Coolibah and Black Box with dbh of ≥ 30 cm.	Plot data from Zone 4 (Plots 4 and 5) shows no canopy cover.	Plot data from Zone 5 (Plot 22) shows no canopy cover.
AND			
Ground layer: ▪ 10 % or more of the ground cover comprises native graminoids, other herbs, chenopods and/or native low shrubs (i.e. woody plants typically less than 50 centimetres tall)	Plot data from Zone 3 (Plots 2, 6, 9 and 10) shows an average native proportion of ground cover of 38 % (excluding shrubs therefore average would be much higher)	Plot data from Zone 4 (Plots 4 and 5) shows an average native proportion of ground cover of 52 % (excluding shrubs therefore average would be much higher).	Plot data from Zone 5 (Plot 22) shows a native proportion of ground cover of 94 % (excluding shrubs therefore average would be much higher).
AND			
Exotic species: ▪ In the ground layer, the percentage cover of non-native perennial plant species does not exceed the percentage cover of native plant species (annual or perennial)	As demonstrated above, the proportional cover of native ground layer species is greater than non-native.		
Conclusion	**Part of TEC**	**Not part of TEC**	**Not part of TEC**

Key – green cell = threshold met, red cell = threshold not met

7.4 Threatened plants

Desktop review (PMST report and NSW BioNet Atlas data) identified six plant species with potential to occur in the locality. Of these, two species were considered unlikely to occur (refer **Appendix A** for assessment) and four species were targeted by survey to determine presence or absence within the direct impact areas, (refer to **Section 6.2.3** for details of survey methods and effort). This includes:

- *Atriplex infrequens* – vulnerable under the EPBC Act
- *Austrostipa metatoris* – vulnerable under the EPBC Act
- *Calotis moorei* (Moore's Burr-daisy) – endangered under the EPBC Act
- *Solanum karsense* (Menindee Nightshade) – vulnerable under the EPBC Act.

None of the EPBC Act listed threatened plant species were recorded from the targeted survey. Details of the scope, timing, and methodology for the targeted flora surveys are outlined in **Section 6.4.1**.

Habitat assessment for the threatened plant species considered as part of this BDAR is located in **Appendix A**. Considering the bilateral agreement, the survey and assessment undertaken in accordance with the BAM is considered adequate for assessing these species and no assessments of significance have been completed. The surveys have determined that there are no populations of threatened plants in the direct impact areas and no habitat critical for survival for a threatened plant species listed under the EPBC Act.

7.5 Threatened animals

Desktop review (PMST report and NSW BioNet Atlas data) identified eight animal species (EPBC Act) with potential to occur in the locality. The list of species is identified in **Appendix A**. Of these, four species were considered to have a moderate likelihood of occurring and were targeted in the survey. None of the EPBC Act listed fauna species were recorded from the surveys within the direct impact area (refer to **Section 6.3.2**) and the are no important populations or critical habitat for a threatened fauna species present within the direct impact area. Further discussion on the habitat available and likelihood of threatened fauna species occurring is provided in **Section 6.4.2**.

An assessment of significance has been undertaken for fauna species considered to potentially occur and is provided in **Appendix D**. The outcomes of the assessment are summarised in **Table 7.3** and conclude that there will be no significant impact on MNES. Habitat assessment for the threatened animal species considered as part of this BDAR are located in **Appendix A**.

7.6 Summary of assessment of significance

For threatened biodiversity listed under the EPBC Act, significance assessments have been completed in accordance with the EPBC Act Policy Statement 1.1 Significant Impact Guidelines (Department of Environment, 2013). An assessment of significance has been undertaken for the TEC and threatened fauna species considered to potentially occur. The outcomes of the assessment are summarised in **Table 7.3** and conclude that there will be no significant impact on MNES.

Table 7-3 Summary findings of the EPBC Act significance assessments

Species/Ecological Community	Assessment of significance questions (EPBC Act)									Important Population	Likely Significant Impact
	1	2	3	4	5	6	7	8	9		
Endangered ecological communities*											
Coolibah – Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions	Y	N	N	N	N	N	Y	X	X	NA	No
Endangered species^											
Australasian Bittern (*Botaurus poiciloptilus*)	N	N	N	N	N	N	N	N	N	Yes	No
Australian Painted Snipe (*Rostratula australis*)	N	N	N	N	N	N	N	N	N	Yes	No
Vulnerable species⁺											
Grey Falcon (*Falco hypoleucos*)	N	N	N	N	N	N	N	N	N	Yes	No
Koala (*Phascolarctos cinereus*) (combined populations of Queensland, NSW and the Australian Capital Territory)	N	N	N	N	N	N	N	N	N	Yes	No

Species/Ecological Community	Assessment of significance questions (EPBC Act)									Important Population	Likely Significant Impact
	1	2	3	4	5	6	7	8	9		
Squatter Pigeon (southern population) (*Geophaps scripta scripta*)	N	N	N	N	N	N	N	N	N	Yes	No

Notes: Y = Yes (negative impact), N = No (no or positive impact), X = not applicable.

* An action is likely to have a significant impact on a critically endangered or endangered ecological community if there is a real chance or possibility that it will:

1) reduce the extent of an ecological community
2) fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines
3) adversely affect habitat critical to the survival of an ecological community
4) 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
5) 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
6) cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to:

   - assisting invasive species, that are harmful to the listed ecological community, to become established, or

   - causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community, or
7) interfere with the recovery of an ecological community.

^ An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

1) Lead to a long-term decrease in the size of a population
2) Reduce the area of occupancy of the species
3) Fragment an existing population into two or more populations
4) Adversely affect habitat critical to the survival of a species
5) Disrupt the breeding cycle of a population
6) Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline
7) Result in invasive species that are harmful to a species becoming established in the species' habitat
8) Introduce disease that may cause the species to decline
9) Interfere with the recovery of the species.

+ An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

1) lead to a long-term decrease in the size of an important population of a species
2) reduce the area of occupancy of an important population
3) fragment an existing important population into two or more populations
4) adversely affect habitat critical to the survival of a species
5) disrupt the breeding cycle of an important population
6) modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline
7) result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat
8) introduce disease that may cause the species to decline, or
9) interfere substantially with the recovery of the species.

7.7 Migratory species

Based on the PMST report and NSW BioNet Atlas records within a 50-kilometre radius of the study area, ten species listed as migratory under the EPBC Act may occur in the broader locality (refer to **Table 7-4**). Surveys for migratory birds were undertaken as part of the field surveys (refer to **Section 6.3.2** for details). The surveys included time-based area surveys (about two hectares for 20 minutes) and point surveys along the Darling River (Baaka) (refer to **Figure 6-3**), conducted in summer (November 2020) during which time most of the listed migratory species are present in eastern Australia.

'Important habitat' for a migratory species is defined as (DoE, 2013):

- Habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species
- Habitat that is of critical importance to the species at particular life-cycle stages
- Habitat utilised by a migratory species which is at the limit of the species range
- Habitat within an area where the species is declining.

An assessment of the likely occurrence of these species and the presence of important habitat is included in **Table A-2** in **Appendix A** and in **Table 7-3** below. While some migratory bird species may occur in the locality (50-kilometre radius around study area), the habitats that will be directly or indirectly impacted by the proposal would not be classed as 'important habitat'.

Following high rainfall in the region prior to surveys in November 2020, sections of the Darling River (Baaka) contained shallow mudflats (see **Photo 9-7** and **Photo 9-8**). These mudflats may provide suitable foraging habitat for a range of wading bird species, and the Black-fronted Dotterel, Black-winged Stilt and Australian Ibis, which were recorded just south of the existing weir during field surveys. However, these are relatively common species and the condition of the habitats observed during surveys is unlikely to be suitable for the migratory wetland species listed in **Table 7-4**, which rely on more wetland-like habitats. These species may occur along suitable sections of the Darling River (Baaka) on occasion, however a nationally significant proportion of a population would not be supported by habitats within the study area. The proposal would not substantially modify, destroy or isolate an area of important habitat for the migratory species, and it would not seriously disrupt the lifecycle of an ecologically significant proportion of a population of migratory birds.

Table 7-4 EPBC Act listed Migratory species that are considered likely to occur near the development site

Species	Common name	Distribution and habitat	Important habitat present?
Apus pacificus	Fork-tailed Swift	Recorded in all regions of NSW. The Fork-tailed Swift is almost exclusively aerial, flying from less than one metre to at least 300 metres above ground and probably much higher.	No. This species is likely to occur in the air space over the development site during seasonal migration, however there is no suitable habitat for this species in the development site.
Calidris acuminata	Sharp-tailed Sandpiper	The Sharp-tailed Sandpiper spends the non-breeding season in Australia with small numbers occurring regularly in New Zealand. Most of the population migrates to Australia, mostly to the south-east and are widespread in both inland and coastal locations and in both freshwater and saline habitats. Many inland records are of birds on passage. Prefers muddy edges of shallow fresh or brackish wetlands, with inundated or emergent sedges, grass, saltmarsh or other low vegetation; this includes	No. The three records are from 1984, the closest being from a small shallow wetland about four kilometres north-north-west of the development site. Considering the habitat requirements for this species describes use of mudflats associated with lots of waterways except rivers, the Darling River (Baaka) is unlikely to provide suitable habitat for this species. However, given the current low flow, there may be some sections of river that provide temporarily suitable after periods of flow. The development site and broader study

Species	Common name	Distribution and habitat	Important habitat present?
		lagoons, swamps, lakes and pools near the coast, and dams, waterholes, soaks, bore drains and bore swamps, saltpans and hypersaline saltlakes inland. They also occur in saltworks and sewage farms. They use flooded paddocks, sedgelands and other ephemeral wetlands, but leave when they dry. They use intertidal mudflats in sheltered bays, inlets, estuaries or seashores, and also swamps and creeks lined with mangroves. They tend to occupy coastal mudflats mainly after ephemeral terrestrial wetlands have dried out, moving back during the wet season. Sometimes they occur on rocky shores and rarely on exposed reefs.	area (i.e. upstream and downstream) does not include any areas of high-quality mudflat habitat for this species.
Calidris ruficollis	Red-necked Stint	It is distributed along most of the Australian coastline with large densities on the Victorian and Tasmanian coasts. The Red-necked Stint breeds in Siberia and sporadically in north and west Alaska, probably from Taymyr region to Anadyr Territory and Koryakland. The Red-necked Stint mostly forages on bare wet mud on intertidal mudflats or sand flats, or in very shallow water, mostly in areas with a film of surface water and mostly close to edge of water. Roosts on sheltered beaches, spits, banks or islets, of sand, mud, coral or shingle, sometimes in saltmarsh or other vegetation.	No. One record from 1984 on the Paroo River about 35 kilometres north-east of the development site. The shallow water habitats of the Darling River (Baaka) may provide some very low-quality habitat for this species, however it is not expected to rely on these areas.
Calidris melanotos	Pectoral Sandpiper	In NSW, the Pectoral Sandpiper is widespread, but scattered. Records exist east of the Great Divide, from Casino and Ballina, south to Ulladulla. West of the Great Divide, the species is widespread in the Riverina and Lower Western regions. Prefers shallow fresh to saline wetlands. The species is found at coastal lagoons, estuaries, bays, swamps, lakes, inundated grasslands, saltmarshes, river pools, creeks, floodplains and artificial wetlands.	No. No records in the 50 kilometre locality. Closest record in from Malta Lake near Menindee. The shallow water habitats of the Darling River (Baaka) may provide some very low-quality habitat for this species, however it is not expected to rely on these areas.
Gallinago hardwickii	Latham's Snipe	Recorded along the east coast of Australia from Cape York Peninsula through to south-eastern South Australia. Occurs in permanent and ephemeral wetlands up to 2000 metres above sea-level.	No. This species occurs in wetlands that contain suitable vegetation for refuge. The Darling River (Baaka) is largely missing any instream vegetation due to the highly modified flows. Some sections may provide some very low-quality habitat for this species, however it is not expected to rely on these areas.
Gelochelidon nilotica	Gull-billed Tern	Gull-billed Terns are found in freshwater swamps, brackish and salt lakes, beaches and estuarine mudflats, floodwaters,	No. This species may fly over the development site and along sections of the Darling River (Baaka) during

Species	Common name	Distribution and habitat	Important habitat present?
		sewage farms, irrigated croplands and grasslands. They are only rarely found over the ocean.	migration, however it is unlikely to use or rely on habitats present.
Motacilla flava	Yellow Wagtail	Rare but regular visitor around Australian coast, especially in the north-west coast Broome to Darwin. Found in open country near swamps, salt marshes, sewage ponds, grassed surrounds to airfields, bare ground; occasionally on drier inland plains.	No. There are no records of this species in the 50 kilometre locality. However, it is widespread and could occur anywhere during migration. The development site and broader study area does not contain any high-quality habitat for this species.
Pluvialis fulva	Pacific Golden Plover	Most Pacific Golden Plovers occur along the east coast and are especially widespread along the Queensland and NSW coastlines. In non-breeding grounds in Australia this species usually inhabits coastal habitats, though it occasionally occurs around inland wetlands. Pacific Golden Plovers usually occur on beaches, mudflats and sand flats (sometimes in vegetation such as mangroves, low saltmarsh such as Sarcocornia, or beds of seagrass) in sheltered areas including harbours, estuaries and lagoons, and also in evaporation ponds in salt works.	No. One record from 1984 on the Paroo River about 30 kilometres north-east of the development site. The shallow water habitats of the Darling River (Baaka) may provide some very low-quality habitat for this species, however it is not expected to rely on these areas.

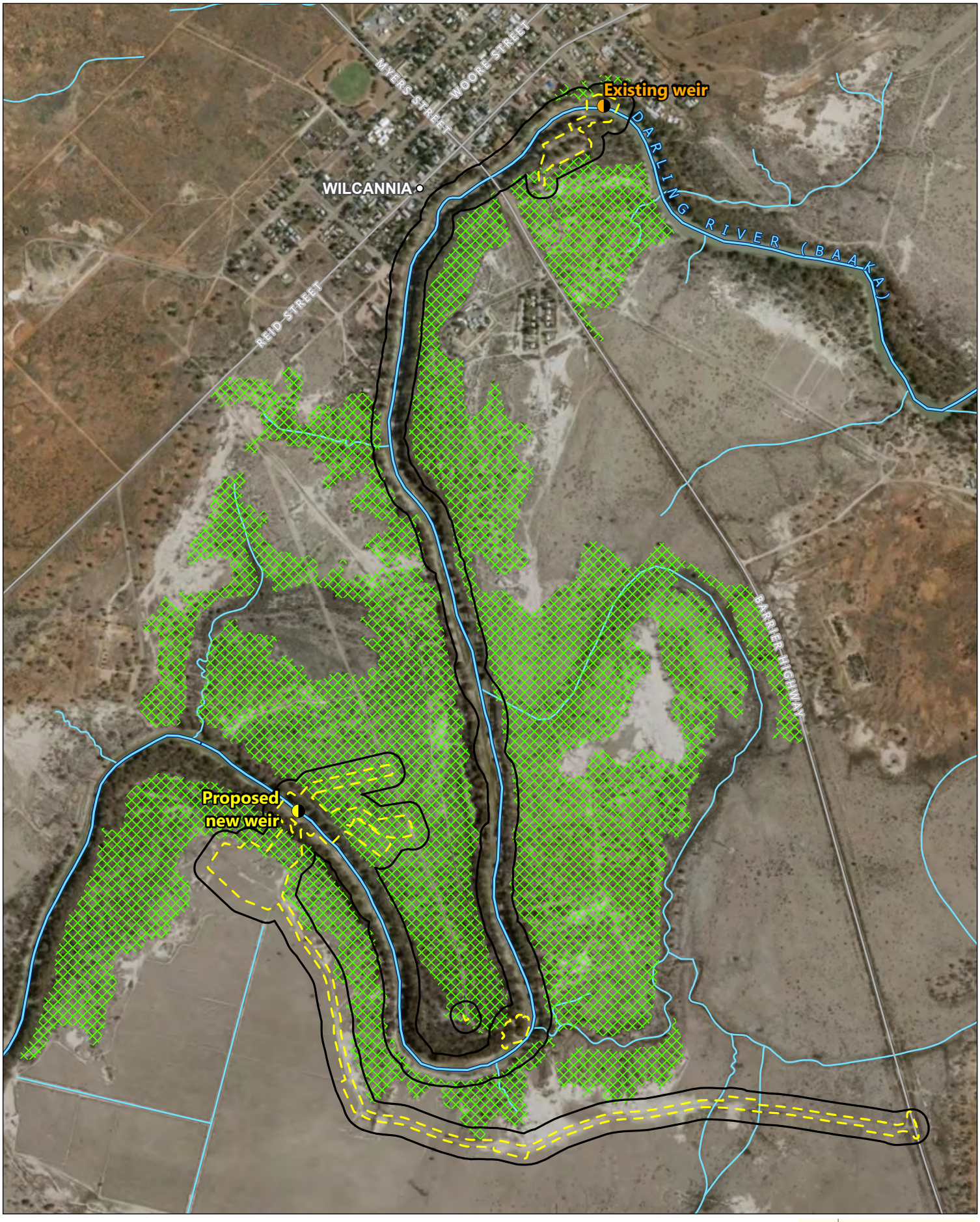

Figure 7-1: Matters of National Environmental Significance

8. Impact avoidance and minimisation

This section of the BDAR demonstrates the efforts taken to avoid and minimise impacts on biodiversity values in accordance with Section 7 of the BAM.

Combined with appropriate mitigation measures and safeguards during construction and operation of the proposal, the siting and planning of the proposal is expected to be sufficient to ensure that the requirements to avoid and minimise impacts on biodiversity values as set out in Section 7 of the BAM are met.

A key part of WINSW's management of biodiversity for this proposal is the application of the 'avoid, minimise, mitigate and offset' hierarchy as follows:

1) Avoid and minimise impacts as the highest priority
2) Mitigate impacts where avoidance is not feasible or practicable in the circumstance
3) Offset where residual, significant unavoidable impacts would occur (if required).

8.1 Avoiding and minimising direct and indirect impacts during proposal planning

8.1.1 Options and alternatives considered

Several investigations and studies have been carried out over the past 20 years to identify a preferred solution for water supply at Wilcannia. The local community played a key role in the identification and consideration of options and alternatives and the selection of the proposal as preferred. In 2000, an investigation of ten sites between six and ten kilometres downstream of the existing weir was undertaken (SMEC, 2000). Four of the ten sites were considered further (NSW Public Works, 2013).

Site B situated about 4.2 kilometres downstream from the existing weir was selected as the preferred location. In a subsequent ranking of site suitability, Site A2, located a further one kilometre downstream from Site B, was identified as the alternative preferred site. This was also based on community consultation. In 2014, the NSW Government began investigating options for upgrading the Wilcannia Weir based on these investigations and in 2016, a scoping study and business case for the replacement of Wilcannia Weir was prepared (Jacobs, 2016). The scoping study and business case identified three possible options for the future of the Wilcannia Weir. These were:

- Do nothing
- Replacement of the weir at the existing site
- Replacement of the weir at a new downstream site.

In both replacement options, the town water supply intake would remain at its existing location.

A multicriteria assessment (MCA) process was used to assess the three weir options in a fair, open and transparent way to arrive at the preferred option. The MCA workshop was attended by participants from the NSW Government, Central Darling Shire Council and the Wilcannia community. The analysis used a set of agreed evaluation criteria with agreed weightings which were chosen to assess each option. Each option considered was given a score against the following assessment criteria:

- Environmental
  - Improves riverine ecosystem health
  - Enhances the terrestrial riparian zone health
  - Increases native fish populations
- Social
  - Restores cultural connection to the river

  - Creates local employment opportunities
  - Improves civic amenity and pride
  - Improves visual and recreational amenity
  - Improves water security
- Financial
  - Capital and operational cost
  - Reduces risk of economic loss due to severe water restrictions
  - Stimulates private investment
  - Enhances impact of government investment and services.

All groups at the MCA workshop selected Option 3, the downstream option for a new weir as the preferred option.

Following discussion with the community about the most appropriate downstream site and consideration of the local geomorphology and heritage features, the question of the most appropriate downstream site was re-visited. Four downstream locations were considered (refer to **Figure 8-1**):

- Site B, located about 4.2 kilometres downstream from the existing weir
- Site 1, located about 6 kilometres downstream from the existing weir
- Site A2, located about 5.25 kilometres downstream from the existing weir
- Site D located about 1.9 kilometres downstream of the existing weir.

Following the workshop and in consideration of the feedback, the 2016 business case adopted site A2 as the preferred downstream site, noting that the final location may be adjusted during the design phase of the proposal following community consultation.

During preparation of the preliminary concept design in 2020, opportunities to minimise the environmental impact of the new weir were investigated. These investigations identified an alternative operating regime for the new weir whereby it would be operated at the existing full supply level (RL 65.71 metres) most of the time and only raised to the new full supply level (RL 66.71 metres) if upstream flows dropped below a predetermined threshold. Also, the location of the proposed weir was moved about 250 metres upstream of Site A2 to a straighter section of the river that was easier to access from existing tracks.

Figure 8-1 Options considered for downstream weir location - 2016

8.1.2 Design development

The approach to design development and preliminary construction planning undertaken to date has included a focus on avoiding and/or minimising, as far as practicable, the potential for impacts during all stages of construction. The study area has a number of constraints and characteristics such as items of heritage significance which have influenced the development of the construction methodology to date. These constraints and how the potential impacts related to them have been avoided or minimised are identified in **Technical Report 5**.

Direct impacts to vegetation have been 101inimize101 by using existing tracks and roads to access the construction work sites and avoiding trees and other vegetation of significance as far as practicable. Staging and laydown areas have been situated to 101inimiz more cleared areas where possible. The recreation reserve has been designed to avoid vegetation removal and mature trees. The construction methodology for the new weir has been prepared with the objective of providing a suitable fish passage past the work site once the fishway is complete.

8.2 Avoiding and minimising prescribed impacts during proposal planning

Some types of projects may have impacts on biodiversity values in addition to, or instead of, impacts from clearing vegetation and/or loss of habitat. For many of these impacts, the biodiversity values may be difficult to quantify, replace or offset, making avoiding and minimising impacts critical.

Chapter 6 of the BAM (2020) identifies actions that are prescribed as impacts to be assessed under the biodiversity offsets scheme as per clause 6.1 of the BC Regulation. Such prescribed impacts (including direct and indirect impacts) are impacts:

a) on the habitat of threatened species or ecological communities associated with:
   i. karst, caves, crevices, cliffs, and other geological features of significance, or
   ii. rocks, or
   iii. human made structures, or
   iv. non-native vegetation
b) on areas connecting threatened species habitat, such as movement corridors
c) that affect water quality, water bodies and hydrological processes that sustain threatened entities (including from subsidence or upsidence resulting from underground mining)
d) on threatened and protected animals from turbine strikes from a wind farm
e) on threatened species or fauna that are part of a TEC from vehicle strikes.

8.2.1 Human made structures

The proposal would involve removal of the existing weir located on the Darling River (Baaka) adjacent to the Wilcannia township, this weir is a human-made structure. An inspection of the existing weir structure was conducted during the targeted surveys and did not observe any fauna or threatened species utilising the structure for roosting or shelter. There are no opportunities for roosting microbats within the weir structure.

8.2.2 Habitat connectivity and fauna movement

The proposal would result in clearing of about 200 metres of native vegetation within the Darling River (Baaka) riparian corridor. This clearing would slightly reduce the connectivity of the riparian woodland by the removal of trees. There is also likely to be temporary disturbance during construction, which may deter threatened species from the development site. The threatened animal species that may be affected by the slight decrease in connectivity are all highly mobile bird species. The Red-tailed Black Cockatoo, Brown Treecreeper and Dusky Woodswallow were all observed along the Darling River (Baaka) during surveys. The

final stage of the proposal construction will involve revegetation around the weir site to restore any areas disturbed during the construction, the revegetation will focus on restoring any impacts from lost connectivity along the riparian area, focusing on gaps in the canopy through tree planting.

8.2.3 Water bodies, water quality and hydrological processes

The assessment has considered the nature, extent and duration of short and long-term impacts of the proposal on the water quality in the study area, and the hydrological processes that sustain threatened species.

In its natural state the Darling River (Baaka) is characterised by variable and unpredictable patterns of high and low flows. This variability in environmental conditions has led to adaptations in native aquatic flora and fauna. No terrestrial threatened species were recorded in the direct impact areas, although a number of threatened species (ecosystem credit species) are predicted to occur and may be associated with the aquatic system, including Australasian Bittern, Brolga, White-bellied Sea Eagle, Black-tailed Godwit, Australian Painted Snipe, and Freckled Duck.

When the gate of the new weir is closed, the weir pool would store an additional one metre of water above the level of the existing weir pool at full supply level. Additionally, in this drought security operation mode, a further 18.81 river kilometres of the Darling River (Baaka) upstream of the existing weir pool would be inundated to depths of between zero and one metre. It is evident that damming of the waterway will create a more permanent weir pool, and this is likely to benefit these species. However, the proposal to construct a new weir will alter the normal hydrological processes downstream of the weir and this may impact water quality and habitat availability.

An operations plan for the new weir, approved by the DPE (Water), would be implemented prior to operation, and would consider rules that would avoid and minimise potential impacts downstream of the weir. The operations plan would be prepared by WINSW and would detail the preliminary trigger levels for opening and closing the weir and fishway gates. While the trigger values from the Bourke gauging station have been used as a conservative way to determine the point of transition between for the proposes of assessment, the defined operating rules would be more adaptive and would consider both inflows and forecasts both upstream and downstream of the proposal. The plan would include a broader consideration of the state of the river system than just the flow rate in the river at the Bourke Town Weir and would be refined over time to reflect any future changes in the nature of river flows and local demand for water.

Any potential changes in the upstream sections of the Darling River (Baaka), at the upper extent of the weir pool, are considered to have little impact on the threatened species described above. The pooling of water and fluctuating water levels associated with full storage, are likely to benefit these species.

The potential for downslope sediment mobilization during construction of the weir is able to be avoided and managed during construction through implementation of sediment control measures and water quality monitoring as described in **Section 10**.

8.2.4 Turbine strike

The impacts of wind turbines are not applicable to this proposal.

8.2.5 Wildlife vehicle strike

Increased vehicle movements during construction of the proposal have the potential to result in fauna mortality from vehicle strikes. These potential impacts can be avoided and managed and will be addressed in the construction environmental management plan (CEMP), and include examples such as on-site education, identifying and reporting.

9. Assessment of impacts

9.1 Direct impacts

9.1.1 Removal of native vegetation, threatened ecological communities and habitat for threatened species

The proposal will result in the direct removal of native vegetation to gain access to the river and facilitate construction of the new weir across the river channel. This will include an upgrade of existing tracks to allow all weather access leading to the site for construction and operational maintenance, and removal of a narrow area of riparian vegetation on each bank and adjoining small areas of vegetation adjacent to the bank. A small recreation area and car park of about 0.7 hectares will be established on the north bank of the weir, and this has been sensitively designed to avoid removal of vegetation and impacts to large mature trees. The final stage of the proposal will involve access to and removal of the upstream existing weir, this will involve minimal disturbance due to plan to use an existing access road from the south bank with a short extension.

The direct impact also considered areas of native vegetation present in the river channel that will subject to inundation at full supply level (FSL), and hence considered permanently removed for operation of the weir. During operation the new town pool area (4.92 river kilometres) will experience the greatest change in depth of inundation during drought security operation mode, from that of an existing naturally fluctuating hydrological pattern to that of an artificial weir pool state. The effect would be inundation of the river channel and lower banks to below 65.71 metres AHD, as well as reduced river flow velocities and increased water depths. As a result of this any vegetation identified in the river channel in the town pool area has been assessed as directly impacted. This relates to the River Red Gum open forest/woodland (PCT 36) which occupies the top of the riverbank between the two weirs on both sides of the river. While the riparian vegetation sits higher than the weir pool, a lower condition variant of this community (vegetation zone 2) was mapped on the sloping banks down into the channel.

This impact was calculated using GIS and assessed the area of mapped vegetation associated with PCT36 where this intersects with the height of the full supply level during drought security operation mode. This included the lower reach of any tributaries and equated to about 1.49 hectares and was accounted for in the direct loss of vegetation for the purposes of calculating the offset. This loss is considered a conservative worst case scenario and not factoring any tolerance of the bank vegetation to periodic inundation. In reality when the weir is operating below FSL, native vegetation may be present in the channel, however the extent and condition of this vegetation is not possible to accurately predict or assume and so has been assessed as total loss.

The estimated area of vegetation and habitat removal required for construction and operation therefore equates to 10.14 hectares including the 1.49 hectares in the weir pool. While the exact area of vegetation removal that will occur for the recreation reserve is not able to be quantified, and may be less than 0.7 hectares, for the purpose of calculating offsets, the proposal design has been used to quantify the impact. Similarly, the future VI score for the area of vegetation at the reserve has been set to zero to allow for the car park and likely change in vegetation integrity at the site.

Table 9-1 provides a summary of the direct impacts to native vegetation (construction and operation) that would occur within the direct impact area.

Table 9-1 Summary of direct impacts to native vegetation from the proposal

Veg Zone	PCT ID	PCT name	Condition class	TEC		**Direct impact** (ha)	Current VI score	Future VI score
				BC Act	EPBC Act			
1	36	River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains	Good	Not a TEC	Not a TEC	0.95	75.4	0
2			Low	Not a TEC	Not a TEC	1.62	21.2	0

Veg Zone	PCT ID	PCT name	Condition class	TEC		Direct impact (ha)	Current VI score	Future VI score
				BC Act	EPBC Act			
		mainly in the Darling Riverine Plains Bioregion						
3	39	Coolabah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion	Moderate	Coolibah-Black Box Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain and Mulga Lands Bioregions	Coolibah - Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions	1.94	57.8	0
4			Low		Not a TEC	0.94	15	0
5			Poor		Not a TEC	0.05	0.9	0
6	158	Old Man Saltbush - mixed chenopod shrubland of the semi-arid hot (persistently dry) and arid climate zones (north-western NSW)	Moderate	Not a TEC	Not a TEC	1.94	63.4	0
7			Poor	Not a TEC	Not a TEC	0.71	3.5	0
8			Good	Not a TEC	Not a TEC	1.99	92.4	0
					Total:	**10.14 ha**	-	-

The larger extent of the weir pool (upstream of the existing weir) would experience a temporary increase in the full supply level of one metre above the normal fill level during drought security operation mode and result in the weir pool extending about 18.81 river kilometres further upstream than the existing weir pool, to create a weir pool that is about 85.52 river kilometres long. The river channel upstream of the town pool is characterised by a lack of in-stream vegetation and absence of wetland type vegetation as noted from the surveys. This is likely a result of the incised steep nature of the channel and riverbanks, the rapid flows during high flow events and absence of water during dry periods. As a result, the proposal is not expected to result in permanent removal of any areas of existing native vegetation (direct impact), and no negative impacts to threatened species habitat associated with direct impacts, and in fact would likely result in positive benefits for fauna. This has been assessed as a prescribed impact and discussed in **Section 9.3.5**.

9.1.2 Direct impact to threatened species and habitat

The proposal would not result in any direct impact to threatened species-credit species or their habitat. The impacts to native vegetation listed in **Table 9-1** constitutes impacts to ecosystem-credit species habitat, which is detailed for threatened species recorded or assumed to occur in habitats within the development site. Impacts to ecosystem credit species habitat are detailed below in **Table 9-2**.

Wetlands of the Darling River (Baaka) system provide significant water bird habitat in the Murray-Darling Basin, as they dry and flood, supporting tens of thousands of birds (Kingsford et al. 2002). However, no instream wetlands were identified from the survey of the study area, likely due to the river being dry for an extended period of time and the largely incised nature of the river at this location. The vegetation that would be flooded within the proposed new town pool as a result of the proposal consists of poor condition riparian woodland which provides a low habitat value for wetland bird species. There are no shallow reed beds present.

The direct impact caused by permanent inundation is predicted to occur to the shallow mudflats that currently exist between the existing weir and the proposed new weir. These mudflats may provide suitable

foraging habitat for a range of wading species, and the Black-fronted Dotterel, Black-winged Stilt and Australian Ibis were recorded just south of the existing weir during field surveys. These are relatively common species, and the current condition of the habitats is unlikely to be suitable for threatened and migratory water bird species such as the Black-tailed Godwit, Australasian Bittern, Freckled Duck, Blue-billed Duck, Curlew Sandpiper and Australian Painted Snipe. These species require high condition wetland habitat with thick cover of macrophyte vegetation for foraging and refuge and are less likely to occur within the proposed new town pool. As a result of the proposal, these existing mudflats will be permanently inundated, removing potential low value foraging habitat for wading species. However, the mudflat habitat only exists due to modified flow regimes caused by the existing weir.

The permanent inundation may encourage the growth of instream vegetation and increase habitat quality for water bird species such as the Freckled Duck and Blue-billed Duck. Therefore, additional mitigation measures have not been proposed.

