UMWELT

Wollara Road, Merriwa

Goulburn River Solar Farm

Aquatic Assessment

Job No: 220222

Date: 28/04/2023

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Goulburn River Solar Farm: Aquatic Assessment

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Executive Summary

The project

Lightsource Development Services Australia Pty Ltd (Lightsource bp) proposes to develop a solar farm in the Upper Hunter region of New South Wales (NSW), approximately 28 kilometres (km) south-west of the township of Merriwa within the Upper Hunter Local Government Area (LGA).

The proposed Goulburn River Solar Farm (the project) includes the construction, operation, maintenance and decommissioning of approximately 550 megawatt peak (MWp) of solar photovoltaic (PV) generation with a Battery Energy Storage System (BESS) with 280 MWp and 570 megawatt hour (MWh) capacity. The project will also include supporting infrastructure, a substation and connection to an existing 500 kilovolt (kV) transmission line.

This report

This Aquatic Biodiversity Impact Assessment has been prepared on behalf of Umwelt to support the Environmental Impact Statement (EIS) for the project and responds to the Secretary's Environmental Assessment Requirements (SEARs) for the aquatic ecosystem.

The assessment presented in this report has included a review of relevant legislation, consideration of the existing conditions, an impact assessment to determine the significance of impacts to aquatic biodiversity as a direct result of the construction, operation and decommissioning of the project and the potential impacts of the project on threatened aquatic species which are predicted to occur within the study area (defined here as a 10 kilometre (km) buffer around the Project Area). Recommended mitigation and management measures are identified.

This report builds on findings of both Biodiversity Development Assessment Reports (BDARs) and the Water Resources Assessment prepared by Umwelt (2023).

Existing aquatic environment

The Project Area is located within the catchment of the Goulburn River in east New South Wales, which is in the Hunter/Central Rivers Catchment Management Authority. The Goulburn River is the largest tributary of the Hunter River and accounts for 40 per cent of the Hunter Rivers catchment area but contributes only 23 per cent of its flow.

Within the Project Area, there are 90 mapped hydrolines including 69 first order watercourses, 18 second order watercourses and three third order watercourses which eventually flow into the Goulburn River. Five watercourses have been mapped as key fish habitat (KFH) (DPI, 2007) within the Project Area, however, except for Redlynch Creek, all are highly ephemeral, only holding water for a short time following rainfall and receding rapidly, leaving very few remnant pools for fish refuge. Redlynch Creek contained remnant pools and some flowing water at the time of survey and has a farm dam constructed within the watercourse. None of the watercourses within the Project Area contained important habitat features such as aquatic plants (macrophytes), bank overhang, trailing bank vegetation, riffle sections or woody debris/snags (except for Monaghans Creek which was dry at the time of survey but did contain woody debris). All watercourses and riparian zones were modified by agricultural land practices, including complete removal of the riparian vegetation to top of bank in most areas.

Potential impacts from the project

Three watercourses (or sections of) mapped as KFH occur within the Development Footprint:

- Redlynch Creek, including unnamed tributaries
- an unnamed tributary of Poggy Creek
- an unnamed tributary of Rocky Creek.

Note: While Redlynch Creek is within the Development Footprint, much of this creek occurs within a proposed exclusion zone.

In addition, seven farm dams occur within the Development Footprint.

Direct impacts from the project on aquatic biodiversity would include potential blockage of fish passage (during floods) where filling is required for access roads across KFH watercourses, potential modification to riparian habitat through the spread of exotic flora, potential mortality to protected aquatic fauna during farm dam dewatering and filling and potential impacts on water quality through disturbance of soil on waterfront land. Potential indirect impacts to aquatic biodiversity relate to the mobilisation of poor-quality stormwater runoff from construction activities including vegetation removal, earthworks, establishment and use of construction compounds and access roads and pollution downstream and potential mortality to aquatic flora and fauna.

Following assessment, all watercourses within the study area were considered to have a low or negligible risk of potential impact from the project during construction, operation and decommissioning due to the highly ephemeral nature of the watercourses, the lack of important KFH features and or the minor nature of works proposed within the catchment of these watercourses.

Potential risks can be managed in ephemeral watercourses by:

- undertaking construction when watercourses are dry (where practicable) as aquatic fauna species would not be present
- implementing appropriate erosion and sediment control measures
- installing fish friendly crossings (in accordance with relevant guidelines) where filling for access roads are proposed across watercourses mapped as KFH
- avoiding all construction activities, including tree removal and re-fuelling of vehicles and other machinery, on waterfront land (i.e., land 40 metres from the top of bank, where watercourses have a defined bed and banks)
- re-instating watercourse bed and banks where these are disturbed in areas mapped as KFH.

Potential indirect risks to the perennial watercourse (Goulburn River) which occurs outside of the Project Area, can be managed through the implementation of appropriate erosion and sediment control measures on upstream watercourses during construction.

Threatened species, populations and ecological communities

Following a likelihood of occurrence assessment, the broader study area was considered to provide possible or likely habitat for the following two threatened entities listed under the *Fisheries Management Act 1994* (FM Act):

1. Darling River Hardyhead (*Craterocephalus amniculus),* Endangered population
2. Southern Purple-Spotted Gudgeon (*Mogurnda adspersa),* Endangered species.

Fisheries Management Act

Assessments of significance of impact under the Fisheries Management Act 1994(FM Act) concluded that the project was unlikely to have an adverse effect on the life cycle of Darling River Hardyhead or Southern Purple Spotted Gudgeon such that a viable local population of these species is not likely to be placed at risk of extinction. This was based on the lack of important habitat features for these species within the Project Area and the relatively minor nature of works. Potential indirect impacts on water quality associated with the mobilisation of sediments is relevant to all watercourses within the study area, however, this can be managed using standard erosion and sediment control measures during the construction, operation and decommissioning phases of the Project. Thus, the level of impact to the aquatic environment and threatened aquatic species is considered minor.

In relation to the habitat of threatened species/populations, only Goulburn River contained potential habitat for these two threatened entities. The project does not result in any direct impacts to the Goulburn River and potential indirect impacts can be mitigated through appropriate erosion and sediment control. Thus, the habitat of these threatened species/populations will not be removed or significantly modified, nor will the habitat become fragmented or isolated from other areas of habitat because of the project.

In terms of the importance of the habitat for these species, Goulburn River was mapped as within the indicative distribution for the Darling River Hardyhead but not the Southern Purple Spotted Gudgeon. It is noted that many sections of the Goulburn River within the study area have been highly modified through land use practices in the catchment, with intensive farming practices including extensive clearing of riparian vegetation to the bank, reducing the presence of aquatic vegetation, detritus, trailing bank vegetation and snags, which are important habitat features for these species. Thus, the existing habitat in the Goulburn River within the study area is likely to be of low importance to the long-term survival of these threatened species/populations.

The project is not inconsistent with any priority action statements for the assessed threatened species and population as most recovery actions listed are not directly relevant to the project, except for habitat rehabilitation, which would be undertaken in accordance with the Biodiversity Management Plan for the project. The key threatening process (KTP) 'installation and operation of instream structures and other mechanisms that alter natural flow regimes of rivers and streams' is the only KTP that would be impacted by the project. Any crossings over KFH would be designed to minimise impacts to natural flows.

Environment Protection and Biodiversity Conservation Act

No Matters of National Environmental Significance (MNES) were identified within the study area. As such, no further assessment was required under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Impacts on sensitive areas

KFH within the study area was based on existing KFH mapping by DPI (2007), watercourses sensitivity type (DPI, 2013) and watercourse class (Fairfull and Witheridge, 2003) which were defined following site inspection. Only instream habitat (top of bank to top of bank) is defined as KFH.

All watercourses within the Project Area were defined as having minimally sensitive KFH due to their highly ephemeral nature and the absence of fish habitat features. Regardless, the Development Footprint covers mapped KFH along the following watercourses:

- approximately 250 m along Redlynch Creek
- approximately 150 metres along an unnamed tributary of Poggys Creek
- approximately 530 metres along an unnamed tributary of Rocky Creek.

While the third order portion of Redlynch Creek is defined as an exclusion area, proposed access roads cross this watercourse in four locations. Where filling of watercourses mapped as KFH for the construction of access roads, appropriate fish passage would be maintained through the installation of a high flow design culvert. As such, fish passage would be maintained and KFH would not be permanently lost or disrupted so no aquatic biodiversity offset would be required.

Waterfront land includes the bed and bank of watercourses and all land within 40 metres of the highest bank (DPI, 2012). However, watercourses lacking defined bed and banks are not typically associated with waterfront land. Within the Development Footprint, only Redlynch Creek and an unnamed tributary of Rocky Creek have defined bed and banks and as such, these watercourses have associated waterfront land. Where possible, construction works

would not be undertaken on waterfront land. Any disturbance to waterfront land would be remediated as detailed in the Biodiversity Management Plan.

No aquatic groundwater dependent ecosystems (GDEs) were identified in the study area.

This assessment also concluded that the potential cumulative impacts of the project combined with four other major projects occurring within the Goulburn River catchment was unlikely to be significant, provided the biodiversity management plans for each project are implemented, maintained and monitored.

Recommended mitigation measures

Potential impacts to aquatic ecosystems during construction would be reduced if:

- appropriate erosion and sediment controls are implemented
- construction works, including refuelling of machinery, avoid waterfront land
- there are onsite spill kits for construction works within 100 metres of a watercourse
- instream construction works (for access roads) are conducted when watercourses are dry (where practicable)
- any instream structures are designed using relevant guidelines (to maintain fish passage and minimise impacts to natural flow regimes), particularly on watercourses mapped as KFH
- disturbed bed and banks of watercourses mapped as KFH are rehabilitated with stabilising vegetation.

During operation and decommissioning, potential impacts would be reduced through:

- the routine maintenance of vehicles (to reduce the risk of oil spills etc)
- the routine maintenance of culverts (to ensure they are clear of debris)
- minimal use of herbicides to control exotic species (to reduce pollutants entering downstream watercourses)
- the re-establishment of native riparian vegetation endemic to the region and aquatic habitat features within and on the banks of any watercourses directly impacted.

Conclusion

The aquatic biodiversity impact assessment concludes that the impacts of the project would not significantly compromise the functionality, long-term connectivity or viability of habitats, or ecological processes within watercourses in the study area. Most of the potential construction impacts are associated with indirect impacts on water quality and would therefore be temporary and managed through the adoption of recommended mitigation measures. Impacts on threatened species and endangered populations listed under the FM Act are considered unlikely due to the minor nature of works and the highly ephemeral nature of most watercourses within the Project Area. The Goulburn River is the only perennial watercourse in the study area, however direct instream impacts at this location will not occur and potential indirect impacts can be managed. As such, the project is unlikely to significantly impact the habitat of threatened aquatic species or endangered populations.

Glossary and abbreviations

ALA	Atlas of living Australia
AUSRIVAS	Australian River Assessment System
BC Act	*Biodiversity Conservation Act 2016 (NSW)*
BDAR	Biodiversity Development Assessment Report
BESS	Battery Energy Storage System
CEMP	Construction Environmental Management Plan A site-specific plan developed for the construction phase of a project, to ensure that all contractors and sub-contractors comply with the environmental conditions of approval for the project and manage environmental risks properly.
CMA	Subregion Catchment Management Authority Subregion
Cumulative impacts	Impacts that, when considered together, have different and/or more substantial impacts
DCCEEW	Department of Climate Change, Energy the Environment and Water
Development Footprint	The area directly impacted by the project, being approximately 799.5 ha.
DPE	Department of Planning and Environment
DPI	Department of Primary Industries – Fisheries NSW
EEC	Endangered Ecological Community
EIS	Environmental Impact Statement
EPs	Endangered Populations
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 (Version 7)
KFH	Key Fish Habitat
KTP	Key Threatening Process
Locality	Includes the four Local Government Areas (LGAs) surrounding the Project Area: Upper Hunter, Warrumbungle, Mid-Western Regional and Muswellbrook.
MGA	Map Grid of Australia 94, Zone 56 (easting-northing)
MNES	Matters of national environmental significance
MWh	Megawatt hour
MWp	Megawatt peak

NRAR	Natural Resources Access Regulator
NSW	New South Wales
NPW Act	*National Parks and Wildlife Act*
OEH	Office of Environment and Heritage (NSW) (NB. The functions of OEH were transferred to the Environment, Energy & Science Group within DPIE (now DPE) on 1 July 2019)
PCT	Plant Community Type
PMST	Protected Matters Search Tool
the Project	the Project would include the construction, operation, civil works, maintenance and decommissioning of the proposed solar farm and Battery Energy Storage System (BESS), as well as associated infrastructure.
the Project Area	the Project Area comprises two freehold properties that span across multiple lots, covering an area of approximately 2,000 ha.
SEARs	Secretary's Environmental Assessment Requirements
SEPP	State Environmental Planning Policy
SSD	State Significant Development
Strahler Stream Order	Classification system that gives a waterway an 'order' according to the number of tributaries associated with it. Mapped at 1:50 000 scale
study area	The wider area, including and surrounding the Project Area, with the potential to be directly or indirectly affected by the project and the area defined for desktop studies. The extent of the study area for the Aquatic Assessment includes a 10 km buffer around the Project Area.
Survey site	The location (100 metre reach along watercourses crossed by the study area) within which habitat assessments and surveys were undertaken.
TEC	Threatened Ecological Community

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1. Introduction

Lightsource Development Services Australia Pty Ltd (Lightsource bp) proposes to develop a solar farm in the Upper Hunter region of New South Wales (NSW), approximately 28 kilometres (km) south-west of the township of Merriwa within the Upper Hunter Local Government Area (LGA).

The proposed Goulburn River Solar Farm (the project) includes the construction, operation, maintenance and decommissioning of approximately 550 megawatt peak (MWp) of solar photovoltaic (PV) generation with a Battery Energy Storage System (BESS) with 280 MWp and 570 megawatt hour (MWh) capacity. The project will also include supporting infrastructure, a substation and connection to an existing 500 kilovolt (kV) transmission line.

The project location and regional context are shown in Figure 1-1.

1.1 Background

The Project Area is located between Merriwa (to the north-east) and Coggan (to the south-east) NSW, surrounded by the Goulburn River National Park. The main Project Area is located on freehold land, while parts of Wollara Road which provides access to the site, are located on Crown land. The Project Area comprises two freehold properties that span across multiple lots, covering an area of approximately 2,000 ha with the development footprint occupying approximately 799.5 ha (Figure 1-2).

The Project Area is near the Central West Orana Renewable Energy Zone (REZ) however the Project is not related to the REZ, nor is it dependent on the REZ establishment. The REZ location was selected because of the benefits of relatively low transmission build costs due to its proximity to the existing transmission network structures. Similarly, the Project Area benefits from the existing 500 kV transmission line crossing the south-east portion of the site, allowing easy connection to the national electricity grid.

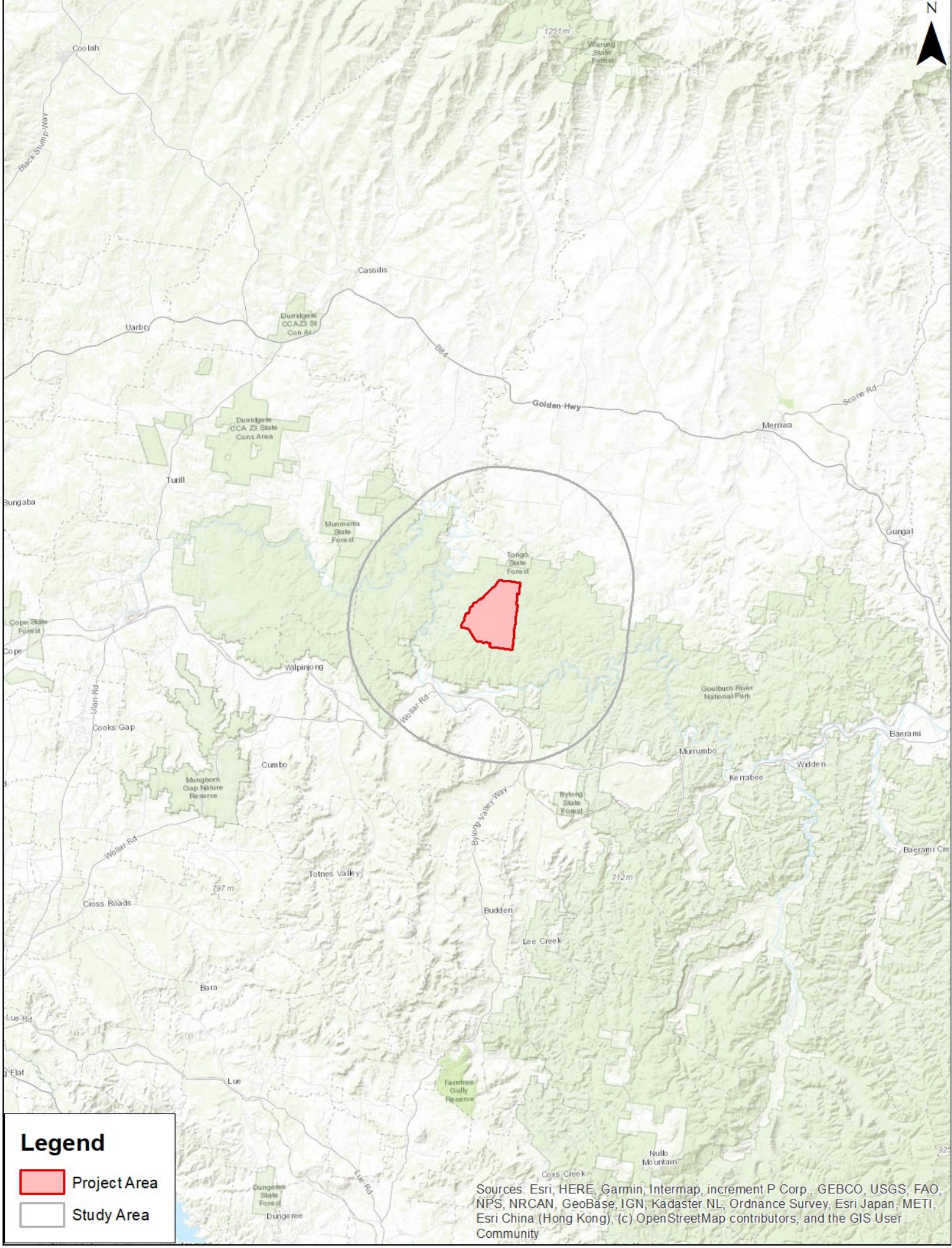
Based on the proximity of the project to the REZ, it is also expected to support the local uptake and use of renewable energy, contribute to achieving State and Federal targets for establishing renewable energy generation within NSW, and provide similar economic and social benefits to the regional community. As part of the Upper Hunter region, the Project Area is also in proximity to the Hunter-Central Coast REZ .