Photo 9-1 Shallow instream habitats within the proposed new town pool may provide temporary foraging habitat for common wading and water bird species

Photo 9-2 Shallow habitats along the edges of the Darling River (Baaka) just downstream of the existing weir, where Black-winged Stilts, Black-front Dotterels, Australian Ibis, Australian Pelican and Black Swans were observed

Table 9-2 Summary of direct impacts on threatened species habitat (ecosystem-credit species)

Species	Common name	EPBC Act	BC Act	Habitat	**Direct impact area** (ha)
Birds					
Artamus cyanopterus cyanopterus	Dusky Woodswallow	-	V	Observed. Woodland (PCT 36, PCT 39), excluding low and disturbed condition	2.90
Calyptorhynchus banksii samueli	Red-tailed Black-Cockatoo (inland subspecies) (foraging)	-	V	Observed. Woodland (PCT 36, PCT 39) and chenopod shrublands (PCT 158), excluding low and very poor condition	4.44
Certhionyx variegatus	Pied Honeyeater	-	V	Assumed present. Woodland (PCT 36, PCT 39), excluding low and disturbed condition	2.90
Circus assimilis	Spotted Harrier	-	V	Observed. All vegetation zones.	10.14

Species	Common name	EPBC Act	BC Act	Habitat	**Direct impact area** (ha)
Daphoenositta chrysoptera	Varied Sittella	-	V	Assumed present. Woodland (PCT 36, PCT 39), excluding low and disturbed condition.	2.90
Epthianura albifrons	White-fronted Chat	-	V	Assumed present. Chenopod shrublands (PCT 158)	4.64
Falco hypoleucos	Grey Falcon	-	V	Assumed present. All vegetation zones.	10.14
Falco subniger	Black Falcon	-	V	Assumed present. All vegetation zones.	10.14
Grantiella picta	Painted Honeyeater	-	V	Assumed not present due to absence of habitat constraints (density of mistletoe).	-
Grus rubicunda	Brolga	-	V	Assumed present. All vegetation zones	10.14
Hamirostra melanosternon	Black-breasted Buzzard (foraging)	-	V	Assumed present. All vegetation zones.	10.14
Hieraaetus morphnoides	Little Eagle (foraging)	-	V	Assumed present. All vegetation zones.	10.14
Lophochroa leadbeateri	Major Mitchell's Cockatoo (foraging)	-	V	Assumed present. Woodland (PCT 36, PCT 39), excluding low and disturbed condition	2.90
Lophoictinia isura	Square-tailed Kite (foraging)	-	V	Assumed present. Woodland (PCT 36, PCT 39)	5.51
Haliaeetus leucogaster	White-bellied Sea-Eagle	-	V	Assumed present. All vegetation zones are within 1km of waterbody	10.14
Melanodryas cucullata cucullata	Hooded Robin (south-eastern form)	-	V	Assumed present. Woodland (PCT 36, PCT 39), excluding low and disturbed condition	2.90
Ninox connivens	Barking Owl (foraging)	-	V	Assumed present. Woodland (PCT 36, PCT 39).	5.51
Tyto novaehollandiae	Masked Owl (foraging)	-	V	Assumed present. Woodland (PCT 36, PCT 39).	5.51
Phaps histrionica	Flock Bronzewing	-	E	Assumed present. Chenopod shrublands (PCT 158).	4.64
Stagonopleura guttata	Diamond Firetail	-	V	Woodland (PCT 36, PCT 39).	5.51
Stictonetta naevosa	Freckled Duck	-	V	Assumed present. Woodland (PCT 36).	2.57
Rostratula australis	Painted Snipe	E	E	Assumed present. Woodland (PCT 36, PCT 39), excluding low and disturbed condition.	2.90

Species	Common name	EPBC Act	BC Act	Habitat	**Direct impact area** (ha)
Pyrrholaemus brunneus	Redthroat		V	Associated with PCT 158, however assumed not present due to only low and poor condition area present, that are too degraded for the species.	0
Limosa limosa	Black-tailed Godwit	-	V	No mapped important areas, but may occasionally use good condition PCT39	1.94
Botaurus poiciloptilus	Australasian Bittern	E	E	Assumed present. Woodland (PCT 36, PCT 39), excluding low and disturbed condition.	2.90
Mammals					
Antechinomys laniger	Kultarr	-	E	Assumed present. Cracking clay (PCT 39, PCT 158).	7.58
Chalinolobus picatus	Little Pied Bat	-	V	Assumed present. All vegetation zones.	10.14
Phascolarctos cinereus	Koala (foraging)	V	V	Assumed present. Woodland (PCT 36, PCT 39), excluding low and disturbed condition.	2.90
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	-	V	Assumed present. All vegetation zones.	10.14
Sminthopsis macroura	Stripe-faced Dunnart	-	V	Assumed present. All vegetation zones	10.14
Rattus villosissmus	Long-haired Rat	-	V	Assumed present. Chenopod shrublands (PCT 158)	4.64
Leggadina forresti	Forrest's Mouse	-	V	Assumed present. Chenopod shrublands (PCT 158)	4.64
Reptiles					
Pseudonaja modesta	Ringed Brown Snake	-	E	Assumed present Woodland (PCT39) and Chenopod shrubland (PCT158)	7.58

Key: E = endangered, V = vulnerable

9.1.2.1 Fauna injury and mortality

Fauna injury or death has the greatest potential to occur during the construction phase when excavation and vegetation clearing would take place. The extent of this impact would be proportionate to the extent of vegetation that is cleared. Less mobile species (ground dwelling reptiles), or those that are nocturnal and nest or roost in trees during the day (arboreal mammals and microbat species), may find it difficult to rapidly move away from the clearing activities when disturbed. In addition to this, entrapment of fauna in any excavated trenches or pits may potentially occur if the trenches or pits are deep and steep sided. Fauna may also become trapped in or may choose to shelter in construction vehicles, infrastructure, machinery and equipment and/or during relocation of stored construction materials that is stored in the development site overnight. Fauna that may take shelter inside construction vehicles, infrastructure, machinery, and equipment and/or during relocation of stored construction materials machinery, may result in injury or death if not thoroughly checked prior to construction activities and equipment use. Direct impacts to fauna can be minimised and avoided through the implementation of the mitigation measures detailed in **Section 10**.

9.2 Indirect impacts

Section 1.2 of the BAM Stage 2 Manual (DPIE, 2019b) defines indirect impacts as "development related activities not associated with clearing for the development footprint". Section 8.2 of the BAM lists potential indirect impacts that may result from construction and/or operation of a new development. The potential indirect impacts that are applicable to this proposal are discussed below. Note, there are listed Threatened Ecological Communities in the development site, as well as PCTs and habitat for threatened species. Though indirect impacts cannot be quantified, the potential for indirect impacts can be minimised through the application of stringent mitigation measures and monitoring the performance of these. Such measures would be documented in a project CEMP.

The types of potential indirect impacts on native vegetation and threatened species (and their habitat) beyond the direct clearing area is summarised in **Table 9-3** and described in more detail in the following sections. The discussion includes an assessment of the extent, duration and consequence of the impact. The summary table below provides reference to the report section where each impact is assessed with the intent of providing a reference to follow the impact to the mitigation section of the BDAR (Chapter 10).

Table 9-3 Summary of potential indirect impacts on native vegetation and habitat for threatened species

Indirect impact and section reference	Impacted entities	Extent	Duration	Consequence
Clearing for weir and access tracks: edge effect, displacement of fauna for life-cycle activities (foraging, shelter, movement, breeding (**Section 9.2.1**)	Native vegetation associated with 3 PCTs and habitat for threatened species adjoining the site including hollow trees	The extent of the indirect disturbance buffer adjacent to the proposal is uncertain and subject to monitoring and assessment	Long-term	Negative changes to the structure and function of the adjoining vegetation
Clearing for weir and access tracks: Increased sedimentation into stream habitat (**Section 9.2.2**)	Aquatic habitat	Weir pool and downstream from weir	Long-term	Temporary loss of habitat for threatened birds and mammals
Transport of weed and pathogens (**Section 9.2.3**)	Native vegetation associated with 3 PCTs and habitat for threatened species adjoining the site	The extent of the indirect disturbance buffer adjacent to the proposal is uncertain and subject to monitoring and assessment	Potential long-term during construction and operation	Negative changes to the structure and function of the adjoining vegetation
Noise and vibration (**Section 9.2.4**)	Threatened fauna	Localised near the new and existing weir construction sites and assess roads	Short-term during construction	Disturbance to breeding activity
Dust pollution (**Section 9.2.5**)	Native vegetation and threatened species	Localised near the new and existing weir construction sites and access roads	Short-term during construction	Negative changes to the structure and function of the adjoining vegetation
Contaminant pollution (**Section 9.2.6**)	Aquatic habitats	Darling River (Baaka) (weir pool, and downstream habitat)	Potential long-term	Decline on habitat condition for aquatic species

9.2.1 Inadvertent impacts on adjacent vegetation and threatened species habitat

Nature, extent and duration of impact

Edge effects refer to the changed abiotic conditions when new edges are created through previously intact vegetation. These indirect impacts can occur in vegetation and habitat retained adjacent to clearing required for the development. Edge effects can result in negative changes to the structure and function of retained vegetation from changed abiotic factors such as increased light intensity and duration, increased exposure to wind and weed invasion in edge habitats.

The development is located in a mixture of vegetation types ranging from closed canopy riparian vegetation with a very open midstorey to open floodplain woodland and disturbed (and previously cropped) saltbush shrublands. Clearing works within riparian vegetation would only be undertaken to facilitate placement of machinery and would not result in total removal of vegetation. Construction lay down areas will be placed in areas already lacking canopy and the access roads are utilising existing tracks to be upgraded, and vegetation is already edge affected. Therefore, the conditions following the clearing of native vegetation for the development are unlikely to dramatically change the abiotic conditions such that retained vegetation adjacent to the development will be substantially modified. Indirect impacts to retained adjacent vegetation and habitats can be minimised and avoided through the implementation of the mitigation measures detailed in **Section 10**.

Large, mature hollow-bearing trees are widespread across the study area and all along the Darling River (Baaka). These represent important microhabitat features and provide potential breeding sites for threatened bird species that have a high likelihood of occurring. This includes Major Mitchell Cockatoo (*Lophochroa leadbeateri*), Barking Owl (*Ninox connivens*) and Masked Owl (*Tyto novaehollandiae*). There were no confirmed breeding sites for these species reported during the survey, however the proposal may remove trees and hollows that provide potential nest sites.

The Square-tailed Kite, Black-breasted Buzzard, Little Eagle and White-bellied Sea Eagle were not found during the surveys although are considered to potentially occur. Three moderately-sized stick nests were located in trees in the study area, none of which were within the development site. No nest sites for these threatened diurnal raptors were identified during the survey.

Mitigation strategies

Pre-clearing survey for new nests and nesting birds should be conducted prior to any clearing activity.

9.2.2 Impact on water quality

Nature, extent and duration of impact

Due to the nature of the proposal being associated with construction activities directly in the river channel and adjacent areas, there is potential for mobilized sediments to enter the waterway, particularly in the event of heavy rainfall during construction. This indirect impact has potential to cause degradation of habitat in the waterway, that is potentially used by threatened fauna species, including birds and mammals. The extent and duration of the impact is unknown but may occur for large distances downstream. Over the long-term operational phase of the proposal, the recovery of ground layer vegetation at the site would be expected to prevent further movement of sediment.

Mitigation strategies

A range of mitigation measures are proposed to prevent sediment entering the waterway, and these would be documented in the CEMP and Soil and Water Management Plan (SWMP).

9.2.3 Transport of weeds and pathogens

Nature, extent and duration

The activities associated with clearing vegetation and increased human presence during construction and operation have potential to introduce weeds into adjacent vegetation outside the proposal as well as increase the risk of introducing plant and animal diseases carried on machinery. A consolidated list of plant species from the flora survey identified a high number of weed species (30), the species identified and their mechanism for dispersal is identified in **Table 9-4**. Of these, three species are considered high threat weeds including Wards Weed (*Carrichtera annua*), African Boxthorn (*Lycium ferocissimum*) and Arabian Grass (*Schismus barbatus*).

Table 9-4 Weed species identified from targeted flora survey

Species	Dispersal Mechanism
Aira caryophyllea	Seeds are small and could be dispersed by wind currents. Seeds may also get caught in the fur, feathers or hair of animals and be dispersed.
Brassica tournefortii	Detached stem fragments and entire mature plants can be blown by the wind, resulting in the dispersal of seeds. Both fruit and seeds have sticky coatings that allow for dispersal on animals, vehicles, and shoes. The film on the seeds also allows for dispersal by water seeds remain viable after six weeks of submersion. Seeds can remain dormant in the seed bank for a year or more. Sometimes detaching near ground level at maturity and dispersing as a tumbleweed.
Bromus catharticus	Spreads by wind, animals (external and internal), mowing equipment, dumped garden waste, contaminated soil and clothing, sometimes in contaminated nursery pots used for revegetation. Provides seeds for birds and small mammals. Very light, wind dispersed seeds, or bird dispersed seeds, or has edible fruit that is readily eaten by highly mobile animals. Very likely that at least one propagule will disperse greater one kilometre.
*Carrichtera annua**	Dominant mechanism is by rain, although may also spreads through vehicle and stock movements due to its ability to adhere to a substrate. Small proportions of ingested seeds can also survive herbivory of native animals and stock, dispersal vectors may include vertebrate herbivores including goats, macropods, emus, sheep, cattle and rabbits. The seed of C. annua contains a mucilaginous layer which aids its floating capabilities so that seeds can be carried in runoff water along runnels in the desert. When it rains, seeds can be flicked up to 25 centimetres from the parent plant. Emus are able to disperse seeds greater than 50 km. It is very likely that at least one propagule will disperse greater than one kilometre.
Centaurea melitensis	Seeds fall close to the plant and can be dispersed a short distance by wind. Seeds are commonly dispersed further by people, animals, water and soil movement. Few seeds survive past four years but can survive up to 10 years under optimum conditions. Most seeds fall near the parent plant or is dispersed over short distances by wind or sometimes water. Longer distance dispersal is usually mediated by human or other animal activities such as being carried on vehicles, transported in mud or soil, on hooves or equipment, clinging to fur or hair, or passing through a digestive tract of an animal.
Centaurium tenuiflorum	The seeds can be dispersed by animals internally and externally, by attaching to the fur, feathers or hair, and can also be dispersed by wind.
Conyza bonariensis	*Conyza bonariensis* is principally a wind-dispersed species, facilitated by light seed accompanied by a pappus which aids flight. Mowing along roadsides, especially during seed production, is likely to increase spread.
Heliotropium supinum	The seeds can be dispersed by animals externally, by attaching to the fur, feathers or hair, and can also be dispersed by wind.
Hordeum leporinum	Seeds are caught and transported in the fur, feathers or hair of animals and be dispersed.
Lactuca serriola	On average, between 15 and 22 seeds per capitulum are produced. Capitula ripen and release seeds over a period of several months. The small seeds with attached pappi are primarily wind-dispersed, but are probably also dispersed by water. Dispersal of the lightweight seeds is

Species	Dispersal Mechanism
	facilitated by the attached pappus and the position of the seeds on tall stems high above the ground. The wind-dispersed seeds have no primary dormancy and form only a short-term seed bank.
Lepidium africanum	This species is dispersed through contaminated agricultural produce. It may also be dispersed by wind, water and human activities (by mowers or slashers and in contaminated soil).
*Lycium ferocissimum**	African boxthorn plants are at least two years old before they flower and produce fruit. Seeds can germinate at any time of the year if there is adequate moisture and warmth. Seed is mainly spread by animals. Birds and foxes eat the fruit and spread the seed and plants are often found beneath bird perches such as trees, poles and powerlines. Seeds can also be spread in contaminated mud or agricultural produce. Additionally, the extensive, branched taproot will sucker and produce new growth if broken.
Medicago minima	The non-dehiscent fruits are relatively large and are unlikely to move far from the parent plant, except perhaps in flood waters. The hooked spines commonly, but not always, found on the fruits allow the entire burrs to adhere firmly to the wool of sheep or the hair of horses and other animals, and to the hair and clothes of humans. Spread in hay and straw transported for livestock, in vegetation used as packaging and in plant seed transported for cultivation.
Medicago sp.	The non-dehiscent fruits are relatively large and are unlikely to move far from the parent plant, except perhaps in flood waters. The hooked spines commonly, but not always, found on the fruits allow the entire burrs to adhere firmly to the wool of sheep or the hair of horses and other animals, and to the hair and clothes of humans. Spread in hay and straw transported for livestock, in vegetation used as packaging and in plant seed transported for cultivation.
Melilotus indicus	This species is dispersed by water and wind. Rainwater runoff and stream flow are the most important means of seed dispersal. Seed dispersed on vehicle tyres and agricultural machinery and as a contaminant in cereal grains and soil.
Polygonum aviculare	The species has effective mechanisms of seed dispersal by human or other agencies. Seeds occur both as an impurity in the harvested crop and as a contaminant of sown seed. They may be dispersed in mud on footwear or tyre treads and can survive ingestion by stock or by birds. They can also be transported by irrigation water.
Polypogon monspeliensis	Seeds of *P. monspeliensis* can be spread by wind or water and animals. Since it occurs among other grass species, the species has likely been spread as a contaminant in hay or straw.
Rostraria pumila	The seeds can be dispersed by animals internally, externally, by attaching to the fur, feathers or hair, and can also be dispersed by wind.
*Schismus barbatus**	Low-moderate distance dispersal by saltation/tumbleweed action. Seeds can spread through the digestion on animals and livestock.
Silene apetala	Seeds may be dispersed by self-dispersal, wind dispersal, dispersal by birds or animals or dispersal by humans.
Sisymbrium erysimoides	Seeds disperse when the dead, dried parent plant breaks at the stem base and tumbles or slides across the ground by wind or other movement. Dispersed primarily by birds and mammals
Solanum nigrum	This species reproduces mainly by seed, which are most often spread by birds and other animals that eat the fruit.
Sonchus oleraceus	This species spreads entirely by seed. The seeds are equipped with a small pappas, or parachute of hairs, which may carry the seed over large distances in strong winds. Seeds lying on the ground may also be transported in moving water.
Spergularia brevifolia	Dispersal from parent plant. The seeds can be dispersed by animals externally, by attaching to the fur, feathers or hair, and can also be dispersed by wind and water.
Spergularia sp.	Dispersal from parent plant. The seeds can be dispersed by animals externally, by attaching to the fur, feathers or hair, and can also be dispersed by wind and water.
Verbena africana	The seeds may be dispersed by animals (i.e. externally), by wind, or in water. They may also be spread in contaminated agricultural produce.

Species	Dispersal Mechanism
Verbena officinalis	The seeds may be dispersed by animals (i.e. externally), by wind, or in water. They may also be spread in contaminated agricultural produce.
Verbena supina	The seeds may be dispersed by animals (i.e. externally), by wind, or in water. They may also be spread in contaminated agricultural produce.
Vicia sp.	This species reproduces by seed, which may be dispersed by water or in contaminated agricultural produce (fodder and pasture seeds).
Xanthium occidentale	The burrs are usually dispersed from the plant in autumn and winter, but they may remain attached on undisturbed plants until the following spring. The burrs are spread by: - Sticking to wool and fur of animals - Floating in waterways - Movement of contaminated grain - Movement of contaminated gravel - Machinery. Seeds germinate when the soil is moist in late winter to summer. Flushes of germination can occur after summer storms or irrigation events. On flood prone areas large germination events are common after floods.

Note: High threat species are identified with asterisk (*)

Plant and animal disease pathogens can be carried on machinery to construction sites and indirectly impact on native vegetation and habitat for threatened species, this includes the following listed key threatened processes.

- Infection of frogs by amphibian chytrid causing the disease chytridiomycosis
- Introduction and establishment of Exotic Rust Fungi on plants of the family Myrtaceae
- Infection of naïve plants by *Phytophora 112inimize112c*

Mitigation strategies

The list of weeds reported from the proposal area in **Table 9-4** includes information on the dispersal mechanisms of the plant. This information is provided to assist in developing appropriate weed control advice in the preparation of the CEMP. Further advice on mitigation measures for controlling weed species are discussed in **Section 10** and focus on control of the high threat weeds prior to clearing, and ongoing monitoring of weed invasion in adjoining habitat during construction as a part of an adaptive management plan.

9.2.4 Noise and vibration

Nature, extent and duration

Anthropogenic noise can alter the behaviour of animals or interfere with their normal functioning (Bowles, 1997). During construction of the proposal there will likely be increased noise and vibration levels in the development site and study area due to vegetation clearing, ground disturbance, machinery and vehicle movements, and general human presence. Noise impacts during operation are expected to be minimal and associated with increased human presence at the community river place. During construction of the proposal the key sources of noise will include:

- Construction traffic – noise along accesses roads during daytime activities only. Additional traffic movements from proposal construction activities are not expected to result in unacceptable changes in traffic noise levels.
- Construction vibration – due to earthmoving and handling of rock. These types of activities would be temporary and occur periodically.

Construction activities will likely result in a small increase in ambient noise levels as well as potentially loud noises and vibration for short periods associated with earthworks. The noise and vibration from activities

associated with the proposal will potentially disturb resident fauna and may disrupt foraging, reproductive, or movement behaviours, however, impacts from noise are likely to be temporarily localised to the construction areas and not spread far. These emissions are not considered likely to have a significant, long-term, impact on wildlife populations outside the area of direct impact. Within the area of impact (including habitats immediately adjacent to the development site), some sensitive species (woodland birds) may avoid the noise and some more tolerant species, including small mammals, will habituate over the longer-term.

Mitigation strategies

A number of measures are proposed, and these are described in **Section 10**. This includes minimising noise from equipment through measures such as keeping both stationary and mobile plant and equipment in good working condition (including mufflers, enclosures etc.), and avoid leaving engines running on standby for extended periods of time and selecting equipment with the lowest noise rating that meets task requirements and minimise operating loud machinery conjunctively.

9.2.5 Dust impacts

Nature, extent and duration

Elevated levels of dust may be deposited onto the foliage of vegetation adjacent to the proposal activities. This has the potential to reduce photosynthesis and transpiration and cause abrasion and radioactive heating resulting in reduced growth rates and decreases in overall health of the vegetation. Consequently, changes in the structure and composition of plant communities and consequently habitat use by fauna may occur.

Some level of dust is likely to be generated throughout the lifecycle of the proposal due to the clearing of vegetation and increased movements of trucks and vehicles along dirt access road. Any resulting dust pollution is likely to be greatest during construction, during periods of earthworks, vegetation clearing, vehicle movements for construction activities and during adverse weather conditions (i.e. high wind). However, deposition of dust on foliage is likely to be highly localised, intermittent, and temporary (particularly during the rain periods) and is therefore not considered likely to be a major impact of the proposal.

Mitigation strategies

Adaptive dust management and monitoring programs using industry best practices and standards to control air quality will be implemented. No dust generating works will be conducted during high winds and stockpiles will be kept covered with material to prevent the generation of dust in addition to applying water dust suppression techniques during dust generating activities along access tracks.

9.2.6 Contaminant pollution

Nature, extent and duration

During the construction phase localised release of contaminants (i.e. hydraulic fluids, oils, drilling fluids, etc.) into the surrounding environment (including the Darling River (Baaka)) may accidentally occur. The most likely result of contaminant discharge will be the localised contamination of soil, the waterway, and potential direct physical trauma to flora and fauna that come into contact with contaminants. Accidental release of contaminants is considered low risk, and if it did occur would likely to be localised and able to be contained.

Mitigation strategies

Control measures will include ensuring that accidental spills are immediately reported and remediated, any contaminated water (if generated) will be separated from stormwater and will be managed in a process water system and on-site signage will be provided to identify contaminated topsoils of relevance.

9.3 Prescribed biodiversity impacts

This section identifies the potential prescribed biodiversity impacts on threatened species associated with the proposal in accordance with Chapter 6 of the BAM. These are impacts that are in addition to, or instead of, impacts from clearing vegetation and/or loss of habitat. Rapid flora and fauna habitat assessments and additional VI plots were undertaken in accessible areas upstream and downstream of the proposed weir to assist in the identification and assessment of prescribed biodiversity impacts (**Figure 9-1**).

9.3.1 Karst, caves, crevices, cliffs, rocks and other geological features

There are no occurrences of karst, caves, crevices and cliffs or other geological features of significance within the development site or threatened species or ecological communities associated with these features. As such, this prescribed impact has not been considered further.

Stimson's Python is the only threated species considered for this assessment that is dependent on rock habitats. No rocky areas or gibber have been identified within 500 metres of the development site (a habitat constraint listed for this species in the TBDC), therefore the Stimson's Python is unlikely to be impacted by the development. The development is unlikely to result in an impact to rocky habitat for any threatened species.

9.3.2 Human-made structures or non-native vegetation

The proposal will involve partial removal and decommissioning of the existing weir located on the Darling River (Baaka) adjacent to the Wilcannia township, this weir is a human-made structure. An inspection of the existing weir structure was conducted during the targeted surveys and did not observe any fauna or threatened species utilising the structure for roosting or shelter. There are no opportunities for roosting microbats within the existing weir structure.

Mitigation strategies

An Ecologist is to be present during the partial removal and decommissioning of the existing weir to ensure that there is no fauna resident in the structure and can be safely removed during the activity if found to be present.

9.3.3 Habitat connectivity

The development would result in clearing of about 200 metres of native vegetation within the Darling River (Baaka) riparian corridor. This clearing would slightly reduce the connectivity of the riparian woodland by the removal of trees. There is also likely to be temporary disturbance during construction, which may deter threatened species from the development site. However, this assessment found that there is unlikely to be any threatened arboreal animal species that occur within or around the development site, as evidenced by an absence of tree scratches and scats at the base of trees during surveys. Therefore, the threatened animal species that may be affected by the slight decrease in connectivity are all highly mobile bird species. The Red-tailed Black Cockatoo, Brown Treecreeper and Dusky Woodswallow were all observed along the Darling River (Baaka) during surveys. These species may experience a temporary disruption during construction of the proposal; however, this is not expected to result in significant impacts to the movement of these species throughout their range. The functional connectivity of the riparian woodland would remain after the completion of the development. There is not expected to be any significant impacts to the ability of threatened species to move across their range.

Impacts to threatened fish species movement has been assessed in a separate aquatic ecology report.

Mitigation strategies

The final stage of the proposal construction will involve revegetation around the weir site to restore any areas disturbed during the construction, the revegetation will focus on restoring any impacts from lost connectivity along the riparian area, focusing on gaps in the canopy through tree planting.

9.3.4 Water bodies, water quality and hydrological processes

Nature, extent and duration

Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands is listed as a Key Threatening Process. This BDAR assesses the potential impacts on terrestrial vegetation and habitat for threatened species. Assessment of any changes to flow of the river and persistence of habitat for threatened fish species and other aquatic ecological communities is documented in a separate Aquatic Ecology Impact Assessment (**Technical Report 3**).

This assessment has considered the potential impacts on native vegetation and threatened species habitat from the construction of the new weir and the associated changes to the Darling River's (Baaka's) current hydrological regimes both upstream and downstream of the proposed weir. A series of rapid assessment sites (n=40) (**Figure 9-1**) in addition to detailed floristic plots (VI plots) were sampled to identify the PCTs present in the in-stream environment, with the rapid sites also focused on assessing the type and condition of habitat for threatened fauna.

The construction of the new weir may have the following effects:

1. Flooding and pooling of water in the 4.92-kilometre section of the Darling River (Baaka) between the proposed new weir and the existing weir (the proposed new town pool)
2. Flooding and pooling of water in the additional approximate 18.81-kilometre section of the Darling River (Baaka) upstream of the existing weir pool extent when the weir is in drought security operation mode (proposed new weir pool extent)
3. Changes to existing baseline flows downstream of the proposed new weir through greater water storage capacity of the new weir (compared with the existing weir) and its cutting of flows when entering drought security mode.

The changes in timing of flooding has the potential to cause long term indirect impacts to surrounding habitats. Floods are particularly important for the breeding cycles of fish and water birds, regeneration and maintenance of floodplain vegetation such as *Eucalyptus camaldulensis* (River Red Gum) and flushing salt from the landscape. The periods of low flow between floods are also important, enabling the wetlands and backwaters to dry out, oxygenation of sediments, aiding nutrient exchange and decomposition of organic matter, as well as providing habitat for terrestrial flora and fauna. These periods of low flow can also reduce groundwater levels beneath floodplains, reducing floodplain salinization and its impact on vegetation health (DEWNR, 2012). Furthermore, the loss of connectivity to the river changes aquatic systems to terrestrial ecosystems. With the diminished connectivity, seed banks of aquatic plants and additionally invertebrate eggs have limited variability.

The existing hydrological regimes in the Darling River (Baaka) and the broader Murray-Darling Basin are highly modified from a history of water off-take for agricultural practices and land management. Irrigation used for farming practices, particularly cotton farming, accounts for about 70 per cent of all surface water extracted in the Murray-Darling Basin (Grafton, R.Q., 2019). The unregulated flooding regime in western NSW consists of peak flows in late winter and spring with low flows in summer and autumn (Dalton, 1990). Anthropogenic changes in the river flow patterns of the Darling River (Baaka) has led to reduced extent and depth of winter flooding, reduced frequency of flooding, increased duration of non-flood periods, increased occurrence and variability of summer floods, increased river flow capacity and decreased total annual flow. These changes have produced major deterioration in much of the riparian vegetation, including reduced tree growth rate, accelerated mortality and minimal regeneration.

Importantly, the proposal would have negligible impacts on flooding. A flooding impact assessment of the proposal is provided in **Technical Report 1** and it includes a weir drown-outflow assessment. Weir drown-out occurs when river flow is sufficiently high to cause the weir structure to cease being the main hydraulic influence on upstream river water levels. This occurs when passing flow produces a high water level immediately downstream of the weir that results in the weir structure becoming completely submerged and the difference in water levels from downstream to upstream becoming typically 0.15 metres or less. The assessment found that weir drown-out would occur at a flow rate of 12,070 megalitres per day. At this flow rate there would be 0.95 metres of water above the weir crest and the water would be 4.01 metres below the top of the low riverbank level. This indicates that the new weir is unlikely to produce any apparent significant upstream flooding impacts as flows increase and approach top of low bank level. The weir drown-out assessment is based on a fixed crest weir and is therefore conservative given the preliminary concept design of the new weir includes weir and fishway gates, which would lessen flow obstruction.

A key design feature of the proposed new weir is the inclusion of dual operating modes. The ability to operate the proposed new weir at a higher full supply level during periods of drought and a normal (lower) full supply level at all other times would enable the proposal to improve the town's water security and at the same time minimise potential flooding and hydrological impacts. The following sections provide an assessment of the potential impacts caused by the changes to the hydrology of the Darling River (Baaka) as a result of the proposal.

9.3.4.1 Impact of the new town pool

The construction of weirs and dams results in the inundation of streamside habitat. The flooding of adjacent riparian zones detrimentally effects the survival of vegetation communities located on the embankments, resulting in the mortality of riparian flora. Impacts associated with vegetation dieback along reservoir banks include increased erosion and sedimentation, along with associated water quality reduction, proliferation of weed species, reduced macrophyte growth, especially within the littoral zone, and loss of vegetative shade cover (NSW Department of Primary Industries, 2006).

The new town pool would be created by the inundation of a 4.92-kilometre section of the Darling River (Baaka) between the proposed new weir and the existing weir. Currently this short section of the Darling River (Baaka) experiences two broad flow regimes; the sub-flow that escapes around the damaged northern side of the existing weir when it is full, and flows that are large enough to overtop the existing weir. This short section (and further downstream) is therefore deprived of regular or baseline normal flows that hold water within the river channel. The result is a deep (about 10 metres) and highly incised channel scoured by large flood events that only temporarily hold water. This has caused predominately bare earth banks, only covered by a mixture of mostly annual forbs and grasses spreading from the woodland on top of the banks and more flood tolerant species (*Cyperus gymnocaulos*), growing along the edges of the water (see **Photo 9-3**, **Photo 9-4** and **Photo 9-5**). Surveys of the Darling River (Baaka) for this assessment did not identify any instream wetlands or aquatic vegetation communities. Only one semi-aquatic and disturbance tolerant plant species, *Ludwigia peploides*, was located at several locations along the river in low abundance (see **Photo 9-6**). It is likely that the low frequency of inundation has resulted in large scale dieback of typical aquatic PCTs, permanent and semi-permanent freshwater lakes wetland of the inland slopes and plains (PCT 238), which is mapped broadly along the Darling River (Baaka) (VIS_ID 4492). This PCT or other instream wetlands may regenerate in the river once water is permanently held in the proposed new town pool.

Photo 9-3 Wide sandbars in the new town pool have quickly regenerated a mixture of *Cyperus gymnocaulos* and weeds following the flood in 2020

Photo 9-4 Meandering sub-channel in the proposed new town pool, with regrowth groundcover species on one side and bare banks on the other

Photo 9-5 Regrowth instream vegetation on sandy edges and steep bare banks in background showing recent flood levels as lines

Photo 9-6 A very low cover of *Ludwigia peploides* in some locations suggests the river may regenerate instream wetlands once water is permanently held within the new town pool

Eucalyptus camaldulensis (River Red Gum) dominates the upper banks of the Darling River (Baaka) around the study area (PCT 36), forming open forests or woodlands. The *Eucalyptus camaldulensis* trees in this section of the river are old and very large (up to two metres DBH), located mainly up on top of the banks, however there are some lower positioned trees (about two or three in the new town pool) where the bank slope is not too steep (see **Photo 9-7** and **Photo 9-8**). *Eucalyptus camaldulensis* forested wetlands can provide habitat for fish and water birds including habitat for breeding, foraging and refuge areas. However, this requires a certain length of flooding duration and time of year. *Eucalyptus camaldulensis* obtains its water from three main sources: ground water, rainfall and river flooding. It is river flooding which enables the species to germinate seeds and survive in semi-arid areas, such as the study area. It is likely that intense flows over the years have washed away most of the low positioned trees, as evidenced by the exposed roots of large trees on the banks. Also, the reduced frequency of flooding events has impacted the regeneration of seedlings along the banks.

Changes in river flow could lead to a decline in *Eucalyptus camaldulensis* health and changes in the understorey composition in the riparian zone. Permanent inundation of lower positioned trees along the proposed new town pool (see **Photo 9-7** and **Photo 9-8)** may lead to dieback of a few trees (Dalton, 1990). However, *Eucalyptus camaldulensis* can survive relatively long periods of continuous flooding, from 24 months, up to three to four years. Literature reviews suggest River Red Gums can survive two to four years of continuous flooding before showing signs of stress (Roberts and Marston, 2000). The proposal area consists

of steep embankments along the river, where a majority of the *Eucalyptus camaldulensis* habitat is located along the top of the embankment, with some individual trees located along the embankment. During operation, the new town pool area (4.92 river kilometres) will experience inundation of the river channel and lower banks to below 65.71 metres ADH. The change from normal flow to inundation will consist of up to the normal FSL 70% of the time and up to the drought FSL 30% of the time. As a result, direct impacts will occur to vegetation situated in the river channel within the new town pool area, relating to the River Red Gum open forest/woodland (PCT 36) This will equate to a loss of 1.49 hectares, as a worst case scenario. It is important to note that areas located within the new weir pool extent, the new weir is expected to raise the water by a maximum of one metre from the current maximum weir height, where prolonged flooding to the River Red Gum habitat is not expected to occur as a result of the proposal (refer to **Section 9.3.4.2**). However, some individual *Eucalyptus camaldulensis* trees, located on the lower extent of the embankments, may dieback if flooded for prolonged periods of time.

Direct impacts and offsets have been calculated for the potential loss of this native vegetation due to a new inundation storage level for the new town pool as described in **Section 9.1.1** and equates to a conservative estimate of two hectares.

Photo 9-7 Medium-sized *Eucalyptus camaldulensis* tree close to water edge that would be inundated by proposed new town pool

Photo 9-8 Two large *Eucalyptus camaldulensis* trees close to water edge that may be inundated by proposed new town pool

9.3.4.2 Impact of new weir pool extent located upstream

A backwater effect occurs when flowing water encounters an obstruction, such as a narrowing of a channel, that limits its forward movement, causing the water level to rise behind the obstruction. Like the existing weir, flows near the new weir would slow down and the water level would rise due to a backwater effect. The greatest increase in water level in a weir pool due to the backwater effect occurs nearest to the weir. The backwater effect diminishes with distance upstream of the weir and eventually become negligible.

The backwater effect at an obstruction becomes negligible at high flows. The backwater effect at the new weir would only become negligible at a high flow rate that results in water levels far above the drought full supply level but well below the top of the lowest riverbank (the left riverbank). Due to the greater obstruction represented by the new weir compared to the existing weir, the new weir requires a higher flow before the backwater effect becomes negligible compared to the existing weir.

As discussed in **Section 2.2.2**, when the new weir is in drought security operation mode there would be a temporary increase in the full supply level of one metre (to RL 66.71 metres), which would result in the weir

pool being one metre deeper and extending about 18.81 river kilometres further upstream than the existing weir pool, to create a total weir pool length of about 85.52 river kilometres. This section of temporary weir pool would alternate between flowing water, still-water and, at times, sections of dry riverbed.

The result of this impact upstream of the existing weir would include deeper permanently inundated sections of the stream immediately upstream, and becoming a negligible change, of that to what current conditions are, towards the end of the proposed weir pool extent, about 85.52 river kilometres upstream of the new weir. The predicted change immediately upstream of the existing weir would be very similar to the existing conditions, only a deeper maximum inundation when the new weir is in drought security operation mode and longer duration of inundation, as the existing weir is damaged and slowly drains water. The largest changes are predicted to occur upstream of the existing weir pool extent, where there should be shallow mudflats when the existing weir is full. Field surveys at this modelled location in November 2020 did not identify any shallow wetland or instream vegetation communities that would be inundated, and as such no direct impact has been calculated for a permanent loss of vegetation or habitat for threatened species.

The Darling River (Baaka) at this location is very similar to the rest of the existing weir pool, consisting of an incised channel with remnant PCT 36 on the top of steep and often bare banks, only containing a selection of ground cover species following the recent flood (see **Photo 9-9** and **Photo 9-10**). The water level was high at this location at the time of survey, which was attributed to the recent flood event. There were no important habitats identified at this location that would be lost as a result of inundation caused by the proposed new weir.

Photo 9-9 Taken near the existing weir pool extent, this photo (looking downstream) shows highly disturbed and scoured banks and some bare instream sand bars with lack of existing in-stream vegetation

Photo 9-10 Taken near the existing weir pool extent, this photo (looking upstream) shows highly disturbed and scoured banks

The proposed new weir pool extent was also investigated during field surveys in November 2020. The water level was very low at this location (less than 10 centimetres) and flowing slowly. Like the existing weir pool extent, the Darling River (Baaka) was highly disturbed from modified flow regimes and there were no important habitats identified. This location is predicted to experience less flow and shorter periods of inundation following flood events than all other sections of the Darling River (Baaka) that were surveyed. The vegetation along the banks is currently a mixture of woodland forbs and grasses from PCT 36 on the top of the bank and flood tolerant species emerging after the recent flood (see **Photo 9-12** and **Photo 9-13**). Some sections of the riverbed are completely bare (see **Photo 9-14**). When full, the proposed new weir will hold low levels of water around the new weir pool extent, creating shallow instream habitats suitable for wading birds (see **Photo 9-11**).

Photo 9-11 Instream habitats are limited at the proposed new weir pool extent. The channel is wider at this location than further downstream. This area contains some rocky substrate that may create diverse instream habitat features under the proposed new flooding regime

Photo 9-12 A small amount of water was present at the proposed new weir pool extent in November 2020 following the recent flood. The maximum depth can be seen on the bank in the photo looking upstream

Photo 9-13 Plot 20 was undertaken along the bank at the proposed new weir pool extent to record the diversity of groundcover species

Photo 9-14 Bare ground in the river channel at the proposed new weir pool extent. The wide channel at this location is likely to provide some shallow habitat for wading birds under the proposed new flooding regime

The practice of varying weir pool levels is expected to restore some of the natural seasonal variability to the entire new weir pool that would have occurred prior to river-regulation, in river levels, water velocities and the associated wetting and drying of littoral areas along the main river channel. Weir pools have the potential to protect and rehabilitate biodiversity and ecosystem functions in the littoral and riparian zone of waterways and adjacent wetlands throughout the reach. Weir pools are predicted to improve the productivity of these areas, increase the extent and health of water dependent vegetation and promote increased populations of fish, increased water bird foraging and connectivity to other significant sites (Brown P. Gehrig 2018).

9.3.4.3 Impacts to native vegetation and threatened species habitat caused by changed hydrology downstream of the new weir

Australian floodplain wetlands are sites of high biodiversity that depend on flows from rivers. Dams, weirs, diversions and river management have reduced flooding to these wetlands, altering their ecology, and causing the death or poor health of aquatic biota. The cumulative synergy between building weirs and diversion increasingly alienates floodplain wetlands by reducing the frequency and volume of flows to them.

Loss of connectivity to the river changes aquatic systems to terrestrial ecosystems. Aquatic plants, sedentary animals (burrowing frogs; aquatic invertebrates) and microbes adapted to unpredictable flood events eventually die and are replaced by terrestrial vegetation (Kingsford, R.T., 2000).

As a result of the new weir, River Red Gum communities located downstream of the proposed weir along the channel, benches and billabongs of the Darling River (Baaka) could be reasonably expected to experience reduced frequency of flow and potentially lower-levels of flooding. This would have the potential to reduce floodplain vegetation health and inputs of carbon into the river (Thoms et al., 2000). This reduction in flow may affect larger areas of the Darling River (Baaka) further downstream and result in less water for threatened species that rely on aquatic habitats, such as the Black-tailed Godwit, Australasian Bittern, Freckled Duck, Blue-billed Duck, Curlew Sandpiper and Australian Painted Snipe.

Public Works Advisory on behalf of Water Infrastructure NSW has carried out storage behaviour modelling to compare flows downstream of the new and existing weirs based on time series data from the Barwon-Darling Source River System Model that simulates Wilcannia Weir pool inflows for a 119-year period from 1900 to 2019. A downstream flow-spells analysis of the predicted discharge from the new and existing weirs over this period found that the new weir would result in:

- An increase in short duration downstream 'cease-to-flow' spells (flows less than one megalitre per day (MLD)) due to the cessation of discharge when the new weir is in the filling phase, which would occur when it transitions from normal operation mode to drought security operation mode. The mean duration of downstream cease-to-flow spells would reduce, due to the implementation of a translucency rule at the new weir that would see all inflows to the combined new town pool and Pool 1 discharged downstream when the new weir is in drought security operation mode. The translucency rule would split some otherwise long cease-to-flow spells into two shorter duration cease-to-flow spells.
- An increase in downstream 'very-low-flow' spells (flows more than 30 MLD), which is attributed to the filling phase splitting some very-low-flow spells in two. This would increase the number of very-low-flow spells but reduce their mean duration. The overall effect would however be minor, with the modelling showing only a one percent reduction in the total number of very-low-flow days over the 119-year simulation period.
- An increase in the number of flows spells downstream of the new weir greater than 350 MLD compared to the existing weir, which is attributed to the translucency rule resulting in the discharge of inflows that would not have passed the existing weir. Overall, the modelling showed a 22 per cent increase in the number of days of flow greater than 350 MLD over the 119-year simulation period.
- The modelling found that the new weir would result in little change in downstream flow spells greater than1,400 MLD, as the new weir would be in normal operation mode at this and higher flow rates and would be operating to optimise downstream flows.

An ecological benefit of the translucency rule is that it would discharge water downstream during dry periods that would provide an opportunity to fill depressions and pools therefore providing water as foraging habitat for aquatic dependent birds.

Several sites within the river channel were visited and investigated downstream of the proposed new weir location during the targeted field surveys, the furthest being around 28 kilometres downstream. The intent of the investigation was to identify the presence of pools and in-stream wetland vegetation that may provide important habitat for threatened fauna species, such as wader birds and listed migratory bird species such as the Painted Snipe, Latham's Snipe and Black-tailed Godwit. These areas were surveyed to assess the condition of the riparian vegetation and aquatic habitat downstream of the weir, as the proposal will involve a change to the current downstream flows and therefore potentially resulting in indirect impacts.

These results of this downstream investigation are summarised as:

- The instream vegetation and habitat immediately downstream of the proposed new weir pool are of very similar condition to those habitats identified in the proposed new weir pool area (see **Photo 9-15**, **Photo 9-16** and **Section 9.3.4.1** for discussion).

- Further downstream the river was assessed at around 20 kilometres and 28 kilometres. At these points, the habitat was accessible to undertake surveys. These areas were also disturbed by heavy grazing, bare banks were common, and the instream sandbars were dominated by invasive weed species, providing a representation of the habitat condition within the study area. This area is currently very degraded from farming (as evidenced by bare earth banks and evidence of grazing goats – see **Photo 9-18**) and likely the modified flow regimes that have been a common feature of the Darling River (Baaka) for many years.

An inspection of the downstream river channel up to 28 kilometres from the weir, indicates importantly, that no instream pools or wetlands that would be considered important aquatic habitat features and provide suitable habitat for wading and water bird species, (including listed migratory birds) were observed (see **Photo 9-17** for typical example of degraded and lacking habitat). It is likely that the existing weir has contributed to the current degraded condition of the Darling River (Baaka) downstream.

Photo 9-15 About two kilometres downstream of the proposed new weir, instream habitats are similar to the proposed new weir pool. A narrow subchannel meanders around sand bars with regrowth native groundcovers and weeds. Aquatic plant *Ludwigia peploides* is growing in low abundance along the edge

Photo 9-16 About two kilometres downstream of the proposed new weir, instream habitats are similar to the proposed new weir pool. A narrow subchannel meanders around sand bars with regrowth native groundcovers and weeds

Photo 9-17 Looking downstream about 28 kilometres downstream of the proposed new weir, where disturbed bare banks are common

Photo 9-18 Looking upstream about 28 kilometres downstream of the proposed new weir, where the upper banks are heavy grazed by goats and the instream sandbars are dominated by weeds

9.3.5 Impacts to groundwater dependent ecosystems

An assessment of the impacts to down-stream flooding as a result of the new weir, is detailed in **Technical Report 1**. It has been assessed that once top of bank flows are reached, with the weir completely submerged during large flood events, the change in flood levels (afflux) is expected to be negligible and accordingly, so too the potential for flood impacts. Additionally, while the cease-to-flow events will increase, their duration will be brief and would not correspond to a drop in downstream water level. As per **Section 9.3.4.3**, modeling predicts an increase in the number of downstream cease-to-flow spells, as well as downstream 'very-low-flow' spells (flows more than 30 MLD). However, there will be a reduction in the mean duration of both the cease-to-flow spells and the very-low-flow spells.

Floodplain vegetation, such as the River Red Gum community (PCT 36), is dependent on flooding to recharge groundwater levels, where reduced flood events could lead to lower water table levels and higher groundwater salinity in nearby vegetation communities. The assessment indicated that the proposal is not expected to impact downstream flooding or reduce downstream water levels, and therefore vegetation communities, including PCT 36, are not expected to be impacted.

The vegetation types that have been ground-truthed and mapped with a known and high likelihood of groundwater dependence in the surrounding landscape, including land surrounding the town weir pool and downstream floodplain include:

- River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion (PCT 36)
- Coolabah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion (PCT 39)
- Old Man Saltbush - mixed chenopod shrubland of the semi-arid hot (persistently dry) and arid climate zones (north-western NSW) (PCT 158)
- Lignum shrubland wetland on regularly flooded alluvial depressions in the Brigalow Belt South Bioregion and Darling Riverine Plains Bioregion (PCT 247).

A groundwater impact assessment developed for the proposal (refer to **Technical Report 1**) has identified that groundwater mounding in the new 4.92 river kilometre 'new town pool' is likely to occur up to 100 metres out from either side of the river channel. Equilibrium groundwater levels near to the new town pool are expected to rise to within five metres of the ground surface. Shallow groundwater in this area (greater than three metres below ground level) has potential to become saline through evapo-concentration over time. The impact of this increased salinity on the condition of the PCTs surrounding the weir pool is difficult to predict and is uncertain. However, long-term groundwater salinisation in low-lying areas next to the new town pool would be similar to that which has already occurred upstream of the existing weir in low-lying areas.

Section 8.5 of the BAM suggests that an adaptive management plan can be used to address impacts that are infrequent or difficult to measure. Further details around monitoring of the GDEs and adaptive management are described in **Section 10.**

9.3.6 Wind turbine strikes

The impacts of wind turbines are not applicable to this proposal.

9.3.7 Vehicle strike

The risk of fauna injury and mortality during the construction and operation of the proposal through vehicle strike is considered low. Vehicle strike is an impact that reduces local population numbers and is a common occurrence in Australia. Mammals, reptiles, amphibians, and birds are all at risk of vehicle strike, particularly those common species (birds) that are tolerant of disturbance and remain in the development site during construction. The risk of an increase in the frequency of vehicle strike due to the development is relatively low and would generally be limited to vehicle movements to and from the new weir construction site through the entrance off Union Bend Road. There would also be an increase in construction traffic during the decommissioning of the existing weir. Construction activities will only occur during the day, therefore there is no risk of collision at night from construction vehicles.

After the completion of the proposal, there will be an increase in traffic from the general public entering and leaving the community river place. This community river place is on land that is already established for public recreation and vehicle use, as such the proposal would not introduce a new use within this area. Considering there is currently very little traffic using the proposed access roads into the new weir location, the proportional increase will be substantial. However, the actual amount of traffic that is expected to use the new access to the community river place is likely to be low and limited to low speed limits during the day only.

Importantly, there is already vehicle traffic in the area and the development would not introduce a new impact. Vehicle strike associated with the development is unlikely to affect any threatened species of animals or animals that are part of a TEC.

Avoidance and mitigation strategies

Increased vehicle movements during construction of the proposal have the potential to result in fauna mortality from vehicle strikes. These potential impacts can be avoided and managed and will be addressed in the CEMP, and include examples such as on-site education, identifying and reporting hazards as they occur during construction, and setting appropriate working hours and vehicle speed limits.

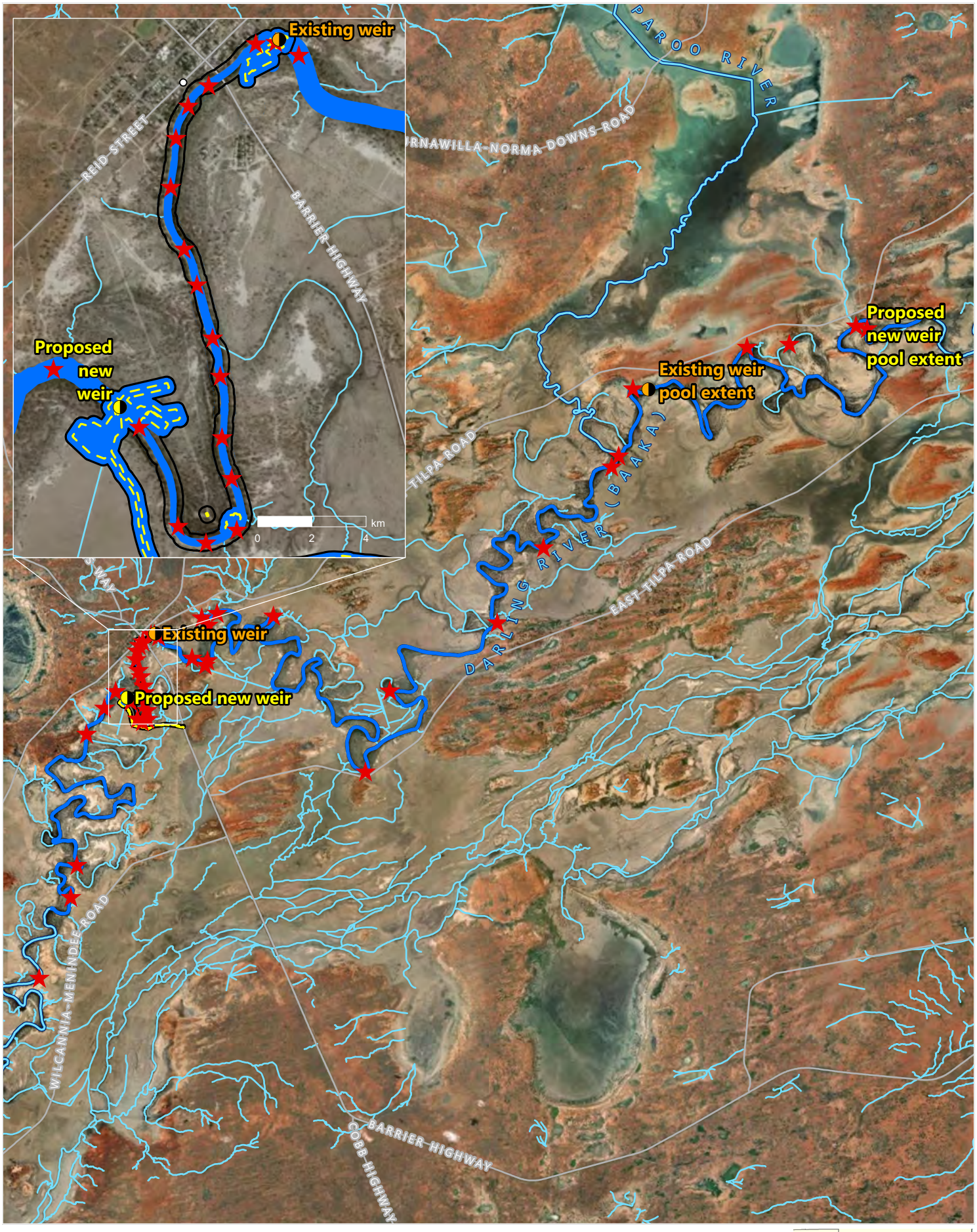

Figure 9-1: Prescribed biodiversity impact assessment

9.4 Cumulative impacts

The potential biodiversity impacts of the proposal must be considered as a consequence of the construction and operation of the proposal within the existing environment. The proposal will not act alone in causing impacts to biodiversity. The incremental effects of multiple sources of impact (past, present and future) are referred to as cumulative impacts and provide an opportunity to consider the proposal within a strategic context.

The overall effect of cumulative impacts could be positive or negative, depending on the nature of the proposal and the nearby communities and environment. Once the new Wilcannia Weir is operational, other proposals and / or programs which interrelate may enhance the proposal and create positive cumulative benefits. The operation of the proposal could also cause cumulative benefits or impacts when it interrelates or possibly enhances the construction or operation of other projects and/or programs within the Murray Darling Basin catchment.

9.4.1 Regulation of water

The naturally occurring chain of lakes near Menindee on the Darling River (Baaka) have been modified by the NSW Government to improve its storage capacity for agriculture, recreation, mining, urban water supply and to manage Darling River (Baaka) floods. Consequently, the flows through the lower Darling River (Baaka) and the Great Darling Anabranch are highly regulated. The average annual flow in the Darling River (Baaka) has been reduced by more than 40 per cent as a result of water taken from the upper catchments of the Barwon–Darling river system (Murray Darling Basin Authority, 2021). The timing of flows in the lower Darling (Baaka) has been changed, with the largest volume of water now flowing in summer to meet consumptive demand, rather than in autumn or spring when water flows from the north.

Cumulative impacts to the regulation of water in the lower Darling River (Baaka) and the Great Darling Anabranch have been considered by WINSW. Further information is provided in the aquatic ecology assessment report and EIS, including discussion on commitments to minimise downstream impacts. Cumulative impacts to water regulation would be minimised by concept and detailed design criteria relating to flow, release rules, any proposed translucency measures and other alteration of riverine hydrology, flow energy and sediment transport.

9.4.2 Western Weirs Program

The Western Weirs Program is a study by WINSW to investigate a whole-of-river system approach to the management of the Barwon-Darling and Lower Darling systems and their river infrastructure.

WINSW a has developed a strategic business case for the program. The program seeks to improve water security for towns in the Far West Region, including Aboriginal communities supplied by those towns. It evaluates infrastructure options to improve water security for towns and improve river flows along the Barwon-Darling and Lower Darling rivers (Baaka). The strategic business case also assesses alternative non-weir options that could have similar benefits for improving town water security. A key driver of the study is to improve system flows, so any future improvements to the volume or quality of inflows to Wilcannia that are identified would be beneficial.

The strategic business case for the Western Weirs Program is being considered by Infrastructure NSW. Infrastructure NSW will determine if the program receives further funding to proceed to a more detailed analysis in a final business case.

Implementation of the Western Weirs program may include all or some of the following:

- Construction of either new or upgraded weirs at towns incorporating gates and fishways
- Possible removal or lowering of some weirs that do not supply water for towns
- Alternative options to weirs to improve town water security.

Within WINSW, the Wilcannia Weir Replacement project team has consulted regularly with the Western Weirs Program team to ensure that it is informed of the proposal's construction and operation, so that there is overarching consistency between the proposal and the various hydraulic modelling studies being undertaken for the Western Weirs Program.

9.4.3 Vegetation and habitat loss

There is limited information available to identify and assess the cumulative loss of vegetation, habitat and hollow-bearing trees associated with approved developments along the Darling River (Baaka) within the locality. As such it is reasonable to assume that much of the historic clearing in the Darling Riverine Plains bioregion has been for grazing and crop development. Benson *et al* (2014) in their assessment of the status of vegetation communities in the western plains, highlight that 23 of the 42 (54%) 'critically endangered' and 'endangered' communities from the western plains (i.e. BC Act, as of 2014) occur in the Daring Riverine Plains Bioregion, this is compared to the sand plains and rocky ranges of the drier, far inland bioregions.

Information in the NSW BioNet Classification database estimating the extent of vegetation cleared (from pre-European times) advises the following for the three PCTs that will be impacted by the proposal:

- PCT39 Coolabah – River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling River Plans Bioregion (60% cleared)
- PCT36 River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion (53% cleared)
- The Old Man Saltbush - mixed chenopod shrubland of the semi-arid hot (persistently dry) and arid climate zones (north-western NSW) (88% per cleared).

Benson *et al* 2014, further suggest that remaining vegetation is subject to a suite of key threatening processes including further vegetation clearing on higher nutrient soils in wetter regions, altered hydrological regimes due to draw-off of water from river systems and aquifers, high continuous grazing pressure by domestic stock, feral goats and rabbits and in some places native herbivores.

10. Mitigating and managing all impacts on biodiversity values

While direct impacts are easily quantified and controlled by managing the extent of clearing within the direct impact area, the indirect impacts are subject to the efficacy of implemented environmental controls. As such, direct impacts are defined during proposal design, whereas indirect impacts are mitigated through effective environmental management during construction and can also be associated with an adaptive management strategy where impacts are uncertain. The following section outlines measures to minimise, mitigate and monitor the predicted impacts to biodiversity that are described in **Section 9**.

10.1 Mitigation measures

Proposed mitigation measures are documented in **Table 10-1** which includes details of the proposed action or technique, timing, frequency, and responsibility for implementing each measure.

Table 10-1 Proposed biodiversity mitigation measures

Impact	Action ID	Biodiversity mitigation measure	Outcome	Timing and frequency	Responsibility	Effectiveness of action
Avoiding and minimising impact on native vegetation and habitat (**Section 8.1**)	BIO1	Prior to construction, the limits of the work zone, areas for parking and turning of vehicles, and plant equipment will be accurately and clearly marked out by a qualified surveyor. These areas would be located so that vegetation disturbance is minimised as much as possible, and the dripline of trees avoided.	Avoid and minimise clearing of vegetation and habitat during proposal planning	Pre-construction, pre-clearing	WINSW and construction contractor	Known and proven effective
	BIO2	construction machinery, equipment, Materials, work vehicles, and stockpiles will be placed to avoid damage to surrounding vegetation and will be outside tree driplines.				
	BIO3	Construction personnel will be informed of the environmentally sensitive aspects of the proposal area, including plans for impacted and adjoining areas of vegetation to be removed and mitigation measures for impacts to biodiversity.				
	BIO4	Where possible, clearing of native vegetation will be avoided. Clearing of vegetation will be staged to allow for dispersal of potentially occurring fauna species. Habitat items such as hollow logs and coarse woody debris will be retained where possible, potentially by relocating these items to vegetation beyond the development site.				
	BIO5	Supplementary surveys will be carried out for species credit matters to further validate presence / absence within the appropriate survey seasons required under the BAM for *Convolvulus tedmoorei*, *Swainsona murrayana* and Little Eagle nesting habitat.				
Removal of native vegetation, threatened ecological communities, threatened species and	BIO6	**Pre-clearing inspection:** An ecologist will be engaged in the weeks before clearing begins to: a) Identify any fauna that may have the potential to be disturbed, injured or killed as a result of clearing activities (nesting birds, large stick nests occupied by threatened diurnal raptors) b) Map location of any hollow-bearing trees and physically mark these habitat features to be protected during construction or considered during the clearing work (flagging tape)	Avoid, minimise, and mitigate impacts to biodiversity	Pre-clearing	WINSW and contractors	Known and proven effective measure

Impact	Action ID	Biodiversity mitigation measure	Outcome	Timing and frequency	Responsibility	Effectiveness of action
habitat (**Section 9.1.1**, **Section 9.1.2** and **Section 9.3.2**)		c) If there are hollows within the development site, conduct stag watching during the day and night to determine if these are being used by fauna, in particular forest owls or Major Mitchel Cockatoo d) Checking construction vehicles and any areas which have been excavated for fauna during pre-start and post activities				
	BIO7	**Staged Habitat Removal:** A staged habitat removal process is required for removal of habitat (hollow-bearing trees, habitat trees, and bushrock). Staged habitat removal minimises direct impacts on fauna by providing them with an opportunity to vacate hollows and relocate naturally. The process includes: a) If possible, avoid clearing during breeding seasons for hollow-dependent fauna b) Contact vets and wildlife carers before construction activities commence c) Ensure a licensed wildlife carer and/or ecologist is present during vegetation clearing/habitat removal d) Adopt a two staged habitat removal strategy, for example clearing non-habitat trees first (shrubs, regrowth, ground cover) followed by habitat trees. Allow at least 24 hours for fauna to vacate habitat before removing habitat trees e) Fell habitat trees carefully using equipment that allows habitat trees to be lowered to the ground with minimal impact (claw extension). Do not fell trees towards exclusion zones f) Ensure a wildlife carer and/or ecologist inspects trees before and after felling. Capture and relocate non-injured fauna that are found in any felled trees to pre-determined habitat identified for fauna release to be undertaken by a licensed ecologist or wildlife carer.	Avoid, minimise, and mitigate impacts to fauna during clearing and construction	Construction	Contractor	Known and proven effective measure
	BIO8	A vegetation management plan will be prepared as part of the CEMP and will detail the management of native trees, shrubs and other vegetation (including hollow-bearing trees) within the development site. Key requirements in this plan will be included in the induction pack for all contractors.	Avoid, minimise, and mitigate impacts to vegetation and habitat	Pre-construction, pre-clearing, construction, operation	WINSW and contractors	Known and proven effective measure

Impact	Action ID	Biodiversity mitigation measure	Outcome	Timing and frequency	Responsibility	Effectiveness of action
	BIO9	Excavated areas such as pits/trenches will be inspected daily prior to starting work to check for trapped fauna. Any trapped fauna must be removed by trained fauna handling personnel. Alternatively, fauna ramps (logs or wooden planks) will be installed to provide an escape for trapped fauna. If any pits/trenches are to remain open overnight, they will be securely covered, where reasonable and feasible.	Avoid, minimise, and mitigate impacts to fauna during construction	During construction	WINSW and contractors	Known and proven effective measure
	BIO10	Pre-start-up checks will be undertaken for possible fauna sheltering in excavated areas, construction machinery, equipment, construction vehicles and infrastructure, plant, and before relocating stored construction materials. Fauna must be removed by trained fauna handling personnel prior to starting any construction activities.				
Impact on water quality (**Section 9.2.2**)	SW1	A construction soil and water management plan will be prepared as a sub-plan of the construction environmental management plan and will outline measures to manage soil and water impacts associated with the construction works. The construction soil and water management plan will include but not be limited to: ▪ Measures to minimise/manage erosion and sediment transport within the construction footprint and offsite including requirements for the preparation of erosion and sediment control plans for all progressive stages of construction ▪ Measures to manage stockpiles including locations, sediment controls and stabilisation ▪ Measures to manage accidental spills including the requirement to maintain materials such as spill kits ▪ Measures to manage potential tannin leachate ▪ Concrete waste management procedures ▪ A surface water quality monitoring program to monitor the performance of management measures.	Avoid, minimise, and mitigate impacts to aquatic habitat and species	Pre-construction, construction, operation	WINSW and construction contractor	Known effectiveness
Contaminant pollution (**Section 10.2.2**)	SW2	Erosion and sediment control measures will be implemented at all works sites in accordance with the principles and requirements in *Managing Urban Stormwater – Soils and Construction Volume 1* (Landcom 2004) and Volume 2D (NSW Department of Environment, Climate Change and Water 2008), commonly referred to as the "Blue Book". Erosion and sediment control measures will be identified in the construction soil and water management plan and will likely consist of sediment fencing and sediment basins and include:	Avoid, minimise, and mitigate impacts from contaminant pollution	During construction	WINSW and construction contractor	Known and proven effective measure

Impact	Action ID	Biodiversity mitigation measure	Outcome	Timing and frequency	Responsibility	Effectiveness of action
		▪ Implementing practices to minimise disturbance of banks (such as creating no access zones, minimising vegetation removal and installing rock gabions) ▪ Undertaking bank stability practices as soon as possible after installing instream structures ▪ Undertaking construction and demolition during low or no flow in the watercourse to minimise sediment loads downstream. A suitably qualified erosion and sediment control specialist will be engaged where deemed appropriate to provide advice regarding erosion and sediment control including review of erosion and sediment control plans. ▪				
Habitat connectivity (**Section 9.3.3**)	BIO11	▪ Revegetation of the riverbanks will be undertaken as soon as possible. A rehabilitation plan should be included as part of the CEMP. The rehabilitation plan will guide the long-term rehabilitation of applicable parts of the proposal. Such areas will include areas disturbed during construction that are not required to be maintained or cleared for the operation of the proposal. ▪ The rehabilitation plan will focus on prevention of soil erosion and re-establishing local endemic plant species, restoration of riparian vegetation (weed control) to protect and improve threatened aquatic species habitat, and drought conditions during the establishment phase of the proposal.	Avoid soil erosion and invasion of weeds in disturbed areas and their spread in adjoining edges of intact forest	Developed pre-construction and implemented pre-clearing, during and post construction	WINSW and contractors	Known and effective measure, although potential for issues during extreme weather, drought and floods
Increase in weeds and disease pathogens in adjacent vegetation (**Section 9.2.4**)	BIO12	▪ Weed management will be undertaken in areas affected by construction prior to any clearing works in accordance with the *Biosecurity Act 2015* to ensure they are not spread to the surrounding environment; including during transport disposal off-site to a licensed waste disposal facility ▪ Priority weeds will be identified, mapped, and removed before clearing for construction, and their location recorded for use in ongoing weed monitoring program ▪ During construction, all personnel, vehicles, and machinery driving to and from site will follow a protocol to prevent the spread or introduction of plant diseases, particularly *Phytophthora cinnamomi*, namely vehicles and machinery will be clean, including the tyres, footwear of personnel, and any equipment ▪ All weeds, propagules, other plant parts and/or excavated topsoil material that is likely to be infested with weed propagules that are likely to regenerate will be	Control spread of weed from the proposal	Pre-construction, and construction	WINSW and contractors	Known effectiveness

Impact	Action ID	Biodiversity mitigation measure	Outcome	Timing and frequency	Responsibility	Effectiveness of action
		treated on site or bagged, removed from site, and disposed of at a licensed waste disposal facility ▪ Wash down stations will be constructed at suitable locations to wash down vehicles and employee shoes to stop the spread of weeds, pathogens (including amphibian chytrid fungus, *Phytophthora cinnamomi* and exotic rust fungi) and the introduction of new species.				
Noise and vibration impacts (**Section 9.2.5**)	NV1	A construction noise and vibration management plan will be prepared as a sub-plan of the construction environmental management plan, in accordance with Water Infrastructure NSW guidelines and policies.	Avoid, minimise, and mitigate impacts to biodiversity	During construction	WINSW and construction contractor	Known and proven effective measure
	NV5	Only have necessary equipment on-site and turn off when not in use.				
	NV3	Select low-noise plant and equipment. Ensure equipment mufflers operate in a proper and efficient manner.				
Dust pollution (**Section 9.2.6**)	AQ2	▪ Dust suppression techniques will be implemented and incorporated into the construction environmental management plan, as outlined in the 'Blue Book' (Landcom, 2004), such as not carrying out dust generating works during high winds, water spraying of surfaces, covering stockpiles and covering surplus soils and materials during transportation ▪ Exposed and disturbed surfaces will be stabilised at construction work sites that are not active.	Avoid, minimise, and mitigate impacts from dust pollution	During construction	WINSW and construction contractor	Known and proven effective measure
Wildlife impacts from vehicle strike (**Section 9.3.7**)	BIO13	▪ Vehicle movements within the proposal area will be limited to a 20 kilometre per hour speed limit to reduce the risk of vehicle strike to fauna ▪ Drivers must stay vigilant for fauna during machinery operation and vehicle movements.	Reduce the risk of fauna mortality from vehicle strike	Construction and operation	WINSW and contractors	Known and proven effective measure
Groundwater dependent ecosystems	BIO14	A vegetation monitoring program will be developed in consultation with WaterNSW to monitor for changes in the vegetation integrity of groundwater dependent ecosystems as well as groundwater regime (e.g., declines in water level and increases in salinity). This will focus on plant community types immediately	Inform the need for further indirect offsets should a	Pre-construction Construction	WINSW and WaterNSW	Known and proven effective measure

Impact	Action ID	Biodiversity mitigation measure	Outcome	Timing and frequency	Responsibility	Effectiveness of action
		adjacent to the new town weir and additional floodplain plant community type sites immediately downstream of the new weir. ▪ The monitoring program will consider: ▪ The level of detail (number of replicates, number of sites, distance from weir and distance downstream, survey timing, precision of measurement of variables) required to detect a level of change that indicates an impact ▪ Vegetation integrity data and associated groundwater data to detect if change associated with groundwater and no other factors ▪ Data will be analysed soon after collection to facilitate prompt adaptive management actions and the mitigation of unforeseen impacts ▪ Site-specific trigger values (performance criteria) for corrective action. These could be based on vegetation integrity values ▪ Any negative effect on plant community type vegetation integrity will be considered in the form of an adaptive management plan that considers mitigation options for maintaining the health of affected PCTs, or additional offsets where applicable.	negative change in vegetation integrity occur and be attributed to increase in soil salinity.	Operation		

10.2 Monitoring and adaptive management

As explained in the BAM Operational Manual Stage 2, some impacts are difficult to predict or assess prior to commencement of the development. The management of uncertain impacts requires the development of an adaptive management plan with the aim of adjusting actions based on results of monitoring to achieve a specified outcome.As discussed in **Section 9.3.5**, , equilibrium groundwater levels within 100 meres out from either side of the river channel at the new town pool are expected to rise to within five meters of the surface. Shallow groundwater in this area (greater than three metres below ground level) has potential to become saline through evapo-concentration over time. While these levels of salinization will be similar to what has been experienced upstream from the existing weir pool the impact of this on the integrity of the PCTs surrounding the new town pool and downstream low-lying areas are uncertain. A comprehensive monitoring program should be developed post-approval to assess any change in vegetation integrity for the PCTs that have been identified as GDEs. This would focus on PCTs immediately adjacent to the weir pool (within 100 metres), and additional floodplain PCT sites immediately downstream of the weir. The results will inform the need for further indirect offsets should a negative change in vegetation integrity occur and be attributed to increase in soil salinity.