1.2 Project Overview

Subject to the final design process, the key components of the Project are shown on include:

- Approximately 1 million bifacial solar PV modules in an east-west single-axis tracking arrangement
- A BESS with an approximate 280 MWp and 570 MWh capacity, housed in a series of outdoor containers, either distributed across the site or aggregated in one central location
- Onsite 500 kV switchyard and substation, with underground electrical conduits and cabling leading into the yard and overhead lines reaching above to the existing transmission line
- Communications tower, up to 30 m high, providing communications, radio and cellular services to the site and the wider region
- Internal and perimeter gravel access roads allowing for site maintenance
- Temporary construction facilities
- Site office and operations and maintenance building with parking for the operations team
- Primary access point from existing driveway off Wollara Road, with two additional emergency access points proposed along the north-western boundary of the Project Area
- Upgrades to Ringwood Road
- Drainage line crossings, if and where required, to manage existing surface water flows
- Perimeter security fencing, crossing gates, water tanks or dams, and internal access points to facilitate sheep grazing.

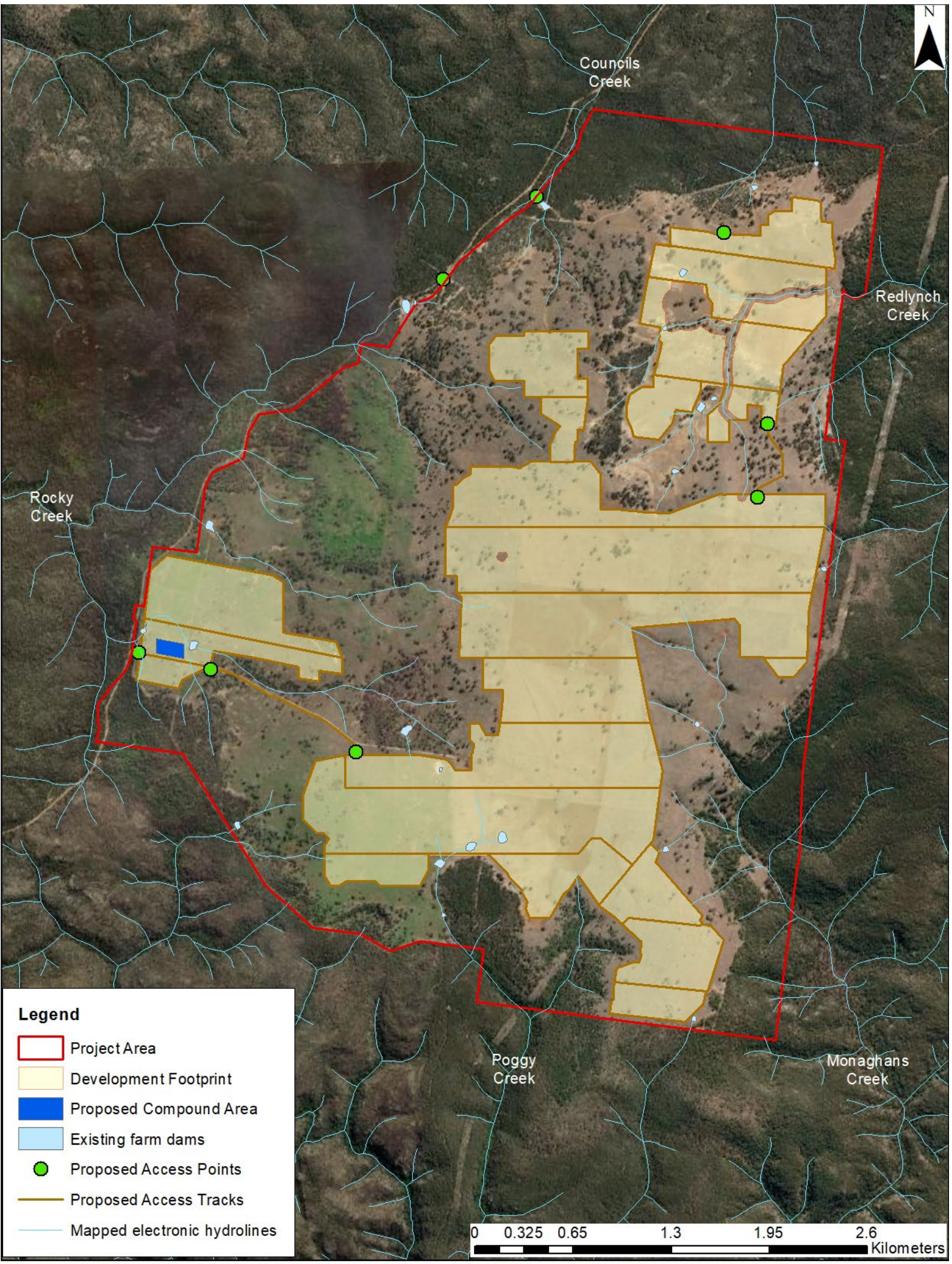
Detailed descriptions of the project components are contained in the Environmental Impact Statement (EIS).



COAST ECOLOGY
ENVIRONMENTAL ASSESSMENTS

0 2.75 5.5 11 16.5 22 Kilometers

Figure 1.1. Locality
Goulburn River Solar Farm
Job No. 220222 Date. 19/04/2023



COAST ECOLOGY
ENVIRONMENTAL ASSESSMENTS

Figure 1.2. Project Area and Development Footprint
Goulburn River Solar Farm
Job No. 220222 Date. 19/04/2023

1.2.1 Timing

The project is expected to operate for 40 years or more. After the initial 40-year operating period, the solar farm would either be decommissioned, removing all above ground infrastructure, and returning the site to its existing land capability, or repurposed with new PV equipment subject to technical feasibility and planning consents.

1.3 Purpose and scope of this report

The EIS has been prepared in line with the State Significant Development Guidelines – Preparing an Environmental Impact Statement (DPIE, 2021) and assesses the potential impacts associated with the project in accordance with the Secretary's Environmental Assessment Requirements (SEARs), issued on 1 February 2022.

The aquatic assessment specifically addresses the SEARs relevant to the assessment of the aquatic environment (refer Table 1-1).

Specifically, this assessment:

- Describes the existing aquatic environment in terms of ecological values, including type and condition of aquatic habitats.
- Determines the presence or likelihood of occurrence of threatened species, populations and endangered ecological communities (EECs) as listed under the *Fisheries Management Act 1994* (FM Act).
- Determines the presence or likelihood of occurrence of matters of national environmental significance (MNES) as listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).
- Identifies threatened fish species, populations and EECs within the locality that have the potential to be impacted by the project.
- Assesses the impact of the project on threatened fish species, populations and ecological communities.
- Assesses the impact of the project on protected and sensitive lands.

Table 1-1. SEARs relevant to the assessment of aquatic biodiversity

Key Issue	Report Reference
Biodiversity The EIS must include: • an assessment of the likely impacts on listed aquatic threatened species, populations or ecological communities, scheduled under the *Fisheries Management Act 1994* (FM Act), and a description of the measures to minimise and rehabilitate impacts, and • if an offset is required, details of the measures proposed to address the offset obligations.	Section 5.4 includes assessment of impacts on threatened aquatic species, populations and ecological communities (listed under the FM Act) that are predicted in the study area. Section 5.6.1 addresses offset requirements

1.4 Structure of this report

The structure of the report is outlined below:

Chapter 1 – provides an introduction to the report and outlines relevant SEARs to be addressed.

Chapter 2 – provides an overview of relevant legislation, policies and guidelines applicable to the assessment.

Chapter 3 – describes the methodology and approach for the assessment.

Chapter 4 – describes the existing environment with respect to catchments, watercourses and threatened aquatic species and ecological communities found within the study area.

Chapter 5 – provides an assessment of the impacts to aquatic biodiversity from the construction, operation and decommissioning of the project and potential impacts on threatened species, populations and EECs. It also considers cumulative impacts on aquatic biodiversity from the combined effects of the project and any adjacent projects.

Chapter 6 - provides recommended avoidance and mitigation measures.

Chapter 7 – provides a summary of findings and conclusion.

Chapter 8 - provides a full reference list.

2. Legislative and policy context

2.1 Legislation

2.1.1 NSW legislation

2.1.1.1 Environmental Planning and Assessment Act 1979

The *Environmental Planning and Assessment Act 1979* (EP&A Act) and *Environmental Planning and Assessment Regulation 2021* (EP&A Regulation) establish a framework for the assessment and approval of developments in NSW. They also provide for the making of environmental planning instruments, including state environmental planning policies (SEPPs) and local environmental plans (LEPs), which determine the permissibility and approval pathway for development proposals and form a part of the environmental assessment process.

Section 4.36 of the EP&A Act provides for the declaration of a project as State Significant Development (SSD). Under the EP&A Act, the declaration of a project as SSD can be made by meeting the requirements of a SEPP or by the Minister for Planning and Homes.

Clause 20 of Schedule 1 of Planning Systems SEPP prescribes that development for the purpose of 'electricity generating works' that has a capital investment value of more than $30 million is SSD. The project has a capital investment value of greater than $30 million. Therefore, the project is declared as SSD and the development application for the project will be subject to the requirements of Division 4.7 of the EP&A Act. The development application will be lodged with the Planning Secretary of the Department of Planning and Environment (DPE).

The Minister for Planning and Homes is the consent authority for SSD projects. Section 4.5(1) of the EP&A Act also provides that the Independent Planning Commission (IPC) is the consent authority for SSD where it is declared to be the consent authority under an EPI. The Minister for Planning and Public Spaces has issued a general delegation of the consent authority function for SSD projects to the IPC in instances where more than 50 public objections are received on the application, where the applicant has made a reportable political donations disclosure and/or where the Local Council objects to the Project.

Section 4.41 of the EP&A Act identifies various authorisations which are not required for an SSD project. Of relevance to this assessment, the following authorisations are not required for approved SSD (and accordingly the provisions of any Act that prohibit an activity without such an authority do not apply):

- a permit under section 201, 205 or 219 of the FM Act
- a water use approval under section 89, a water management work approval under section 90 or an activity approval (other than an aquifer interference approval) under section 91 of the *Water Management Act 2000* (WM Act).

2.1.1.2 Fisheries Management Act 1994

The FM Act provides for the conservation, protection and management of fisheries, aquatic systems and habitats in NSW. The FM Act establishes mechanisms for:

- the listing of threatened species, populations and ecological communities or key threatening processes,
- the declaration of critical habitat, and
- consideration and assessment of threatened species impacts in the development assessment process.

Part 7A, section 221ZT(a) of the FM Act relates to the environmental assessment under Part 4 of the EP&A Act. Section 4 of this report identifies threatened species, populations and ecological communities listed under Schedule 4, 4A and 5 of the FM Act which are predicted to occur in the locality. In accordance with sections 221ZV and 221ZX of the FM Act, Appendix A of this report assesses likely impacts of the project (assessment of significance) on these listed species and Section 5 summarises the impacts of the project on threatened entities.

Construction works on watercourses do not require a permit for 'dredging' or 'reclamation' (section 201), harm to marine vegetation (section 205) or blockage of fish passage (section 219) in accordance with section 4.41 of the EP&A Act (approvals/legislation that do not apply for SSD). Regardless of the exemption to obtain permits, this assessment has considered potential impacts on watercourses based on fish habitat type as defined in *Policy and Guidelines for Fish Habitat Conservation and Management* (DPI, 2013).

Schedule 6 of the FM Act outlines the key threatening processes (KTPs) related to aquatic species and ecological communities. These are considered in section 5.4.2.

2.1.1.3 Biodiversity Conservation Act 2016

The *Biodiversity Conservation Act 2016* (BC Act) aims to avoid, minimise and offset impacts on biodiversity from development and conserve biodiversity at a bioregional and state scale. It lists a number of threatened species, populations and ecological communities to be considered in deciding whether there is likely to be a significant impact on threatened biota, or their habitats.

A Biodiversity Development Assessment Report (BDAR) has been prepared by Umwelt (2022) in accordance with Section 7.9 of the BC Act as part of the EIS. No threatened aquatic species listed under the BC Act were identified within the locality during database searches (section 4.8.1).

Groundwater dependent ecosystems (GDEs) protected under the BC Act have been identified within the study area and considered in section 4.4.

2.1.1.4 Water Management Act 2000

The WM Act recognises the need to allocate and provide water for the environmental health of our rivers and groundwater systems, while also providing licence holders with access to water. The object of the WM Act is the sustainable and integrated management of the state's water sources for the benefit of present and future generations.

Part 3 of the WM Act establishes three types of approvals that may be required to obtain. These are:

- water use approvals
- water management work approvals (water supply work approvals, drainage work approvals and flood work approvals)
- activity approvals (controlled activity approvals and aquifer interference approvals).

As noted above, under section 4.41 of the EP&A Act, approved SSD does not require a water use approval under section 89, a water management work approval under section 90 or an activity approval under section 91 of the WM Act. The aquifer interference approval provisions of the WM Act have not been activated in NSW at this stage, so there is no requirement for an aquifer interference approval.

The design and construction of the project would consider the *Guidelines for Controlled Activities on Waterfront Land: Riparian Corridors* (Department of Industry 2018; section 2.1.2.5) to enable the mitigation of potential impacts to water quality.

The impacts of the project on waterfront land are considered in section 5.6.2.

2.1.2 Policy and guidelines

Policy and guidelines are discussed in the following sections.

2.1.2.1 Policy and Guidelines for Fish Habitat Conservation and Management

The *Policy and Guidelines for Fish Habitat Conservation and Management* (DPI, 2013) outlines policies and guidelines aimed at maintaining and enhancing fish habitat for the benefit of native fish species, including threatened species, in marine, estuarine and freshwater environments.

It is applicable to all planning and development proposals and various activities that affect aquatic ecosystems in NSW.

One of the key objectives of the FM Act is to conserve 'key fish habitats' (KFH). KFH's are defined in the policy and guidelines to include all marine and estuarine habitats up to highest astronomical tide level (that reached by 'king' tides) and most permanent and semi-permanent freshwater habitats including rivers, creeks, lakes, lagoons, billabongs, weir pools and impoundments up to the top of the bank. Small headwater creeks and gullies (known as first and second order streams), that only flow for a short period after rain are generally excluded, as are farm dams constructed on such systems. Wholly artificial waterbodies such as irrigation channels, urban drains and ponds, salt and evaporation ponds are also excluded except where they are known to support populations of threatened fish or invertebrates.

The Department of Primary Industries - Fisheries (DPI) assesses activity and development proposals in relation to consideration for the 'sensitivity' of the affected fish habitat. In this context, 'sensitivity' is defined by the importance of the habitat to the survival of fish and ability to withstand disturbance.

If the aquatic habitat in question is defined as KFH, it is then assigned a fish habitat sensitivity ranking which is used within the policy and guideline statements to differentiate between permissible and prohibited activities or developments related to the importance of the 'type' of KFH. Table 2-1 defines those types of habitats that are considered KFH for the purpose of the application of the FM Act.

It is noted that for the purposes of the policy and guidelines, first and second order streams on gaining streams (streams where the channel bottom is lower than the level of the surrounding groundwater table so that water potentially moves from the ground into the channel) are not considered KFH. In addition, the definition of "fish" includes not only fin fish, but also crustaceans, molluscs, worms, insects and other invertebrates that spend all or part of their life cycle in aquatic habitats.

Table 2-1. Key fish habitat and sensitivity classification scheme (DPI, 2013)

Sensitivity Ranking	Waterway Description
TYPE 1 Highly sensitive key fish habitat	• Freshwater habitats that contain in-stream gravel beds, rocks greater than 500 mm in two dimensions, snags greater than 300 mm in diameter or 3 metres in length, or native aquatic plants • Any known or expected protected or threatened species habitat or area of declared 'critical habitat' under the FM Act
TYPE 2 Moderately sensitive key fish habitat	• Freshwater habitats and brackish wetlands, lakes and lagoons other than those defined in TYPE 1 • Weir pools and dams up to full supply level where the weir or dam is across a natural waterway
TYPE 3 Minimally sensitive key fish habitat may include	• Coastal and freshwater habitats not included in TYPES 1 or 2 • Ephemeral aquatic habitat not supporting native aquatic or wetland vegetation

The policy and guidelines also state that *"to ensure "no net loss" of aquatic habitats, NSW DPI requires that proponents should, as a first priority, aim to avoid impacts upon KFH. Where avoidance is impossible or impractical, proponents should then aim to minimise impacts. Any remaining impacts should then be offset with compensatory works"*.