The monitoring program should include monitoring for changes in the vegetation integrity as well as groundwater regime (declines in water level and increases in salinity). In establishing the monitoring program to assess a potential impact to the PCTs the following should be considered:

- The level of detail (number of replicates, number of sites, distance from weir and distance downstream, survey timing, precision of measurement of variables) should be sufficient to detect the level of change that indicates an impact
- Vegetation integrity data should have associated groundwater data to detect if change is associated with groundwater and no other factors
- Data should be analysed soon after collection to facilitate prompt adaptive management actions and the mitigation of unforeseen impacts
- Set site-specific trigger values (performance criteria) for corrective action, this could be based on vegetation integrity values.

Monitoring is performance based and requires a trigger for necessary remedial action to be taken, such as adjusting the activity causing the impact or adjusting the mitigation measure. Any negative effect on PCT vegetation integrity should be considered in the form of an adaptive management plan that considers mitigation options for maintaining the health of affected PCTs, or additional offsets where applicable.

As discussed in **Sections 2.2.2.2** and **8.2.3**, WaterNSW would operate the new weir in accordance with an operations plan approved by the DPE (Water). An outline operations plan is provided in Appendix I of the EIS that shows the likely structure of the plan and the type of content that it is expected to contain. The operations plan is being prepared in consultation with the DPE (Water), DPE (Environment and Heritage), Fisheries NSW, the Murray-Darling Basin Authority and WaterNSW. The operations plan will continue to be developed with the stakeholder agencies. The operations plan could be used to implement adaptive management approaches including the groundwater monitoring and response program described above.

11. Thresholds for the assessment and offsetting of impacts of development

This section identifies the impact thresholds that the assessor must apply, including impacts:

- On a potential entity that are serious and irreversible impacts
- For which the assessor is required to determine an offset requirement
- That do not require further assessment by the assessor.

11.1 Impacts on a potential entity that are serious and irreversible impacts

No SAII entities were confirmed or are expected to occur within the development site and therefore serious and irreversible impacts are considered unlikely. As such, the additional impact assessment provision outlined in Section 9.1 of the BAM has not been completed.

11.2 Impacts for which the assessor is required to determine an offset requirement

The determination of impacts on the development site which require an offset was undertaken in accordance with Section 10.1 of the BAM.

11.2.1 Impacts on native vegetation (ecosystem-credits)

An offset is required for the impacts to most of the native vegetation in the direct impact area as outlined in **Table 11-1.** Complete removal of the vegetation within the direct impact area is assumed, and as such the future VI score is assess as zero. The location of the vegetation zones that will be impacted are shown in **Figure 11-1** which includes areas where offsets are required and areas not requiring offsets or assessment (i.e. cleared tracks, and cleared land).

Table 11-1 Direct impacts to PCTs which require an offset

Vegetation Zone	PCT ID	PCT name	Condition class	TEC		**Direct impact** (ha)	Current VI score	Change in VI
				BC Act	EPBC Act			
1	36	River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion	Good	No	No	**0.95**	75.4	-75.4
2			Low	No	No	1.62	22.9	-21.2
3	39	Coolabah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion	Moderate	Yes	Yes	1.94	57.8	-57.8
4			Low		No	0.94	15	-15
6	158	Old Man Saltbush - mixed chenopod shrubland of the semi-arid hot (persistently dry) and arid climate zones (north-western NSW)	Moderate	No	No	1.9	63.4	-63.4
8			Good	No	No	1.6	92.4	-92.4

11.3 Impacts for which the assessor is not required to determine an offset

An offset is not required for impacts where the vegetation integrity score is below the thresholds set out in Subsection 9.2.1 of the BAM for impacts on native vegetation and Subsection 9.2.2 of the BAM for impacts on threatened species. Impacts not requiring offset are described in **Table 11-2**.

Table 11-2 Impacts which do not require an offset

Vegetation Zone	PCT ID	PCT name	**Condition** class	**Direct impact area** (ha)	Current VI score	VI score threshold*	Offset required
5	39	Coolabah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion	Poor	0.05	0.9	⩾15	No
7	158	Old Man Saltbush - mixed chenopod shrubland of the semi-arid hot (persistently dry) and arid climate zones (north-western NSW)	Poor	0.71	3.5	⩾17	No

**Note: Vegetation integrity score thresholds as set out by Section 9.2 of the BAM*

11.4 Impacts that do not require further assessment by the assessor

In accordance with Section 10.4 of the BAM, an assessor is not required to assess areas of land on the development site for ecosystem-credits where native vegetation (defined under Chapter 3 or Chapter 4 of the BAM) is absent. In this case being 1.32 hectares comprising cleared land along existing tracks that will be used during construction, the existing caravan park access adjacent to the existing weir, and the existing weir structure itself. These areas were purposefully selected to avoid and minimise disturbance to vegetation and threatened species habitat. Direct impacts to vegetation have been minimised by using existing tracks and roads to access the construction work sites and avoiding trees and other vegetation of significance as far as practicable (refer to **Section 8.1**).

The areas of cleared land within the development site were assessed for suitable threatened species habitat (as defined in Chapter 5 of the BAM). However, these cleared areas (such as existing tracks) were found to lack habitat suitable for species-credit threatened species. Furthermore, patches of cleared land within the development site would not be subject to new prescribed impacts (as listed in in Chapter 6 of the BAM). The only prescribed impact relevant to cleared land would be 'vehicle strikes' resulting from increased vehicle use on existing cleared tracks (access tracks). **Section 9.3.7** includes an assessment for prescribed impact - vehicle strikes. Apart from this one prescribed impact, the assessor is not required to assess areas of cleared land within the development site.

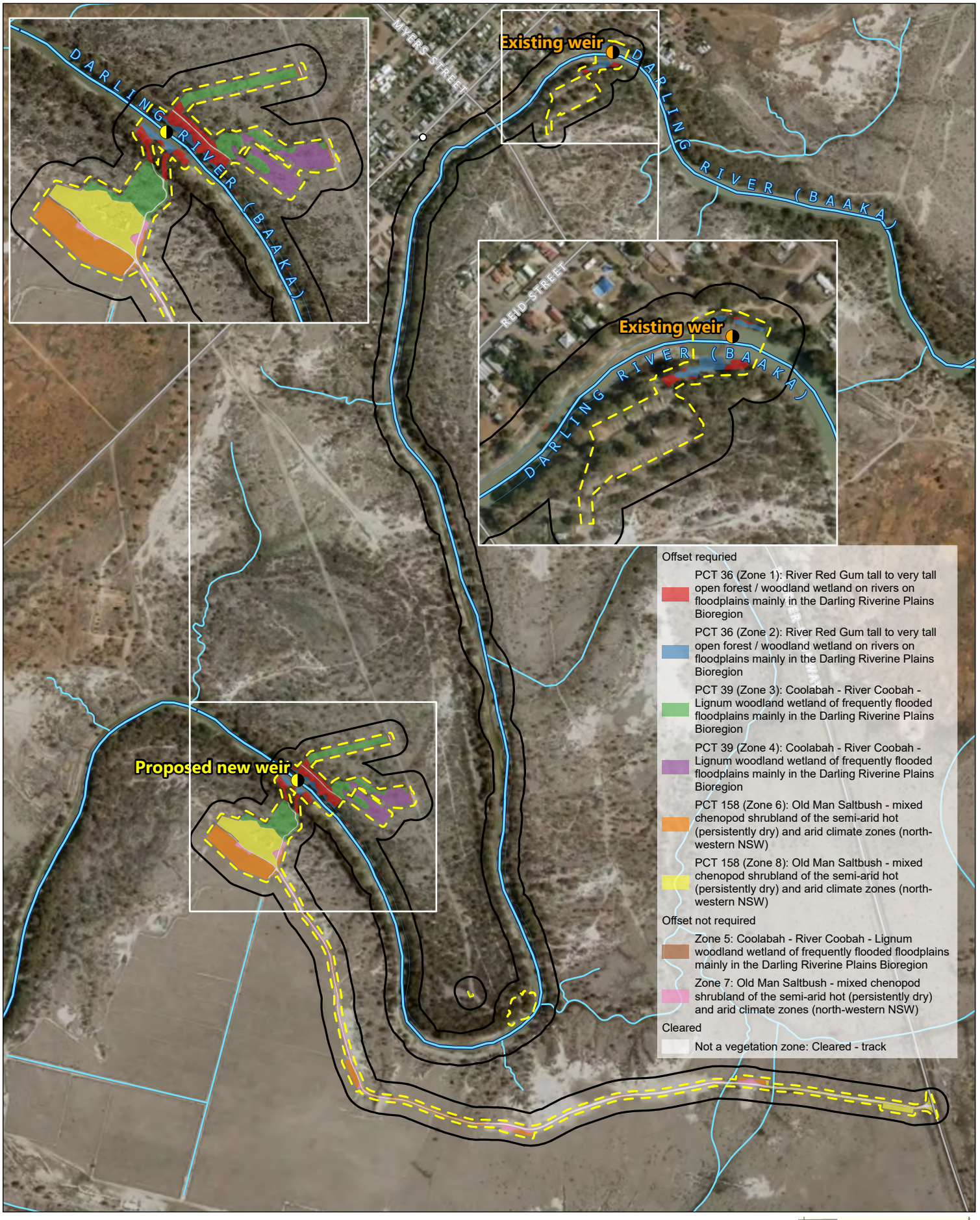

Figure 11-1: Impacts requiring offsets

12. Biodiversity credit requirements

12.1 NSW Biodiversity Conservation Act, 2016

A summary of the biodiversity credit requirements for the proposal are provided below in **Table 12-1**. The proposal would require 262 ecosystem credits. No species credits are required. The draft credit report is provided in **Appendix E**.

Table 12-1 Ecosystem-credits required by vegetation zone

Vegetation Zone	PCT ID	PCT name	Condition class	TEC		**Direct impact area** (ha)	**Vegetation integrity loss**	Credits
				BC Act	EPBC Act			
1	36	River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion	Good	No	No	0.9	75.4	31
2			Low	No	No	1.52	21.2	15
							Sub-total	*46*
3	39	Coolabah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion	Moderate	Yes	Yes	1.94	57.8	56
4			Low		No	0.93	15	7
							Sub-total	*63*
6	158	Old Man Saltbush - mixed chenopod shrubland of the semi-arid hot (persistently dry) and arid climate zones (north-western NSW)	Moderate	No	No	1.5	63.4	61
8			Good	No	No	1.6	92.4	92
							Sub-total	*153*
						Total		**262**

12.2 Matters of National Environmental Significance

Vegetation zone 3 associated with PCT 39 is of sufficient condition to correspond with the listed Coolibah - Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregion (Endangered Ecological Community listed under the EPBC Act). After all avoidance measures have been applied the proposal will impose a residual impact on 1.94 hectares of this TEC, and a total of 56 credits is required to offset this impact.

12.3 Biodiversity Offset Strategy

In order to meet the biodiversity offsets required for this proposal WINSW investigated the feasibility of developing a Biodiversity Stewardship Agreement (BSA) on suitable land adjoining the proposal on the southern side of the new weir. However, WINSW were unable to reach agreement with the landholder. Thus, the strategy for meeting the proposals credit obligation to offset residual impacts would be to firstly source any available like-for-like credits from the Biodiversity Offsets Scheme Public Register in accordance with clause 6.3 of the BC Regulation. **Table 12-2** shows a summary of the ecosystem credits required to offset each PCT impacted by the proposal and the options for sourcing like-for-like credits as provided by the BAM-C.

Table 12-2 Ecosystem credits required and like-for-like options

Credit type	Sum of credits required	Like-for-like credit retirement options			
		Class	Trading group	HBT[1]	IBRA
PCT 36: River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion	46	Inland Riverine Forests This includes PCT's: 9, 36, 78, 79, 112, 249, 356, 362	Inland Riverine Forests - ⩾ 50% - < 70% cleared group (including Tier 3 or higher threat status	Yes	Wilcannia Plains, Barnato Downs, Darling Depression, Louth Plains, Menindee, Paroo Overflow, Paroo-Darling Sands and Scopes Range. or Any IBRA subregion that is within 100 kilometres of the outer edge of the impacted site (i.e. Mootwingee Downs, Scopes Range, Barrier Range Outwash, Barnato Downs, Wilcannia Plains, Menindee, Darling Depression, White Cliffs Plateau, Paroo Overflow and Paroo-Darling Sands).
PCT 39: Coolabah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion	63	Coolibah-Black Box Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain and Mulga Lands Bioregions This includes PCT's: 37, 39, 40, 55	None (TEC)	Yes	
PCT 158: Old Man Saltbush - mixed chenopod shrubland of the semi-arid hot (persistently dry) and arid climate zones (north-western NSW)	153	Riverine Chenopod Shrublands This includes PCT's: 158, 159, 195	Riverine Chenopod Shrublands - ⩾ 70% - <90% cleared group (including Tier 2 or higher threat status).	No	

Note: HBT[1] = Hollow bearing trees

Biodiversity Offsets Scheme public registers that hold information about biodiversity credits, obligations and transactions created under the provisions of current NSW biodiversity legislation are maintained by DPE. The public registers support the operation of the biodiversity credit market by helping to connect credit buyers and sellers and to increase market transparency.

To ensure that BioBanking credits and credit obligations created under the repealed *Threatened Species Conservation Act 1995* could still be used or met within the newer credit market, the Biodiversity Conservation (Savings and Transitional) Regulation 2017 preserved these credits and credit obligations. As such, two public registers currently exist, one for BioBanking (BBAM) credits and one for BAM credits.

Both credit registers were searched on 14 October 2021, to identify whether any of the required ecosystem credits are currently issued for sale or listed as an expression of interest for future sale. Both public registers identified no ecosystem credit matches applicable to the like-for-like or alternative trading groups within the required IBRA sub-regions listed in **Table 12-2** at present.

The options available to satisfy the proposal offset liability would entail either one of or a combination of the following options:

- Payment directly to the Biodiversity Conservation Fund, managed by the Biodiversity Conservation Trust
- Purchasing credits from the open market or

- Establishing a stewardship site.

In the case of this proposal, it is recommended that WINSW purchase credits from the market as the first option where available. Alternatively, WINSW could pay directly into the fund as it can be achieved within the shortest timeframe. A further recommendation is to undertake consultation with BCT to ascertain more information on the credits which are available.

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Appendix A. Habitat assessment and likelihood of occurrence assessment for threatened species

State and nationally listed threatened species identified from the literature review, database searches and the BAM-C, were considered in terms of their likelihood to occur in the habitats present within the survey area based on identified habitat requirements. The habitat suitability assessment for threatened species is provided in **Table A-1** and **Table A-2**.

Table A-1 Habitat suitability assessment for threatened plant species

Species	Common name	EPBC Act	BC Act	Record source (50 km radius)	Distribution and habitat	Habitat constraints and geographic limitations (BAM-C)	Habitat suitability	Likelihood of occurrence and inclusion or exclusion from assessment
Acacia carneorum	Purple-wood Wattle	V	V	PMST	Occurs in the far western plains, south from west of Tibooburra to the Menindee area. Also has a limited distribution in South Australia. Grows in grassland and woodland in red, sandy soil; also found in Mulga communities on sand dunes, level sandy sites and alluvial accumulations along watercourses; recorded from inland semi-arid *Acacia* and *Casuarina* shrublands and woodlands. Preferred soils are shallow, calcareous and loamy, and include brown earths, crusty alkaline soils and neutral red duplex soils; confined to red-earth dune soils in Kinchega NP as a dominant or occasionally co-dominant, usually on dune crests or slopes. Associated species include *Alectryon oleifolius, Casuarina cristata, C. pauper, Maireana pyramidata, Eucalyptus socialis* and *Enchylaena tomentosa.*	-	Low – the soils within the study area are dominated by grey-brown silty clay alluvium. Suitable habitat for this species is likely located further away from the River.	Low / Excluded. Habitats in the study area are marginal for this species.
Atriplex infrequens	A saltbush	V	V	1 – BioNet PMST	Confined to the NSW far western plains. North western records recorded from east of Tibooburra, south-east of	None	High – the study area contains habitat that meets the description	Moderate / Included.

Species	Common name	EPBC Act	BC Act	Record source (50 km radius)	Distribution and habitat	Habitat constraints and geographic limitations (BAM-C)	Habitat suitability	Likelihood of occurrence and inclusion or exclusion from assessment
				BAM-C GHD, 2020	Brewarrina and near Wilcannia with isolated collections from the Pooncarie area in the south. Also recorded in 1917 in South Australia. Atriplex infrequens is associated with broad drainage tracts, clay flats and possibly occasionally inundated habitats. Very little ecological information is available for this species so it's critical habitat components can only be speculated as relatively undisturbed and ungrazed drainage lines and flats.		for this species, which includes all vegetation, though less likely in disturbed areas.	Much of the vegetation in the study area may provide suitable habitat for this species.
Austrostipa metatoris	A spear-grass	V	V	PMST GHD, 2020	Most records occur in the Murray Valley with sites including Cunninyeuk Station, Stony Crossing, Kyalite State Forest (now part of Murrumbidgee Valley Regional Park) and Lake Benanee. Scattered records also occur in central NSW including Lake Cargelligo, east of Goolgowi, Condobolin and south-west of Nymagee. Otherwise only known from near Bordertown in south-east South Australia, where it may be locally extinct. Grows in sandy areas of the Murray Valley; habitats include sandhills, sandridges, undulating plains and flat open mallee country, with red to red-brown clay-loam to sandy-loam soils. Associated species include *Eucalyptus populnea, E. intertexta, Callitris glaucophylla, Casuarina cristata, Santalum acuminatum* and *Dodonaea viscosa.*	None	Moderate – some of the habitats in the study area may be suitable for this species, however sandy areas are more common further from the Darling River.	Low / Excluded. The habitats in the development site are primarily the wrong soil type for this species. No records in the locality. This species has a low likelihood of occurring.

Species	Common name	EPBC Act	BC Act	Record source (50 km radius)	Distribution and habitat	Habitat constraints and geographic limitations (BAM-C)	Habitat suitability	Likelihood of occurrence and inclusion or exclusion from assessment
Calotis moorei	A burr-daisy	E	E	1 – BioNet PMST	The species is confined to NSW and is known from only four populations in NSW, the type locality north-west of Louth near the homestead of Mt Mulyan sheep station, west of Wilcannia, around the Menindee area and an old record at Zara Station near Deniliquin. The species grows in sandy soil and appears to be associated with Acacia woodlands and chenopod shrublands.	None	Moderate – the study area contains chenopod shrublands, however the dominant soil type is grey-brown silty clay alluvium. Areas of sandy soil are more common further from the Darling River.	Low / Excluded. The habitats in the development site are primarily the wrong soil type for this species. No records in the locality. This species has a low likelihood of occurring.
Convolvulus tedmoorei	Bindweed	-	E	BAM-C	This species has been recorded from northern inland areas of South Australia, south-western Queensland and western NSW. There are few known records from NSW: two areas on the Murrumbidgee and Darling River (Baaka) floodplains in central-western NSW (from Toganmain Station, Darlington Point, and from a locality 8km north-west of Louth); and two other records from east of Broken Hill on the road to Wilcannia, and from the Menindee Road, Scarsdale. Grows in self-mulching grey clay soils on the floodplains of the Darling and Murrumbidgee Rivers.	None	High – the study area is located on grey-brown silty clay alluvium on the Darling River (Baaka) floodplain.	Moderate / Included. The habitat within the study area matches the description of the few known areas of occurrence within NSW.
Nitella parooensis	-	-	CE	PMST	*Nitella parooensis* is Endemic to NSW, existing in a very small range (~8 km2) in the claypan wetlands of North Western NSW. It is currently known to occur in three small temporary freshwater wetlands within the Paroo River Catchment in the Nocoleche Nature	-	Low – the study area does not contain any freshwater wetlands. The lignum drains are unlikely to hold any water following heavy rain or flooding. This is	Low / Excluded. Habitats in the study area are marginal for this species.

Species	Common name	EPBC Act	BC Act	Record source (50 km radius)	Distribution and habitat	Habitat constraints and geographic limitations (BAM-C)	Habitat suitability	Likelihood of occurrence and inclusion or exclusion from assessment
					Reserve. The largest site where N. paroonesis is known to occur is a temporary lignum swamp on the edge of a floodplain that fills either after minor flooding of the river or from local runoff. It occurs on heavy grey cracking clay and is fringed by *Eucalyptus ochrophloia* (Yapunyah) and *E. largiflorens* (Black box) with an understorey of *Duma florulenta* (Lignum) and *Acacia stenophylla* (River Coobah). Herbaceous species include *Eleocharis plana*, *Marsilea* spp., *Alternanthera denticulata*, *Cyperus gilesii*, *Aponogeton queenslandicus* and *Eragrostis australasicus*. Submerged species include the charophytes *Chara braunii*, *Nitella sonderi* and *Nitella cristata*. The other sites are shallow temporary wetlands adjacent to the floodplain on red clay substrate. The wetlands fill from local runoff after heavy rain. Often found in water so turbid the plant cannot be visually located.		evidenced by a missing herb layer. No standing water was observed during surveys.	
Phyllanthus maderaspatensis	-	-	E	BAM-C	Recorded for the Brewarrina and Collarenebri districts in the north-western plains of NSW. Very widely distributed across the tropics of Qld, the NT, and WA, with additional records from SA. Grows in floodplain areas on heavy soils and may rely on appropriate and intermittent rainfall and flooding events for its survival. The species is described	Habitat constraints - ▪ Floodplains and/or clay soils No geographic constraints	Moderate – generally the characteristics of the study area meet the habitat requirements of this species due to the presence of heavy clay soils on floodplains. However the modified	Moderate / Included. There may be some areas of suitable habitat for this species in the study area.

Species	Common name	EPBC Act	BC Act	Record source (50 km radius)	Distribution and habitat	Habitat constraints and geographic limitations (BAM-C)	Habitat suitability	Likelihood of occurrence and inclusion or exclusion from assessment
					as being a summer-growing annual and is thus dependent on seasonal conditions. Often associated with open grasslands and eucalypt woodlands in or near creek beds, and grassy flats and levees near watercourses.		hydrology of the Darling River (Baaka) may not flood the banks frequently enough for this species.	
Solanum karsense	Menindee Nightshade	V	V	PMST	Menindee Nightshade is a species of Solanum endemic to NSW, restricted to the far south-western plains, extending up the Darling River (Baaka) to the Menindee and Wilcannia districts. Mainly restricted to the area between the Darling and Lachlan Rivers. Localities include Kars Station, Lake Tandou, Lake Cawndilla, Oxley area, between Broken Hill and Menindee, and the Darling River. It has been recorded from Kinchega National Park and Nearie Lake Nature Reserve. Grows in occasionally flooded depressions with heavy soil, including level river floodplains of grey clay with Black Box and Old Man Saltbush, and open treeless plains with solonized brown soils. Habitats are generally lake beds or floodplains of heavy grey clays with a highly self-mulching surface. Also found on sandy floodplains and ridges and in calcareous soils, red sands, red-brown earths and loamy soils.	Habitat constraints – ▪ Semi-permanent/ephemeral wet areas No geographic constraints	Moderate – The study area is located on the Darling River (Baaka) banks and floodplain with grey-brown silty clay. Old Man Saltbush communities are common.	Moderate / Included. There may be some areas of suitable habitat for this species in the study area.
Swainsona murrayana	Slender Darling Pea	V	V	4 – BioNet	Found throughout NSW, it has been recorded in the Jerilderie and Deniliquin areas of the southern riverine plain, the Hay plain as far north as Willandra	None	Moderate - the soils within the study area are dominated by grey-brown silty clay	Moderate / Included. There may be some areas of suitable

Species	Common name	EPBC Act	BC Act	Record source (50 km radius)	Distribution and habitat	Habitat constraints and geographic limitations (BAM-C)	Habitat suitability	Likelihood of occurrence and inclusion or exclusion from assessment
					National Park, near Broken Hill and in various localities between Dubbo and Moree. The species has been collected from clay-based soils, ranging from grey, red and brown cracking clays to red-brown earths and loams. Grows in a variety of vegetation types including bladder saltbush, black box and grassland communities on level plains, floodplains and depressions and is often found with *Maireana* species. Plants have been found in remnant native grasslands or grassy woodlands that have been intermittently grazed or cultivated.		alluvium on the Darling River (Baaka) floodplain.	habitat for this species in the study area.

* Distribution and habitat requirement information adapted from: Australian Government Department of the Environment http://www.environment.gov.au/biodiversity/threatened/index.html, EESG http://www.environment.nsw.gov.au/threatenedspecies/
Key: CE = critically endangered, E = endangered, PE = presumed extinct, V = vulnerable

Table A-2 Habitat assessment for threatened animal species

Species	Common name	EPBC Act	BC Act	Record source (50 km radius)	Credit type (BAM)	Distribution and habitat	Habitat constraints and geographic limitations	Likelihood of occurrence / BAM assessment inclusion
Birds								
Amytornis modestus obscurior	Thick-billed Grasswren (north-west NSW subspecies)	CE	CE	PMST	Species-credit species	Generally thought to be extinct in NSW until located in the Packsaddle area in 2008. May still occur at other locations in Upper Western Region. Sedentary, usually inhabiting dense, low saltbush, cottonbush, bluebush and nitre-bush areas on sandy plains or depressions in gibber; also occurs along watercourses in clumps of Canegrass; when disturbed, individuals take refuge in any available cover, including piles of old flood debris along dry sandy watercourses and down rabbit burrows. In NSW, priority habitat appears to be shrubland dominated by Blackbush (*Maireana pyramidata*) that is higher and denser than surrounding areas.	None	Low / Excluded Recorded from Packsaddle, 200 kilometres north-west of Wilcannia. The study area contains some suitable habitats in the form of low saltbush shrublands, however soils are primarily clays on the floodplain. Only one known population in NSW so low likelihood this species would occur in the development site.
Amytornis striatus	Striated Grasswren	-	V	PMST	Species-credit species	This species is widely distributed through the arid and semi-arid regions of mainland Australia, with three subspecies currently recognised. In NSW, the race striatus was formerly distributed from the Namoi Valley area through the southern half of the Murray-Darling Basin. It is now	None	Low / Excluded There is no spinifex or mallee vegetation in the study area suitable for this species.

Species	Common name	EPBC Act	BC Act	Record source (50 km radius)	Credit type (BAM)	Distribution and habitat	Habitat constraints and geographic limitations	Likelihood of occurrence / BAM assessment inclusion
						currently known from only two disjunct localities. In central NSW, populations remain extant in Yathong Nature Reserve and surrounding areas of leasehold land. A second population occurs in south-western NSW in the Scotia Mallee west of the Darling River, including Tarawi NR, Scotia Sanctuary and adjoining properties. This population is contiguous with populations in adjoining mallee country in South Australia. Confined to areas with mature spinifex (*Triodia irritans*), usually in association with mallee eucalypts and sandy soils.		
Ardeotis australis	Australian Bustard	-	E	5 – BioNet, BAM-C	Species -credit species	The Australian Bustard mainly occurs in inland Australia and is now scarce or absent from southern and south-eastern Australia. In NSW, they are mainly found in the north-west corner and less often recorded in the lower western and central west plains regions. Occasional vagrants are still seen as far east as the western slopes and Riverine plain. Breeding now only occurs in the north-west region of NSW. Mainly inhabits tussock and hummock grasslands, though prefers tussock grasses to hummock grasses; also occurs in	None	Moderate / Included This species is widespread and could occur in the habitats within the study area. This species was targeted during surveys of the development site.