KFH maps have been compiled by DPI and are considered in section 3.4.1 and the impacts of the project on KFH are discussed in section 5.6.1.

2.1.2.2 Why Do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings

Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings (Fairfull and Witheridge, 2003*)* provides guidelines for the planning, design, construction and maintenance of watercourse crossings aimed at minimising impacts on fish passage and aquatic biodiversity. The guidelines outline types of potential impacts from instream structures and subsequently provides guidance on suitable crossing structures to avoid barriers to fish passage.

DPI considers proposals in relation to habitat sensitivity type (Table 2-1) and also waterway class. The waterway classification scheme has been adapted from Fairfull and Witheridge (2003) and factors in the functionality of the waterway as fish habitat (Table 2-2). Watercourses are classified using indicators such as:

- hydraulic geometry (stream shape and size),
- frequency of stream flows (perennial, intermittent or ephemeral),
- presence of aquatic habitat units (pools, riffles, vegetation, snags),
- presence of threatened or protected fish species and other native fish, and
- connection to adjacent habitats (e.g. floodplain wetlands).

Waterway class can be used to assess the impacts of certain activities on fish habitats in conjunction with the habitat sensitivity type. The waterway class scheme can also be used to make management recommendations to minimise impacts on different fish habitats.

Table 2-2. Classification of waterways for fish passage (Fairfull & Witheridge, 2003)

Classification	Characteristics of waterway class	Minimum [1] Recommended Crossing type
Class 1 Major key fish habitat	Marine or estuarine waterway or permanently flowing or flooded freshwater waterway (e.g. river or major creek), habitat of a threatened or protected fish species or 'critical habitat'.	Bridge, arch structure or tunnel
Class 2 Moderate key fish habitat	Non-permanently flowing (intermittent) stream, creek or waterway (generally named) with clearly defined bed and banks with semi-permanent to permanent waters in pools or in connected wetland areas. Freshwater aquatic vegetation is present. TYPE 1 and 2 habitats present.	Bridge, arch structure, culvert [2] or ford.
Class 3 Minimal key fish habitat	Named or unnamed waterway with intermittent flow and sporadic refuge, breeding or feeding areas for aquatic fauna (e.g. fish, yabbies). Semi-permanent pools form within the waterway or adjacent wetlands after a rain event. Otherwise, any minor waterway that interconnects with wetlands or other CLASS 1-3 fish habitats.	Culvert [3] or ford
Class 4 Unlikely key fish habitat	Waterway (generally unnamed) with intermittent flow following rain events only, little or no defined drainage channel, little or no flow or free standing water or pools post rain events (e.g. dry gullies or shallow floodplain depressions with no aquatic flora present).	Culvert [4], causeway or ford
Notes [1] In all cases bridges are preferred to arch structures, culverts, fords and causeways (in that order).		

Classification	Characteristics of waterway class	Minimum [1] Recommended Crossing type
[2] High priority given to the "High Flow Design" procedures presented for the design of these culverts - refer to Design Considerations section of this document, or engineering guidelines (Witheridge, 2002). [3] Minimum culvert design using the "Low Flow Design" procedures; however, "High Flow Design" and "Medium Flow Design" should be given priority where affordable (refer to Witheridge (2002)). [4] Fish friendly waterway crossing designs possibly unwarranted. Fish passage requirements should be confirmed with the local fisheries department/authority.		

2.1.2.3 Threatened Species Survey and Assessment Guidelines

The NSW threatened species survey and assessment guidelines are referred to as the *Threatened Species Test of Significance Guidelines* (OEH, 2018).

The objective of section 7.3 of the BC Act, the test of significance, is to provide standardised and transparent consideration of threatened species and ecological communities, and their habitats, through the development assessment process.

The guidelines help applicants or proponents of a development or activity to interpret and apply the factors in the test. They also provide guidance for consent authorities to encourage a consistent method of assessment for applications that may have an impact on threatened species and ecological communities or their habitats. The guidelines relate to the determination of whether a proposed development or activity is likely to significantly affect threatened species or ecological communities, or their habitats, within the meaning of that phrase in section 7.3.

No aquatic threatened species or ecological communities listed under the BC Act were identified in desktop studies, hence these guidelines were not required for the aquatic impact assessment. These guidelines are relevant and considered further in the BDAR.

2.1.2.4 Aquatic Ecology in Environmental Impact Assessment – EIA Guideline

The aim of the guideline *Aquatic Ecology in Environmental Impact Assessment - EIA guideline* (NSW Department of Planning, 2003) (the EIA guideline) is to:

- Encourage a standardised, rigorous approach to aquatic investigations in environmental impact assessment.
- Provide information which can be used to understand and manage changes to the aquatic environment in NSW.

The guidelines provide reference for:

- The extent to which the existing environment needs to be described.
- The extent to which a proposal is likely to affect aquatic biodiversity.
- The minimal acceptable standard for assessment of potential impacts on aquatic biodiversity.
- Predicting cumulative impacts within a body of water.
- When monitoring should be done and what components of the aquatic environment (biotic and abiotic) should be monitored.
- Requirements for adequate information to manage potential impacts and initiate feedback from monitoring to management.

The existing environment, assessment and sampling methodology, potential impacts, as well as recommendations for mitigation measures which are outlined in this report have taken into consideration the EIA guidelines.

2.1.2.5 Guidelines for controlled activities on waterfront land

The *Guidelines for controlled activities on waterfront land: Riparian corridors* (DPI, 2018) include provision for the protection of waterfront land. Controlled activities include any works or any activity which affects the quantity or flow of water in a water source, carried out in, on, or under waterfront land.

Waterfront land includes the bed and bank of any river, lake or estuary and all land within 40m of the highest bank of the river, lake or estuary.

A key objective of these guidelines is to establish and preserve the integrity of riparian corridors. Ideally, the environmental functions of riparian corridors should be maintained or rehabilitated by applying the following principles:

- Identify whether or not there is a watercourse present and determine its order in accordance with the Strahler System.
- If a watercourse is present, define the riparian corridor/vegetated riparian zone (VRZ) on a map in accordance with Table 2-3.
- Seek to maintain or rehabilitate a riparian corridor/VRZ with fully structured native vegetation in accordance with Table 2-3.
- Seek to minimise disturbance and harm to the recommended riparian corridor/VRZ.
- Minimise the number of creek crossings and provide perimeter road separating development from the riparian corridor/VRZ.
- Locate services and infrastructure outside of the riparian corridor/VRZ. Within the riparian corridor/VRZ provide multiple service easements and/or utilise road crossings where possible.
- Treat stormwater run-off before discharging into the riparian corridor/VRZ.

Non-riparian corridor works such as infrastructure, can be authorised within the outer riparian corridor, so long as the average width of the VRZ can be achieved over the length of the watercourse within the development site.

While non-native vegetation may provide some bank stability, the objectives of the guidelines relate to the preservation and rehabilitation of native riparian vegetation in accordance with the minimum riparian corridor requirements.

Table 2-3. Recommended riparian corridor widths (DPI, 2018)

Watercourse type	VRZ width (each side of watercourse)	Total RC width
First order	10 metres	20 metres + channel width
Second order	20 metres	40 metres + channel width
Third order	30 metres	60 metres + channel width
Fourth order and greater	40 metres	80 metres + channel width

Note: Where a watercourse does not exhibit the features of a defined channel with bed and banks, the Natural Resources Access Regulator (NRAR) may determine that the watercourse is not waterfront land for the purposes of the WM Act.

The impacts of the project on riparian vegetation are considered in section 5.1.

2.1.3 Commonwealth legislation

2.1.3.1 Environment Protection and Biodiversity Conservation Act 1999

The objective of the EPBC Act is to protect and manage prescribed MNES. Under the EPBC Act, proposed 'actions' that have the potential to significantly impact on MNES, the environment of Commonwealth land, or that are being carried out by an Australian Government agency, must be referred to the Commonwealth Minister for the Environment for assessment.

On 2 February 2022, the project was determined to be a Controlled Action, requiring approval under the EPBC Act due to its potential impact on listed threatened species and ecological communities. The project will therefore be assessed under the bilateral agreement between the Commonwealth and NSW Governments. The Commonwealth Department of Climate Change, Energy, the Environment and Water (DCCEEW) (formerly the Department of Agriculture, Water, and the Environment) has issued its assessment requirements which have been incorporated into the SEARs for the project.

This aquatic biodiversity impact assessment concluded that there is unlikely to be any significant impacts to MNES relevant to aquatic biodiversity resulting from the project (refer section 5.5).

3. Methodology

3.1 Study area

The study area for the assessment included watercourses either directly or indirectly affected by the project, which was identified by application of a 10-km buffer around the Project Area (Figure 1-1). Section 3.5 describes the criteria for the selection of watercourses considered suitable for habitat assessments and fauna surveys.

Survey sites included a 100m reach along each watercourse (subject to property access and other constraints), within which habitat assessments and surveys were undertaken.

3.2 Desktop assessment

A desktop review of relevant guidelines, previous species sighting records, documents and reports relevant to the project was undertaken from the locality on 24/04/2022 using the following public ecological databases and websites:

- A search of the NSW Fisheries threatened species list (DPI, undated a) and Spatial Data Portal within the locality (which includes the four Local Government Areas (LGAs) surrounding the Project Area: Upper Hunter, Warrumbungle, Mid-Western Regional and Muswellbrook (DPI, undated b)), for Threatened species indicative distribution maps. The mapping provides the indicative (or known and expected) distributions for a number of NSW freshwater threatened species based on modelling. The indicative distribution means there is a high probability that the species would occur in a stream segment, given the species has been recorded there or the environmental conditions are the same as a stream segment where the species is already known to occur. Modelled indicative distribution maps are not available for all NSW freshwater threatened species due to the limited number of records for some species or the limited number of correlated environmental attributes (section 4.8.4). For threatened species where distribution maps were not available, habitat assessment and review of Primefacts (electronic resource produced by DPI)(elec for each individual species were used to determine their likely presence (DPI, undated c).
- A search of the Spatial Data Portal for the Central Rivers (DPI, undated b) was undertaken for KFH mapping (section 3.4.1) and Fish Community Status of NSW mapping and Fish Communities and Threatened Species Distribution of NSW Report prepared by DPI (DPI, 2016). The report rates the condition of fish communities as either Very Good, Good, Moderate, Poor or Very Poor (section 3.8).
- A search on the DCCEEW Protected Matters Search Tool (PMST) for MNES within 10 km of the Project Area (section 4.8.3).
- Species Profile and Threats Database, profiles and references therein for federally listed threatened species were used to determine likely occurrence and provide distribution and habitat information (Table 4-3).
- An area search was conducted within the BioNet website for the Atlas of NSW Wildlife (OEH, 2022). BioNet is a portal for accessing government held information about plants and animals in NSW. It is supported by several NSW government held agencies. BioNet contains records for aquatic threatened species and EEC's listed under the BC Act, the FM Act and the EPBC Act which have been recorded within the locality. The search was conducted for all protected species (threatened and non-threatened) within a 10 km buffer of the Project Area (section 4.8.1)
- A search of Atlas of Living Australia (ALA) records. ALA is a collaborative, digital, open infrastructure that pulls together Australian biodiversity data from multiple sources. A search of the ALA was conducted within a 10 km buffer for threatened species and protected species such as platypus and turtles (section 4.8.2).
- Review of Survey Guidelines for Australia's threatened fish (DSEWPC, 2011) to determine the likelihood of a species presence or absence at a site. The guidelines are not mandatory however, and desktop analysis of historic data can be used as an alternative survey approach.

- Review of DAWE Directory of Important Wetlands (DAWE 2022).

The information obtained was used to inform survey design and assist in the description of ecological context, assessment of potentially occurring threatened species, endangered populations (EPs) and threatened ecological communities (TECs).

3.3 Stream order mapping

The Strahler ordering system (Strahler, 1952), as described in NSW Government Gazette no. 37 on 24 March 2006 was used to characterise the watercourses within the study area.

The Strahler ordering system is a hierarchical numbering system based on the degree of branching within a watercourse and provides an indication of the complexity of a creek system. For the purposes of this order, watercourses are deemed to be continuous even if they lose definition and then reappear downstream. The methodology used is as follows:

- Starting at the top of a catchment, any watercourse which has no other watercourses flowing into it is classed as a first order stream (1).
- Where two first order streams join, the stream becomes a second order stream (2).
- If a second order stream is joined by a first order stream - it remains a second order stream.
- When two second order streams join, they form a third order stream (3).
- A third order stream does not become a fourth order stream until it is joined by another third order stream and so on.

Strahler stream orders for watercourses within the study area are listed in Table 3-2 and shown in Figure 3-2.

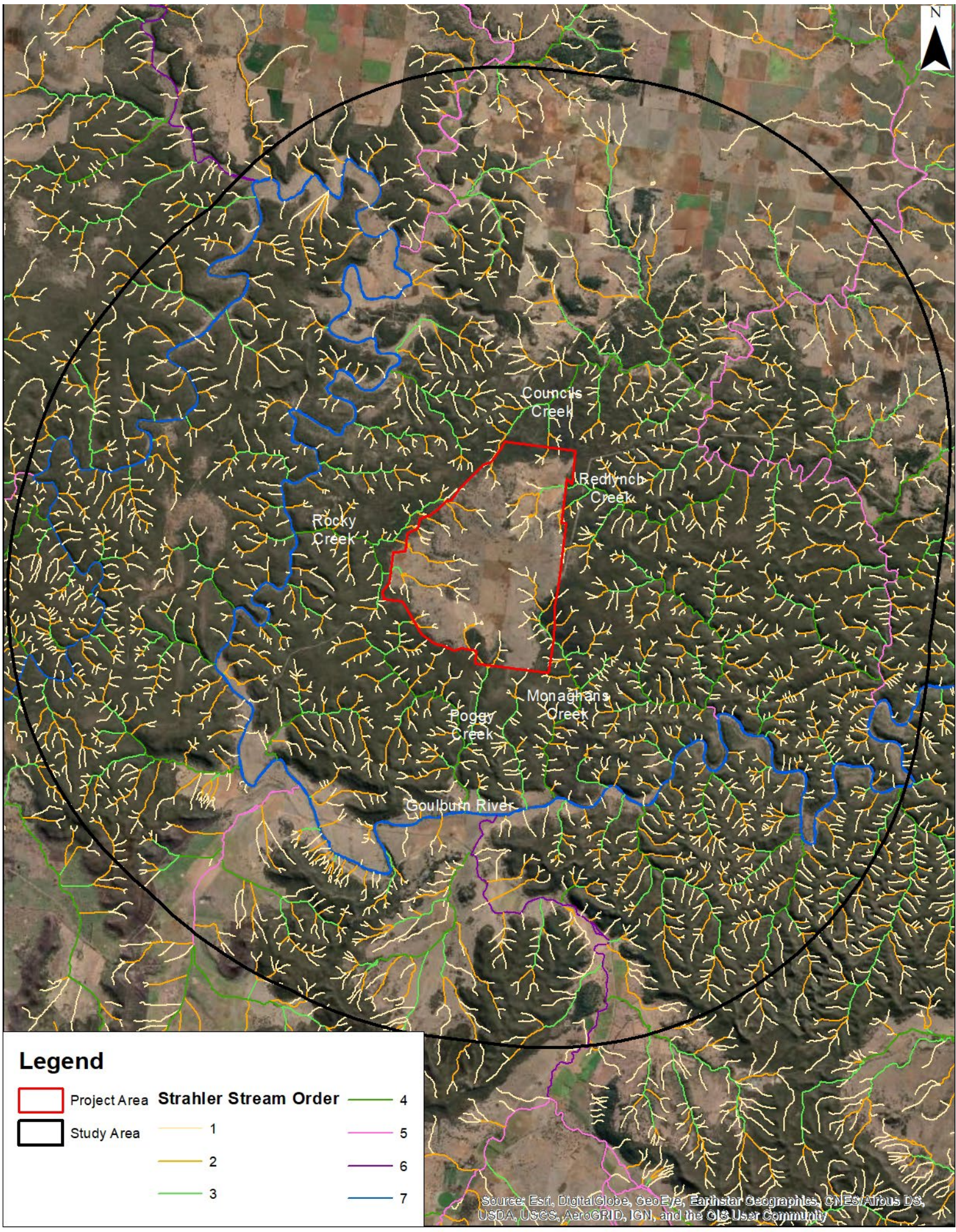


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Figure 3.1. Strahler Stream Order within the Study Area
Goulburn River Solar Farm
Job No. 220222 Date. 27/04/2022

3.4 Watercourse classification

3.4.1 Key fish habitat mapping

To meet the objectives of the FM Act to 'conserve key fish habitats', DPI identified KFH as those aquatic habitats that are important to the sustainability of the recreational and commercial fishing industries, the maintenance of fish populations generally, and the survival and recovery of threatened aquatic species.

A policy definition of the term KFH was developed to guide the compilation of maps. For freshwater environments, KFH was defined to include most permanent and semipermanent freshwater habitats including:

- Permanently flowing rivers and creeks including those where the flow is modified by upstream dam(s), up to the top of the natural bank regardless of whether the channel has been physically modified.
- Intermittently flowing rivers and creeks that retain water in a series of disconnected pools after flow ceases including those where the flow is modified by upstream dam(s), up to the top of the natural bank regardless of whether the channel has been physically modified.
- Billabongs, lakes, lagoons, wetlands associated with other permanent fish habitats (e.g. permanent rivers and creeks, estuaries etc.).
- Flood channels or flood runners that may normally be dry but would be used by fish to move/migrate across or along floodplains between habitats during high flow events.
- Any waterbody, if it is known to support or could be confidently expected (based on predictive modelling) to support threatened species, threatened populations or threatened communities listed under the provisions of Part 7A of the FM Act.