Species	Common name	EPBC Act	BC Act	Record source (50 km radius)	Credit type (BAM)	Distribution and habitat	Habitat constraints and geographic limitations	Likelihood of occurrence / BAM assessment inclusion
						low shrublands and low open grassy woodlands; occasionally seen in pastoral and cropping country, golf courses and near dams.		
Artamus cyanopterus cyanopterus	Dusky Woodswallow	-	V	1 – BioNet, BAM-C	Ecosystem-credit species	Dusky woodswallows are widespread in eastern, southern and south western Australia. The species occurs throughout most of NSW, but is sparsely scattered in, or largely absent from, much of the upper western region. Most breeding activity occurs on the western slopes of the Great Dividing Range. Primarily inhabit dry, open eucalypt forests and woodlands, including mallee associations, with an open or sparse understorey of eucalypt saplings, acacias and other shrubs, and ground-cover of grasses or sedges and fallen woody debris. It has also been recorded in shrublands, heathlands and very occasionally in moist forest or rainforest. Also found in farmland, usually at the edges of forest or woodland.	None	Confirmed / Included. This species was observed outside the development site, at the extent of the new weir pool about 90 kilometres upstream of the proposed new weir.
Botaurus poiciloptilus	Australasian Bittern	E	E	BAM-C PMST	Ecosystem-credit species	Australasian Bitterns are widespread but uncommon over south-eastern Australia. In NSW they may be found over most of the state except for the far north-	Habitat constraints - ▪ Brackish or freshwater wetlands	Low / Excluded There are no permanent freshwater wetlands in the study area. The Darling River (Baaka) did not contain any

Species	Common name	EPBC Act	BC Act	Record source (50 km radius)	Credit type (BAM)	Distribution and habitat	Habitat constraints and geographic limitations	Likelihood of occurrence / BAM assessment inclusion
						west. Favours permanent freshwater wetlands with tall, dense vegetation, particularly bullrushes (*Typha* spp.) and spikerushes (*Eleocharis* spp.).	No geographic constraints	area of tall and dense vegetation.
Burhinus grallarius	Bush Stone-curlew	-	E	BAM-C	Species -credit species	The Bush Stone-curlew is found throughout Australia except for the central southern coast and inland, the far south-east corner, and Tasmania. Only in northern Australia is it still common however and in the south-east it is either rare or extinct throughout its former range. Inhabits open forests and woodlands with a sparse grassy groundlayer and fallen timber.	Habitat constraints - ▪ Fallen/standing dead timber including logs No geographic constraints	Moderate / Included Not known from the region though identified by the BAM-C. Can be a somewhat cryptic species so it was included in targeted surveys of the development site.
Calidris ferruginea	Curlew Sandpiper	CE	E	3 – BioNet, PMST	Dual credit species: Ecosystem (Foraging) Species (Breeding)	The Curlew Sandpiper is distributed around most of the Australian coastline (including Tasmania). It occurs along the entire coast of NSW, particularly in the Hunter Estuary, and sometimes in freshwater wetlands in the Murray-Darling Basin. Inland records are probably mainly of birds pausing for a few days during migration. The Curlew Sandpiper breeds in Siberia and migrates to Australia (as well as Africa and Asia) for the non-breeding period, arriving in Australia between August and November, and	Habitat constraints - ▪ As per mapped important areas	Low / Excluded No important areas mapped near the development site. The Darling River (Baaka) is unlikely to provide habitat suitable for the Curlew Sandpiper.

Species	Common name	EPBC Act	BC Act	Record source (50 km radius)	Credit type (BAM)	Distribution and habitat	Habitat constraints and geographic limitations	Likelihood of occurrence / BAM assessment inclusion
						departing between March and mid-April. It generally occupies littoral and estuarine habitats, and in NSW is mainly found in intertidal mudflats of sheltered coasts. It also occurs in non-tidal swamps, lakes and lagoons on the coast and sometimes inland.		
Calyptorhynchus banksii samueli	Red-tailed Black-Cockatoo (inland subspecies)	-	V	21 – BioNet, BAM-C	Dual credit species: Ecosystem (Foraging) Species (Breeding)	The Red-tailed Black-Cockatoo is the most widespread of the Black-Cockatoos, ranging broadly across much of northern and western Australia as well as western Victoria. In NSW, two subspecies occur, one in northeastern NSW and an inland subspecies. The Red-tailed Black-Cockatoo (inland subspecies) is known to occur around watercourses and overflows of the Darling, Paroo, Bogan, Macquarie and Barwon Rivers extending in an arc along the Darling River (Baaka) from Wentworth (though rare south of Menindee) in the south to Bourke and thence through to Brewarrina in the north. It extends east to Walgett and perhaps Boggabilla on the Barwon and south through to the Macquarie Marshes. Red-tailed Black-Cockatoos are found in a wide variety of habitats. Prefer *Eucalyptus* forest and woodlands,	Habitat constraints – ▪ Hollow bearing trees ▪ Living or dead tree with hollows greater than15cm diameter and greater than 5m above ground No geographic constraints	Confirmed / Included Several family groups of up to 20 birds were observed, the closest being between the existing weir and the proposed new weir development sites. Efforts to identify breeding habitat were unsuccessful. Therefore, this species has been included as an ecosystem-credit species only.

Species	Common name	EPBC Act	BC Act	Record source (50 km radius)	Credit type (BAM)	Distribution and habitat	Habitat constraints and geographic limitations	Likelihood of occurrence / BAM assessment inclusion
						particularly river red gum and coolabah lined water courses. In the arid zone usually occur mainly near eucalypts along larger watercourses and associated *Acacia* and *Casuarina* woodlands nearby. Also utilise grasslands, scrublands, wetlands and vegetation on floodplains.		
Certhionyx variegatus	Pied Honeyeater	-	V	BAM-C	Ecosystem-credit species	Widespread throughout acacia, mallee and spinifex scrubs of arid and semi-arid Australia. Occasionally occurs further east, on the slopes and plains and the Hunter Valley, typically during periods of drought. Inhabits wattle shrub, primarily Mulga (*Acacia aneura*), mallee, spinifex and eucalypt woodlands, usually when shrubs are flowering; feeds on nectar, predominantly from various species of emu-bushes (*Eremophila* spp.); also from mistletoes and various other shrubs (*Grevillea* spp.); also eats saltbush fruit, berries, seed, flowers and insects.	None	Moderate / Included A range of flowering trees and shrubs in the development site may provide suitable foraging habitat for this species.
Circus assimilis	Spotted Harrier	-	V	4 – BioNet, BAM-C	Ecosystem-credit species	The Spotted Harrier occurs throughout the Australian mainland, except in densely forested or wooded habitats of the coast, escarpment and ranges, and rarely in Tasmania. Individuals	None	Confirmed / Included This species was observed flying over the Darling River (Baaka) and perching in a nearby tree about halfway

Species	Common name	EPBC Act	BC Act	Record source (50 km radius)	Credit type (BAM)	Distribution and habitat	Habitat constraints and geographic limitations	Likelihood of occurrence / BAM assessment inclusion
						disperse widely in NSW and comprise a single population. Occurs in grassy open woodland including *Acacia* and mallee remnants, inland riparian woodland, grassland and shrub steppe. It is found most commonly in native grassland, but also occurs in agricultural land, foraging over open habitats including edges of inland wetlands.		up the existing weir pool extent.
Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)	-	V	8 – BioNet	Ecosystem-credit species	Endemic to eastern Australia and occurs in eucalypt forests and woodlands of inland plains and slopes of the Great Dividing Range. It is less commonly found on coastal plains and ranges. Found in eucalypt woodlands (including Box-Gum Woodland) and dry open forest of the inland slopes and plains inland of the Great Dividing Range; mainly inhabits woodlands dominated by stringybarks or other rough-barked eucalypts, usually with an open grassy understorey, sometimes with one or more shrub species; also found in mallee and River Red Gum (Eucalyptus camaldulensis) Forest bordering wetlands with an open understorey of acacias, saltbush, lignum, cumbungi and grasses; usually not found in woodlands		Unlikely / Excluded This species was observed as being common and widespread along the Darling River (Baaka) in River Red Gum woodland. However, the western boundary of the range of the eastern subspecies runs approximately through Corowa, Wagga Wagga, Temora, Forbes, Dubbo and Inverell. The site is therefore outside of the distribution of the eastern subspecies and the birds identified are not part of the threatened species listing.

Species	Common name	EPBC Act	BC Act	Record source (50 km radius)	Credit type (BAM)	Distribution and habitat	Habitat constraints and geographic limitations	Likelihood of occurrence / BAM assessment inclusion
						with a dense shrub layer; fallen timber is an important habitat component for foraging; also recorded, though less commonly, in similar woodland habitats on the coastal ranges and plains. Hollows in standing dead or live trees and tree stumps are essential for nesting.		
Daphoenositta chrysoptera	Varied Sittella	-	V	1 – BioNet, BAM-C	Ecosystem-credit species	The Varied Sittella is sedentary and inhabits most of mainland Australia except the treeless deserts and open grasslands. Distribution in NSW is nearly continuous from the coast to the far west. Inhabits eucalypt forests and woodlands, especially those containing rough-barked species and mature smooth-barked gums with dead branches, mallee and Acacia woodland. Feeds on arthropods gleaned from crevices in rough or decorticating bark, dead branches, standing dead trees and small branches and twigs in the tree canopy. Nests in an upright tree fork high in the living tree canopy.	None	Moderate / Included There is potential habitat for this species in woodlands within the study area.
Epthianura albifrons	White-fronted Chat	-	V	1 – BioNet BAM - C	Ecosystem-credit species	The White-fronted Chat is found across the southern half of Australia, from southernmost Queensland to southern Tasmania,	None	Moderate / Included This species was potentially heard flying over the study area during surveys. Habitat

Species	Common name	EPBC Act	BC Act	Record source (50 km radius)	Credit type (BAM)	Distribution and habitat	Habitat constraints and geographic limitations	Likelihood of occurrence / BAM assessment inclusion
						and across to Western Australia as far north as Carnarvon. Found mostly in temperate to arid climates and very rarely sub-tropical areas, it occupies foothills and lowlands up to 1000 metres above sea level. In NSW, it occurs mostly in the southern half of the state, in damp open habitats along the coast, and near waterways in the western part of the state. Along the coastline, it is found predominantly in saltmarsh vegetation but also in open grasslands and sometimes in low shrubs bordering wetland areas. Gregarious species, usually found foraging on bare or grassy ground in wetland areas, singly or in pairs.		in the study area may form part of the range of a local population.
Falco hypoleucos	Grey Falcon	-	E	PMST, BAM-C	Ecosystem-credit species	The Grey Falcon is sparsely distributed in NSW, chiefly throughout the Murray-Darling Basin, with the occasional vagrant east of the Great Dividing Range. The breeding range has contracted since the 1950s with most breeding now confined to arid parts of the range. There are possibly less than 5000 individuals left. Population trends are unclear, though it is believed to be extinct in areas with more than 500mm rainfall in NSW. Usually restricted	None	Moderate / Included This species may hunt in the study area at any time of the year.

Species	Common name	EPBC Act	BC Act	Record source (50 km radius)	Credit type (BAM)	Distribution and habitat	Habitat constraints and geographic limitations	Likelihood of occurrence / BAM assessment inclusion
						to shrubland, grassland and wooded watercourses of arid and semi-arid regions, although it is occasionally found in open woodlands near the coast. Also occurs near wetlands where surface water attracts prey.		
Falco subniger	Black Falcon	-	V	1 – BioNet BAM-C	Ecosystem-credit species	The Black Falcon is widely, but sparsely, distributed in NSW, mostly occurring in inland regions. Some reports of 'Black Falcons' on the tablelands and coast of NSW are likely to be referrable to the Brown Falcon. In NSW there is assumed to be a single population that is continuous with a broader continental population, given that falcons are highly mobile, commonly travelling hundreds of kilometres (Marchant & Higgins 1993). The Black Falcon is found along tree-lined watercourses and in isolated woodlands, mainly in arid and semi-arid areas. It roosts in trees at night and often on power poles by day.	None	Moderate / Included This species may hunt in the study area at any time of the year.
Geophaps scripta scripta	Squatter Pigeon (southern subspecies)	V	CE	PMST	Species-credit species	Found from north Queensland to the North West Slopes of NSW and extending down to the Liverpool Plains and Dubbo. Today they are very rare in the southern parts of their range. Inhabits grassy woodlands and plains, preferring	None	Moderate / Included The study area may provide some areas of suitable habitat for the Squatter Pigeon, however sandy habitats are typically located away from the Darling River.

Species	Common name	EPBC Act	BC Act	Record source (50 km radius)	Credit type (BAM)	Distribution and habitat	Habitat constraints and geographic limitations	Likelihood of occurrence / BAM assessment inclusion
						sandy areas and usually close to water.		This species was targeted during surveys of the development site.
Grantiella picta	Painted Honeyeater	V	V	PMST, BAM-C	Ecosystem-credit species	The Painted Honeyeater is nomadic and occurs at low densities throughout its range. The greatest concentrations of birds, and almost all breeding, occur on the inland slopes of the Great Dividing Range in NSW, Victoria and southern Queensland. During the winter it is more likely to be found in the north of its distribution. Inhabits Boree, Brigalow and Box-Gum Woodlands and Box-Ironbark Forests. A specialist feeder on the fruits of mistletoes growing on woodland eucalypts and acacias. Prefers mistletoes of the genus Amyema.	Habitat constraints - ▪ Mistletoes present at a density of greater than five mistletoes per hectare No geographic constraints	Moderate / Included The study area did not contain the required density of mistletoes; however this species was targeted during surveys of the development site.
Grus rubicunda	Brolga	-	V	BAM-C	Ecosystem-credit species	The Brolga was formerly found across Australia, except for the south-east corner, Tasmania and the south-western third of the country. It is still abundant in the northern tropics, but very sparse across the southern part of its range. Though Brolgas often feed in dry grassland or ploughed paddocks or even desert claypans, they are dependent on wetlands too, especially shallow swamps,	None	Moderate / Included This species may occur anywhere in the study area following suitable rainfall.

Species	Common name	EPBC Act	BC Act	Record source (50 km radius)	Credit type (BAM)	Distribution and habitat	Habitat constraints and geographic limitations	Likelihood of occurrence / BAM assessment inclusion
						where they will forage with their head entirely submerged.		
Haliaeetus leucogaster	White-bellied Sea-Eagle	M	V	BAM-C	Dual credit species: Ecosystem (foraging) Species (breeding)	Distributed along the coastline (including offshore islands) of mainland Australia and Tasmania. Found in coastal habitats (especially those close to the seashore) and around terrestrial wetlands in tropical and temperate regions of mainland Australia and its offshore islands. The habitats occupied by the sea-eagle are characterised by the presence of large areas of open water (larger rivers, swamps, lakes, and the sea).	Habitat constraints - ▪ Foraging: Within 1km of a rivers, lakes, large dams or creeks, wetlands and coastlines ▪ Breeding: Living or dead mature trees within suitable vegetation within 1km of a rivers, lakes, large dams or creeks, wetlands and coastlines No geographic constraints	Moderate / Included Only foraging habitat was identified during surveys. This species has been included as an ecosystem-credit species only, no breeding habitat would be impacted.
Hamirostra melanosternon	Black-breasted Buzzard	-	V	3 – BioNet, BAM-C	Dual credit species: Ecosystem (foraging) Species (breeding)	The Black-breasted Buzzard is found sparsely in areas of less than 500mm rainfall, from north-western NSW and north-eastern South Australia to the east coast at about Rockhampton, then across northern Australia south almost to Perth, avoiding only the Western Australian deserts. Lives in a range of inland habitats, especially along timbered watercourses which is the preferred breeding habitat. Also hunts over grasslands and sparsely timbered woodlands.	Habitat constraints - ▪ Breeding: Land within 40 metres of riparian woodland on inland watercourses/waterholes containing dead or dying eucalypts No geographic constraints	Moderate / Included Only foraging habitat was identified during surveys. This species has been included as an ecosystem-credit species only, no breeding habitat would be impacted.

Species	Common name	EPBC Act	BC Act	Record source (50 km radius)	Credit type (BAM)	Distribution and habitat	Habitat constraints and geographic limitations	Likelihood of occurrence / BAM assessment inclusion
Hieraaetus morphnoides	Little Eagle	-	V	3 – BioNet, BAM-C	Dual credit species: Ecosystem (foraging) Species (breeding)	The Little Eagle is found throughout the Australian mainland excepting the most densely forested parts of the Dividing Range escarpment. It occurs as a single population throughout NSW. Occupies open eucalypt forest, woodland or open woodland. Sheoak or Acacia woodlands and riparian woodlands of interior NSW are also used.	Habitat constraints – ▪ Breeding: Nest trees - live (occasionally dead) large old trees within vegetation) No geographic constraints	Moderate / Included Only foraging habitat was identified during surveys. This species has been included as an ecosystem-credit species only, no breeding habitat would be impacted.
Limosa limosa	Black-tailed Godwit	M	V	BAM-C	Dual credit species: Ecosystem (foraging) Species (breeding)	A migratory wading bird that breeds in Mongolia and Eastern Siberia and flies to Australia for the southern summer, arriving in August and leaving in March. In NSW, it is most frequently found at Kooragang Island (Hunter River estuary). Occurs in sheltered bays, estuaries and lagoons with large intertidal mudflats and sand flats. Also found at inland mudflats, swamps.	Habitat constraints - ▪ As per mapped important areas	Moderate / Included No important areas mapped near the development site. The Darling River (Baaka) is unlikely to provide habitat suitable for the Black-tailed Godwit, however PCT 39 may provide foraging habitat following flooding..
Lophochroa leadbeateri	Major Mitchell's Cockatoo	-	V	5 – BioNet, BAM-C GHD, 2020	Dual credit species: Ecosystem	Found across the arid and semi-arid inland, from south-western Queensland south to north-west Victoria, through most of South Australia, north into the south-west Northern Territory and across to the west coast between Shark	Habitat constraints - ▪ Hollow bearing trees ▪ Living or dead tree with hollows greater than 10cm diameter	Moderate / Included Suitable habitat its widespread and there is a record from 1989 in Wilcannia. This species was targeted during surveys of the development site. No

Species	Common name	EPBC Act	BC Act	Record source (50 km radius)	Credit type (BAM)	Distribution and habitat	Habitat constraints and geographic limitations	Likelihood of occurrence / BAM assessment inclusion
					(foraging) Species (breeding)	Bay and about Jurien. In NSW it is found regularly as far east as about Bourke and Griffith, and sporadically further east than that. Inhabits a wide range of treed and treeless inland habitats, always within easy reach of water. Inhabits a wide range of treed and treeless inland habitats, always within easy reach of water.	No geographic constraints	birds or breeding habitat was identified. This species has been included as an ecosystem credit species only.
Lophoictinia isura	Square-tailed Kite	-	V	1 – BioNet, BAM-C	Dual credit species: Ecosystem (foraging) Species (breeding)	Typically inhabits coastal forested and wooded lands of tropical and temperate Australia. In NSW it is often associated with ridge and gully forests dominated by Eucalyptus longifolia, Corymbia maculata, E. elata, or E. smithii. Individuals appear to occupy large hunting ranges of more than 100 km^2. They require large living trees for breeding, particularly near water with surrounding woodland /forest close by for foraging habitat. Nest sites are generally located along or near watercourses, in a tree fork or on large horizontal limbs.	Habitat constraints – ▪ Nest trees No geographic constraints	Moderate / Included Only foraging habitat was identified during surveys. This species has been included as an ecosystem-credit species only, no breeding habitat would be impacted.
Melanodryas cucullata cucullata	Hooded Robin (south-eastern form)	-	V	BAM-C	Ecosystem-credit species	The Hooded Robin is widespread, found across Australia, except for the driest deserts and the wetter coastal areas - northern and eastern coastal Queensland and	None	Moderate / Included This species has not previously been recorded in the locality, however vegetation meeting the

Species	Common name	EPBC Act	BC Act	Record source (50 km radius)	Credit type (BAM)	Distribution and habitat	Habitat constraints and geographic limitations	Likelihood of occurrence / BAM assessment inclusion
						Tasmania. However, it is common in few places, and rarely found on the coast. Prefers lightly wooded country, usually open eucalypt woodland, acacia scrub and mallee, often in or near clearings or open areas. Requires structurally diverse habitats featuring mature eucalypts, saplings, some small shrubs and a ground layer of moderately tall native grasses. The nest is a small, neat cup of bark and grasses bound with webs, in a tree fork or crevice, from less than one metre to five metres above the ground.		habitat requirements on this species is present in the study area.
Ninox connivens	Barking Owl	-	V	BAM-C	Dual credit species: Ecosystem (foraging) Species (breeding)	Found throughout continental Australia except for the central arid regions. Inhabits woodland and open forest, including fragmented remnants and partly cleared farmland. It is flexible in its habitat use, and hunting can extend in to closed forest and more open areas.	Habitat constraints - ▪ Hollow bearing trees ▪ Living or dead trees with hollows greater than 20 centimetres diameter and greater than 4m above the ground No geographic constraints	Moderate / Included This species has been included as an ecosystem-species due to the widespread availability of habitat and scattered records across North West NSW on the Atlas of Living Australia.
Oxyura australis	Blue-billed Duck	-	V	2 – BioNet	Ecosystem-	Endemic to south-eastern and south-western Australia. It is widespread in NSW, but most common in the southern Murray-	None	Moderate / Included The Darling River (Baaka) may provide suitable habitat

Species	Common name	EPBC Act	BC Act	Record source (50 km radius)	Credit type (BAM)	Distribution and habitat	Habitat constraints and geographic limitations	Likelihood of occurrence / BAM assessment inclusion
					credit species	Darling Basin area. Birds disperse during the breeding season to deep swamps up to 300 kilometres away. It is generally only during summer or in drier years that they are seen in coastal areas. Prefers deep water in large permanent wetlands and swamps with dense aquatic vegetation. The species is completely aquatic, swimming low in the water along the edge of dense cover. It will fly if disturbed but prefers to dive if approached. Partly migratory, with short-distance movements between breeding swamps and overwintering lakes with some long-distance dispersal to breed during spring and early summer. Usually nest solitarily in Cumbungi over deep water between September and February. They will also nest in trampled vegetation in Lignum, sedges or Spike-rushes, where a bowl-shaped nest is constructed. The most common clutch size is five or six. Males take no part in nest-building or incubation.		for this species during periods of suitable flow. Listed associated habitat within the development site is PCT 247, which would likely only provide suitable habitat after a high rainfall event or flooding of the Darling River.
Pedionomus torquatus	Plains-wanderer	CE	E	PMST	Dual credit species:	The Plains-wanderer has declined greatly since European settlement. Areas where the species was formerly common and is now so	Habitat constraints - ▪ Breeding: As per mapped areas	Low / Excluded There are no mapped areas available to identify breeding habitat for this

Species	Common name	EPBC Act	BC Act	Record source (50 km radius)	Credit type (BAM)	Distribution and habitat	Habitat constraints and geographic limitations	Likelihood of occurrence / BAM assessment inclusion
					Ecosystem (foraging) Species (breeding)	reduced in numbers that it is effectively extinct include eastern NSW, south-western Victoria, and south-eastern South Australia. Its current stronghold is the western Riverina of southern NSW. Plains-wanderers live in semi-arid, lowland native grasslands that typically occur on hard red-brown soils. These grasslands support a high diversity of plant species, including a number of state and nationally threatened species. Habitat structure appears to play a more important role than plant species composition. Preferred habitat of the Plains-wanderer typically comprises 50% bare ground, 10 per cent fallen litter, and 40% herbs, forbs and grasses. Most of the grassland habitat of the Plains-wanderer is less than five centimetres high, but some vegetation up to a maximum of 30 centimetres is important for concealment, as long as grass tussocks are spaced 10-20 centimetres apart. During prolonged drought, the denudation of preferred habitats may force birds into marginal denser and taller grassland	No geographic constraints	species. No grasslands habitats were identified in the study area.

Species	Common name	EPBC Act	BC Act	Record source (50 km radius)	Credit type (BAM)	Distribution and habitat	Habitat constraints and geographic limitations	Likelihood of occurrence / BAM assessment inclusion
						habitats that become temporarily suitable.		
Phaps histrionica	Flock Bronzewing	-	E	4 – BioNet BAM-C	Ecosystem-credit species	Patchily distributed and rarely observed in NSW. It is likely to occur north of Broken Hill and west of Cobar when conditions are right. The extensive Mitchell grasslands around Brewarrina and Goodooga should also provide suitable habitat. Observed in a variety of vegetation types, including grassy plains, saltbush, spinifex and open mulga. Its preferred habitat is tussock grassland, particularly Mitchell grassland. They need to drink daily and may be seen adjacent to water, at stock tanks, bore drains and pools in water courses.	None	Moderate / Included The study area contains saltbush shrublands. Mitchell grasslands are mapped in the locality however none were identified in the study area. This species may occur occasionally when conditions are suitable.
Pomatostomus temporalis temporalis	Grey-crowned Babbler (eastern subspecies)	-	V	2 – BioNet, BAM-C	Ecosystem-credit species	In NSW, the eastern sub-species occurs on the western slopes of the Great Dividing Range, and on the western plains reaching as far as Louth and Balranald. It also occurs in woodlands in the Hunter Valley and in several locations on the north coast of NSW. It may be extinct in the southern, central and New England tablelands. Inhabits open Box-Gum Woodlands on the slopes, and Box-Cypress-pine and open Box Woodlands on alluvial	None	Low / Excluded This western extent of this subspecies is described as being the western plains reaching as far as Louth and Balranald. Wilcannia is west of these locations so is presumable outside of the range of the eastern subspecies.

Species	Common name	EPBC Act	BC Act	Record source (50 km radius)	Credit type (BAM)	Distribution and habitat	Habitat constraints and geographic limitations	Likelihood of occurrence / BAM assessment inclusion
						plains. Build and maintain several conspicuous, dome-shaped stick nests about the size of a football. A nest is used as a dormitory for roosting each night. Nests are usually located in shrubs or sapling eucalypts, although they may be built in the outermost leaves of low branches of large eucalypts. Nests are maintained year-round, and old nests are often dismantled to build new ones.		
Pyrrholaemus brunneus	Redthroat	-	V	BAM-C	Ecosystem-credit species	In NSW, the species is confined to the far west of the state, with populations known from four main areas, though the species is probably under-recorded due to its shy habits and low observer numbers within its distribution. In NSW the species has been recorded mainly in chenopod shrublands including Old Man Saltbush, Black Bluebush and Dillon Bush shrublands. Around Broken Hill it appears to be associated with the denser vegetation, particularly *Acacias*, found in drainage lines that run from the rocky hills. In other locations it is known from Canegrass and Lignum swamps and depressions, particularly on floodplains. In other parts of its	None	Moderate / Included The study area contains chenopod shrublands, which are described as suitable habitat for this species.

Species	Common name	EPBC Act	BC Act	Record source (50 km radius)	Credit type (BAM)	Distribution and habitat	Habitat constraints and geographic limitations	Likelihood of occurrence / BAM assessment inclusion
						range, the Redthroat mainly inhabits acacia (particularly Mulga) and chenopod shrublands, often along watercourses or drainage lines. At this point of time it is not known from Mulga woodlands in NSW. More rarely it is also known to occur in mallee with a diverse heath shrub layer (SA/Victoria), taller semi-arid woodlands (WA), heathlands dominated by banksia and tea tree (Victoria) and shrublands with a White Cypress Pine overstorey (SA).		
Rostratula australis	Australian Painted Snipe	E, M	E	PMST, BAM-C	Ecosystem-credit species	Most records are from the south-east, particularly the Murray Darling Basin, with scattered records across northern Australia and historical records from around the Perth region in Western Australia. Prefers fringes of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber. Nests on the ground amongst tall vegetation, such as grasses, tussocks or reeds.	None	Moderate / Included Suitable habitat for this species is limited. The floodplain may temporarily become habitat following flooding of the Darling River, however this is considered an uncommon event and these areas would not represent important habitat for this species.
Stagonopleura guttata	Diamond Firetail	-	V	BAM-C	Ecosystem-credit species	Found in grassy eucalypt woodlands, including Box-Gum Woodlands and Snow Gum (*Eucalyptus pauciflora*) Woodlands. Also occurs in open	None	Moderate / Included Habitat for this species is widespread in the study area.

Species	Common name	EPBC Act	BC Act	Record source (50 km radius)	Credit type (BAM)	Distribution and habitat	Habitat constraints and geographic limitations	Likelihood of occurrence / BAM assessment inclusion
						forest, mallee, Natural Temperate Grassland, and in secondary grassland derived from other communities. Often found in riparian areas (rivers and creeks), and sometimes in lightly wooded farmland. Nests are globular structures built either in the shrubby understorey, or higher up, especially under hawk's or raven's nests. Birds roost in dense shrubs or in smaller nests built especially for roosting.		
Stictonetta naevosa	Freckled Duck	-	V	1 – BioNet, BAM-C	Ecosystem-credit species	The Freckled Duck is found primarily in south-eastern and south-western Australia, occurring as a vagrant elsewhere. It breeds in large temporary swamps created by floods in the Bulloo and Lake Eyre basins and the Murray-Darling system, particularly along the Paroo and Lachlan Rivers, and other rivers within the Riverina. The duck is forced to disperse during extensive inland droughts when wetlands in the Murray River basin provide important habitat. The species may also occur as far as coastal NSW and Victoria during such times. Prefer permanent freshwater swamps and creeks with heavy growth of Cumbungi, Lignum or Tea-tree. During drier	None	Moderate / Included The Darling River (Baaka) may provide suitable habitat for this species during periods of suitable flow. Listed associated habitat within the development site includes PCT 247, which would likely only provide suitable habitat after a high rainfall event or flooding of the Darling River.

Species	Common name	EPBC Act	BC Act	Record source (50 km radius)	Credit type (BAM)	Distribution and habitat	Habitat constraints and geographic limitations	Likelihood of occurrence / BAM assessment inclusion
						times they move from ephemeral breeding swamps to more permanent waters such as lakes, reservoirs, farm dams and sewage ponds.		
Tyto novaehollandiae	Masked Owl	-	V	BAM-C	Dual credit species: Ecosystem (foraging) Species (breeding)	Extends from the coast where it is most abundant to the western plains. Overall records for this species fall within about 90 per cent of NSW, excluding the most arid north-western corner. There is no seasonal variation in its distribution. Inhabits dry eucalypt forests and woodland, typically prefers open forest with low shrub density. Requires old trees for roosting and nesting.	Habitat constraints – ▪ Hollow bearing trees ▪ Living or dead trees with hollows greater than 20cm diameter No geographic constraints	Moderate / Included This species has been included as an ecosystem-species due to the widespread availability of habitat. However, this species becomes less common toward to the north-west corner of NSW. Records in are very rare in the region.
Mammals								
Antechinomys laniger	Kultarr	-	E	BAM-C	Ecosystem-credit species	Widespread across arid and semi-arid NSW but present in very low numbers. Records typically derive from captures by domestic cats or are collected after falling into steep-sided holes. Recent records have come primarily from the Cobar and Brewarrina region. A terrestrial insectivore that inhabits open country, especially claypans among Acacia woodlands. Nocturnal, sheltering by day in hollow logs or tree-stumps,	None	Moderate / Included The study area contains suitable habitat features for this species. Moderate cracking clays were observed in floodplain depressions which may provide suitable habitat.

Species	Common name	EPBC Act	BC Act	Record source (50 km radius)	Credit type (BAM)	Distribution and habitat	Habitat constraints and geographic limitations	Likelihood of occurrence / BAM assessment inclusion
						beneath saltbush and spinifex tussocks, in deep cracks in the soil and in the burrows of other animals.		
Chalinolobus picatus	Little Pied Bat	-	V	2 – BioNet, BAM-C	Ecosystem-credit species	The Little-Pied Bat is found in inland Queensland and NSW (including Western Plains and slopes) extending slightly into South Australia and Victoria. Occurs in dry open forest, open woodland, mulga woodlands, chenopod shrublands, cypress pine forest and mallee and Bimbil box woodlands. Roosts in caves, rock outcrops, mine shafts, tunnels, tree hollows and buildings.	None	Moderate / Included Suitable habitat for this species is widespread in the study area. Hollow-bearing trees may offer suitable roosting habitat.
Leggadina forresti	Forrest's Mouse	-	V	BAM-C	Ecosystem-credit species	Forrest's Mouse is sparsely distributed across arid and semi-arid inland Australia. In north west NSW, it has been recorded from Sturt National Park, Tibooburra, Fowler's Gap, Mutawintji National Park (as subfossil remains), and from near Wilcannia. The species has also recently been recorded from Ledknapper Nature Reserve, and Culgoa National Park near Weilmoringle. Forrest's Mouse occurs in arid and semi-arid plains habitats, especially tussock grassland and chenopod shrubland. Also mulga or savannah	None	Moderate / Included Potential suitable habitat for this species is widespread.

Species	Common name	EPBC Act	BC Act	Record source (50 km radius)	Credit type (BAM)	Distribution and habitat	Habitat constraints and geographic limitations	Likelihood of occurrence / BAM assessment inclusion
						woodlands, claypans and sandy ridges.		
Phascolarctos cinereus	Koala	V	V	1 – BioNet, BAM-C	Dual credit species: Ecosystem (foraging) Species (breeding)	In NSW it mainly occurs on the central and north coasts with some populations in the west of the Great Dividing Range. Inhabit eucalypt woodlands and forests. Feed on the foliage of more than 70 eucalypt species and 30 non-eucalypt species, but in any one area will select preferred browse species.	Habitat constraints – ▪ Breeding: Areas identified via survey as important habitat (see comments) No geographic constraints	Moderate / Included Potential habitat is widespread in the study area. This species was targeted during surveys.
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	-	V	1 – BioNet, BAM-C	Ecosystem-credit species	The Yellow-bellied Sheathtail-bat is a wide-ranging species found across northern and eastern Australia. In the most southerly part of its range - most of Victoria, south-western NSW and adjacent South Australia - it is a rare visitor in late summer and autumn. There are scattered records of this species across the New England Tablelands and North West Slopes. Roosts singly or in groups of up to six, in tree hollows and buildings; in treeless areas they are known to utilise mammal burrows.	None	Moderate / Included Suitable habitat for this species is widespread in the study area. Hollow-bearing trees may offer suitable roosting habitat.
Sminthopsis macroura	Stripe-faced Dunnart	-	V	BAM-C	Ecosystem-	Throughout much of inland central and northern Australia, extending into central and northern NSW,	None	Moderate / Included Potential suitable habitat for this species is widespread.