Small headwater creeks and gullies (known as first and second order streams), that only flow for a short period after rain were generally excluded, as were farm dams constructed on such systems. Wholly artificial waterbodies such as irrigation channels, urban drains and ponds, salt and evaporation ponds were also excluded except where they are known to support populations of threatened fish or invertebrates.

DPI KFH mapping is shown in Figure 3.2.

3.4.2 Key fish habitat sensitivity and class analysis

The *Policy and Guidelines for Fish Habitat Conservation and Management* (DPI, 2013) provides a framework to classify KFH types based on their aquatic habitat features as described in Table 2-1.

In addition to the habitat sensitivity type, DPI assesses proposals in relation to waterway class. The waterway classification scheme has been adapted from Fairfull and Witheridge (2003) and factors in the functionality of the waterway as fish habitat. The criteria by which the watercourse class is derived are defined in Table 2-2.

Within the Proposal Area, KFH Type and Class for each watercourse are discussed in section 4.5.

3.5 Determination of survey sites

Using electronic hydroline mapping, 90 mapped hydrolines (including drainage lines) were identified within the study area (Figure 3-2). This included 69 first order watercourses, 18 second order watercourses and three third order watercourses. Five watercourses have been mapped by DPI as KFH (2007) (Figure 3-2).

The criteria in Table 3-1 was used to rank these watercourses into one of three categories – high, moderate and low priority.

Table 3-1. Watercourse categories

Priority ranking	Criteria
High	• Key Fish Habitat (DPI, 2007). • Threatened fish species predicted to occur based on DPI mapping (DPI, 2016) and results of database searches (Protected Matters Search Tool and ALA (2021) records).
Medium	• Key Fish Habitat (DPI, 2007). • Third order or above (Strahler stream ordering system). • Identified as having nearby wetland habitat.
Low	• Threatened fish species unlikely to occur based on DPI (2016) mapping and results of database searches (Protected Matters Search Tool and ALA (2021) records). • Not Key Fish Habitat (DPI, 2007). • First or second watercourses order based on Strahler stream order.

Watercourses with a moderate or high priority ranking were assessed further and used for the selection of survey sites and potential targeted threatened species survey. Survey sites are summarised in Table 3-2, including coordinates and Strahler stream order. All watercourses within the project area flow into Goulburn River.

Table 3-2. Survey site identification, co-ordinates, watercourse, Strahler stream order

Survey Site	Latitude	Longitude	Map X	Map Y	Watercourse	Strahler Stream Order
1	-32.264574	150.122678	228956	6426603	Redlynch Creek	3
2	-32.264169	150.120131	228714	6426641	Redlynch Creek	3
3	-32.295687	150.113879	228219	6423130	Unnamed tributary of Monaghans Creek	3
4	-32.299578	150.092402	226208	6422643	Unnamed tributary of Poggy Creek	2
5	-32.283825	150.072266	224263	6424339	Unnamed tributary of Rocky Creek	3
6	-32.277082	150.076840	224674	6425099	Unnamed tributary of Rocky Creek	2
7	-32.258019	150.100655	226861	6427274	Unnamed tributary of Councils Creek	2
8	-32.355998	150.066366	223927	6416319	Goulburn River	7

[a] Coordinates taken from field Garmin GPS Map Datum GDA 1994 zone 56

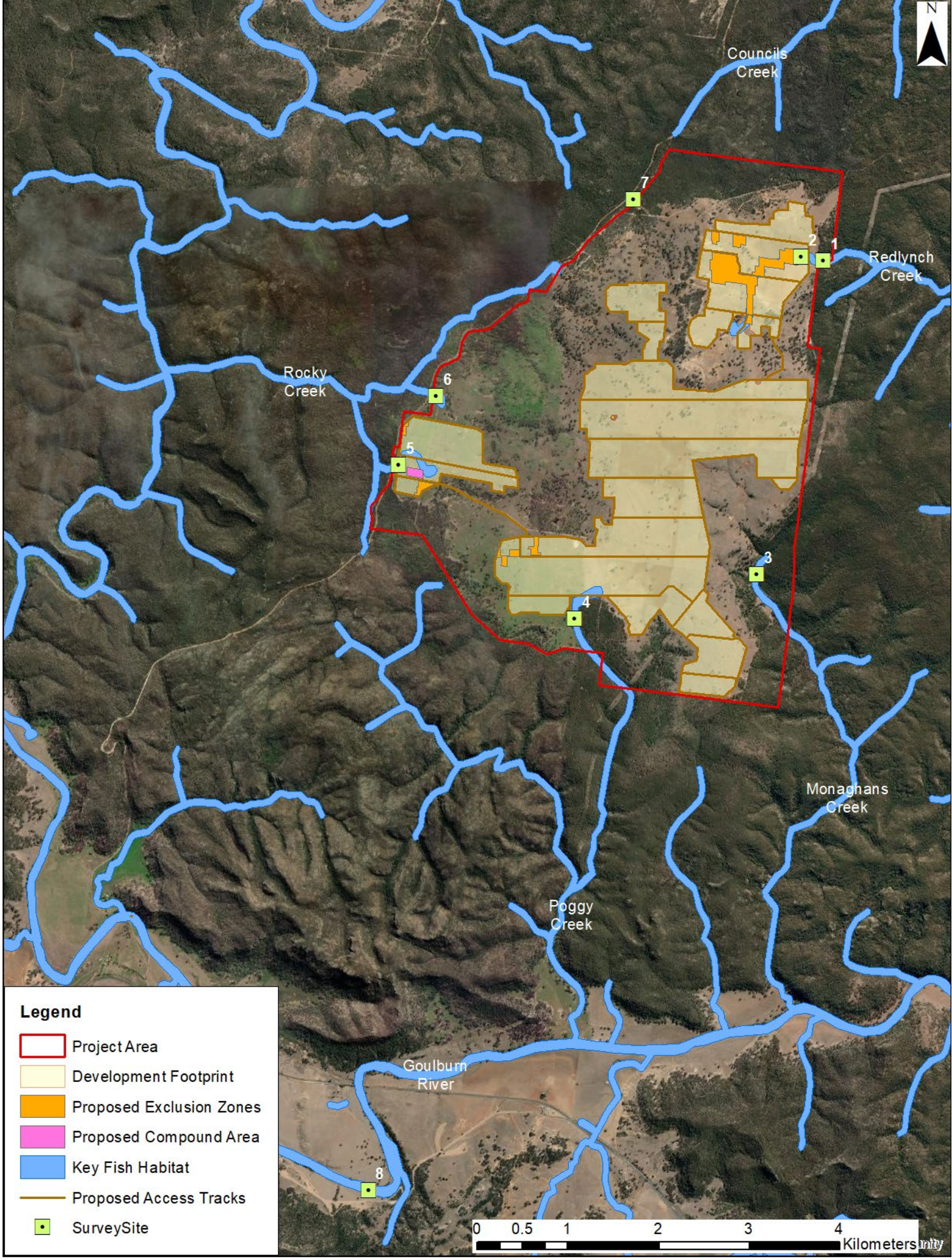

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Figure 3.2. Key Fish Habitat (DPI, 2016) and Survey Sites
Goulburn River Solar Farm
Job No. 220222
Date. 19/04/2023

3.6 Field survey

Preliminary mapping of the broad scale aquatic habitats within the study area was undertaken using recent aerial photography in conjunction with topographic maps prior to field surveys. Topographic maps were used to gain a broad understanding of catchment characteristics including adjacent land use, elevation, access routes and distance from source.

An aquatic survey was undertaken on 5-6th May 2022.

3.6.1 Habitat assessment

An assessment of the aquatic habitat at each of the survey sites was undertaken, and indicators of stream condition noted. The aquatic habitat characteristics were recorded using standard recording sheets (NSW AUSRIVAS, 2007) along with assessment of the suitability of the habitat for threatened species with potential to occur in the area.

Habitat features and stream condition indicators assessed include:

- Topography
- Water level (height of bank and evidence of erosion)
- Shading of the river
- Riparian vegetation (percent cover of upper, middle and lower stratum)
- Stream width (minimum, maximum., mode)
- Stream depth (minimum, maximum, mode)
- Identification of macrophytes
- Percent cover of aquatic vegetation (algae, moss, macrophytes)
- Percent cover of detritus
- Description of natural substrate (percent bedrock, boulder, cobble, clay etc)
- Per cent of total macrophytes that are submerged, emergent or floating
- Presence of drought and flood refuge areas
- Presence of pool, riffle and edge habitats
- Presence of natural or artificial barriers to fish passage upstream and downstream
- Visual assessment of disturbance related to human activities for:
    - water quality
    - instream habitat
    - riparian zone
    - catchment assessment

  Visual assessments are ranked using the following categories
    - no evidence of disturbance
    - little disturbance
    - moderate disturbance
    - high disturbance
    - extreme disturbance

Photographs were also taken upstream and downstream from the centre point of each survey site.

The results of the habitat assessment are presented in section 4.5.

3.6.2 Targeted threatened species survey requirements

Guidelines are available for sampling threatened aquatic species listed under the EPBC Act, however they are not available for threatened aquatic species listed under the FM Act. Where available, recommended sampling techniques targeting threatened species with potential to occur in the study area are summarised in Table 3-3.

Table 3-3. Summary of recommended survey techniques for target threatened species

Target threatened species	FM Act	EPBC Act	Recommended Sampling Techniques (DSEWPC, 2011)
Darling River Hardyhead *(Craterocephalus amniculus)*	EP	-	No specific guidelines are available for this species however Murray hardyhead guidelines recommend the use of scoop nets, small seines, fyke nets or un-baited traps.
Murray-Darling Basin population of Eel Tailed Catfish (*Tandanus tandanus*)	EP	-	No specific guidelines are available for this species
Southern Purple Spotted Gudgeon (*Mogurnda adspersa*)	E	-	No specific guidelines are available for this species however other gudgeon species are targeted using bait traps.

Within the Project Area, only Redlynch Creek contained remnant pools suitable for sampling (refer Table 3-4; Plates 1 and 2). The remnant pools were small and shallow (less than 0.5 metre depth) and bait traps were considered the most appropriate sampling technique. There was insufficient space and/or flows at these survey sites for the use of other recommended sampling techniques identified in Table 3-3.

Table 3-4. Fauna survey locations and sampling techniques

Survey site	Watercourse	Sample Technique[a]
1 (outside Project Area)	Redlynch Creek	3 bait traps
2	Redlynch Creek	3 bait traps

[a] Bait traps (0.5 metres long x 0.24 metres wide x 0.24 metres high) baited with chicken meal and sardines and left for 4 hours.

Plate 1. Bait trap at survey site 1, Redlynch Creek

Plate 2. Bait trap at survey site 2, Redlynch Creek

3.7 Riparian and aquatic vegetation survey and mapping

Riparian vegetation (percent cover of upper, middle and lower stratum and dominant species) and aquatic vegetation (macrophytes) were recorded using standard recording sheets (NSW AUSRIVAS, 2007). These results are provided in section 4.5.

In addition, the BDAR mapped the terrestrial vegetation within the study area and categorised it into plant community types (PCTs) using plot/transect data. The methodology used is discussed further in the BDAR. The BDAR terrestrial vegetation mapping was used to determine the type and extent of riparian vegetation within the Project Area. The area of riparian vegetation along each hydroline was calculated using the *Guidelines for controlled activities on waterfront land: Riparian corridors* (DPI, 2018; refer section 2.1.2.5 and Table 2-3 for methodology). The results are presented in section 4.7 and a discussion of riparian vegetation impacted by the project is provided in section 5.1.2.1.

3.8 Fish community status mapping

The Fish Communities and Threatened Species Distributions of NSW project (FCTSD) combined data collected over twenty years of biological surveys with standard statistical analysis and spatial distribution models, to provide mapping of the status of fish communities and threatened species distributions across NSW. The FCTSD project mapped the status of fish communities across NSW as Very Good, Good, Moderate, Poor, or Very Poor (DPI, 2016).

None of the watercourses within the Project Area were mapped, however Goulburn River was defined as ‘Fair’ to ‘Poor’ within the study area (Figure 3-3)

The fish community status mapping is useful in determining the importance of the habitat within the Project Area to threatened species that occur in the locality.

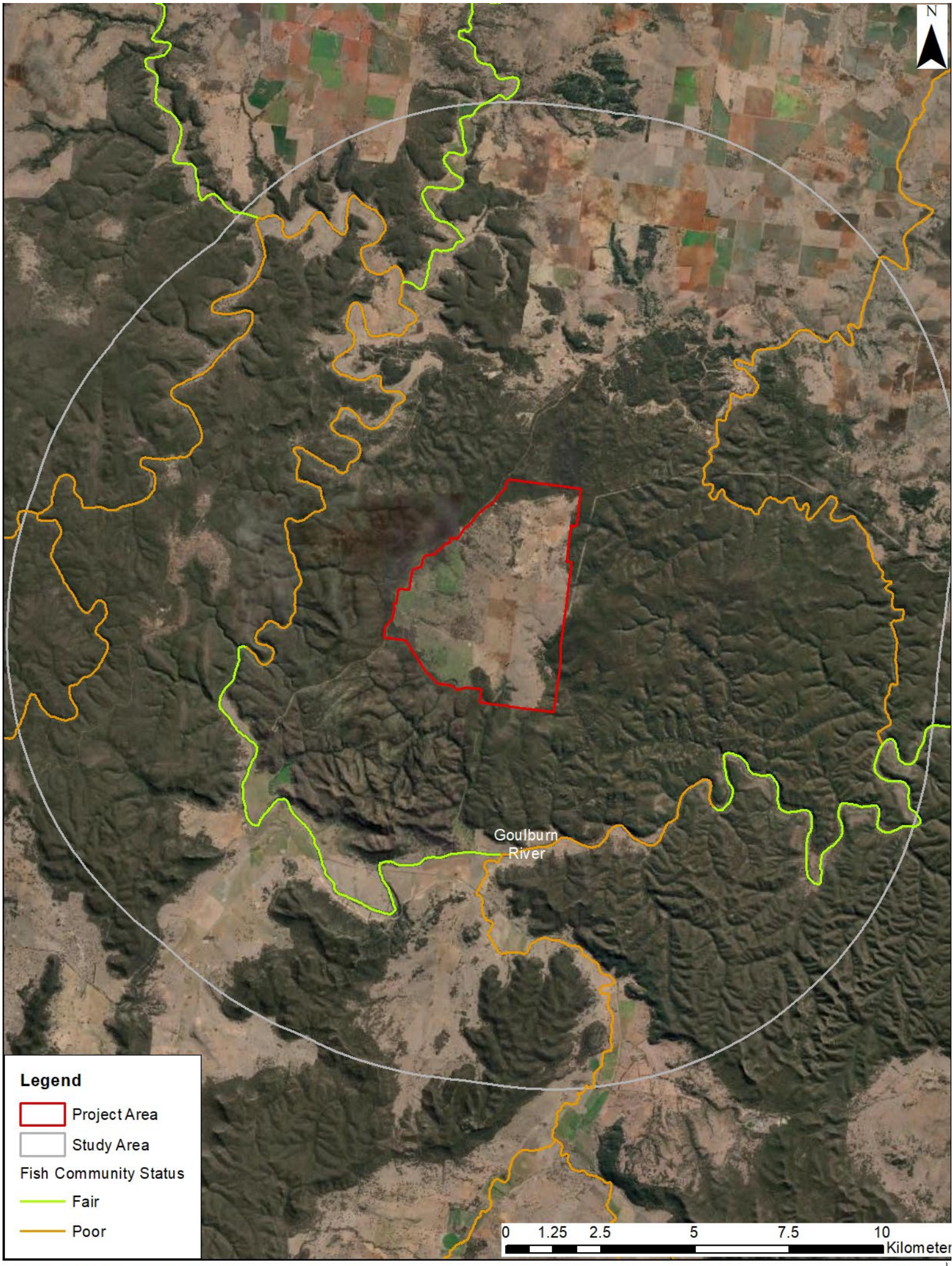

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Figure 3.3. Key Community Status Mapping (DPI, 2016)
Goulburn River Solar Farm
Job No. 220222 Date. 04/11/2022

3.9 Directory of important wetlands

The directory of important wetlands (DAWE, 2022) returned one important wetland: Hunter Estuary, however as this estuary is 150 km upstream of the Project Area, it will not be impacted by the project and does not require further assessment.

3.10 Risk of impact criteria

The criteria used to define the risk of impact of the project on watercourses within the study area are listed in Table 3-5. The risk of impact of the project during construction, operation and decommissioning is considered in section 5.

Table 3-5. Criteria for defining the risk of impact of the project on receiving watercourses

Risk of Impact	Criteria
Moderate	• Watercourse occurs within the Project Area, would be directly impacted by instream works or works within the riparian vegetation.
Low	• Watercourse is within the study area but outside the Project Area and provides potential habitat for threatened species and may be impacted indirectly by the project. • Watercourse is within the Project Area however construction activities would be minor, would not directly impact the watercourses and indirect impacts can be managed.
Negligible	• Watercourse is within the study area but outside the Project Area, is unlikely to provide habitat for threatened species and would not be directly impacted by construction activities. Indirect impacts can be managed. • Watercourse is within the Project Area and would be directly impacted by construction activities however the watercourse has been defined a low priority watercourse.

4. Existing environment

4.1 Weather and climatic conditions

The weather during surveys conducted between 5-6 May 2022 was fine and mild with air temperatures ranging between 4.5-22.7 degrees Celsius. Rainfall recorded 5 May 2022 was 14.2 millimetres (mm), mostly in the morning prior to the commencement of surveys (BOM, 2022a).

Most of NSW has received above average rainfall over the past 2.5 years, largely due to La Niña (BOM, 2022a). Thus, the area was not considered to be in drought at the time of survey.

4.2 Goulburn River

The watercourses within the Project Area are all tributaries of Goulburn River. Goulburn River in east New South Wales is in the Hunter/Central Rivers Catchment Management Authority and starts below Ulan at an elevation of 434m and ends at an elevation of 97.3m merging with the Hunter River near Denman. Goulburn River drops around 337m over its 221km length. It is the largest tributary of the Hunter River and accounts for 40 per cent of the Hunter River's catchment area, but contributes only 23 per cent of its flow.

4.3 Water Quality

Stream salinity is a significant management issue in the Hunter River basin. Sources of salt include rainfall and weathering products, which enter the stream via surface runoff pathways, and groundwater sources, particularly from Permian coal measures. Streams with identified groundwater interactions often have high salinities. In the Upper Goulburn River and Wollar Creek, median electrical conductivities exceed 2300 µS/cm (NSW EPA, 2013). Coal mining is thought to contribute to stream salinity, although this is difficult to confirm due to lack of long-term monitoring data and a highly variable climate.

Visual assessment of water quality was undertaken at each survey site using categories described (section 3.6.1). Watercourses with remnant pools present at the time of survey were categorised as having a low to moderate level of disturbance, attributed to catchment land use practices (i.e. farming). Visual assessments for each survey site are provided in section 4.5.

4.4 Groundwater Dependent Ecosystems

The Bureau of Meteorology's GDE Atlas (BOM, 2022b) provides the following groundwater dependent ecosystem definitions:

- Aquatic ecosystems that rely on the surface expression of groundwater – this includes 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 – this includes all vegetation ecosystems.
- Subterranean ecosystems – this includes cave and aquifer ecosystems.

The GDE Atlas does not map any aquatic GDEs within the study area however a portion of the study area has been defined as a low potential Terrestrial GDE (Figure 4-1).

The riparian vegetation associated with GDEs within the Project Area are discussed further in section 4.7. Further details regarding GDEs are available in the Water Resources Assessment (Umwelt, 2023) and the BDARs (Umwelt, 2023 further considers terrestrial GDEs.

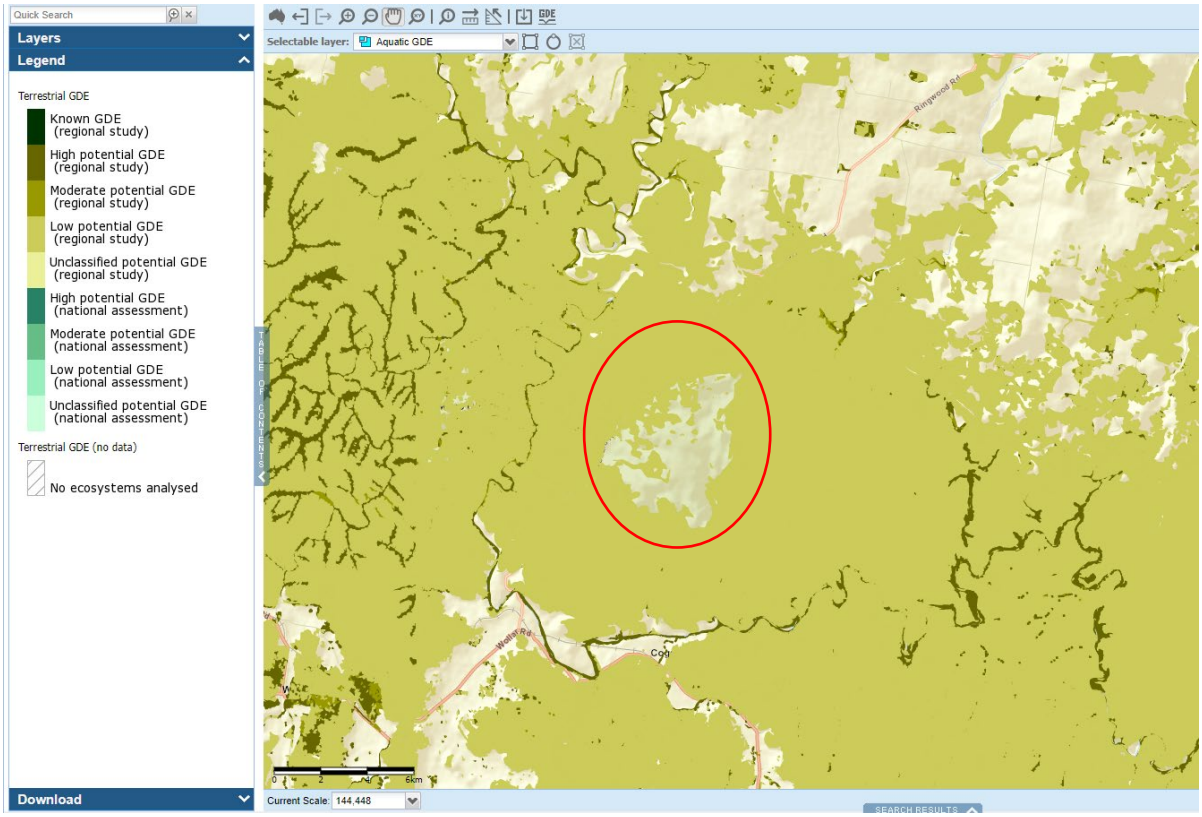


Figure 4-1. Terrestrial Groundwater Dependent Ecosystem (GDE) mapping (BOM)

4.5 Aquatic habitat within the study area

Watercourses were categorised into KFH habitat types based on their sensitivity (DPI, 2013), watercourse classifications (Fairfull and Witheridge, 2003) and identified aquatic features in the field surveys. This is discussed in section 4.5.1 to section 4.5.6 and summarised in Table 4-1.

4.5.1 Redlynch Creek

Site inspections were undertaken at two survey sites along Redlynch Creek (Figure 3-2). Survey site 1 is located outside of the Project Area in a steep valley within Goulburn River National Park. At this survey site, the average bank width of Redlynch Creek was five metres. Water was flowing along a low flow channel approximately one metre wide and numerous pools were present. Riffle sections included a diversity of habitat with bedrock, boulders, cobbles, pebbles, gravel, sand and silt all represented. Some large snags were present, along with detritus, trailing bank vegetation and bank overhangs. Riparian vegetation was intact and dominant canopy species included Narrow-leaved Ironbark *Eucalyptus fibrosa* and Brown Bloodwood *Corymbia trachyphloia*, with a middle stratum dominated by shrubs including Narrow-leaved Geebung *Persoonia linearis*, *Acacia sp.* and *Dodonaea triangularis*. The lower stratum was sparse due to exposed bedrock and boulders (which had a high proportion of surface area covered by moss), however species included some native grasses (Couch Grass *Cynodon dactylon*) and native ferns along with exotic grasses and herbs. Within the watercourse itself, macrophytes included *Juncus sp.* and Buttercup *Ranunculus sp.* The land use on both sides of the bank consisted of National Park.

Visual assessment indicated that the water quality, instream habitat and riparian zone had little evidence of disturbance, despite the intensive agriculture upstream, with clear water, limited instream disturbance and an intact riparian zone (Plates 3 and 4). At this survey site, the watercourse was defined as Type 2 moderately sensitive KFH.

Plate 3. Survey site 1: upstream

Plate 4. Survey site 1: downstream

Survey site 2 is in the northeast corner of the Project Area in a broad valley and is located approximately 280 metres upstream of survey site 1 (Figure 3-2). At survey site 2, the average bank width was 4 metres. Water was flowing along a low flow channel approximately one metre wide with several pools. Substrate consisted mainly of bedrock and clay however riffle sections were absent from this survey site. Due to the absence of riparian vegetation, no snags or detritus were recorded, and the degraded nature of the bank limited the presence of trailing bank vegetation and bank overhang. Riparian vegetation was highly disturbed from agricultural practices, and few remnant trees remained (only isolated Grey Box *Eucalyptus macrocarpa* and White Box *Eucalyptus albens*). The middle stratum was absent and the lower stratum consisted entirely of exotic grasses and herbs. Within the watercourse itself, macrophytes included *Juncus sp*. and Buttercup *Ranunculus sp*. The land use on both sides of the bank consisted of cleared agricultural land.

Visual assessment indicated that the water quality was moderately disturbed, while the instream habitat and riparian zone had a high level of disturbance through the presence of pumps for water extraction, filamentous algae, devegetation and bank degradation as cattle were not excluded from the edge of the watercourse (Plates 5 and 6).

Within the Project Area, Redlynch Creek had a high level of disturbance and provided limited aquatic habitat, however it was the only watercourse within the Project Area to have flowing water at the time of survey. At this survey site, the watercourse was defined as Type 3 minimally sensitive KFH.

Plate 5. Survey site 2: upstream

Plate 6. Survey site 2: downstream

4.5.2 Unnamed tributary Monaghans Creek

Survey site 3 is in the southeast corner of the Project Area in a steep valley (Figure 3-2). At this survey site, the average bank width was 8 metres with a low flow channel approximately one metre wide. No water was flowing at the time of survey. Riffle sections included a diversity of habitat with boulders, cobbles, pebbles, gravel, sand and silt all represented. Some large snags were present, along with detritus, trailing bank vegetation and bank overhangs. Riparian vegetation was intact and dominant canopy species included Narrow-leaved Ironbark *Eucalyptus fibrosa,* Grey Box *E. macrocarpa,* Spotted Gum *Corymbia maculata* and Black Pine *Callitris endlicheri* with a middle stratum dominated by a diversity of shrubs. The lower stratum was dominated by exotic grasses and herbs. No aquatic vegetation was recorded within the watercourse itself. The land use on both sides of the bank consisted of agricultural land, however due to the steepness of the valley, a wide riparian vegetation zone has been retained (Plate 7 and 8).

Visual assessment indicated that the instream habitat and riparian zone had little evidence of disturbance, despite the intensive agriculture upstream.

Due to the steepness of the surrounding topography, there are limited opportunities for water pooling and as such, there was limited aquatic habitat available. At this survey site, the watercourse is defined as Type 3 minimally sensitive KFH.

Plate 7. Survey site 3: upstream

Plate 8. Survey site 3: downstream

4.5.3 Unnamed tributary Poggy Creek

Survey site 4 is in the south of the Project Area in a broad valley (Figure 3-2). At this survey site, the banks were not well defined, however the average bank width was one metre wide. No water was flowing at the time of survey however the area was wet (approximately 10 cm deep). No riffle sections were present and despite the presence of regrowth in the canopy, large snags were absent. There was limited detritus and no bank overhangs or trailing bank vegetation. Riparian vegetation was disturbed, with sparse regrowth including Narrow-leaved Ironbark *Eucalyptus fibrosa*, Grey Box *E. macrocarpa* and Brown Bloodwood *C. trachyphloia*, a sparse middle stratum including *Acacia implexa, Pomaderris sp*. and a lower stratum consisting of exotic grasses and herbs. The watercourse was dominated by the exotic creeper *Tradescantia albiflora*.

Visual assessment indicated that the instream habitat and riparian zone had a moderate level of disturbance from the invasion by exotic species in the instream zone, and the devegetation of the riparian zone (Plates 9 and 10).

The watercourse at this survey site had a high level of disturbance and provided limited aquatic habitat. At this survey site, the watercourse was defined as Type 3 minimally sensitive KFH.

Plate 9. Survey site 4: upstream

Plate 10. Survey site 4: downstream

4.5.4 Unnamed tributaries of Rocky Creek

Site inspections were undertaken at two survey sites along Rocky Creek on the western boundary of the Project Area in a broad valley (Figure 3-2). At survey site 5, the channel had been modified through the construction of a farm dam however there was some bank definition downstream of the farm dam before the watercourse crossed Wollara Road via a pipe culvert. At this survey site, the average bank width was 4 metres. No water was flowing at the time of survey, and apart from the farm dam, no pools were present nor were there any riffle sections. The substrate consisted mainly of sand and silt, and there were no aquatic habitat features such as snags, detritus, trailing bank vegetation, bank overhangs or aquatic vegetation. Riparian vegetation had been cleared with no upper or middle stratum species present, and the lower stratum was dominated by exotic grasses and herbs. The land use on both sides of the bank consisted of farmland.

Visual assessment indicated that the water quality, instream habitat and riparian zone had a high level of disturbance, through the alteration of natural hydrology (i.e. farm dam), bank erosion and devegetation of the riparian zone, and there was limited aquatic habitat present (Plates 11 and 12). The dam may however provide habitat for protected aquatic species such as eels, turtles and crustaceans.

At this survey site, the watercourse was defined as Type 3 minimally sensitive KFH.

Plate 11. Survey site 5: upstream

Plate 12. Survey site 5: downstream

At survey site 6, the channel had also been modified through the construction of a farm dam, however there was some bank definition downstream of the farm dam before the watercourse crossed Wollara Road via a pipe culvert. At this survey site, the average bank width was 10 metres. No water was flowing at the time of survey, and apart from the farm dam, no pools were present and there were no riffle sections. The substrate consisted mainly of sand and silt, and there were no aquatic habitat features such as snags, detritus, trailing bank vegetation, bank overhangs or aquatic vegetation. Riparian vegetation had been cleared with no upper or middle stratum species present, and a lower stratum dominated by exotic grasses and herbs. The land use on both sides of the bank consisted of farmland.

Visual assessment indicated that the water quality, instream habitat and riparian zone had a high level of disturbance, through the alteration of natural hydrology (i.e. farm dam), bank erosion and devegetation of the riparian zone, and there was limited aquatic habitat present (Plates 13 and 14). The farm dam may however provide habitat for protected aquatic species such as eels, turtles and crustaceans.

At this survey site, the watercourse is defined as Type 3 minimally sensitive KFH.

Plate 13. Survey site 6: upstream dam

Plate 14. Survey site 6: downstream

4.5.5 Unnamed tributary of Councils Creek

Survey site 7 is located on an unnamed tributary of Councils Creek. The survey site is on the western boundary of the Project Area in a broad valley (Figure 3-2). The watercourse at this survey site had limited bank definition and an average bank width of one metre. No water was flowing at the time of survey, however there were some small pools (less than 20 cm deep). There were no riffle sections, trailing bank vegetation, bank overhangs or aquatic vegetation however there were snags and detritus. The substrate consisted mainly of sand and silt. Riparian vegetation was relatively intact, however the proximity of Wollara Road did impact the riparian zone. Canopy species included Narrow-leaved Ironbark *E. fibrosa,* Grey Box *E. macrocarpa* and Brown Bloodwood *C. trachyphloia*. Middle stratum consisted of a dense shrub layer and the lower stratum consisted of a mix of native and exotic grasses and herbs. The land use on both sides of the bank consisted of farmland, road and access roads.

Visual assessment indicated that the water quality was poor due to the proximity of the road and access roads, resulting in bare, unstabilised substrate, while the riparian zone was relatively intact with a low level of disturbance. There was limited aquatic habitat present (Plates 15 and 16). At this survey site, the watercourse is defined as Type 3 minimally sensitive KFH.

Plate 15. Survey site 7: upstream

Plate 16. Survey site 7: downstream

4.5.6 Goulburn River

Goulburn River is the only perennial watercourse within the study area, however it is outside of the Project Area (Figure 3-2). At survey site 8, this river was approximately 30 m wide and there were moderate flows. Riparian vegetation had been largely cleared for farmland, with only a few remnant trees remaining, no middle stratum species and a lower stratum consisting of exotic grasses and herbs. There were limited snags (due to the absence of riparian vegetation), no large rocks or native aquatic plants however the reach did contain sandy/gravel beds. The land use on both banks and the broader catchment consisted of rural properties and rail and road infrastructure.

Visual assessment indicated that the water quality and instream habitat had little to moderate signs of disturbance, while the riparian zone had been highly disturbed through past clearing of the riparian vegetation and the intensive agricultural land use within the catchment (Plates 17 and 18).

At this survey site, the watercourse is defined as Type 1 highly sensitive KFH.

Plate 17. Survey site 8: upstream

Plate 18. Survey site 8: downstream

4.6 Summary of aquatic habitat within the study area

Table 4-1 summarises the watercourses within the study area, including their KFH sensitivity (Type) and the watercourse Class. In summary, all watercourses within the Project Area were defined as Type 3 minimally sensitive KFH based on the absence of important aquatic habitat features and only Redlynch Creek (survey site 2) had flowing water at the time of survey despite recent rainfall events.

The lack of flowing water and only limited refuge areas observed in a year with above average rainfall indicates that these watercourses are highly ephemeral, only holding water for a short period following rain events, and draining away quickly, leaving limited aquatic fauna refuge areas.

The presence of macrophytes/aquatic vegetation is an important habitat feature in defining the type and sensitivity of KFH as it provides refuge, breeding and foraging habitat. There are three types of aquatic vegetation:

- submerged;
- floating; and
- emergent.

While some of the survey sites contained sparse cover of emergent macrophytes (i.e. *Juncus sp.*), they did not contain submerged or floating macrophytes. The presence of sparse, emergent macrophytes is not considered to be an important habitat feature for aquatic fauna.