Species	Common name	EPBC Act	BC Act	Record source (50 km radius)	Credit type (BAM)	Distribution and habitat	Habitat constraints and geographic limitations	Likelihood of occurrence / BAM assessment inclusion
					credit species	western Queensland, Northern Territory, South Australia and Western Australia. They are rare on the NSW Central West Slopes and North West Slopes with the most easterly records of recent times located around Dubbo, Coonabarabran, Warialda and Ashford. Inhabits native dry grasslands and low dry shrublands, often along drainage lines where food and shelter resources tend to be better.		
Reptiles								
Antaresia stimsoni	Stimson's Python	-	V	1 – BioNet, BAM-C	Species-credit species	Occurs in north-west NSW, from Bourke and Gundabooka National Park in the east to Broken Hill and Wilcannia in the south. The species occupies a broad spectrum of habitats includes woodlands, shrublands (including *Acacia* and chenopods) and hummock grasslands, where rocky outcrops provide caves and deep crevices and where tree-lined watercourses provide numerous low hollows and fallen trees.	Habitat constraints – ▪ Rocky areas ▪ Areas within 500m of rocks or gibber	Moderate / Included No gibber or rocky areas are known from within 500m of the develop site. However, this species was targeted during spotlighting surveys.
Pseudonaja modesta	Ringed Brown Snake	-	E	BAM-C	Ecosystem-credit species	Determined on the basis of only limited records until recently, it is thought to occupy the north-west portion of the state having been recorded from Tarawi Nature	None	Moderate / Included The description of suitable habitat includes those present in the study area. Therefore, this species has a

Species	Common name	EPBC Act	BC Act	Record source (50 km radius)	Credit type (BAM)	Distribution and habitat	Habitat constraints and geographic limitations	Likelihood of occurrence / BAM assessment inclusion
						Reserve, 140km south of Broken Hill, Silverton, Tibooburra, Wanaaring and from Kilberoo, 140km north-west of Bourke. Recent surveys have identified a large population in the Scotia Sanctuary-Tarawi NR region. A terrestrial species that inhabits drier areas including rocky outcrops and dry watercourses. Occurs in a variety of vegetation types including woodlands, shrublands, mallee and grasslands. By night it shelters in ground debris or abandoned animal burrows.		moderate potential of occurring.
Migratory species								
Apus pacificus	Fork-tailed Swift	M	-	PMST	NA	Recorded in all regions of NSW. The Fork-tailed Swift is almost exclusively aerial, flying from less than one metre to at least 300 metres above ground and probably much higher.	NA	Low. This species is likely to occur in the air space over the development site during seasonal migration, however there is no suitable habitat for this species in the development site.
Calidris acuminata	Sharp-tailed Sandpiper	M	-	3 – BioNet PMST	NA	The Sharp-tailed Sandpiper spends the non-breeding season in Australia with small numbers occurring regularly in New Zealand. Most of the population migrates to Australia, mostly to the south-east and are widespread in	NA	Low. The three records are from 1984, the closest being from a small shallow wetland about four kilometres north-north-west of the development site.

Species	Common name	EPBC Act	BC Act	Record source (50 km radius)	Credit type (BAM)	Distribution and habitat	Habitat constraints and geographic limitations	Likelihood of occurrence / BAM assessment inclusion
						both inland and coastal locations and in both freshwater and saline habitats. Many inland records are of birds on passage. Prefers muddy edges of shallow fresh or brackish wetlands, with inundated or emergent sedges, grass, saltmarsh or other low vegetation; this includes lagoons, swamps, lakes and pools near the coast, and dams, waterholes, soaks, bore drains and bore swamps, saltpans and hypersaline saltlakes inland. They also occur in saltworks and sewage farms. They use flooded paddocks, sedgelands and other ephemeral wetlands, but leave when they dry. They use intertidal mudflats in sheltered bays, inlets, estuaries or seashores, and also swamps and creeks lined with mangroves. They tend to occupy coastal mudflats mainly after ephemeral terrestrial wetlands have dried out, moving back during the wet season. Sometimes they occur on rocky shores and rarely on exposed reefs.		Considering the habitat requirements for this species describes use of mudflats associated with lots of waterways except rivers, the Darling River (Baaka) is unlikely to provide suitable habitat for this species. However, given the current low flow, there may be some sections of river that provide temporarily suitable after periods of flow. The development site and broader study area (i.e. upstream and downstream) does not include any areas of high-quality mudflat habitat for this species.
Calidris ruficollis	Red-necked Stint	M	-	1 – BioNet	NA	It is distributed along most of the Australian coastline with large densities on the Victorian and Tasmanian coasts. The Red-necked Stint breeds in Siberia and	NA	Low. One record from 1984 on the Paroo River about 35 kilometres north-east of the development site. The

Species	Common name	EPBC Act	BC Act	Record source (50 km radius)	Credit type (BAM)	Distribution and habitat	Habitat constraints and geographic limitations	Likelihood of occurrence / BAM assessment inclusion
						sporadically in north and west Alaska, probably from Taymyr region to Anadyr Territory and Koryakland. The Red-necked Stint mostly forages on bare wet mud on intertidal mudflats or sand flats, or in very shallow water; mostly in areas with a film of surface water and mostly close to edge of water. Roosts on sheltered beaches, spits, banks or islets, of sand, mud, coral or shingle, sometimes in saltmarsh or other vegetation.		shallow water habitats of the Darling River (Baaka) may provide some very low-quality habitat for this species, however it is not expected to rely on these areas.
Calidris melanotos	Pectoral Sandpiper	M	-	PMST	NA	In NSW, the Pectoral Sandpiper is widespread, but scattered. Records exist east of the Great Divide, from Casino and Ballina, south to Ulladulla. West of the Great Divide, the species is widespread in the Riverina and Lower Western regions. Prefers shallow fresh to saline wetlands. The species is found at coastal lagoons, estuaries, bays, swamps, lakes, inundated grasslands, saltmarshes, river pools, creeks, floodplains and artificial wetlands.	NA	Low. No records in the 50 kilometre locality. Closest record in from Malta Lake near Menindee. The shallow water habitats of the Darling River (Baaka) may provide some very low-quality habitat for this species, however it is not expected to rely on these areas.
Gallinago hardwickii	Latham's Snipe		-	1 – BioNet PMST	NA	Recorded along the east coast of Australia from Cape York Peninsula through to south-eastern South Australia. Occurs in permanent and ephemeral	NA	Low. This species occurs in wetlands that contain suitable vegetation for refuge. The Darling River

Species	Common name	EPBC Act	BC Act	Record source (50 km radius)	Credit type (BAM)	Distribution and habitat	Habitat constraints and geographic limitations	Likelihood of occurrence / BAM assessment inclusion
						wetlands up to 2000 metres above sea-level.		(Baaka) is largely missing any instream vegetation due to the highly modified flows. Some sections may provide some very low-quality habitat for this species, however it is not expected to rely on these areas.
Gelochelidon nilotica	Gull-billed Tern	M	-	3 – BioNet	NA	Gull-billed Terns are found in freshwater swamps, brackish and salt lakes, beaches and estuarine mudflats, floodwaters, sewage farms, irrigated croplands and grasslands. They are only rarely found over the ocean.	NA	Low. This species may fly over the development site and along sections of the Darling River (Baaka) during migration, however it is unlikely to use or rely on habitats present.
Motacilla flava	Yellow Wagtail	M	-	PMST	NA	Rare but regular visitor around Australian coast, especially to the north-west coast between Broome and Darwin. Found in open country near swamps, salt marshes, sewage ponds, grassed surrounds to airfields, bare ground; occasionally on drier inland plains.	NA	Low. There are no records of this species in the 50 kilometre locality. However, it is widespread and could occur anywhere during migration. The development site and broader study area does not contain any high-quality habitat for this species.
Pluvialis fulva	Pacific Golden Plover	M	-	1 – BioNet	NA	Most Pacific Golden Plovers occur along the east coast, and are especially widespread along the Queensland and NSW coastlines. In non-breeding grounds in Australia this species usually inhabits coastal habitats, though it	NA	Low. One record from 1984 on the Paroo River about 30 kilometres north-east of the development site. The shallow water habitats of the

Species	Common name	EPBC Act	BC Act	Record source (50 km radius)	Credit type (BAM)	Distribution and habitat	Habitat constraints and geographic limitations	Likelihood of occurrence / BAM assessment inclusion
						occasionally occurs around inland wetlands. Pacific Golden Plovers usually occur on beaches, mudflats and sand flats (sometimes in vegetation such as mangroves, low saltmarsh such as Sarcocornia, or beds of seagrass) in sheltered areas including harbours, estuaries and lagoons, and also in evaporation ponds in salt works.		Darling River (Baaka) may provide some very low-quality habitat for this species, however it is not expected to rely on these areas.
* Distribution and habitat requirement information adapted from: Australian Government Department of the Environment http://www.environment.gov.au/biodiversity/threatened/index.html, EESG http://www.environment.nsw.gov.au/threatenedspecies/ Key: CE = critically endangered,E = endangered,EP = endangered population, Ex = extinct, M = migratory, PE = presumed extinct, V = vulnerable								

Appendix B. Floristic survey composition and structure data

Table B-1 Species and estimated cover recorded in each of the Vegetation Integrity survey plots

Species	GF code	Plots																											
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Abutilon sp.	FG																												0.1
Acacia stenophylla	TG	5	0.1					1		0.1				1		2								0.1	0.5				
Aira caryophyllea	EX																				0.1								
Alternanthera nodiflora	FG		0.1			0.1	0.1							3		0.1													
Angianthus sp.	FG																										0.1		
Asperula gemella	FG	5						2						0.5		0.8													
Atriplex angulata	SG																										0.1		
Atriplex holocarpa	SG											0.2	0.1											1	0.1	0.1		0.1	0.2
Atriplex leptocarpa	SG		0.1			0.1	0.2	0.1	0.1	0.2						0.5					0.1		2		0.1				
Atriplex limbata	FG																											5	
Atriplex lindleyi	SG					0.1			0.1			0.1													0.2			0.3	1
Atriplex nummularia	SG								2		0.5	4																	
Atriplex pseudocampanulata	SG								0.1														0.1						
Atriplex semibaccata	SG						0.1				0.1																		
Atriplex suberecta	FG														0.1		0.3			0.5									
Atriplex suberecta	SG		0.1				0.1	0.1																					
Atriplex vesicaria	SG																											0.1	
Austrostipa nitida	GG								0.1																				
Austrostipa nodosa	GG	0.1																											
Austrostipa scabra	GG									0.1																	2	2	
Boerhavia dominii	FG		0.1				0.1			0.1						0.1													
Bolboschoenus caldwellii	GG														0.1														

Species	GF code	Plots																											
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Brachyscome ciliaris	FG	0.1	0.1				0.1			0.1	0.1														0.1		0.2	0.2	
Brachyscome melanocarpa	FG																						0.1						
Brachyscome spp.	FG								0.1																				
Brassica tournefortii	EX	0.3																											
Bromus catharticus	EX							0.1							0.1	0.5													
Bulbine semibarbata	FG		0.1			0.1	0.1																0.1	0.1			0.1		0.1
Calandrinia eremaea	FG				0.1																								
Calotis erinacea	SG															0.1				30									
Calotis scapigera	FG	0.5	1					0.1														0.5			0.1				
Carrichtera annua	HT		0.5		0.1	1	0.1		1	5	2	0.1												0.5	0.5			0.5	0.2
Centaurea melitensis	EX	1	0.1			0.1																			0.5				
Centaurium tenuiflorum	EX			0.1														0.1		0.1		0.5							
Centipeda cunninghamii	FG			0.1																									
Centipeda minima	FG																	0.1	2		5	0.5							
Centipeda spp.	FG																0.4												
Chenopodium curvispicatum	SG										0.1			0.1		0.3													
Chenopodium nitrariaceum	SG	10	15		10	5	10	0.5	0.1	5	10			2		3							0.5	0.2	1				
Chloris truncata	GG									0.1																			
Convolvulus erubescens	OG						0.1																				0.1		
Convolvulus remotus	OG																											0.1	
Conyza bonariensis	EX			0.3											0.1		0.1	0.1		2									
Cullen tenax	FG																					0.1							
Cynodon dactylon	GG			0.1				0.1							1	0.1	0.1			2									
Cyperus gymnocaulos	GG			25											15		0.2	20	20	1		20							
Dactyloctenium radulans	GG																												0.1

Species	GF code	Plots																											
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Dissocarpus biflorus	SG																										0.2		0.1
Dissocarpus paradoxus	SG		0.1						8		0.2	0.5	3										0.1	0.1		0.1		0.2	0.5
Duma florulenta	SG	1	5		0.1	0.1	8	0.2		10	2			20		0.5							0.4	0.3	50				
Dysphania spp.	FG																		0.1										
Einadia nutans	FG	0.1	0.1				0.1	5		0.1	0.3			1		1							0.1		0.5				
Enchylaena tomentosa	FG	0.1	1				0.1							0.1		0.5					0.1			0.1	0.5		0.1		
Enneapogon avenaceus	GG																										0.1	0.3	
Enteropogon acicularis	GG																										0.1		
Eragrostis dielsii	GG																											0.1	
Eragrostis parviflora	GG													1															
Eragrostis spp.	GG							0.1																					
Eremophila bignoniiflora	SG									2				0.1										0.1					
Eriochloa crebra	GG		0.2		0.5	0.2	0.5			0.1		0.1	0.1										0.5	3	1				0.1
Ethuliopsis cunninghamii	FG			0.1																									
Eucalyptus camaldulensis	TG	30		5				50		2				30		10		0.2		0.1		3							
Eucalyptus coolabah	TG	1	10				10																3		5				
Eucalyptus largiflorens	TG										40																5		
Euchiton involucratus	FG																					0.1							
Euchiton sphaericus	FG																			0.1	0.1		0.1						
Euchiton spp.	FG		0.1							0.1																			
Euphorbia inappendiculata var. *queenslandica*	FG		0.1					0.1		0.1						0.1		0.1		0.1		0.1							0.1
Euphorbia stevenii	FG				1			0.1																					
Glinus lotoides	FG																0.1	0.1	0.1		0.1								
Glycine spp.	OG																			1									
Goodenia glauca	FG	0.1	0.1					0.2								0.1													

Species	GF code	Plots																											
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Goodenia heteromera	FG	0.1		20												0.1	0.1		0.1			0.3							
Haloragis aspera	FG	0.1																											
Haloragis glauca	FG													0.1															
Heliotropium supinum	EX																					0.1							
Hordeum leporinum	EX						0.1																	0.1					0.3
Juncus bufonius	GG														0.1		0.1												
Juncus spp.	GG													0.1															
Lachnagrostis filiformis	GG		0.1	0.2	0.1	0.1								2	2		0.2	10	0.1	0.5		1	2						
Lactuca serriola	EX	0.5						0.1							0.5	0.5	0.5	0.1		0.1				0.1	0.1				0.1
Leiocarpa brevicompta	FG								0.1	0.1			0.1											0.1	0.1		0.1	0.1	0.1
Leiocarpa websteri	SG		0.5		0.5	0.1	0.1		0.1	0.1	0.1	0.1	3		0.1								10						
Lepidium africanum	EX		0.1		0.1	0.1		0.1		0.2				0.1	0.1		0.1			0.5	0.1	0.1	0.5	0.1				
Lotus cruentus	FG												0.1							2									
Lycium ferocissimum	EX															0.1													
Lysiana exocarpi	OG															0.3													
Maireana appressa	SG																										0.1	0.2	
Maireana lobiflora	SG																											0.1	
Maireana pyramidata	SG																											5	
Malacocera tricornis	SG								0.1																			0.1	
Marsilea drummondii	EG															0.5													
Medicago minima	EX									0.1																		0.1	
Medicago sp.	EX																												
Melilotus indicus	EX			0.1					0.1					0.1	15		0.1	10		5		2							0.1
Minuria spp.	FG					0.1			0.1																		1		
Myoporum montanum	SG	2	0.1					0.5						1		1													

Species	GF code	Plots																											
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Neobassia proceriflora	SG				0.1	0.1	0.2		15	1	0.2	0.5	10										20	10		0.5		0.1	5
Nicotiana velutina	FG																0.1				0.1								
Olearia pimeleoides	SG	0.1																											
Osteocarpum acropterum	SG																										0.1	1	
Oxalis perennans	FG	2	0.1					2		0.1				2		0.5													
Panicum decompositum	GG				0.1				0.1	0.1	0.1	0.1	0.1											0.2		0.1		0.1	0.1
Panicum spp.	GG											0.1																	
Paspalidium jubiflorum	GG	4		0.1				0.1		0.1						4				0.2									
Persicaria lapathifolia	FG			0.1										0.1			20	0.5											
Phyllanthus lacunarius	FG				0.1	0.1																							
Picris squarrosa	FG			0.1				0.1																					
Plantago drummondii	FG		4						0.1											0.1							1	0.5	
Plantago turrifera	FG				0.5		1			0.1													0.1		0.1				0.2
Podolepis jaceoides	FG								0.1			0.1																	
Polygonum aviculare	EX			0.1											0.1								0.1						
Polypogon monspeliensis	EX														15		2	0.1											
Portulaca oleracea	FG		0.3			0.5	0.5			0.1			0.1										0.1	0.5	0.1		0.1		
Pseudognaphalium luteoalbum	FG			2											0.1			0.1	0.5	0.5	15	0.5							
Pycnosorus globosus	FG								0.1																				
Rhagodia spinescens	SG																										5		
Rhodanthe corymbiflora	FG			0.1	0.1		0.1					0.1	0.1										1						0.1
Rhodanthe floribunda	FG	0.1	0.1							0.1	0.1																		
Rostraria pumila	EX		0.5							0.1	0.1	0.1																0.1	0.2
Rumex brownii	FG							0.1						1		0.2													
Rumex crystallinus	FG			0.5											0.5		25		0.1	0.1	0.5	0.1	0.1						

Species	GF code	Plots																											
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Rumex spp.	SG		0.1																						0.1				
Rytidosperma setaceum	GG																												0.1
Salsola australis	SG							0.1			0.1																	0.1	
Sarcozona praecox	FG																								0.1		0.1	0.1	
Schismus barbatus	HT				0.5	0.5	1		0.1														0.1		0.1	0.1	0.2		0.2
Sclerolaena brachyptera	SG										0.1	0.5	0.2													0.1	0.1	0.2	
Sclerolaena diacantha	SG																										0.2	0.2	
Sclerolaena divaricata	SG		1		10	20	1	0.3	0.5	0.2	0.2	0.5	0.2	0.1									15	10	0.2	0.5	0.1	0.1	5
Sclerolaena intricata	SG																											0.2	
Sclerolaena muricata	SG								0.1	0.5				0.5		0.1													
Sclerolaena obliquicuspis	SG																											2	
Sclerolaena stelligera	SG	0.2				0.1																	0.3						
Sclerolaena tricuspis	SG								5			20																	
Sclerolaena ventricosa	SG																									0.5			2
Senecio glossanthus	FG		0.1		0.1		0.1			0.1													0.1	0.1					
Senecio runcinifolius	FG			0.1										0.2															
Sida cunninghamii	FG					0.1			0.1	0.1		0.1				0.1													0.1
Silene apetala	EX	0.1								0.1																			
Sisymbrium erysimoides	EX		0.1		0.5			1		0.1	0.2			12		0.1	0.1					0.1		0.1	0.5			0.1	
Solanum esuriale	FG	0.1									0.1																		
Solanum nigrum	EX							0.1						0.1		0.1													
Sonchus oleraceus	EX	0.2	1			1	0.1		0.1	0.1	0.1	0.1	0.1			0.1		0.2	0.5				0.2	0.1	0.5				0.1
Spergularia brevifolia	EX														0.1						5								
Spergularia sp.	EX																	0.1											
Sphaeromorphaea littoralis	FG																				5								

Species	GF code	Plots																											
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Sporobolus mitchellii	GG								0.1							0.2				0.5		0.1			0.1				
Stemodia florulenta	FG																					0.1							
Stenopetalum spp.	FG																	0.1										0.1	
Swainsona greyana	FG	5																											
Swainsona swainsonioides	FG								0.5																				
Tetragonia tetragonioides	FG	0.1	5	0.1	0.1	0.1	0.1	20		0.1	0.2					1	0.1						0.1	0.5	0.1				
Teucrium racemosum	FG	1	0.1				0.1			0.1														0.1					
Verbena africana	EX															0.1													
Verbena officinalis	EX			0.1														0.1		0.1	0.1	0.1							
Verbena supina	EX																			0.1	0.1								
Vicia sp.	EX														0.5		0.2	5	5			0.2							
Vittadinia cervicularis var. *cervicularis*	FG	0.1					0.1																						
Vittadinia cuneata	FG															0.1													0.1
Wahlenbergia fluminalis	FG	0.1		0.1										0.1		0.1		0.1		0.1		0.1							
Wahlenbergia spp.	FG									0.1													0.1		0.1		0.1		
Walwhalleya proluta	GG					0.1																							
Xanthium occidentale	EX			0.2										0.1	1		5	4	20			0.5							
Xerochrysum bracteatum	FG	0.1																											

Appendix C. Vegetation integrity assessment plot data

Table C-1 Vegetation integrity assessment plot data

Veg zone	Plot	PCT ID	Area (ha)	Patch size	Condition class	Zone	Easting	Northing	Bearing	No. tree species	No. shrub species	No. grass species	No. forb species	No. fern species	No. other species	Tree cover (%)	Shrub cover (%)	Grass cover (%)	Forb cover (%)	Fern cover (%)	Other cover (%)	No. Large Trees	No. Hollow trees	Average Litter Cover (%)	Length Fallen Logs (m)	Tree Stem 5-10cm	Tree Stem 10-20cm	Tree Stem 20-30cm	Tree Stem 30-50cm	Tree Stem 50-80cm	Tree Regeneration?	High Threat Exotic cover
1	Plot1	36	5.00	100	Good	54	725310.14	6503714.1	124	3	5	2	16	0	0	36.0	13.2	4.1	14.2	0	0	9	5	0.9	8.0	1	1	1	1	1	1	0
3	Plot2	39	5.00	100	Good	54	725334.6	6503781.4	148	2	8	2	18	0	0	10.1	21.6	0.3	7.2	0.0	0.0	2	1	0.8	0.0	0	1	1	1	0	1	0.5
2	Plot3	36	5.00	100	Low	54	725337.47	6503658.9	298	1	0	4	11	0	0	5.0	0.0	25.4	23.3	0.0	0.0	0	0	0.1	27.0	0	0	0	0	0	0	0.0
4	Plot4	39	5.00	100	Low	54	725417.46	6503660.7	100	0	4	3	11	0	0	0.0	20.2	0.7	3.8	0.0	0.0	0	0	0.1	5.0	0	0	1	0	0	0	0.6
4	Plot5	39	5.00	100	Low	54	725449.98	6503688.7	110	0	6	3	8	0	0	0.0	25.4	0.4	1.2	0.0	0.0	0	0	0.1	0.0	0	0	0	0	0	0	1.5
3	Plot6	39	5.00	100	Good	54	725450.95	6503757.5	6	1	7	1	15	0	1	10.0	19.6	0.5	2.8	0.0	0.1	2	1	0.4	0.0	1	0	0	0	0	1	1.5
1	Plot7	36	5.00	100	Good	54	725145.045	6503738.3	117	2	6	4	10	0	0	51.0	1.7	0.5	29.6	0.0	0.0	7	2	1.0	28.0	1	1	0	0	0	1	0.0
7	Plot8	158	5.00	100	Low	54	725080.98	6503574.4	140	0	10	3	10	0	0	0.0	31.0	0.3	1.4	0.0	0.0	0	0	0.1	0.0	0	0	0	0	0	0	1.1
3	Plot9	39	5.00	100	Good	54	725152.94	6503659.2	157	2	7	5	16	0	0	2.1	18.9	0.5	1.6	0.0	0.0	1	1	0.3	3.0	0	0	0	0	0	1	5.0
3	Plot10	39	5.00	100	Good	54	725206.73	6503559.5	40	2	11	1	5	0	0	42.0	13.8	0.1	0.6	0.0	0.0	2	1	0.4	4.0	1	0	0	1	0	1	2.0
6	Plot11	158	5.00	100	Good	54	727053.04	6502695.0	263	0	6	3	6	0	0	0.0	26.0	0.3	0.7	0.0	0.0	0	0	0.1	0.0	0	0	0	0	0	0	0.1

Veg zone	Plot	PCT ID	Area (ha)	Patch size	Condition class	Zone	Easting	Northing	Bearing	No. tree species	No. shrub species	No. grass species	No. forb species	No. fern species	No. other species	Tree cover (%)	Shrub cover (%)	Grass cover (%)	Forb cover (%)	Fern cover (%)	Other cover (%)	No. Large Trees	No. Hollow trees	Average Litter Cover (%)	Length Fallen Logs (m)	Tree Stem 5-10cm	Tree Stem 10-20cm	Tree Stem 20-30cm	Tree Stem 30-50cm	Tree Stem 50-80cm	Tree Regeneration?	High Threat Exotic cover
7	Plot12	158	5.00	100	Low	54	726312.78	6502713.9	242	0	4	2	6	0	0	0.0	13.4	0.2	3.5	0.0	0.0	0	0	0.1	0.0	0	0	0	0	0	0	0.0
1	Plot13	36	5.00	100	Good	54	725226.37	6503660.5	123	2	8	3	9	0	0	31.0	23.9	3.1	8.0	0.0	0.0	3	3	1.0	5.0	1	1	0	0	0	1	0.0
2	Plot14	36	5.00	100	Low	54	726217.04	6506147.8	244	0	0	5	4	0	0	0.0	0.0	18.2	0.8	0.0	0.0	0	0	0.0	0.0	0	0	0	0	0	0	0.0
1	Plot15	36	5.00	100	Good	54	726241.8	6506076.7	105	2	8	3	13	1	1	12.0	6.0	4.3	4.3	0.5	0.3	3	1	0.8	3.0	1	1	1	1	0	0	0.1
2	Plot16	36	5.00	100	Low	54	726118.63	6506097.6	77	0	0	4	8	0	0	0.0	0.0	0.6	46.1	0.0	0.0	0	0	0.0	0.0	0	0	0	0	0	0	0.0
2	Plot17	36	5.00	100	Low	54	725666.00	6505751.3	204	1	0	3	6	0	0	0.2	0.0	30.1	1.0	0.0	0.0	0	0	0.0	0.0	0	0	0	0	0	1	0.0
2	Plot18	36	5.00	100	Low	54	725717.35	6504506.6	143	0	0	2	6	0	0	0.0	0.0	20.1	2.9	0.0	0.0	0	0	0.0	0.0	0	0	0	0	0	0	0.0
2	Plot19	36	5.00	100	Low	54	725842.49	6503942.3	162	1	0	5	9	0	1	0.1	0.0	4.1	33.5	0.0	1.0	0	0	0.2	2.0	0	0	0	0	0	1	0.0
2	Plot20	36	5.00	100	Low	54	752515.55	6517512.8	140	0	2	0	7	0	0	0.0	0.2	0.0	25.8	0.0	0.0	0	0	0.5	10.0	0	0	0	0	0	0	0.0
2	Plot21	36	5.00	100	Low	54	727945.56	6506693.8	333	1	0	3	10	0	0	3.0	0.0	21.1	2.4	0.0	0.0	0	0	0.0	0.0	0	0	0	0	0	1	0.0
5	Plot22	39	5.00	100	Disturbed	54	725562.9	6503741.8	327	1	8	2	12	0	0	3.0	38.4	2.5	12.0	0.0	0.0	0	0	0.2	0.0	0	0	0	0	0	0	0.1
n/a	Plot23	247	5.00	100	Disturbed	54	725335.3	6504320.3	337	1	7	2	7	0	0	0.1	20.8	3.2	5.3	0.0	0.0	0	0	0.2	0.0	0	0	0	0	0	0	0.5
n/a	Plot24	247	5.00	100	Moderate	54	725232.10	6504405.6	282	2	5	2	12	0	0	5.5	51.8	1.1	1.7	0.0	0.0	1	1	0.4	0.0	0	0	0	0	0	1	0.6

Veg zone	Plot	PCT ID	Area (ha)	Patch size	Condition class	Zone	Easting	Northing	Bearing	No. tree species	No. shrub species	No. grass species	No. forb species	No. fern species	No. other species	Tree cover (%)	Shrub cover (%)	Grass cover (%)	Forb cover (%)	Fern cover (%)	Other cover (%)	No. Large Trees	No. Hollow trees	Average Litter Cover (%)	Length Fallen Logs (m)	Tree Stem 5-10cm	Tree Stem 10-20cm	Tree Stem 20-30cm	Tree Stem 30-50cm	Tree Stem 50-80cm	Tree Regeneration?	High Threat Exotic cover
8	Plot25	158	5.00	100	Very_Poor	54	726436.62	6502774.8	80	0	5	1	1	0	0	0.0	1.7	0.1	0.1	0.0	0.0	0	0	0.0	0.0	0	0	0	0	0	0	0.1
n/a	Plot26	38	5.00	100	Good	54	724927.2	6505130.0	204	1	10	3	9	0	1	5.0	16.0	2.2	2.8	0.0	0.1	0	2	0.3	0.0	0	0	0	1	2	0	0.2
n/a	Plot27	153	5.00	100	Moderate	54	724789.05	6504964.7	227	0	14	4	8	0	1	0.0	9.6	2.5	6.4	0.0	0.1	0	0	0.1	0.0	0	0	0	0	0	0	0.5
8	Plot28	158	5.00	100	Disturbed	54	725109.5	6504890.8	144	0	5	4	10	0	0	0.0	12.6	0.4	2.1	0.0	0.0	0	0	0.0	0.0	0	0	0	0	0	0	0.4

Appendix D. EPBC Act significance assessments

For threatened biodiversity listed under the EPBC Act, significance assessments have been completed in accordance with the EPBC Act Policy Statement 1.1 Significant Impact Guidelines (Department of Environment, 2013). Whether or not an action is likely to have a significant impact depends upon the sensitivity, value, and quality of the environment that is affected, and upon the intensity, duration, magnitude and geographic extent of the impacts (Department of Environment, 2013).

Importantly, for a 'significant impact' to be 'likely', it is not necessary for a significant impact to have a greater than 50 per cent chance of happening; it is sufficient if a significant impact on the environment is a real or not remote chance or possibility (Department of Environment, 2013). This advice has been considered while undertaking the assessments.

An assessment of significance test has been undertaken for the threatened ecological community Coolibah – Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions (listed as endangered under the EPBC Act). An assessment of significance test has also been undertaken for the following species:

- Australasian Bittern (*Botaurus poiciloptilus*) endangered species
- Australian Painted Snipe (*Rostratula australis*) endangered species
- Grey Falcon (*Falco hypoleucos*) vulnerable species
- Koala (*Phascolarctos cinereus*) (combined populations of Queensland, NSW and the Australian Capital Territory) vulnerable species
- Squatter Pigeon (southern population) (*Geophaps scripta scripta*) vulnerable species.

No threatened plants or animals listed under the EPBC Act were identified during surveys or are they expected to occur based on the presence of suitable habitat.

When assessing vulnerable species, the assessment centres around whether the population that would be impacted is an 'important population' or not. An 'important population' is a population that is necessary for a species' long-term survival and recovery (Department of Environment, 2013). This may include populations identified as such in recovery plans, and/or that are:

- Key source populations either for breeding or dispersal
- Populations that are necessary for maintaining genetic diversity, and/or
- Populations that are near the limit of the species range.

This definition of what constitutes an 'important population' has guided the assessments for vulnerable species.

D.1 Coolibah – Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions

The Commonwealth listing advice for the Coolibah – Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions TEC (listed as endangered under the EPBC Act), describes this community as representing occurrences of one type of semi-arid to humid subtropical woodland where *Eucalyptus coolabah* subsp. *coolabah* (Coolibah) and/or *Eucalyptus largiflorens* (Black Box) are the dominant canopy species and where the understorey tends to be grassy (TSSC, 2011). The ecological community is associated with the floodplains and drainage areas of the Darling Riverine Plains and the Brigalow Belt South bioregions.

The vegetative community provides characteristic habitat features of value to particular fauna, including a grassy understorey with scattered fallen logs, areas of deep-cracking clay soils, patches of thick regenerating

Eucalyptus saplings, and large trees containing a diverse bark and foliage foraging resource and an abundance of small and large hollows. The fertile and relatively mesic environment of these woodlands provides essential resources for the persistence of fauna in the semi-arid region, supports a wide range of declining woodland birds and provides important nesting sites for colonial breeding waterbirds.

Within the development site, the Coolibah – Black Box Woodlands TEC corresponds to the occurrence of vegetation zone 3 and is shown in **Figure 5-2**.

An action is likely to have a significant impact on a critically endangered or endangered ecological community if there is a real chance or possibility that it will:

1. reduce the extent of an ecological community

About 26,000 km^2 to 29,700 km^2 of Coolibah – Black Box Woodlands were estimated to have occurred in the NSW part of the Darling Riverine Plains and Brigalow Belt South bioregions at the time of European settlement. Based on analyses of aerial photographs, satellite imagery and cropping maps throughout the same region Keith et al. (2009) estimated that no more than 10,300 km^2 to 12,500 km^2 of the community remained with woody vegetation cover in 2007, representing an overall 61 per cent reduction in the distribution of the community (NSW Scientific Committee, 2019).

Based on the estimated direct impact area, the proposal would result in the direct clearing of about 1.94 hectares of the endangered ecological community in moderate condition (VI = 57.9) to allow for construction and operation of the weir. A total 282 hectares of PCT39 in different condition states was mapped just in the immediate the study area.