Another important habitat feature in defining the type and sensitivity of KFH is the presence of in-stream gravel beds, rocks greater than 500 mm, snags greater than 300 mm in diameter or three metres in length. Within the Project Area, Redlynch Creek (survey site 2) contained bedrock and gravel and the unnamed tributary of Monaghans Creek (survey site 3) contained bedrock, cobbles, pebbles and gravel. No other watercourses at survey sites contained instream gravel beds or riffle sections. Only the unnamed tributary of Monaghans Creek (survey site 3) contained large snags.

Most of the survey sites contained limited bank overhang and trailing bank vegetation which are also important habitat features as they provide habitat for macroinvertebrates and therefore foraging resources for native fish species.

Watercourse Class is mainly used to determine the minimum crossing type required to maintain fish passage. Except for Redlynch Creek, all watercourses (at survey sites) within the Project Area were defined as Class 4 unlikely KFH (Table 4-1), in which case fish friendly waterway crossing designs are unwarranted. Redlynch Creek at the survey site was defined as a Class 3 minimal KFH and therefore the minimum crossing structures are a culvert or ford (in that order of preference (refer Table 2-2)).

The fish community status along the Goulburn River where it occurs within the study area, has been rated as poor to fair (DPI, 2016; Figure 3-3), which represents a fish community in low to moderate health. No other watercourses within the study area were ranked as part of the fish community status mapping project.

Table 4-1. Watercourses within the Project Area, Key Fish Habitat Type and Watercourse Class

Survey Site	Watercourse	Water present[a]?	Strahler stream order	Habitat Type[b]	Class[c]
1	Redlynch Creek (outside of Project Area)	Yes	3	Type 2 moderately sensitive KFH (contains snags greater than 300 mm in diameter, riffle sections, native aquatic plants).	Class 2 moderate KFH (clearly defined banks, semi permanent water in pools, freshwater aquatic vegetation present).
2	Redlynch Creek	Yes – only in residual pools.	3	Type 3 minimally sensitive KFH (does not contain snags, native aquatic vegetation, instream gravel beds and is ephemeral).	Class 3 Minimal KFH (defined channel, some aquatic vegetation, connected farm dam, some refuge pools present).
3	Unnamed tributary of Monaghans Creek	No	3	Type 3 minimally sensitive KFH (contains snags greater than 300 mm in diameter, but lacks aquatic vegetation, instream gravel beds and is highly ephemeral).	Class 4 Unlikely KFH (defined channel but no aquatic vegetation, steep gully so limited refuge even after rain events).
4	Unnamed tributary of Poggy Creek	No	2	Type 3 minimally sensitive KFH (does not contain snags, native aquatic vegetation, instream gravel beds and is highly ephemeral).	Class 4 Unlikely KFH (intermittent flows only after rain events, no defined channel, little or no flow post rain events and no aquatic flora present).
5	Unnamed tributary of Rocky Creek	No	3	Type 3 minimally sensitive KFH (does not contain snags, native aquatic vegetation, instream gravel beds and is highly ephemeral).	Class 4 Unlikely KFH (constructed dam along drainage line, intermittent flows only after rain events, no defined channel, little or no flow post rain events and no aquatic flora present).
6	Unnamed tributary of Rocky Creek	No	2	Type 3 minimally sensitive KFH (does not contain snags, native aquatic vegetation, instream gravel beds and is highly ephemeral).	Class 4 Unlikely KFH (constructed dam along drainage line, intermittent flows only after rain events, no defined channel, little or no flow post rain events and no aquatic flora present).
7	Unnamed tributary of Councils Creek	No	1	Type 3 minimally sensitive KFH (does not contain snags, native aquatic vegetation, instream gravel beds and is highly ephemeral).	Class 4 Unlikely KFH (intermittent flows only after rain events, no defined channel, little or no flow post rain events and no aquatic flora present).
8	Goulburn River (outside of Project Area)	Yes	7	Type 1 highly sensitive KFH (contains instream gravel beds, rocks greater than 500 mm, snags greater than 300 mm or 3 metres in length however no native aquatic vegetation within the survey site.	Class 1 major KFH (named perennial watercourse, potential habitat for threatened species (Darling River Hardyhead *C. amniculus*).

[a] within a 100 metre reach centred on the survey site; [b] Habitat Sensitivity Type: *Policy and guidelines for fish habitat conservation and management* (DPI, 2013);

[c] Classification of Watercourse for Fish Passage: *Why do fish need to cross the road? Fish passage requirements for waterway crossings* (Fairfull & Witheridge, 2003); KFH=Key Fish Habitat.

4.7 Riparian vegetation

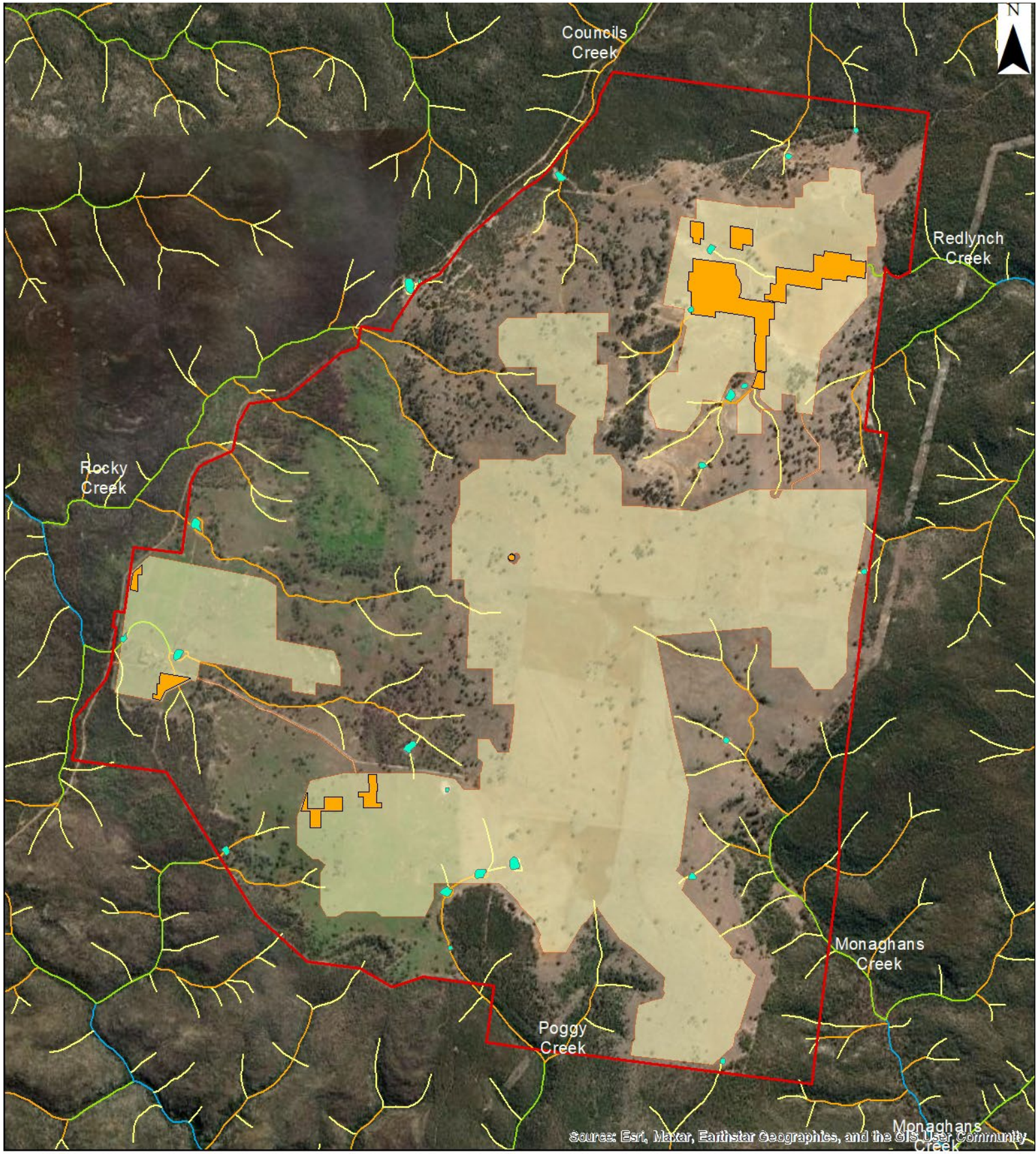
Where a watercourse does not exhibit the features of a defined channel with bed and banks, the watercourse is not waterfront land for the purposes of the WM Act (DPI, 2018). Thus, for the purpose of this assessment, vegetation has only been defined as riparian vegetation where it is associated with a hydroline defined as moderate to high priority watercourses. The impacts of the project on non-riparian vegetation are considered in the BDAR.

In addition, while non-native riparian vegetation may provide some bank stability, the preservation of non-native riparian vegetation is not an objective in the *Guidelines for controlled activities on waterfront land* nor does its removal trigger the KTP 'Degradation of native riparian vegetation along NSW watercourses'. As such, non-native vegetation is not included in the calculation of riparian vegetation. For example, where field surveys determined that the vegetation along a hydroline consisted 100% of exotic grasses and herbs in the lower stratum, with no middle or upper stratum, this was not defined as riparian vegetation, despite being assigned a PCT in the BDAR.

As the Development Footprint has been situated largely outside of mapped hydrolines and exclusion zones were modified in the design phase to exclude much of Redlynch Creek and associated riparian vegetation, no native riparian vegetation would be impacted by the project. Three isolated patches of PCT 483 Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley occurred on unnamed tributaries within the Development Footprint, however these tributaries lacked a defined channel and therefore these patches of PCT 483 Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley are not considered riparian vegetation.

4.8 Farm dams

Seven farm dams occur within the development footprint, which likely provide habitat for protected aquatic species such as eels, turtles and crustaceans (Figure 4-2).



COAST ECOLOGY
ENVIRONMENTAL ASSESSMENTS

Figure 4.2. Farm dams within the project area
Goulburn River Solar Farm
Job No. 220222 Date. 19/04/2023

4.9 Threatened species, populations and ecological communities

4.9.1 NSW BioNet

The BioNet search tool for past records did not contain any records of threatened aquatic species in the study area but did have records of protected species including four Platypus *Ornithorhynchus anatinus* records and six Eastern Snake-necked Turtle *Chelodina longicollis* records.

4.9.2 Atlas of Living Australia

No threatened aquatic species were recorded on the ALA (2022) however it did contain records of the following 10 protected species within the study area:

1. Flathead Gudgeon *Philypnodon grandiceps*
2. Inland Galaxias *Galaxias olidus*
3. Cox Gudgeon *Gobiomorphus coxii*
4. Firetail Gudgeon *Hypseleotris galii*
5. Western Carp Gudgeon *Hypseleotris klunzingeri*
6. Jackass Morwong *Nemadactylus macroptera*
7. Teethies *Platycephalus richardsoni*
8. Platypus *O. anatinus*
9. Macquarie River Turtle *Emydura macquarii macquarii*
10. Eastern Snake-necked Turtle *C. longicollis*.

4.9.3 Protected matters search tool

The results of the searches of PMST are provided in Table 4-2. Terrestrial threatened and migratory species and terrestrial EEC's are considered in the BDAR. Only MNES relating to the aquatic environment are considered further in this assessment.

Table 4-2. Matters of National Environmental Significance within the locality

MNES	Results of PMST Report	Relevance to the Aquatic Assessment
Listed threatened species	35	No threatened aquatic species are predicted to occur in the study area. All threatened species are terrestrial and have been assessed in the BDAR.
Listed TECs	8	No aquatic TECs are predicted to occur in the study area. All listed TECs are terrestrial and have been considered in the BDAR.
Listed Migratory species	12	No aquatic migratory species are predicted to occur in the study area. All migratory species are birds and have been assessed in the BDAR
Ramsar wetlands of international importance	1 Hunter Estuary	N/A Refer to section 3.9
Commonwealth Marine Area	None	N/A
World Heritage properties	None	N/A

MNES	Results of PMST Report	Relevance to the Aquatic Assessment
National Heritage places	None	N/A
Great Barrier Reef Marine Park	None	N/A

4.9.4 DPI website and Fisheries spatial data portal

Review of DPI threatened species list, species profiles including Primefacts and threatened species indicative distribution maps resulted in two endangered populations and one endangered species listed under the FM Act, that have an indicative distribution within the locality (i.e. Upper Hunter, Warrumbungle, Mid-Western Regional and/or Muswellbrook Local Government Areas (LGAs)) (Table 4-3;Figure 4-3).

Table 4-3 considers if the study area contains suitable distribution/habitat for these threatened species/populations to determine target species for survey.

Table 4-3. Likelihood of occurrence for threatened species/populations previously recorded in the locality

Species	Status	Description, distribution and habitat preferences	Likelihood of occurrence in the study area
Darling River Hardyhead population in the Hunter River catchment *Craterocephalus amniculus*	EP FM Act	The Darling River Hardyhead is a small-bodied native fish that occurs in the upper tributaries of the Darling River near the Queensland-New South Wales border. A small population also occurs in the Hunter River catchment. The population in the Hunter River catchment has always been relatively small. The Darling River Hardyhead population in the Hunter River catchment is listed as an endangered population in NSW. The species is most commonly found in the north-east part of the Murray-Darling Basin, especially in the MacIntyre, Namoi other border rivers. The Hunter River population is the only known occurrence of the species in an eastward flowing river. They are usually found in slow flowing, clear, shallow waters or in aquatic vegetation at the edge of such waters. The species has also been recorded from the edge of fast flowing habitats such as the runs at the head of pools. They are usually found singly or in small or large schools of up to about 50 fish. Little data has been recorded on the reproductive biology of the species, however it is closely related to the Murray hardyhead (*Craterocephalus fluviatilis*), which is considered a short lived (annual) species with an extended breeding season from spring through to autumn. The eggs will usually be deposited amongst aquatic vegetation. Darling River Hardyheads primarily eat algae and fly larvae, but have also been seen to feed on small insects. In addition to its natural rarity, the species is threatened by a number of processes including habitat degradation, thermal pollution, water extraction and predation and competition from alien fish.	Moderate The study area (Goulburn River) occurs within the indicative distribution for this species (DPI, 2016) and sections of the Goulburn River may provide suitable habitat for this species. As such, this species has been included in an assessment of significance of impact (section 5.4, Appendix A).
Eel-tailed Catfish *T. tandanus* in the Murray-Darling Basin	EP FM Act	Eel-Tailed Catfish is a medium-sized fish with a large head and a compressed rear portion of the body. It has a relatively long life span, living for at least 8 years. Individuals have been reported to grow to 900 mm in length and 6.8 kg in weight; however they are more likely to grow to 500 mm and 2 kg. The western population was once highly abundant and widespread throughout the Murray-Darling River System in	Low The study area is outside of the indicative distribution for this species (DPI, 2016), and identified indicative watercourses for this species are not linked to the Goulburn River and its tributaries.

Species	Status	Description, distribution and habitat preferences	Likelihood of occurrence in the study area
		NSW, Queensland, Victoria and South Australia. However, in NSW most riverine populations have declined significantly since the 1970s, and the species is no longer common in many areas where it was formally abundant. Eel-Tailed Catfish is now rare or absent from many rivers and creeks in Victoria as well as many of the major tributaries in NSW including the central Murray, Darling, Murrumbidgee, Lachlan, Paroo and Warrego Rivers. The Murray-Darling Basin population of Eel-Tailed Catfish is listed as an endangered population in NSW. Eel-tailed Catfish is a non-migratory, benthic (bottom dwelling) species. It is relatively sedentary and adults typically only move within a 5 km range. Individuals are more active at night compared with during the day. The species inhabits a diverse range of freshwater environments including rivers, creeks, lakes, billabongs and lagoons. It prefers clear, sluggish or still waters, but can also be found in flowing streams with turbid waters. Substrates range from mud to gravel and rock. Individuals are sexually mature at 3-5 years of age and spawn in spring/summer when water temperatures are 20-24ºC. Males construct and defend a nest up to 2 metres in diameter, made from pebbles and gravel. Eel-Tailed Catfish is predominantly an opportunistic carnivore, feeding mainly on small fish, freshwater prawns, yabbies, snails, aquatic insects and zooplankton. The species is threatened by loss of habitat through river regulation, predation and competition from alien fish, reduced success of spawning and recruitment due to alterations to flow patterns and flooding regimes, thermal pollution, chemical pollution and historic overfishing.	
Southern Purple-Spotted Gudgeon *M. adspersa*	E FM Act	Southern Purple Spotted Gudgeon is listed as an endangered species in NSW. Two populations of Southern Purple Spotted Gudgeon occur in NSW; an eastern population found in coastal catchments north of the Clarence River, and a western population found throughout the Murray-Darling Basin. During the early 1980s, the Murray-Darling Basin population experienced rapid and	Moderate The study area is outside of the indicative distribution for this species (DPI, 2016), however there are some downstream tributaries of the Goulburn River within the indicative distribution mapping. As such, this species has been included in an assessment of significance of impact (section 5.4, Appendix A).