While there will be a decrease in the extent of the Coolibah – Black Box Woodlands TEC at the site, the loss is considered negligible in the context of the occurrence of the vegetation community throughout its broader locality and the moderate condition of the vegetation to be removed.

2. fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines

Coolibah – Black Box Woodlands were formerly extensive over the floodplains of the Darling Riverine Plains and Brigalow Belt South bioregions. However, the ecological community is now becoming more fragmented, particularly in the central and eastern parts of its distribution (Keith et al., 2009). Data from northern and southern subregions of this community in NSW demonstrate that, between the 1980s and 2004, the community became more fragmented as the number of patches of the community more than doubled and their median size declined by more than 80 per cent (Keith et al., 2009). The same pattern is also evident in the western part of the distribution in NSW, although not to the same extent. This decline in median patch sizes (to 60 hectares) of the ecological community in NSW demonstrates that a high proportion of patches of the ecological community are less than 100 hectares in size and this trend is likely to continue without intervention (TSSC, 2011).

The direct impacts to this TEC as a result of the proposal are limited to small patches within the floodplain. The proposal will not break apart any large contiguous blocks of this TEC. The proposal will not fragment or increase fragmentation of the Coolibah – Black Box Woodlands TEC.

3. adversely affect habitat critical to the survival of an ecological community

The patches of the Coolibah – Black Box Woodlands TEC to be impacted by the action are relatively large and although modified by human activity, are in moderate condition (as determined by floristic plots – VI = 57.9). Existing habitat, where this community occurs, will be cleared for construction and operation of the proposal. This will result in the direct removal of about 1.94 hectares. While there will be a decrease in the extent of the Coolibah – Black Box Woodlands TEC, the impact would be minimal in the context of the occurrence within the locality and this relatively small area is not consierred critical the survival of the community.

4. 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

Where the TEC will be removed by the proposal, all abiotic factors (water, nutrients and soil) will be permanently modified and/or destroyed through vegetation removal and construction of infrastructure. The proposal may also modify abiotic factors of retained vegetation based on the proximity of its operations, though these modifications are likely to be very minor. The small area to be impacted will not results in permanent changes to the surrounding soil and nutrients that would negatively affect the presence of remaining areas.

The groundwater assessment report has not assessed any changes in the downstream groundwater levels associated with reduced cease-to-flow events and therefore fewer opportunities to recharge the shallow aquifer in floodplain areas adjacent to the river downstream from the weir. The proposed translucency rules will result in downstream flows greater than 30 MLD and greater than 350 MLD being greater than the base case. The data for downstream flows greater than 1400 MLD is little changed between the base case and the proposal. These data indicate when water is released from the weir, the frequency of large volumes being released will be greater than the base case, and this is related to the greater volumes of water being stored than the existing weir. The larger volumes may result in recharge of the shallow aquifer and avoid impacts to GDEs; however, this is uncertain.

There will be no reduction in groundwater levels, rather a potential increase. The impact of the changed flow regimes on the condition of the surrounding GDEs downstream of the weir is difficult to predict and uncertain. Further monitoring will be conducted in line with adaptive management plan, to determine in the future if there is a negative impact.

5. 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

The structure and composition varies depending on topography and flooding or disturbance history. The Coolibah – Black Box Woodlands are found on the grey, self-mulching clays of periodically waterlogged floodplains, swamp margins, ephemeral wetlands, and stream levees (NSW Scientific Committee, 2019). The landscape has a flat to low relief where small changes in slope and height can influence the species composition (Department of Sustainability, Environment, Water, Population and Communities, 2011).

The composition of the TEC is likely to be modified as a result of the proposal through weed invasion and the removal of vegetation. The patches of TEC are in good condition and a reduction in ecological function can be expected from the proposal in the form of:

- Altered community structure
- Altered species composition
- Disruption of ecological processes (altered drainage)
- Invasion and establishment of exotic species
- Degradation of habitat
- Fragmentation of habitat.

Reduction in ecological function of Coolibah – Black Box Woodland TEC due to habitat fragmentation is associated with land clearing activities (Department of Planning, Industry and Environment, 2019). The extent to which species composition will be altered by the proposal cannot be predicted. Functionally important species such as pollinators may be prevented from accessing newly created fragments of the TEC. Fauna connectivity will only be marginally impacted, as the total area of vegetation proposed to be cleared is

divided between both the northern and southern sides of the river, both of which maintain connectivity to existing TEC vegetation.

Weed invasion will encroach into the newly created fragments from the new habitat edge and weed species, particularly grasses, will replace functionally important native groundcover species. Though, species composition in the patches of the TEC is considered minimal as the development site is already altered by weed invasion from past disturbance. The proposal is not considered likely to cause any further substantial change in species composition.

6. 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

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

Weed introduction and spread and the infection of native plants by *Phytophthora cinnamomi* have been identified as being spread by construction machinery. *Phytophthora* infects the roots of plants and has the potential to cause dieback. Machinery associated with vegetation clearance and subsequent construction for the proposal has the potential to introduce and transmit weed propagules and *Phytophthora* to remaining native vegetation remnants. This is a potential indirect impact through the spread and transmission of weeds and pathogens into retained habitat near the road.

This can be mitigated through the implementation of suitable control measures for vehicle and plant hygiene. Mitigation measures will be included as part of the CEMP to prevent the introduction or spread of weeds and pathogens. The proposal mitigation strategy and environmental management procedures would include guidance for preventing the introduction and/or spread of weeds and disease-causing agents such as bacteria and fungi.

Considering the current disturbance of vegetation within the development site, the proposal is unlikely to cause a substantial reduction in the quality or integrity of the occurrence of this TEC.

7. interfere with the recovery of an ecological community

A national recovery plan for the TEC has not been prepared, however is required. The recovery of the ecological community is complex, due to the need for a highly adaptive management process and high levels of planning, cross-jurisdictional co-ordination, co-ordination between managers and support by key stakeholders.

The main threats to this TEC and the priority actions required to address them are largely understood. The Conservation Advice sufficiently outlines the priority actions needed for this TEC and many of the threats affecting the TEC are best managed at a landscape scale, coordinated with management of other TECs.

Conclusion

In summary, the proposal is considered unlikely to have an adverse effect on the extent of the Coolibah – Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions TEC. The proposal would not significantly impact on the local occurrence of the community. No significant fragmentation or appreciable increase in isolation of habitat will occur as a result of the proposal. The highest quality vegetation in the development site would largely be avoided through design. The proposal is considered unlikely to substantially and adversely modify the composition of this TEC as the current composition has already been modified. Considering the minor extent of the proposed disturbance, the overall conclusion is that the proposal is unlikely to result in a significant impact to this TEC.

D.2 Australasian Bittern (*Botaurus poiciloptilus*) Endangered species

The Australasian Bittern (*Botaurus poiciloptilus*) is an endangered species in NSW and across Australia. It is estimated that there are less than 1,600 adults left in NSW, and the population is likely declining (NSW Scientific Committee, 2019a). The Australasian bittern is generally solitary, but sometimes occurs in pairs or dispersed aggregations of up to 12 birds. The Australasian Bittern occurs mainly in freshwater wetlands and, rarely, in estuaries or tidal wetlands. It favours wetlands with tall dense vegetation, where it forages in still, shallow water up to 0.3 metres deep, often at the edges of pools or waterways, or from platforms or mats of vegetation over deep water. It favours permanent and seasonal freshwater habitats, particularly those dominated by sedges, rushes and reeds (*Phragmites, Cyperus, Eleocharis, Juncus, Typha, Baumea, Bolboschoenus*) or cutting grass (*Gahnia*) growing over a muddy or peaty substrate.

The Australasian Bittern is considered to potentially use habitat within the development site and associated with the good condition River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion (PCT 36) and the good condition Coolabah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion (PCT 39). The total impacts to PCT 36 and PCT 39 are minor and estimated at 2.84 hectares. This species may utilise the habitat within the development site on occasion; however, there are no permanent freshwater wetlands in the study area and the Darling River (Baaka) did not contain any area of tall and dense vegetation.

An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

1. lead to a long-term decrease in the size of a population

The Australasian Bittern is dependent on tall densely vegetated wetlands and creeks and has adapted to using modified or degraded wetlands including artificially constructed environments. It is estimated that there are less than 1,600 adults remaining in NSW and in recent decades. The Australasian Bittern is believed to have undergone a reduction in population size in NSW, based on comparative evidence from broadscale surveys (NSW Scientific Committee, 2019a). However, nesting locations for the species are not published and their location in relation to the study area is not known.

Indirect impacts as a result of the proposal would be associated with edge effects, light, and noise, these would be localised in relation to home range and territory. The number of individuals or pairs potentially affected is not known, however the small areas of PCT 36 and PCT 39 in the direct impact area (2.84 hectares) is minor in relation to the habitat and home range requirements of the species. There are considerably larger wetland habitats in the broader study area, including Lignum shrubland wetland on regularly flooded alluvial depressions in the Brigalow Belt South Bioregion and Darling Riverine Plains Bioregion (PCT 247), that are likely better provide for the life-cycle requirements of this species. The small size of the PCTs in the development site suggests that any use of this habitat would only be temporary, and the habitat is too small to support the ongoing life cycle needs for this large species.

2. reduce the area of occupancy of the species

The Australasian Bittern is widespread but uncommon over south-eastern Australia. In NSW they may be found over most of the state except for the far north-west. Australasian Bittern favour permanent freshwater wetlands and riparian vegetation with tall, dense vegetation, particularly bulrushes (*Typha* spp.) and spike rushes (*Eleocharis* spp.).

The area of occupancy of the Australasian Bittern in Australia is thought to have declined by 70 per cent between 1977 and 2008 and is estimated to be between 600 and 800 km^2 in NSW (TSSC, 2019). These declines are considered to have led to a comparable decline in the size of the adult population. The declines are primarily linked to the clearing or modification of wetlands for urban and agricultural development, as well as the extraction of water from wetlands for irrigation (TSSC, 2011a).

The proposal would result in a direct impact to about 2.84 hectares of potential habitat for the Australasian Bittern, comprised of good quality PCT 36 and PCT 39. The proposed impact would be minor and not considered significant to the area of occupancy of this species.

The review of habitat availability and records of this species suggest that potential habitat is widespread throughout NSW and to the south of the study area, including dense vegetation on the margins of freshwater creeks, rivers and natural or artificial wetlands.

3. fragment an existing population into two or more populations

In NSW, it is estimated that from 30 per cent to as much as 90 per cent of coastal freshwater wetlands have been destroyed, with much of the remainder fragmented, degraded and under continuing threat (NSW Scientific Committee, 2019a).

The proposal would not result in isolation of remnant vegetation patches and would not create barriers to the movement of this species on either a patch or landscape scale. The actual development site is largely already cleared for historic industrial purposes and does not contain large areas of habitat for this species. The direct removal of vegetation will include new and upgraded all weather access tracks leading to the development site for construction and operational maintenance, and removal of a narrow area of riparian vegetation on each bank and adjoining small areas of vegetation adjacent to the bank. A small recreation area and car park of about 0.7 hectares will be established on the north bank of the weir, and this has been sensitively designed to avoid removal of existing trees, particularly large mature trees. The final stage of the proposal will involve access to and partial removal and decommissioning of the upstream existing weir, this will involve minimal disturbance due to the plan to use an existing access road from the south bank with a short extension. The impacts which would occur as a result of the proposal would be minor and would not contribute further to fragmentation.

There is limited data on the distribution of local and regional populations to identify if a population would be fragmented, however potential habitat would be traversed. This species is capable of dispersing across fragmented habitats including easements and cleared land.

4. adversely affect habitat critical to the survival of a species

The proposal would result in the direct impact to about 2.84 hectares of potential foraging habitat for the Australasian Bittern. Given that the Australasian Bittern is presumed to have undergone a severe reduction in numbers, based on historic habitat loss and degradation across the core part of its range, all-natural habitat (including constructed wetlands with suitable habitat) in which the Australasian Bittern is known or likely to occur should be considered critical to the survival of the species (TSSC, 2019). However, the habitat within the development site is already currently disturbed and this small area of marginal habitat is unlikely to be critical for any resident birds in this locality or provide critical habitat for new birds to establish a territory.

There are considerably larger wetland habitats in the broader study area, including PCT 247. It is assumed that these habitats have potential to contribute to the long-term maintenance of the species including maintaining genetic diversity and the long-term evolutionary development of the species. However, these habitats would not be impacted by the proposal.

5. disrupt the breeding cycle of a population

The proposal would result in a minor impact on potential foraging habitat for the Australasian Bittern, however, the development site shows no evidence or records of this species. Measures to minimise impacts on waterways during construction would be implemented as part of the construction environmental management plan.

6. modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

Owing to the small total number of Australasian Bitterns and the significant observed declines in both total numbers and the species' extent of occurrence (Garnett et al. 2011), all populations should be considered important (TSSC, 2019).

Although there is no known species recorded of the Australasian Bittern within the development site, impacts would result in a decrease in potential habitat including about 2.84 hectares consisting of PCT 36 and PCT 39. Considerably larger areas of suitable habitat occur widely throughout the broader study area. The potential impact from the proposal is not expected to lead to a decline in the species in this region.

7. result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat

The potential for weed invasion is considered possible as a result of the proposal and appropriate controls would be required during construction and operation of the weir to reduce this threat. Invasive species would be managed during construction under a CEMP and under normal site maintenance during operation. Invasive plant species would generally be managed as a first priority before construction commences to reduce the likelihood of their spread.

8. introduce disease that may cause the species to decline, or

Infection of native plants by *Phytophthora cinnamomi* has been identified as being spread by construction machinery. This water-borne fungus infects the roots of plants and has the potential to cause dieback. Machinery associated with vegetation clearance and subsequent construction for the proposal has the potential to transmit the fungus to remaining native vegetation remnants of the species. This is a potential indirect impact to the species through the transmission of pathogens into retained habitat next to the development site. This can be mitigated through the development and implementation of suitable control measures for vehicle and plant hygiene and is unlikely to have a significant impact. The proposal's environmental management procedures would include guidance for preventing the introduction and/or spread of disease-causing agents such as bacteria and fungi.

9. interfere with the recovery of the species.

The Draft National Recovery Plan for the Australasian Bittern (*Botaurus poicilioptilus*) (Department of the Environment and Energy, 2019a) outlines the following priorities:

- Taking prompt action is necessary in order to mitigate the key threats to Australasian Bittern and also provide valuable information to help identify long-term population trends
- Action would provide a more informed basis for the long-term management and recovery of Australasian Bittern
- Action is desirable, but not critical to the recovery of Australasian Bittern or assessment of trends in that recovery.

The proposal would not conflict with the recovery of this species. The development site has been selected on the basis of avoiding high quality habitats for threatened fauna, and mitigation and offset measures would target threatened fauna. There are no priority sites for conservation of this species within the development site boundary.

Conclusion

The Australasian Bittern would experience a small reduction in potential habitat consisting of PCT 36 and PCT 39, totalling about 2.84 hectares, as a result of the proposal. Further, potential habitat exists within the broader study area consisting of PCT 247, however, this habitat would not be impacted. The proposal is

considered unlikely to reduce the population size of the Australasian Bittern or decrease its reproductive success. The proposal would not interfere with the recovery of the Australasian Bittern and would not contribute to the key threats to this species. After consideration of the factors above, the overall conclusion is made that the proposal is unlikely to result in a significant impact to the Australasian Bittern. The impact to Australasian Bittern habitat from the proposal is not considered to be of significance, having regard to its context and intensity.

D.3 Australian Painted Snipe (*Rostratula australis*) Endangered species

The Australian Painted Snipe (*Rostratula australis*) prefers fringes of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber. They nest on the ground amongst tall vegetation, such as grasses, tussocks or reeds. Breeding is often in response to local conditions; generally occurring from September to December and foraging occurs nocturnally on mud-flats and in shallow water.

The movements of the Australian Painted Snipe are poorly known, and it may be a migratory species. Sightings of individuals are erratic, and it is thought the species is likely to be nomadic in response to suitable conditions, such as floods.

The Australian Painted Snipe is considered to potentially use habitat within the development site and associated with the good condition River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion (PCT 36) and the good condition Coolabah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion (PCT 39). The total impacts to PCT 36 and PCT 39 are minor and estimated at 2.84 hectares. This species may utilise the habitat within the development site on occasion; however, there are no permanent freshwater wetlands in the study area and the Darling River (Baaka) did not contain any area of tall and dense vegetation. Given the highly ephemeral nature of food and habitat resources, it is likely that existing resources within the development site would be utilised infrequently and on a transitory basis only.

An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will:

1. lead to a long-term decrease in the size of a population

The Australian Painted Snipe is inferred to have undergone a severe decline in the number of mature individuals since the 1950's and specifically over the last three generations (~26 years) due to the loss and degradation of its wetland habitat (Department of the Environment and Energy, 2019b). The likely causes of the decline of the Australian Painted Snipe are habitat modification and loss. The species has probably suffered considerably from wetland drainage and the diversion of water from rivers, which means that shallow wetlands, its key habitat, never form. Major water resource developments in the northern Murray-Darling Basin from the 1960s-1990s have coincided with a decline in Australian Painted Snipe numbers (Lane and Rogers, 2000).

Indirect impacts as a result of the proposal would be associated with edge effects, light, and noise, these would be localised in relation to home range and territory. The number of individuals or pairs potentially affected is not known, however the small areas of PCT 36 and PCT 39 to be impacted by the proposal (2.84 hectares) is minor in relation to the habitat and home range requirements of the species. There are considerably larger wetland habitats in the broader study area, including Lignum shrubland wetland on regularly flooded alluvial depressions in the Brigalow Belt South Bioregion and Darling Riverine Plains Bioregion (PCT 247), that are likely better provide for the life-cycle requirements of this species. The small size of the PCTs in the development site suggests that any use of this habitat would only be temporary, and the habitat is too small to support the ongoing life cycle needs for this large species. The proposal will not substantially change the hydrological conditions of the wetlands within and surrounding the development site and only minimal vegetation clearing is required. Therefore, it is unlikely to lead to a long-term decrease in the size of a population.

2. reduce the area of occupancy of the species

The species' area of occupancy was estimated by Garnett et al. (2011) to be 2,000 km^2 and decreasing. The area of occupancy has undoubtedly declined as about 50 per cent of wetlands in Australia have been removed since European settlement.

The Australian Painted Snipe has a historical distribution through most of Australia including some desert regions, but the Murray-Darling Basin, particularly the Riverina region of Victoria and NSW, appears to have been a stronghold for the species (Blakers et al. 1984). Due to the highly secretive behaviour and concealing habitats commonly used, the specific habitat requirements of the Australian Painted Snipe are much less well known than for most other Australian waterbirds. The species typically inhabits shallow freshwater and brackish wetlands, especially where inundation is temporary but also permanent wetlands with shallow zones.

The proposal would result in a direct impact to 2.84 hectares of potential habitat for the Australian Painted Snipe, comprised of good quality PCT 36 and PCT 39. The proposed impact would be minor and not considered significant to the area of occupancy of this species.

The review of habitat availability and records of this species suggest that potential habitat is widespread throughout NSW and to the south of the study area, including dense vegetation on the margins of freshwater creeks, rivers and natural or artificial wetlands.

3. fragment an existing population into two or more populations

Drainage has had an impact on wetlands, with some regions being more affected than others. For instance, 89 per cent of wetlands in south-east South Australia have been lost (Department of the Environment and Energy, 2019b). Drainage of temporary wetlands across the landscape has also resulted in fragmentation of suitable habitat. Consequently, the Australian Painted Snipe may now have to travel larger distances between wetlands and expend more energy more often in order to obtain adequate food and shelter that is productive enough for breeding. The degradation of remaining wetlands further 'fragments' the pattern of suitable habitat (Department of the Environment and Energy, 2019b).

The proposal would not result in isolation of remnant vegetation patches and would not create barriers to the movement of this species on either a patch or landscape scale. The development site is largely already currently cleared for historic purposes and does not contain large areas of habitat for this species. The direct removal of vegetation will include access tracks and removal of a narrow area of riparian vegetation on each bank and adjoining small areas of vegetation adjacent to the bank. A small recreation area and car park of about 0.7 hectares will be established on the north bank of the weir, avoiding the removal of existing trees. The impacts which would occur as a result of the proposal would be minor and would not contribute further to fragmentation. The proposal is considered unlikely to result in the creation of barriers to movement to, between or within habitat and is therefore unlikely to fragment an existing population into two or more populations.

There is limited data on the distribution of local and regional populations to identify if a population would be fragmented, however potential habitat would be traversed. This species is capable of dispersing across fragmented habitats including easements and cleared land.

4. adversely affect habitat critical to the survival of a species

Due to relatively scarce records and unpredictable movements, very little is known about the specific habitat requirements of the Australian Painted Snipe. The Australian Painted Snipe generally inhabits shallow terrestrial freshwater wetlands, including temporary and permanent lakes, swamps and claypans. They also use inundated or waterlogged grassland or saltmarsh, dams, rice crops, sewage farms and bore drains (Department of the Environment and Energy, 2019b). Australian Painted Snipe breeding habitat requirements may be quite specific: shallow wetlands with areas of bare wet mud and mixed heights of low

vegetation. Nest records are all, or nearly all, from or near small islands in freshwater wetlands, with a combination of very shallow water, exposed mud, dense low cover and sometimes some tall dense cover (Rogers et al. 2005).

As a guide, habitat critical to the survival of the Australian Painted Snipe can be considered to include (Department of the Environment and Energy, 2019b):

- Any habitat where the species is known or likely to occur (especially with suitable breeding habitat) within the indicative distribution map.
- Any location outside the above area that may be periodically occupied by Australian Painted Snipe when conditions are favourable.

The proposal would result in the direct impact to about 2.84 hectares of potential foraging habitat for the Australian Painted Snipe. However, the habitat within the development site is already currently disturbed and this small area of marginal habitat is unlikely to be critical for any resident birds in this locality or provide critical habitat for new birds to establish a territory. Given the highly ephemeral nature of food and habitat resources, it is likely that existing resources within the development site would be utilised infrequently and on a transitory basis only. Therefore, the proposal is unlikely to adversely affect habitat critical to the survival of a species.

There are considerably larger wetland habitats in the broader study area, including PCT 247. It is assumed that these habitats have potential to contribute to the long-term maintenance of the species including maintaining genetic diversity and the long-term evolutionary development of the species. However, these habitats would not be impacted by the proposal.

5. disrupt the breeding cycle of a population

The Australian Painted Snipe may breed in response to wetland conditions rather than during a particular season. The proposal would result in a minor impact on potential foraging habitat for the Australian Painted Snipe, however, the study area shows only one record of this species. Related impacts such as removal of vegetation and access by vehicles may impact on local breeding cycles or individual pairs; however, this is unlikely to disrupt the breeding cycle of a population. Measures to minimise impacts on waterways during construction would be implemented as part of the CEMP.

6. modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

Loss and degradation of wetlands, through drainage and the diversion of water for agriculture and reservoirs, are thought to have contributed most to this decline. Over-grazing, drought and reduced rainfall are also contributing factors that have adversely affected the species across its range (Department of the Environment and Energy, 2019b).

Impacts from the proposal would result in a decrease in potential habitat including approximately 2.84 hectares of PCT 36 and PCT 39. Considerably larger areas of suitable habitat occur widely throughout the broader study area. Therefore, the potential impact from the proposal is not expected to lead to a decline in the species in this region. Additionally, appropriate erosion and sediment control measures will be installed and maintained. Therefore, it is unlikely that the proposal will modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

7. result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat

The potential for weed invasion is considered possible as a result of the proposal and appropriate controls would be required during construction and operation of the weir to reduce this threat. Invasive species would

be managed during construction under a CEMP and under normal site maintenance during operation. Invasive plant species would generally be managed as a first priority before construction commences to reduce the likelihood of their spread.

8. introduce disease that may cause the species to decline, or

Infection of native plants by *Phytophthora cinnamomi* has been identified as being spread by construction machinery. This water-borne fungus infects the roots of plants and has the potential to cause dieback. Machinery associated with vegetation clearance and subsequent construction for the proposal has the potential to transmit the fungus to remaining native vegetation remnants of the species. This is a potential indirect impact to the species through the transmission of pathogens into retained habitat next to the development site. This can be mitigated through the development and implementation of suitable control measures for vehicle and plant hygiene and is unlikely to have a significant impact. The proposal's environmental management procedures would include guidance for preventing the introduction and/or spread of disease-causing agents such as bacteria and fungi.

9. interfere with the recovery of the species.

The Draft National Recovery Plan for the Australian Painted Snipe (*Rostratula australis*) (Department of the Environment and Energy, 2019b) outlines the following priorities:

- Taking prompt action is necessary in order to mitigate the key threats to the Australian Painted Snipe and also provide valuable information to help identify long-term population trends
- Action would provide a more informed basis for the long-term management and recovery of the Australian Painted Snipe
- Action is desirable, but not critical to the recovery of Australian Painted Snipe or assessment of trends in that recovery.

The proposal would not conflict with the recovery of this species. The development site has been selected on the basis of avoiding high quality habitats for threatened fauna, and mitigation and offset measures would target threatened fauna. There are no priority sites for conservation of this species within the development site boundary.

Conclusion

The Australian Painted Snipe would experience a small reduction in potential habitat consisting of PCT 36 and PCT 39, totalling 2.84 hectares, as a result of the proposal. Further, potential habitat exists within the broader study area consisting of PCT 247, however, this habitat would not be impacted. The proposal is considered unlikely to reduce the population size of the Australasian Bittern or decrease its reproductive success. The proposal would not interfere with the recovery of the Australian Painted Snipe and would not contribute to the key threats to this species. After consideration of the factors above, the overall conclusion is made that the proposal is unlikely to result in a significant impact to the Australian Painted Snipe. The impact to Australian Painted Snipe habitat from the proposal is not considered to be of significant.

D.4 Grey Falcon (*Falco hypoleucos*)

The Grey Falcon is sparsely distributed in NSW, chiefly throughout the Murray-Darling Basin, with the occasional vagrant east of the Great Dividing Range. The breeding range has contracted since the 1950s with most breeding now confined to arid parts of the range. There are possibly less than 5000 individuals left. Population trends are unclear, though it is believed to be extinct in areas with more than 500mm rainfall in NSW (NSW Scientific Committee, 2009).

The Grey Falcon inhabits woodland, shrubland and grassland in the arid and semi-arid zones, especially wooded watercourses. Grey Falcons use standing dead trees as lookout posts. Woodland has been cleared

extensively in the sheep-wheat belt of NSW, and much of the Grey Falcon's habitat has been degraded by overgrazing (NSW Scientific Committee, 2009).

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

1. lead to a long-term decrease in the size of an important population of a species

Within NSW, the number of breeding Grey Falcons has been previously estimated, with low reliability, as 2,000 globally (NSW, Queensland, Victoria, South Australia, Northern Territory, Western Australia) of which fewer than one-quarter would occur in NSW; or fewer than 500 mature individuals on the basis of geographic range. The highest densities for the species in Australia occur in inland and northern Australia. The current population estimate in NSW is between 50 and 200 mature individuals. The species consists of a single population and is considered monotypic (NSW Scientific Committee, 2009).

The study area may provide approximately 10.14 hectares of suitable habitat for the Grey Falcon, consisting of all vegetation zones and may provide foraging habitat all year round. This species is usually restricted to shrubland, grassland and wooded watercourses of arid and semi-arid regions, which are present within the study area.

There were no Grey Falcons identified during the surveys, however there are multiple records for this species over the broader region. The Grey Falcon has been determined to have a moderate likelihood of occurring within the study area. However, this species is highly mobile and is unlikely to be impacted during construction. The removal of vegetation will only impact a small amount of suitable vegetation when the context of available vegetation within the broader region is taken into consideration. Therefore, it is unlikely that the proposal would lead to a long term decrease in the Grey Falcon national population.

2. reduce the area of occupancy of an important population

The extent of occurrence of the Grey Falcon is estimated at 6.1 million km^2, and the area of occupancy is estimated at 6,000 km^2 (TSSC, 2020). The proposal would result in a direct impact to approximately 10.14 hectares of potential habitat for the Grey Falcon, comprising of all vegetation types within the development site. The proposed impact would be minor and not considered significant, therefore, it is unlikely that the proposal will reduce the area of occupancy of an important population.

3. fragment an existing important population into two or more populations

As outlined by TSSC (2020), the Grey Falcon experiences habitat loss and fragmentation through grazing by exotic herbivores and nest shortages. Herbivores such as camels in arid and semi-arid areas are preventing the regeneration of suitable nesting trees, consequently reducing the abundance of prey (TSSC, 2020). Land clearing of the semi-arid zone and overgrazing of arid zone rangelands have been identified as possible threats to the availability of nesting trees (TSSC, 2020). Additional factors posing threats to the Grey Falcon consist of invasive species, climate change, demographic and genetic stochastic events, disturbance, direct mortality and harvesting (TSSC, 2020).

The Grey Falcon is a highly mobile and dispersive, with wintering in northern Australia and dispersal towards the coast during droughts. Population fragmentation is therefore considered unlikely (NSW Scientific Committee, 2009). Furthermore, there is no evidence of population fragmentation, although woodland habitat is increasingly fragmented on the inland slopes and plains (NSW Scientific Committee, 2009).

The proposal would not result in isolation of remnant vegetation patches and would not create barriers to the movement of the Grey Falcon on either a patch or landscape scale. The development site is largely already currently cleared for historic industrial purposes and does not contain large areas of habitat for this species. The impacts which would occur as a result of the proposal would be minor and would not contribute further to fragmentation for this species.

4. adversely affect habitat critical to the survival of a species

The Grey Falcon is likely to utilize all of the habitat types within the development site for hunting. Critical habitat for the survival of this species is not defined; however, the Grey Falcon inhabits woodland areas, particularly along wooded watercourses. The proposal would result in the direct impact to approximately 10.14 hectares of habitat suitable for the Grey Falcon. This is considered a marginal impact considering the available suitable habitat within the broader region. The habitat within the development site is already currently disturbed and this area of marginal habitat is unlikely to be critical for any resident birds in this locality or provide critical habitat for new birds to establish a territory. The proposal is therefore unlikely to adversely affect habitat critical to the survival of the species.

5. disrupt the breeding cycle of an important population

Recent research has shown that the Grey Falcon is a 'reluctant nomad' and that if conditions become unsuitable for breeding, these birds prefer to stay and forego breeding than to search for more favourable conditions (TSSC, 2020). The proposal would result in a minor impact on potential hunting habitat for the Grey Falcon, however, no species were recorded during surveys and the direct impact to suitable habitat is marginal compared to the habitat availability within the broader locality.

6. modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The current population estimate in NSW of the Grey Falcon is between 50 and 200 mature individuals. The main threats to the Grey Falcon are thought to be clearing of habitat in the semi-arid zone, and degradation of habitat in the arid and semi-arid zones by overgrazing, with likely effects on the Falcon's foraging habitat, nest sites and food supply (NSW Scientific Committee, 2009).

Although there were no species recorded during surveys, impacts would result in a decrease in potential habitat including approximately 10.14 hectares consisting of all habitat types within the development site. However, considerably larger areas of suitable habitat occur widely throughout the broader study area and locality. The potential impact from the proposal is not expected to lead to a decline in the species in this region.

7. result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

Grey Falcon chicks are vulnerable to cat and fox predation, where nests area accessible. However, there were no Grey Falcons recorded during the surveys undertaken and invasive species, such as the cat and fox are already established within the region.

Additionally, the potential for weed invasion is considered possible as a result of the proposal and appropriate controls would be required during construction and operation of the weir to reduce this threat. Invasive species would be managed during construction under a CEMP and under normal site maintenance during operation. Invasive plant species would generally be managed as a first priority before construction commences to reduce the likelihood of their spread.

8. introduce disease that may cause the species to decline, or

Infection of native plants by *Phytophthora cinnamomi* has been identified as being spread by construction machinery. This water-borne fungus infects the roots of plants and has the potential to cause dieback. Machinery associated with vegetation clearance and subsequent construction for the proposal has the potential to transmit the fungus to remaining native vegetation remnants of the species. This is a potential indirect impact to the species through the transmission of pathogens into retained habitat next to the development site. This can be mitigated through the implementation of suitable control measures for vehicle and plant hygiene and is unlikely to have a significant impact. The proposal's environmental management

procedures would include guidance for preventing the introduction and/or spread of disease-causing agents such as bacteria and fungi.

9. interfere substantially with the recovery of the species.

The Commonwealth Minister for the Environment has declared that that a national recovery plan for the Grey Falcon is not required. An approved Conservation Advice for the species provides sufficient direction to implement priority actions, mitigate against key threats and enable recovery. Management and research activities are being undertaken at state and local levels (TSSC, 2020). However, current threats to this species include loss and fragmentation of habitat due to clearing for agricultural purposes, the degradation of habitat by overgrazing by domesticated herbivores, the degradation of habitat by invasive weeds, climate change, demographic and genetic stochastic events, disturbance, direct mortality and harvesting.

While a small amount of clearing of suitable habitat may occur, the extent of habitat loss as a proportion of the habitat available within the region is small. In addition, the species is known to utilise a wide range of different habitats, minimising the impact of habitat clearing on the species. Given this, the proposal is unlikely to interfere with the recovery of the Grey Falcon.

The proposal would not conflict with the recovery of this species. The development site has been selected on the basis of avoiding high quality habitats for threatened fauna, and mitigation and offset measures would target threatened fauna. There are no priority sites for conservation of this species within the development site boundary.