Species	Status	Description, distribution and habitat preferences	Likelihood of occurrence in the study area
		dramatic reductions in distribution and abundance. The population is now confined to small remnant populations in the Macquarie, Gwydir and Border Rivers catchments and a self-sustaining population created from captive-bred fish in the Castlereagh Catchment. Since all remaining populations in the western region are small, isolated and disconnected from each other, there is limited gene flow between populations. There have been few recent records of the eastern population despite targeted sampling at those locations where the species has previously been found. Only two extant populations are known, one in the Richmond catchment and the other in the Hunter Valley. However, the population in Goorangoola Creek (Hunter River catchment) is outside what was previously considered the natural range of the species and it remains unknown whether the population is endemic or recently introduced. Southern Purple Spotted Gudgeon are a benthic species that can be found in a variety of habitat types such as rivers, creeks and billabongs with slow-moving or still waters or in streams with low turbidity. Cover in the form of aquatic vegetation, overhanging vegetation from riverbanks, leaf litter, rocks or snags are important for the species. Most remnant populations in NSW occur in small to medium sized streams. They feed mainly on terrestrial insects and their larvae, worms, small fish, tadpoles, and some plant matter. Eggs are deposited in clusters on solid objects such as rocks, wood or broadleafed plants. The male guards and fans the eggs until they hatch (3 - 8 days). The species is threatened by loss of habitat, changes in water levels from river regulation, predation and competition from alien fish, reduced success of spawning and recruitment due to alterations to flow patterns and flooding regimes, increased turbidity and damage of stream banks by livestock access and thermal pollution.	

4.9.5 Summary of database searches

Database searches resulted in one endangered population and one endangered species being identified as target species for further assessment (Table 4-3):

- Darling River Hardyhead (*C. Amniculus)* - Endangered population under the FM Act
- Southern Purple-Spotted Gudgeon (*M. Adspersa)* - Endangered species under the FM Act.

No threatened species listed under the EPBC Act have been previously identified in the study area, nor are the watercourses within the study area considered likely to provide habitat for any threatened species listed under the EPBC Act.

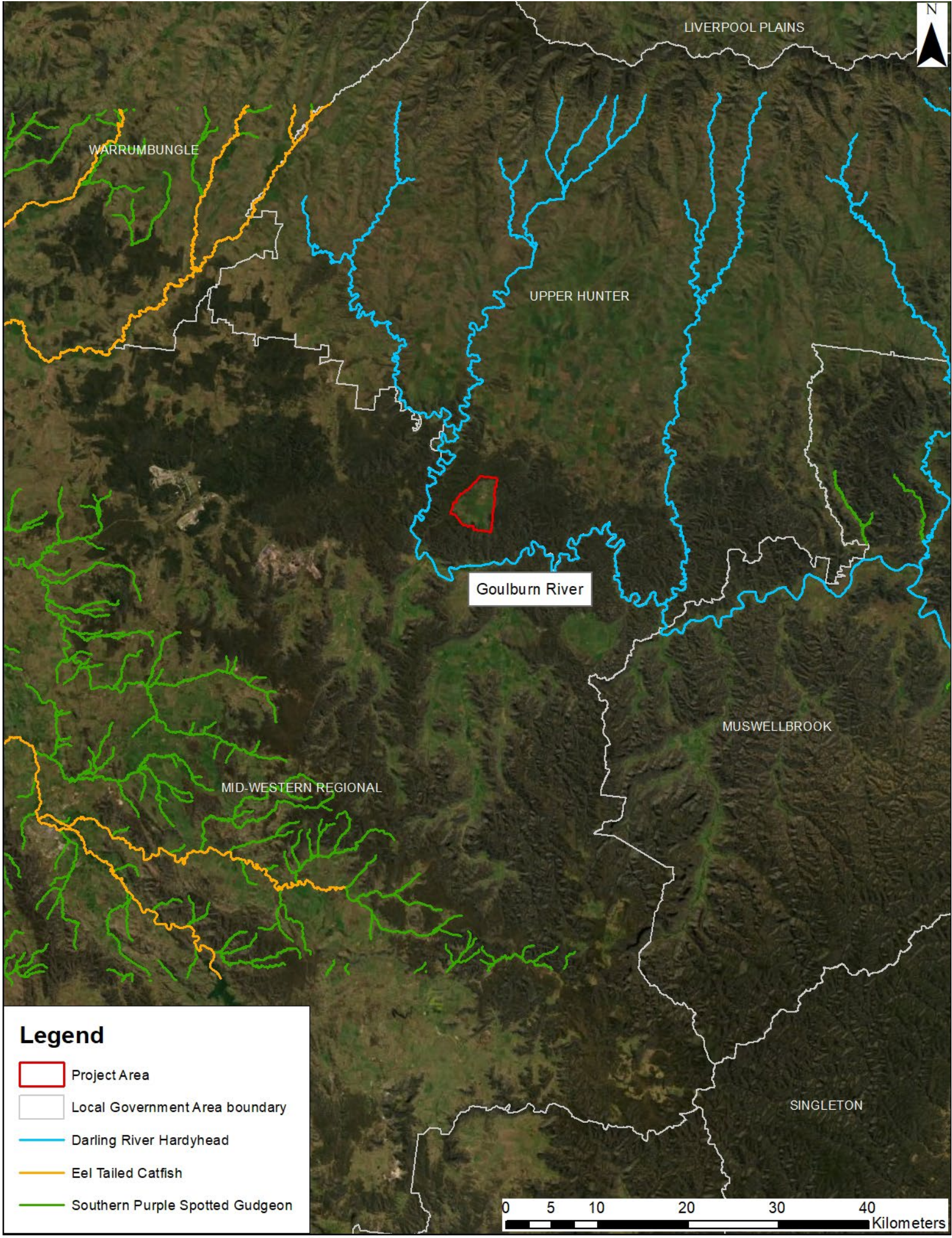
4.10 Target aquatic fauna survey results

Fauna sampling opportunities were limited to Redlynch Creek as it was the only watercourse within the Project Area containing remnant pools at the time of survey. Bait traps did not capture any aquatic fauna at either of the two survey sites (1 and 2).

No threatened species were recorded during surveys.

4.10.1 Critical habitat

The study area does not contain any water or land identified as critical habitat under the FM Act.



COAST ECOLOGY
ENVIRONMENTAL ASSESSMENTS

Figure 4.3. Indicative distribution mapping (DPI, 2016) for threatened aquatic species in the locality
Goulburn River Solar Farm
Job No. 220222 Date. 04/11/2022

5. Impact assessment

This impact assessment has been structured under six sub-sections, and considers the potential impacts of the project on:

1. aquatic biodiversity during construction
2. aquatic biodiversity during operation
3. aquatic biodiversity during decommissioning
4. threatened species, populations and EECs protected by the FM Act
5. key threatening processes identified under the FM Act
6. matters of national environmental significance (MNES) protected by the EPBC Act
7. sensitive areas:
    a. KFH
    b. waterfront land.

5.1 Construction

Consideration of the potential impacts of the project on water quality and aquatic biodiversity is provided in sections 5.1.1 and 5.1.2. These potential impacts and the subsequent risk to receiving watercourses are detailed in Table 5-1.

5.1.1 Potential impacts on water quality

Without the implementation of appropriate erosion and sediment controls and mitigation measures throughout construction, construction activities have the potential to impact water quality in watercourses within the Project Area and receiving watercourses in the study area, through the mobilisation of sediments and other contaminants via wind or stormwater runoff.

Potential activities which can result in water quality impacts include:

- clearing of vegetation
- instream works including filling
- transportation of dust, litter and other pollutants associated with construction
- transportation of soils, exposed sediments and contaminants associated with stockpiles, construction compounds and or storage areas
- transportation of pollutants from accidental spills or leaks of fuels and/or oils from the maintenance or refuelling of construction plant equipment
- transportation of concrete dust, concrete slurries or washout water associated with concrete works.

The Water Resources Assessment (Umwelt, 2023) for the project concluded that construction of the project, including the implementation of appropriate mitigation and management measures, is unlikely to cause changes to the water quality environment against the identified NSW Water Quality Objectives.

5.1.2 Potential impacts on aquatic biodiversity

Potential impacts on aquatic biodiversity during construction include:

1. removal of riparian corridor vegetation
2. removal of instream vegetation/large woody debris
3. obstruction to fish passage
4. alterations to hydrology
5. spread of exotic vegetation
6. poor water quality
7. removal/filling of farm dams.

5.1.2.1 Removal of riparian corridor vegetation

The riparian corridor forms a transition zone between the land and the watercourse. The protection, restoration or rehabilitation of VRZ's is important for maintaining or improving the shape, stability (or geomorphic form) and ecological functions of a watercourse (DPI, 2018).

The riparian corridor reduces the risk of erosion by reinforcing and increasing cohesion of the soil, and by providing a protective surface matting. Vegetation also uses water in the banks and increase the drainage of the soils which reduces the risk of bank failure due to heavy saturated soils. The riparian corridor and the associated layer of litter and debris also increases channel roughness, slowing the flow and reducing the capacity of the flowing water to erode and transport sediment.

Most pollutants and nutrients are attached to sediment particles and riparian vegetation plays an important role in trapping this sediment and associated nutrients and pollutants before they reach the channel. The potential impacts of excess nutrients and sediments are discussed further in section 5.1.2.4. The wider the riparian corridor buffer zone, the more effective it is at trapping sediment.

The riparian corridor also plays an important role in ecological function. Healthy, native riparian vegetation reduces the water temperature of aquatic habitats by shading. Without shading, water temperature increases, which can result in unfavourable conditions and can lead to fish kills.

During the design phase of the project, proposed exclusion zones were expanded to exclude the majority of mapped hydrolines (including a large section of Redlynch Creek) and the associated riparian vegetation. As such, no riparian vegetation would be impacted by the proposal. Three small patches of paddock trees (PCT 483 Grey Box x White Box grassy open woodland on basalt hills in the Merriwa region, upper Hunter Valley, which cover a total area of approximately 0.18 ha) are associated with mapped hydrolines within the Development Footprint, however as these hydrolines do not have defined bed and banks, they are not defined as waterfront land by NRAR and the associated vegetation is not defined as riparian vegetation.

The KTP 'degradation of native riparian vegetation along NSW watercourses' (listed under the FM Act; refer section 5.4.2) is not triggered by the proposal.

5.1.2.2 Removal of instream vegetation/large woody debris

Large woody debris and macrophytes within the stream provides shelter, feeding and spawning habitat for many native birds, fish and invertebrates. Instream or aquatic vegetation is also effective at water purification by further removing nutrients.

Only the unnamed tributary on Monaghans Creek contained large woody debris within the Project Area, and this creek would not be directly impacted by the project. Hence, the KTP 'removal of large woody debris' listed under the FM Act is not triggered by the project.

None of the watercourses within the Project Area contained native macrophytes considered likely to provide aquatic habitat.

5.1.2.3 Obstruction of fish passage

All watercourses crossed by the Project Area have been defined as ephemeral and are close to the source and most watercourses have been defined as Type 3 minimally sensitive KFH and Class 4 unlikely KFH. Redlynch Creek has been defined as Type 3 minimally sensitive KFH but Class 3 minimal KFH.

Redlynch Creek has been defined as an exclusion area, however four access roads are proposed across this creek. Similarly, access roads are proposed across KFH on the unnamed tributary of Poggy Creek and the unnamed tributary of Rocky Creek (Figure 3-2). If filling is

required for the construction of access roads across watercourses mapped as KFH, then fish passage would be maintained in accordance with DPI guidelines (Fairfull and Witheridge, 2003, refer section 2.1.2.2 and Table 2.2).

No other impacts on fish passage are likely during construction works.

5.1.2.4 Alterations to hydrology

The filling of creeks and or installation of culverts may result in impacts to water flows to receiving watercourses. The 'installation and operation of instream structures and other mechanisms that alter natural flow regimes of rivers and streams' is a KTP under the FM Act and would be triggered by the proposal. This is considered further in section 5.4.2.

Negative impacts to hydrology can be mitigated through the installation of instream structures that are in accordance with the DPI guidelines (i.e. a high flow culvert design).

5.1.2.5 Spread of exotic vegetation

The Project Area currently has an extensive cover of exotic grasses and herbs, many of which are serious environmental weeds. There is potential for these exotic species to spread to downstream riparian zones during construction disturbance without appropriate erosion and sediment control measures and weed management (which would be included in the Erosion and Sediment Control Plan and Weed and Pest Management Plan respectively).

From an aquatic ecology perspective, excessive use of herbicide is not recommended for exotic species control.

5.1.2.6 Poor water quality

Indirect impacts relating to reduced water quality from construction activities can impact aquatic biodiversity in downstream watercourses in the following ways:

- shading of aquatic vegetation due to high turbidity, smothering aquatic vegetation and resulting in dieback
- mortality of filter feeding aquatic fauna, including invertebrates, by blocking filter apparatus preventing oxygen flow
- fish kills due to clogging fish gills
- fish kills resulting from high turbidity, making it difficult for fish to see and catch prey
- fish kills resulting from increased nutrients and subsequent algal blooms and oxygen depleted water
- low recruitment in fish species where eggs laid on the bottom of rivers are buried by sedimentation
- potential increase in abundance of pest species able to tolerate poorer water quality which can subsequently outcompete native species for resources
- reduction in native fish species presence through altered habitat resulting from sedimentation in remnant pools
- toxicity and mortality in freshwater organisms, particularly microorganisms, invertebrates and vegetation resulting from pollutants such as petroleum, diesel, hydraulic fluids, oils and herbicide that may be spilled into ephemeral waterways and become mobilised following rainfall events. The effects of toxicity and mortality can move up the food chain and indirectly impact higher order species such as fish, birds and mammals.

Potential direct and indirect impacts to water quality from construction is relevant to all watercourses within the study area. The above impacts on aquatic biodiversity due to impacts to water quality are worst case scenarios. The Water Resources Assessment (Umwelt, 2023) for the project concluded that construction of the project is unlikely to

cause changes to the water quality environment against the identified NSW Water Quality Objectives. Measures to minimise the impacts on water quality are provided in section 6.

5.1.2.7 Farm dams

Direct impacts on farm dams from construction include filling/dewatering, loss of habitat and mortality. A dewatering protocol would be prepared as part of the Construction Environmental Management Plan (CEMP) for all farm dams that require filling, to minimise direct impacts on aquatic fauna.

Indirect impacts on farm dams from construction include a reduction in water quality following rainfall. This would be mitigated with appropriate erosion and sediment control.

Table 5-1. Potential construction impacts on water quality and aquatic biodiversity and associated risk to receiving watercourses

Watercourse	Construction activities	Potential impacts on water quality and aquatic biodiversity	Risk to receiving watercourses and aquatic biodiversity
Redlynch Creek	Redlynch Creek is within the Development Footprint for the installation of Project infrastructure and for the reclamation (farm dam filling) of a portion of Redlynch Creek	Potential direct impacts from construction activities include: • construction impacts on the bed and banks of this watercourse for four proposed access roads. Potential indirect impacts on water quality from construction activities at this site include: • mobilisation of sediments and other contaminants to downstream watercourses • transportation of pollutants from accidental spills or leaks of fuels and/or oils from the maintenance or refuelling of construction plant equipment.	Receiving watercourses include downstream areas of Redlynch Creek, which flows into Goulburn River. There is a low risk to Redlynch Creek within the Project Area in addition to potential indirect impacts to good quality downstream areas of this watercourse.
Unnamed tributary of Monaghans Creek	The unnamed tributary of Monaghans Creek is outside the Development Footprint.	Potential indirect impacts on water quality from construction activities at this site are unlikely as the majority of Monaghans Creek catchment is outside of the Development Footprint.	The aquatic biodiversity within and downstream of the unnamed tributary of Monaghans Creek has a low risk of being indirectly impacted from poor water quality as: • the majority of Monaghans Creek catchment is outside of the Development Footprint • the watercourse is ephemeral and does not hold water most of the time • any indirect impacts can be mitigated, through appropriate erosion and sediment control measures • threatened aquatic species are considered unlikely to occur in this watercourse.

Watercourse	Construction activities	Potential impacts on water quality and aquatic biodiversity	Risk to receiving watercourses and aquatic biodiversity
Unnamed tributary of Poggy Creek	An unnamed tributary of Poggy Creek occurs within the Development Footprint for the installation of Project infrastructure and for the reclamation (farm dam filling) of a portion of a tributary.	Potential direct impacts from construction activities include: • construction impacts on the bed and banks of this watercourse for proposed access tracks. Potential indirect impacts on water quality from construction activities at this site include: • mobilisation of sediments and other contaminants to downstream watercourses • transportation of pollutants from accidental spills or leaks of fuels and/or oils from the maintenance or refuelling of construction plant equipment.	Risk to receiving watercourses is low as: • the farm dams proposed for filling within the catchment of this tributary are above the area mapped as KFH • the majority of the Poggy Creek catchment is outside of the Development Footprint • the watercourse is ephemeral and does not hold water most of the time • any indirect impacts can be mitigated, through appropriate erosion and sediment control measures • threatened aquatic species are considered unlikely to occur in this watercourse.
Unnamed tributaries of Rocky Creek	Unnamed tributaries of Rocky Creek occur within the Development Footprint for the installation of Project infrastructure and for the reclamation (farm dam filling) of a portion of a tributary.	Potential direct impacts from construction activities include: • construction impacts on the bed and banks of this watercourse for proposed access roads. Potential indirect impacts on water quality from construction activities at this site include: • mobilisation of sediments and other contaminants to downstream watercourses • transportation of pollutants from accidental spills or leaks of fuels and/or oils from the maintenance or refuelling of construction plant equipment.	Risk to receiving watercourses is low as: • the farm dams proposed for filling within the catchment of this tributary are outside the area mapped as KFH • most of the Rocky Creek catchment is outside of the Development Footprint • the watercourse is ephemeral and does not hold water most of the time • any indirect impacts can be mitigated, through appropriate erosion and sediment control measures • threatened aquatic species are considered unlikely to occur in this watercourse.