Conclusion

The Grey Falcon would result in a small reduction of potential habitat consisting of all habitat types within the development site, totalling approximately 10.14 hectares, as a result of the proposal. The proposal is considered unlikely to reduce the population size of the Grey Falcon or decrease its reproductive success. The proposal would not interfere with the recovery of the Grey Falcon and would not contribute to the key threats to this species. After consideration of the factors above, the overall conclusion is made that the proposal is unlikely to result in a significant impact to the Grey Falcon.

D.5 Koala (*Phascolarctos cinereus*) Vulnerable species

The Koala (*Phascolarctos cinereus*) (combined populations of Queensland, NSW and the ACT) is listed as vulnerable under the EPBC Act. A key consideration in assessing the significance of impacts to a Vulnerable species is whether the proposal will impact an 'important population'. As defined in the EPBC Act Policy Statement 1.1 Significant Impact Guidelines (Department of Environment, 2013), an 'important population' is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and/or that are:

- key source populations either for breeding or dispersal
- populations that are necessary for maintaining genetic diversity, and/or
- populations that are near the limit of the species range.

The Koala is listed as vulnerable as it has undergone a substantial decline over three generations, due to the combination of a range of factors. In Queensland, NSW and the ACT the Koala has an extensive but patchy distribution. Across this range, individual populations vary considerably in trends, and the mixture of threats faced (Department of Sustainability, Environment, Water, Population and Communities, 2012).

The Koala is a leaf-eating specialist that feeds primarily during dawn, dusk or night. Its diet is restricted mainly to foliage of *Eucalyptus spp*; however, it may also consume foliage of related genera, including *Corymbia spp., Angophora spp.* and *Lophostemon spp*, and may, at times, supplement its diet with other species, including *Leptospermum spp.* and *Melaleuca spp*.

No Koalas or evidence of recent occupation were identified during surveys. There are no known populations in the locality and reported sightings in far western NSW are rare. There are two records just north of Wilcannia from 1994, both near the Wilcannia-Wanaaring Road. At least one of these records is likely to correspond with the recorded sighting detailed in Ellis et al. (1997). Ellis et al. (1997) recognizes the importance of riparian corridors with feed trees (such as the Darling River) as movement and connectivity corridors. These records represent the most western records in north-west NSW. There are a small cluster of records upstream of the study area on the Darling River (Baaka) near Bourke, including a recent record from 2019. The next closest records to the development site are a small cluster of six records located around Ivanhoe from the late 1960s and 1970s.

The potential impact of the proposal on the Koala includes indirect impacts associated with adjacent vegetation clearing. It is possible that the development site may at some point provide habitat for travelling individuals, however it is highly likely that there is currently no Koala population present. The development site therefore does not constitute important habitat for this species.

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

1. **lead to a long-term decrease in the size of an important population of a species**

In NSW, koalas inhabit a range of forest and woodland communities, including coastal forests, woodlands on the tablelands and western slopes, and woodland communities along watercourses in the western plains. Population densities range from high in parts of the NSW North Coast (three koalas per hectare in an artificially planted reserve at Tucki Tucki to very low (0.006 koalas per hectare) near Eden on the South Coast. Human-induced land-use change continues to impact the habitat of the Koala, resulting in population declines which will only be exacerbated by climate change (DoAWE, 2021).

The development site only provides secondary habitat for the Koala and an important population has not been identified. No sightings were made during targeted surveys and there are only sporadic records for this species over the broader region. Therefore, the abundance of the species, if present, is expected to be very low. The removal of vegetation will only impact a small amount of suitable vegetation (containing feed trees) when the amount of available vegetation in the locality is considered. Due to the large area of contiguous similar habitats that appear to be suitable for the Koala, the proposal is considered unlikely to lead to a long-term decrease in the size of a population.

2. **reduce the area of occupancy of an important population**

While 2.84 hectares of suitable habitat will be cleared, this is a relatively small area compared to available suitable habitat in the broader study area and locality. The area of occupancy of this species is unknown, however, if present within the development site, the population does not meet the definition of an important population. The proposal is unlikely to reduce the area of occupancy of an important population.

3. **fragment an existing important population into two or more populations**

The main identified threats to this species are loss and fragmentation of habitat, vehicle strike, disease, and predation by dogs. Drought and incidences of extreme heat are also known to cause very significant mortality, and post-drought recovery may be substantially impaired by the range of other threatening factors (Department of Sustainability, Environment, Water, Population and Communities, 2012).

The species is highly mobile and will freely walk substantial distances over open areas to move between areas of habitat. The proposal will not affect the movement of the species between habitat patches. Fragmentation is unlikely to be significantly exacerbated beyond current levels as a result of the proposal. If present within the development site, the population does not meet the definition of an important population. Therefore, the works will not result in fragmentation of an existing important population into two or more populations.

4. adversely affect habitat critical to the survival of a species

Habitat critical to the survival of a species refers to areas that are necessary for activities such as:

- Foraging, breeding, roosting, or dispersal
- For the long-term maintenance of the species including the maintenance of other species essential to the survival of the species, such as pollinators
- To maintain genetic diversity and long-term evolutionary development
- For the reintroduction of populations or recovery of the species.

Given the relative widespread nature of similar vegetation in the locality and abundance of higher quality habitat within the range of regional populations, the proposal is not expected to adversely affect habitat critical to the survival of the Koala in the area.

Table 4 (Koala habitat assessment tool) of the EPBC Act Referral Guidelines for the Vulnerable Koala (Department of the Environment, 2014) outlines the criteria for determining whether critical habitat for the Koala is present on a site. The development site would score a 4 due to vegetation composition and habitat connectivity, but the habitat is not considered critical for the Koala.

5. disrupt the breeding cycle of an important population

The habitat within the development site is not considered high enough quality to support a sedentary breeding population. The proposal will not disrupt dispersal and the wider breeding cycle of the population in the area will continue.

6. modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The proposal will result in a decrease in the availability of suitable habitat of about 2.84 hectares. The potential habitat within the development site is fragmented and disturbed and not considered to be of a high quality for this species. The proposal is unlikely to modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

7. result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

Invasive flora and fauna species have not been identified as a key threat to the species and it is unlikely that the proposal will exacerbate invasive species beyond current levels. Further, the Koala is predated upon by Dingo's (*Canis lupus dingo*) and Domestic Dogs (*Canis lupus familiaris*). The proposal will alter disturbance regimes and may change habitat condition in proximity to the weir and access tracks. This may allow Dingo's and Domestic Dogs to better utilise habitat in the area. Mitigation measures will be implemented to limit the increased potential of these invasive species becoming established in the disturbance and adjacent areas. The management of invasive species would be managed under the CEMP and during operation of the weir.

8. introduce disease that may cause the species to decline, or

Infection of native plants by *Phytophthora cinnamomi* has been identified as being spread by construction machinery. This water-borne fungus infects the roots of plants and has the potential to cause dieback. Machinery associated with vegetation clearance and subsequent construction for the proposal has the potential to transmit the fungus to remaining native vegetation remnants of the species. This is a potential indirect impact to the species where key Koala feed trees (all eucalypts) can be infected and die. This can be suitably mitigated through the development and implementation of suitable control measures for vehicle and plant hygiene and is unlikely to have a significant impact. It is the intention to use current best practice hygiene protocols on this proposal as part of the CEMP to prevent the introduction or spread of pathogens. The proposal would be unlikely to increase the potential for significant disease vectors to affect local

populations. The proposal is considered unlikely to introduce or result in the spread of chlamydiosis or Koala Retrovirus.

9. interfere substantially with the recovery of the species.

The Department of Sustainability, Environment, Water, Population and Communities, (2012) identifies threat abatement actions that would support the recovery of the Koala in Queensland, NSW and the ACT, including:

- Develop and implement a development planning protocol to be used in areas of Koala sub-populations or sub-population fragments to prevent loss of Koala sub-populations, habitat critical to the survival of the species and vital habitat connectivity.
- Development plans should explicitly address ways to mitigate risk of vehicle strike when development occurs adjacent to, or within, Koala habitat.
- Develop and implement a management plan to control the adverse impacts of predation on Koalas by dogs in urban, peri-urban and rural environments.
- Monitor the progress of recovery, including the effectiveness of management actions and the need to adapt them, if necessary.
- Identify populations of high conservation priority.
- Develop and implement options of vegetation recovery and re-connection in regions containing fragmented Koala populations, including inland regions in which Koala populations were diminished by drought and coastal regions where development pressures have isolated Koala populations.
- Investigate formal conservation arrangements, management agreements and covenants on private land, and, for both Crown and private land, investigate and/or secure inclusion of habitat critical to the survival of the Koala in reserve tenure, if possible.
- Engage with private landholders and land managers responsible for the land on which populations occur and encourage these key stakeholders to contribute to the implementation of conservation management actions.
- Manage any other known, potential or emerging threats such a Bell Miner (*Manorina melanophrys*) Associated Dieback or Eucalyptus rust.

The proposal is not expected to interfere substantially with the recovery actions identified for the Koala as listed above.

Conclusion

The Koala will suffer a small reduction in extent of suitable habitat from the proposal, totalling 2.84 hectares, consisting of PCT 36 and PCT 39. The proposal is considered unlikely to reduce the size of an important population of the Koala or decrease the reproductive success of this species. The proposal will not interfere with the recovery of the Koala. After consideration of the factors above, an overall conclusion has been made that the proposal is unlikely to result in a significant impact to the Koala. The impact to Koala habitat from the proposal is not considered to be of significance having regard to its context and intensity.

D.6 Squatter Pigeon (*Geophaps scripta scripta*) Vulnerable species

Squatter pigeons (southern) are ground-dwelling birds that inhabit the grassy understorey of open eucalypt woodland, as well as sown grasslands with scattered remnant trees, disturbed areas (such as roads, railways, settlements and stockyards), scrubland, and Acacia regrowth. It is nearly always found near permanent water such as rivers, creeks and waterholes (TSSC, 2015).

The squatter pigeon (southern) nests on the ground, and usually lays two eggs among or under vegetation. This species will breed throughout the year; however, breeding is influenced by heavy rainfall and most commonly occurs during the dry season between May to June. It forages for seeds among sparse and low

grass, in improved pastures, and beside railway lines and with domestic fowl around settlements (TSSC, 2015).

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

1. lead to a long-term decrease in the size of an important population of a species

The current size of the NSW population of the Squatter Pigeon (southern) is uncertain and the species may no longer be resident in the state. The few reports in the last 50 years of 1–2 individuals are from widely scattered localities, but mostly near the Queensland border potentially representing occasional individuals dispersing from Queensland populations (TSSC, 2016). There have been no breeding records of the Squatter Pigeon (southern) in NSW for over 50 years. If the Squatter Pigeon (southern) survives in NSW, the population size is inferred to be very low or extremely low (TSSC, 2016).

The study area may provide approximately 2.84 hectares of suitable habitat for the Squatter Pigeon, consisting of good condition PCT 36 and PCT 39. However sandy habitats are typically located away from the Darling River.

Furthermore, no Squatter Pigeons were identified during surveys. Formerly widespread and abundant in NSW, this species has disappeared from the southern extent of its range and is currently only known from Narrabri north to Boggabilla and east to near Glen Innes. It is highly unlikely that a population of Squatter Pigeon (southern subspecies) is present within the development site.

2. reduce the area of occupancy of an important population

In NSW the Squatter Pigeon (southern population) has experienced a very large reduction in population size and distribution and is now very highly restricted. The area of occupancy of the Squatter Pigeons (southern) was estimated to be 10,000 km^2 in the year 2000 (TSSC, 2016).

The proposal would result in a direct impact to approximately 2.84 hectares of potential habitat for the Squatter Pigeons, comprising of good condition PCT 36 and PCT 39. The proposed impact would be minor and not considered significant, therefore, it is unlikely that the proposal will reduce the area of occupancy of an important population.

3. fragment an existing important population into two or more populations

Current threats include ongoing vegetation clearance and fragmentation, overgrazing of habitat by livestock and feral herbivores such as rabbits (*Oryctolagus cuniculus*), introduction of weeds, inappropriate fire regimes, thickening of understorey vegetation, predation by feral cats (*Felis catus*) and foxes *(Vulpes vulpes*), trampling of nests by domestic stock and illegal shooting (TSSC, 2015). Most of the original range of the Squatter Pigeon (southern) in NSW is now grazed by sheep or under cultivation.

The proposal would not result in isolation of remnant vegetation patches and would not create barriers to the movement of the Squatter Pigeon (southern population) on either a patch or landscape scale. The development site is largely already currently cleared for historic industrial purposes and does not contain large areas of habitat for this species. The direct removal of vegetation will include access tracks and removal of a narrow area of riparian vegetation on each bank. The final stage of the proposal will involve access to and partial removal and decommissioning of the upstream existing weir, this will involve minimal disturbance due to plan to use an existing access road from the south bank with a short extension. The impacts which would occur as a result of the proposal would be minor and would not contribute further to fragmentation.

4. adversely affect habitat critical to the survival of a species

The proposal would result in the direct impact to approximately 2.84 hectares consisting of PCT 36 and PCT 39, which may provide potential foraging habitat for the Squatter Pigeon (southern population). However,

the habitat within the development site is already currently disturbed and this small area of marginal habitat is unlikely to be critical for any resident birds in this locality or provide critical habitat for new birds to establish a territory.

Critical habitat for the survival of this species is not defined; however, the Squatter Pigeon (southern population) is known to access suitable waterbodies to drink on a daily basis. As the proposal will not change the hydrological conditions within and surrounding the development site, the proposal is unlikely to adversely affect habitat critical to the survival of the species.

There are considerably larger wetland habitats in the broader study area, including PCT 247. It is assumed that these habitats have potential to contribute to the long-term maintenance of the species including maintaining genetic diversity and the long-term evolutionary development of the species. However, these habitats would not be impacted by the proposal.

5. disrupt the breeding cycle of an important population

The proposal would result in a minor impact on potential foraging habitat for the Squatter Pigeon (southern population), however, the development site shows no evidence or records of this species. Measures to minimise impacts on waterways during construction would be implemented as part of the CEMP.

6. modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The current size of the NSW population of the Squatter Pigeon (southern) is uncertain and the species may no longer be resident in the state (TSSC, 2016). There have been no breeding records of the Squatter Pigeon (southern) in NSW for over 50 years. If the Squatter Pigeon (southern) survives in NSW, the population size is inferred to be very low or extremely low (TSSC, 2016).

Although there is no known species recorded of the Squatter Pigeon (southern population) within the development site, impacts would result in a decrease in potential habitat including approximately 2.84 hectares consisting of good condition PCT 36 and PCT 39. Considerably larger areas of suitable habitat occur widely throughout the broader study area and locality. The potential impact from the proposal is not expected to lead to a decline in the species in this region.

7. result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat

The potential for weed invasion is considered possible as a result of the proposal and appropriate controls would be required during construction and operation of the weir to reduce this threat. Invasive species would be managed during construction under a CEMP and under normal site maintenance during operation. Invasive plant species would generally be managed as a first priority before construction commences to reduce the likelihood of their spread.

8. introduce disease that may cause the species to decline, or

Infection of native plants by *Phytophthora cinnamomi* has been identified as being spread by construction machinery. This water-borne fungus infects the roots of plants and has the potential to cause dieback. Machinery associated with vegetation clearance and subsequent construction for the proposal has the potential to transmit the fungus to remaining native vegetation remnants of the species. This is a potential indirect impact to the species through the transmission of pathogens into retained habitat next to the development site. This can be mitigated through the implementation of suitable control measures for vehicle and plant hygiene and is unlikely to have a significant impact. The proposal's environmental management procedures would include guidance for preventing the introduction and/or spread of disease-causing agents such as bacteria and fungi.

9. interfere substantially with the recovery of the species.

The Commonwealth Minister for the Environment has declared that that a national recovery plan for the Squatter Pigeon (southern population) is not required; however, current threats to this species include loss and fragmentation of habitat due to clearing for agricultural purposes, the degradation of habitat by overgrazing by domesticated herbivores, the degradation of habitat by invasive weeds, and predation by numerous avian and terrestrial predators. While a small amount of clearing of suitable habitat may occur, the extent of habitat loss as a proportion of the habitat available within the region is small. In addition, the species is known to utilise a wide range of different habitats, minimising the impact of habitat clearing on the species. Given this, the proposal is unlikely to interfere with the recovery of the Squatter Pigeon (southern population).

The proposal would not conflict with the recovery of this species. The development site has been selected on the basis of avoiding high quality habitats for threatened fauna, and mitigation and offset measures would target threatened fauna. There are no priority sites for conservation of this species within the development site boundary.

Conclusion

The Squatter Pigeon (southern population) would result in a small reduction of potential habitat consisting of PCT 36 and PCT 39, totalling approximately 2.84 hectares, as a result of the proposal. Further, potential habitat exists within the broader study area consisting of PCT 247, however, this habitat would not be impacted. The proposal is considered unlikely to reduce the population size of the Squatter Pigeon (southern population) or decrease its reproductive success. There have been no breeding records of the Squatter Pigeon (southern) in NSW for over 50 years (TSSC, 2016). The proposal would not interfere with the recovery of the Squatter Pigeon (southern population) and would not contribute to the key threats to this species. After consideration of the factors above, the overall conclusion is made that the proposal is unlikely to result in a significant impact to the Squatter Pigeon (southern population). The impact to Squatter Pigeon (southern population) habitat from the proposal is not considered to be of significance, having regard to its context and intensity.

Appendix E. Biodiversity credit report

BAM Biodiversity Credit Report (Like for like)

Proposal Details

Assessment Id
00022314/BAAS19068/20/00022315

Proposal Name
Wilcannia Weir

BAM data last updated *
24/11/2021

Assessor Name
Brenton Hays

Assessor Number
BAAS19068

BAM Data version *
50

Proponent Names

Report Created
13/12/2021

BAM Case Status
Open

Assessment Revision
2

Assessment Type
Major Projects

Date Finalised
To be finalised

* Disclaimer: BAM data last updated may indicate either complete or partial update of the BAM calculator database. BAM calculator database may not be completely aligned with Bionet.

Potential Serious and Irreversible Impacts

Name of threatened ecological community	Listing status	Name of Plant Community Type/ID
Nil		

Species
Nil

Additional Information for Approval

PCT Outside Ibra Added

None added

PCTs With Customized Benchmarks

PCT
No Changes

Predicted Threatened Species Not On Site

Name
Grantiella picta / Painted Honeyeater
Pomatostomus temporalis temporalis / Grey-crowned Babbler (eastern subspecies)

Ecosystem Credit Summary (Number and class of biodiversity credits to be retired)

Name of Plant Community Type/ID	Name of threatened ecological community	Area of impact	HBT Cr	No HBT Cr	Total credits to be retired
36-River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion	Not a TEC	2.4	30	15	45
39-Coolabah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion	Coolibah-Black Box Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain and Mulga Lands Bioregions	2.9	56	7	63
158-Old Man Saltbush - mixed chenopod shrubland of the semi-arid hot (persistently dry) and arid climate zones (north-western NSW)	Not a TEC	3.3	0	139	139

BAM Biodiversity Credit Report (Like for like)

36-River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion

Like-for-like credit retirement options

Class	Trading group	Zone	HBT	Credits	IBRA region
Inland Riverine Forests This includes PCT's: 9, 36, 78, 79, 112, 249, 356, 362	Inland Riverine Forests >=50% and <70%	36_Good	Yes	30	Wilcannia Plains, Barnato Downs, Darling Depression, Louth Plains, Menindee, Paroo Overflow, Paroo-Darling Sands and Scopes Range. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
Inland Riverine Forests This includes PCT's: 9, 36, 78, 79, 112, 249, 356, 362	Inland Riverine Forests >=50% and <70%	36_Low	No	15	Wilcannia Plains, Barnato Downs, Darling Depression, Louth Plains, Menindee, Paroo Overflow, Paroo-Darling Sands and Scopes Range. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

BAM Biodiversity Credit Report (Like for like)

39-Coolabah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion

Like-for-like credit retirement options

Name of offset trading group	Trading group	Zone	HBT	Credits	IBRA region
Coolibah-Black Box Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain and Mulga Lands Bioregions This includes PCT's: 37, 39, 40, 55	-	39_Good	Yes	56	Wilcannia Plains, Barnato Downs, Darling Depression, Louth Plains, Menindee, Paroo Overflow, Paroo-Darling Sands and Scopes Range. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
Coolibah-Black Box Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain and Mulga Lands Bioregions This includes PCT's: 37, 39, 40, 55	-	39_Low	No	7	Wilcannia Plains, Barnato Downs, Darling Depression, Louth Plains, Menindee, Paroo Overflow, Paroo-Darling Sands and Scopes Range. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

	Coolibah-Black Box Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain and Mulga Lands Bioregions This includes PCT's: 37, 39, 40, 55	-	39_Disturbed	No	0	Wilcannia Plains, Barnato Downs, Darling Depression, Louth Plains, Menindee, Paroo Overflow, Paroo-Darling Sands and Scopes Range. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

158-Old Man Saltbush - mixed chenopod shrubland of the semi-arid hot (persistently dry) and arid climate zones (north-western NSW)	**Like-for-like credit retirement options**					
	Class	Trading group	Zone	HBT	Credits	IBRA region
	Riverine Chenopod Shrublands This includes PCT's: 158, 159, 195	Riverine Chenopod Shrublands >=70% and <90%	158_Low	No	139	Wilcannia Plains, Barnato Downs, Darling Depression, Louth Plains, Menindee, Paroo Overflow, Paroo-Darling Sands and Scopes Range. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

	Riverine Chenopod Shrublands This includes PCT's: 158, 159, 195	Riverine Chenopod Shrublands >=70% and <90%	158_VeryPoor	No	0	Wilcannia Plains, Barnato Downs, Darling Depression, Louth Plains, Menindee, Paroo Overflow, Paroo-Darling Sands and Scopes Range. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

Species Credit Summary

No Species Credit Data

Credit Retirement Options

Like-for-like credit retirement options

Appendix F. Predicted threatened species report

BAM Predicted Species Report

Proposal Details

Assessment Id	Proposal Name	BAM data last updated *
00022314/BAAS19068/20/00022315	Wilcannia Weir	24/11/2021
Assessor Name	Report Created	BAM Data version *
Brenton Hays	29/04/2022	50
Assessor Number	Assessment Type	BAM Case Status
BAAS19068	Major Projects	Open
Assessment Revision		Date Finalised
3		To be finalised

* Disclaimer: BAM data last updated may indicate either complete or partial update of the BAM calculator database. BAM calculator database may not be completely aligned with Bionet.

Threatened species reliably predicted to utilise the site. No surveys are required for these species. Ecosystem credits apply to these species.

Common Name	Scientific Name	Vegetation Types(s)
Australasian Bittern	Botaurus poiciloptilus	36-River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion
		39-Coolabah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion
Australian Painted Snipe	Rostratula australis	36-River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion
		39-Coolabah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion
Barking Owl	Ninox connivens	36-River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion
		39-Coolabah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion
Black Falcon	Falco subniger	36-River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion

Black Falcon	Falco subniger	39-Coolabah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion
		158-Old Man Saltbush - mixed chenopod shrubland of the semi-arid hot (persistently dry) and arid climate zones (north-western NSW)
Black-breasted Buzzard	Hamirostra melanosternon	36-River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion
		39-Coolabah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion
		158-Old Man Saltbush - mixed chenopod shrubland of the semi-arid hot (persistently dry) and arid climate zones (north-western NSW)
Black-tailed Godwit	Limosa limosa	39-Coolabah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion
Brolga	Grus rubicunda	36-River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion
		39-Coolabah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion
		158-Old Man Saltbush - mixed chenopod shrubland of the semi-arid hot (persistently dry) and arid climate zones (north-western NSW)
Diamond Firetail	Stagonopleura guttata	36-River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion
		39-Coolabah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion
Dusky Woodswallow	Artamus cyanopterus cyanopterus	36-River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion
		39-Coolabah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion

Dusky Woodswallow	Artamus cyanopterus cyanopterus	158-Old Man Saltbush - mixed chenopod shrubland of the semi-arid hot (persistently dry) and arid climate zones (north-western NSW)
Flock Bronzewing	Phaps histrionica	158-Old Man Saltbush - mixed chenopod shrubland of the semi-arid hot (persistently dry) and arid climate zones (north-western NSW)
Forrest's Mouse	Leggadina forresti	158-Old Man Saltbush - mixed chenopod shrubland of the semi-arid hot (persistently dry) and arid climate zones (north-western NSW)
Freckled Duck	Stictonetta naevosa	36-River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion
Grey Falcon	Falco hypoleucos	36-River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion
		39-Coolabah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion
		158-Old Man Saltbush - mixed chenopod shrubland of the semi-arid hot (persistently dry) and arid climate zones (north-western NSW)
Grey-crowned Babbler (eastern subspecies)	Pomatostomus temporalis temporalis	39-Coolabah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion
Hooded Robin (south-eastern form)	Melanodryas cucullata cucullata	36-River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion
		39-Coolabah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion
Koala	Phascolarctos cinereus	36-River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion
		39-Coolabah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion
Kultarr	Antechinomys laniger	39-Coolabah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion

Kultarr	Antechinomys laniger	158-Old Man Saltbush - mixed chenopod shrubland of the semi-arid hot (persistently dry) and arid climate zones (north-western NSW)
Little Eagle	Hieraaetus morphnoides	36-River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion
		39-Coolabah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion
		158-Old Man Saltbush - mixed chenopod shrubland of the semi-arid hot (persistently dry) and arid climate zones (north-western NSW)
Little Pied Bat	Chalinolobus picatus	36-River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion
		39-Coolabah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion
		158-Old Man Saltbush - mixed chenopod shrubland of the semi-arid hot (persistently dry) and arid climate zones (north-western NSW)
Long-haired Rat	Rattus villosissimus	158-Old Man Saltbush - mixed chenopod shrubland of the semi-arid hot (persistently dry) and arid climate zones (north-western NSW)
Major Mitchell's Cockatoo	Lophochroa leadbeateri	36-River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion
		39-Coolabah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion
		158-Old Man Saltbush - mixed chenopod shrubland of the semi-arid hot (persistently dry) and arid climate zones (north-western NSW)
Masked Owl	Tyto novaehollandiae	36-River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion
		39-Coolabah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion

Painted Honeyeater	Grantiella picta	39-Coolabah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion
Pied Honeyeater	Certhionyx variegatus	36-River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion
		39-Coolabah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion
		158-Old Man Saltbush - mixed chenopod shrubland of the semi-arid hot (persistently dry) and arid climate zones (north-western NSW)
Red-tailed Black-Cockatoo (inland subspecies)	Calyptorhynchus banksii samueli	36-River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion
		39-Coolabah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion
		158-Old Man Saltbush - mixed chenopod shrubland of the semi-arid hot (persistently dry) and arid climate zones (north-western NSW)
Redthroat	Pyrrholaemus brunneus	158-Old Man Saltbush - mixed chenopod shrubland of the semi-arid hot (persistently dry) and arid climate zones (north-western NSW)
Ringed Brown Snake	Pseudonaja modesta	39-Coolabah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion
		158-Old Man Saltbush - mixed chenopod shrubland of the semi-arid hot (persistently dry) and arid climate zones (north-western NSW)
Spotted Harrier	Circus assimilis	36-River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion
		39-Coolabah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion
		158-Old Man Saltbush - mixed chenopod shrubland of the semi-arid hot (persistently dry) and arid climate zones (north-western NSW)

Square-tailed Kite	Lophoictinia isura	36-River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion
		39-Coolabah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion
Stripe-faced Dunnart	Sminthopsis macroura	36-River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion
		39-Coolabah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion
		158-Old Man Saltbush - mixed chenopod shrubland of the semi-arid hot (persistently dry) and arid climate zones (north-western NSW)
Varied Sittella	Daphoenositta chrysoptera	36-River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion
		39-Coolabah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion
White-bellied Sea-Eagle	Haliaeetus leucogaster	36-River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion
		39-Coolabah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion
		158-Old Man Saltbush - mixed chenopod shrubland of the semi-arid hot (persistently dry) and arid climate zones (north-western NSW)
White-fronted Chat	Epthianura albifrons	158-Old Man Saltbush - mixed chenopod shrubland of the semi-arid hot (persistently dry) and arid climate zones (north-western NSW)
Yellow-bellied Sheathtail-bat	Saccolaimus flaviventris	36-River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion
		39-Coolabah - River Coobah - Lignum woodland wetland of frequently flooded floodplains mainly in the Darling Riverine Plains Bioregion

Yellow-bellied Sheathtail-bat	Saccolaimus flaviventris	158-Old Man Saltbush - mixed chenopod shrubland of the semi-arid hot (persistently dry) and arid climate zones (north-western NSW)

Threatened species Manually Added

None added

Threatened species assessed as not within the vegetation zone(s) for the PCT(s)

Common Name	Scientific Name	Plant Community Type(s)
Grey-crowned Babbler (eastern subspecies)	Pomatostomus temporalis temporalis	36-River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion
Painted Honeyeater	Grantiella picta	36-River Red Gum tall to very tall open forest / woodland wetland on rivers on floodplains mainly in the Darling Riverine Plains Bioregion

Threatened species assessed as not within the vegetation zone(s) for the PCT(s)

Refer to BAR for detailed justification

Common Name	Scientific Name	Justification in the BAM-C

Appendix G. Candidate threatened species report

BAM Candidate Species Report

Proposal Details

Assessment Id 00022314/BAAS19068/20/00022315	Proposal Name Wilcannia Weir	BAM data last updated * 10/06/2021
Assessor Name Brenton Hays	Report Created 12/10/2021	BAM Data version * 45
Assessor Number BAAS19068	Assessment Type Major Projects	BAM Case Status Open
Assessment Revision 1	Date Finalised To be finalised	

* Disclaimer: BAM data last updated may indicate either complete or partial update of the BAM calculator database. BAM calculator database may not be completely aligned with Bionet.

List of Species Requiring Survey

Name	Presence	Survey Months
Ardeotis australis Australian Bustard	No (surveyed)	☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☐ Sep ☐ Oct ☑ Nov ☐ Dec ☐ Survey month outside the specified months?
Atriplex infrequens A saltbush	No (surveyed)	☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☐ Sep ☐ Oct ☑ Nov ☐ Dec ☐ Survey month outside the specified months?
Burhinus grallarius Bush Stone-curlew	No (surveyed)	☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☐ Sep ☐ Oct ☑ Nov ☐ Dec ☐ Survey month outside the specified months?

Calyptorhynchus banksii samueli Red-tailed Black-Cockatoo (inland subspecies)	No (surveyed)	☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☐ Sep ☐ Oct ☑ Nov ☐ Dec ☐ Survey month outside the specified months?
Convolvulus tedmoorei Bindweed	No (surveyed) *Survey months are outside of the months specified in Bionet.	☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☐ Sep ☐ Oct ☑ Nov ☐ Dec ☑ Survey month outside the specified months?
Haliaeetus leucogaster White-bellied Sea-Eagle	No (surveyed)	☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☐ Sep ☐ Oct ☑ Nov ☐ Dec ☐ Survey month outside the specified months?
Hamirostra melanosternon Black-breasted Buzzard	No (surveyed)	☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☐ Sep ☐ Oct ☑ Nov ☐ Dec ☐ Survey month outside the specified months?
Hieraaetus morphnoides Little Eagle	No (surveyed) *Survey months are outside of the months specified in Bionet.	☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☐ Sep ☐ Oct ☑ Nov ☐ Dec ☑ Survey month outside the specified months?
Lophochroa leadbeateri Major Mitchell's Cockatoo	No (surveyed)	☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☐ Sep ☐ Oct ☑ Nov ☐ Dec ☐ Survey month outside the specified months?

Lophoictinia isura Square-tailed Kite	No (surveyed)	☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☐ Sep ☐ Oct ☑ Nov ☐ Dec ☐ Survey month outside the specified months?
Ninox connivens Barking Owl	No (surveyed)	☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☐ Sep ☐ Oct ☑ Nov ☐ Dec ☐ Survey month outside the specified months?
Phascolarctos cinereus Koala	No (surveyed)	☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☐ Sep ☐ Oct ☑ Nov ☐ Dec ☐ Survey month outside the specified months?
Phyllanthus maderaspatensis Phyllanthus maderaspatensis	No (surveyed)	☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☐ Sep ☐ Oct ☑ Nov ☐ Dec ☐ Survey month outside the specified months?
Solanum karsense Menindee Nightshade	No (surveyed)	☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☐ Sep ☐ Oct ☑ Nov ☐ Dec ☐ Survey month outside the specified months?
Swainsona murrayana Slender Darling Pea	No (surveyed) *Survey months are outside of the months specified in Bionet.	☐ Jan ☐ Feb ☐ Mar ☐ Apr ☐ May ☐ Jun ☐ Jul ☐ Aug ☐ Sep ☐ Oct ☑ Nov ☐ Dec ☑ Survey month outside the specified months?

BAM Candidate Species Report

Threatened species assessed as not on site

Refer to BAR for detailed justification

Common name	Scientific name	Justification in the BAM-C
Black-tailed Godwit	Limosa limosa	Refer to BAR
Masked Owl	Tyto novaehollandiae	Refer to BAR
Stimson's Python	Antaresia stimsoni	Habitat constraints