Watercourse	Construction activities	Potential impacts on water quality and aquatic biodiversity	Risk to receiving watercourses and aquatic biodiversity
Unnamed tributary of Councils Creek	The unnamed tributary of Council Creek is outside the Development Footprint.	• Potential indirect impacts on water quality from construction activities at this site are unlikely as the Councils Creek catchment is outside of the Development Footprint.	The aquatic biodiversity downstream in Councils Creek has a low risk of being indirectly impacted from poor water quality as: • Councils Creek catchment is outside of the Development Footprint • the watercourse is ephemeral and does not hold water most of the time • any indirect impacts can be mitigated, through appropriate erosion and sediment control measures • threatened aquatic species are considered unlikely to occur in this watercourse.
Goulburn River	There will be no direct impacts on Goulburn River however construction works would occur within the catchment of this perennial watercourse.	Potential indirect impacts on water quality from construction activities at this site include: • mobilisation of sediments and other contaminants to downstream watercourses • transportation of pollutants from accidental spills or leaks of fuels and/or oils from the maintenance or refuelling of construction plant equipment.	There is a low cumulative risk of indirect impact to this watercourse from the project as despite there being potential habitat for the threatened aquatic species Darling River Hardyhead and Southern Spotted Purple Gudgeon, any indirect impacts can be managed through appropriate erosion and sediment control and avoidance of pollutants.

Summary of risk of impacts on watercourses

All watercourses within the study area have a low risk of impact from the project. Mitigation measures have been provided in Chapter 7 to further minimise impacts.

5.2 Operation

During the operational phase of the project, the installation of solar panels, battery and other infrastructure would be complete and cleared areas would be stabilised. Areas with high risk of soil erodibility would be stabilised and therefore there would be little or no risk of soil erosion and subsequent transport of sediment into nearby watercourses.

Risks to aquatic ecosystems during the operation would be mainly associated with maintenance activities/vehicles and accidental spills or leaks that could potentially mobilise contaminants.

5.2.1 Potential impacts on water quality

For the operational phase, the risks are related to potential impacts to water quality through the mobilisation of sediments and other contaminants via wind or stormwater runoff from:

- transportation of dust, litter, exotic vegetation seed, and other pollutants associated with operations
- transportation of pollutants from accidental spills or leaks from maintenance vehicles
- transportation of herbicides used to control exotic species.

The Water Resources Assessment (Umwelt, 2023) for the project concluded that operation of the project is unlikely to cause changes to the water quality environment.

5.2.2 Impacts to aquatic biodiversity

For the operational phase, the risks to aquatic biodiversity are related to:

- Barriers to fish-passage due to blocked watercourses. This applies to watercourses identified as KFH (i.e. Redlynch Creek, unnamed tributary of Poggy Creek and unnamed tributary of Rocky Creek).
- Changes in water quality resulting in:
    - shading of aquatic vegetation due to high turbidity, smothering aquatic vegetation and causing dieback
    - mortality of filter feeding aquatic fauna, including invertebrates, by blocking filter apparatus preventing oxygen flow
    - fish kills due to clogging fish gills
    - fish kills resulting from high turbidity, making it difficult for fish to see and catch prey
    - fish kills caused from increased nutrients and subsequent algal blooms and oxygen depleted water
    - low recruitment in fish species where eggs laid on the bottom of rivers are buried by sedimentation
    - potential increase in abundance of pest species able to tolerate poorer water quality which can subsequently outcompete native species for resources
    - reduction in native fish species presence through altered habitat caused by sedimentation in remnant pools
    - toxicity and mortality in freshwater organisms, particularly microorganisms, invertebrates and vegetation caused from pollutants such as petroleum, diesel, hydraulic fluids, oils and herbicides that may be spilled into ephemeral waterways and become mobilised following rainfall events. The effects of toxicity and mortality can move up the food chain and indirectly impact higher order species such as fish, birds and mammals.

However, given that there are unlikely to be additional impacts from operations on water quality, the additional risk of impact on aquatic biodiversity from the operation of the project is negligible.

In summary, potential operational impacts on the aquatic biodiversity are considered negligible for the following reasons:

- The proposed instream modifications in KFH would be rehabilitated to ensure the bank morphology is returned to pre-construction condition, and the substrate is stabilised with vegetation.
- Maintenance vehicles would be maintained, therefore the risk of spills would be unlikely.
- Herbicide, if required, would be used within recommended guidelines and not used on waterfront land.

5.3 Decommissioning

At the end of the useful life of the asset, decommissioning would involve the mobilisation of a workforce and additional temporary facilities, and the subsequent removal of equipment and infrastructure. At this time, it is expected that significant movements of light vehicles and trucks for transporting waste would occur. The decommissioning phase would be expected to last less than eight months.

During decommissioning, works would include:

- removal of solar arrays, including the foundation posts, and sorting and packaging of all materials for removal from the site and recycling and/or reuse
- removal of all site amenities and equipment, and recycling and/or reuse of materials wherever practicable
- removal and recycling of posts and cabling,
- removal of fencing including small concrete footings.

The risks associated with decommissioning are related to potential impacts to water quality through the mobilisation of sediments and other contaminants via wind or stormwater runoff from:

- transportation of dust, litter, exotic vegetation seed, and other pollutants associated with vehicle movement
- transportation of pollutants from accidental spills or leaks from vehicles.

The subsequent risks to aquatic biodiversity are discussed in section 5.2.2.

However, given that there are unlikely to be additional impacts during decommissioning on water quality, the additional risk of impact on aquatic biodiversity during decommissioning of the project is negligible.

In summary, potential decommissioning impacts on the aquatic biodiversity are considered negligible for the following reasons:

- any access routes over existing watercourses would be stabilised to prevent excess erosion and sedimentation
- maintenance vehicles would be maintained, therefore the risk of spills would be unlikely.

5.4 Threatened species, populations and aquatic ecological communities assessed under the FM Act

Relevant database searches identified one threatened species (Southern Purple Spotted Gudgeon) and one endangered population (Darling River Hardyhead) listed under the FM Act that have a moderate likelihood of occurrence in the study area (Goulburn River), however these species are unlikely to occur within watercourses within the Project Area. No other threatened species or aquatic ecological communities were identified within the study area.

In summary, the assessment of significance of impact under the FM Act (Appendix A) concluded that the project was unlikely to have an adverse effect on the life cycle of Darling River Hardyhead or Southern Purple Spotted Gudgeon such that a viable local population of these species/populations is likely to be placed at risk of extinction. This was based on the lack of important habitat features for these species within watercourses in the Project Area and the relatively minor nature of works. Potential indirect impacts on water quality associated with the mobilization of sediments is relevant to all watercourses within the study area however this can be managed using standard erosion and sediment control measures during the construction, operation, and decommissioning phases of the project. Thus, the level of impact to the aquatic environment and threatened aquatic species is considered minor.

In relation to the habitat of threatened species/populations, only Goulburn River contained potential habitat for these two threatened entities. The project does not require any direct impacts to Goulburn River and potential indirect impacts can be mitigated through appropriate erosion and sediment control. Thus, the habitat of these threatened species/populations will not be removed or significantly modified, nor will the habitat become fragmented or isolated from other areas of habitat because of the project.

In terms of the importance of the habitat to be potentially modified, Goulburn River was mapped as within the indicative distribution for the Darling River Hardyhead (but not the Southern Purple Spotted Gudgeon), however it is noted that portions of the Goulburn River within the study area have been highly modified through land use practices in the catchment, with intensive farming practices including extensive clearing of riparian vegetation to the bank, reducing the presence of aquatic vegetation, detritus, trailing bank vegetation and snags, which are important habitat features for this species. Thus, the existing habitat in the Goulburn River is likely to be of low importance to the long-term survival of these threatened species/populations.

The project is not inconsistent with any priority action statements for the assessed threatened species and population as most recovery actions listed are not directly relevant to the project, except for habitat rehabilitation, which would be undertaken as part of the Biodiversity Management Plan for the project.

5.4.1 Impacts on critical habitat

The study area does not contain any water or land identified as critical habitat under the FM Act.

5.4.2 Key threatening processes

Eight KTPs are listed under the FM Act however only three are of relevance to the project:

1. degradation of native riparian vegetation along New South Wales water courses
2. installation and operation of instream structures and other mechanisms that alter natural flow regimes of rivers and streams
3. removal of large woody debris from New South Wales rivers and streams.

‘Installation and operation of instream structures and other mechanisms that alter natural flow regimes of rivers and streams’ is triggered by the project where access roads crossing

watercourses mapped as KFH, require filling. In these cases, installation of culverts designed in accordance with relevant DPI guidelines (refer section 2.1.2.2 and section 4.6)) are required to maintain fish passage. The installation of appropriately designed culverts is unlikely to significantly contribute to this KTP.

'Degradation of native riparian vegetation along New South Wales water courses' is not triggered by the project as riparian vegetation has been avoided in the design phase.

'Removal of large woody debris from New South Wales rivers and streams' is not triggered by the project as no watercourses within the Development Footprint contain large woody debris.

5.5 Matters of National Significance assessed under the Commonwealth EPBC Act

No MNES, including threatened and/or migratory aquatic species listed under the EPBC Act have been previously recorded in the study area and none are considered likely to occur within the Project Area. As such, an Assessment of Significance of Impact under the EPBC Act was not required for the project.

5.6 Sensitive areas

5.6.1 Key fish habitat

Policy and Guidelines for Fish Habitat Conservation and Management (DPI, 2013) states that *"to ensure "no net loss" of aquatic habitats, NSW DPI requires that proponents should, as a first priority, aim to avoid impacts upon KFH. Where avoidance is impossible or impractical, proponents should then aim to minimise impacts. Any remaining impacts should then be offset with compensatory works"*.

KFH within the study area was defined based on existing KFH mapping by DPI (2007), watercourses sensitivity type (DPI, 2013) and watercourse class (Fairfull and Witheridge, 2003) which were defined following site inspection. Only instream habitat (top of bank to top of bank) is defined as KFH. This excludes riparian vegetation.

All watercourses within the Project Area were defined as having minimally sensitive KFH due to their highly ephemeral nature and the absence of fish habitat features. Regardless, the Development Footprint covers KFH mapped along the following watercourses (Figure 3-2):

- approximately 250 metres along Redlynch Creek
- approximately 150 metres along an unnamed tributary of Poggys Creek
- approximately 530 metres along an unnamed tributary of Rocky Creek.

The project does not require extensive earthworks or fill and instream works in watercourses mapped as KFH can mostly be avoided. Where filling is required for access roads across these watercourses, culverts would be installed in accordance with relevant guidelines (refer section 2.1.2.2 and section 4.6) to maintain fish passage during flooding, and bed and banks would be stabilised using vegetation in accordance with the Biodiversity Management Plan. As such, KFH would not be permanently lost or disrupted and no aquatic biodiversity offset is required.

5.6.2 Waterfront land

Waterfront land includes the bed and bank of watercourses and all land within 40 metres of the highest bank (DPI, 2012). However, watercourses lacking defined bed and banks are not typically associated with waterfront land. Within the Development Footprint, Redlynch Creek and the unnamed tributary of Rocky Creek had defined bed and banks and therefore have waterfront land associated with them. Impacts to waterfront land would occur through the construction of access roads. Construction works are to avoid waterfront land and where this is not possible (i.e for access roads), the bed and banks of watercourses are to be stabilised with vegetation.

5.7 Cumulative impact assessment

For an EIS, cumulative impacts can be defined as the successive, incremental, and combined effect of multiple impacts, which may in themselves be minor but could become significant when considered together.

The investigation area for the cumulative aquatic biodiversity impact assessment includes watercourses within the Goulburn River catchment. Of the 15 major projects considered in chapter 19 of the EIS, four occur within the Goulburn River catchment (Table 5-2). The potential cumulative impacts of the project combined with these other four major projects are considered further in Table 5-3. Major projects outside of this investigation area were considered unlikely to contribute to cumulative impacts on watercourses within the study area and were therefore not considered further.

Table 5-2. Major Projects within the investigation area

Project	Proximity	Associated watercourses	Further consideration?
Ulan Coal Complex, Moolarben Coal Complex and Wilpinjong Mine	28 km	Goulburn River, > 50 km upstream of the study area	Yes
Liverpool Range Wind Farm	55 km	Turee Creek, flows into Talbragar River which is part of the Macquarie catchment within the Murray–Darling basin	No
Birriwa Solar and Battery Project	60 km	Talbragar River which is part of the Macquarie catchment within the Murray–Darling basin.	No
Valley of the Winds Wind Farm	57 km	Coolaburragundy River flows into Talbragar River which is part of the Macquarie catchment within the Murray–Darling basin.	No
Barneys Reef Wind Farm	50 km	Slapdash Creek, flows into Waldra Creek then the Cudgegong River which is part of the Macquarie catchment within the Murray-Darling basin.	No
Tallawang Solar Farm	50 km	Boomley Creek, flows into Talbragar River which is part of the Macquarie catchment within the Murray-Darling basin.	No
Spicers Creek Wind Farm	80 m	Spicers Creek, which flows into Talbragar River which is part of the Macquarie catchment within the Murray–Darling basin.	No
Merriwa Solar Farm	30 km	Bow River flows into the Goulburn River approximately 25 km downstream of the study area.	Yes

Project	Proximity	Associated watercourses	Further consideration?
Bowmans Creek Wind Farm	96 km	Bowmans Creek flows into the Hunter River.	No
Hills of Gold Wind Farm	101 km	Barnard River flows into the Manning River.	No
Bellambi Heights Renewables Project	54 km	Cudgegong River which is part of the Macquarie catchment within the Murray–Darling basin.	No
Ulan Solar Farm	38 km	Sportsmans Hollow Creek, located at the source of the Goulburn River (i.e. approximately 70 km upstream of the study area).	Yes
Sandy Creek Solar Farm	83 km	Sandy Creek, flows into Talbragar River which is part of the Macquarie catchment within the Murray–Darling basin.	No
Cobbora Solar Farm	82 km	Spring Creek, flows into Talbragar River which is part of the Macquarie catchment within the Murray–Darling basin.	No
Bowdens Silver Project	45 km	Lawsons Creek flows into Cudgegong River which is part of the Macquarie catchment within the Murray–Darling basin.	No

Table 5-3. Summary of potential cumulative impacts

Major Project	Potential impacts on aquatic biodiversity during construction[2]	Construction mitigation measures	Potential impact during operation	Operation mitigation measures	Construction and operation residual impact
Ulan Coal Complex, Moolarben Coal Complex and Wilpinjong Mine	N/A This project is in the operation stage.	N/A	The relevant environment issues identified for the mining operations and associated infrastructure were: • Loss of threatened native flora and fauna. • Surface and groundwater management, including impacts on private water bores and impacts on the Goulburn and Talbragar rivers.	Features of their water management system include: • Controls to prevent the discharge of pollutants. • Controls that minimise the amount of clean water that enters the mine's system. • Minimising work areas and rehabilitating land as soon as possible. • Separating water of differing qualities. • Recycling and reuse of water wherever possible. • Avoiding underground water storage and handling water once. Biodiversity management programs include: • Separating water of differing qualities • The creation of post-mining rehabilitation areas to provide a stable final landform	Provided the biodiversity management programs are implemented, maintained and monitored, the cumulative impacts of the project on the Goulburn River, would be negligible.

Major Project	Potential impacts on aquatic biodiversity during construction[2]	Construction mitigation measures	Potential impact during operation	Operation mitigation measures	Construction and operation residual impact
				with acceptable land use capability. A number of areas are set aside for conservation of endangered ecological communities and their supporting ecosystems • Local provenance native seed is collected from rehabilitated bushland to support the revegetation programs • Regeneration works are conducted to enhance the quality and quantity of native vegetation in conservation areas • Feral animal control and weed management • Ecological and Rehabilitation monitoring.	
Wollar Solar Farm	Construction for this project commenced in July 2022 and is expected to take up to 18 months. The project includes: • Upgrading Barigan Road to ensure safe	N/A	The EIS for the Wollar Solar Farm stated that during operation, there was minimal potential for any impacts to surface water quality to occur. Suitable drainage features would be constructed along internal	Relevant mitigation measures included: • Design waterway crossings and services crossing in accordance with relevant publications. • All fuels, chemicals,	Provided controls are implemented, maintained and monitored, the cumulative impacts of the project the Goulburn River, would be negligible.

Major Project	Potential impacts on aquatic biodiversity during construction[2]	Construction mitigation measures	Potential impact during operation	Operation mitigation measures	Construction and operation residual impact
	movement of construction traffic. • Building an access road to allow deliveries onto the site. • Preparing the site for construction and establishing a site compound. • Building internal access roads to be used construction and for maintenance once operational. • Building a new substation on-site. • Preparing foundations for panels. • Installing panels. • Installing underground cabling to transport power to the substation. • Connecting to the local electricity network via an existing overhead power line. Chapter 19 of the EIS assumed no overlap in the construction phase.		roads to minimise the risk of polluted water leaving the site or entering the waterways.	and liquids would be stored at least 40m from any waterways or drainage lines, not on sloping land and would be stored in an impervious bunded area. • The refuelling of plant and maintenance would be undertaken in impervious bunded areas on hardstand areas only. • All potential pollutants stored on-site would be stored in accordance with HAZMAT requirements and bunded. • Roads and other maintenance access tracks would incorporate appropriate water quality treatment measures such as vegetated swales to minimise the opportunity of dirty water leaving the site or entering the waterways. •	

Major Project	Potential impacts on aquatic biodiversity during construction[2]	Construction mitigation measures	Potential impact during operation	Operation mitigation measures	Construction and operation residual impact
Central West Orana Transmission Project	This is a proposed project and details on proposed construction are not yet available. Chapter 19 of the EIS has assumed no overlap with the project in the construction phase.	N/A	Details on potential operational impacts are not available.	Details on potential operation mitigation measures are not available, however it is anticipated that the following would be undertaken as a minimum: • Design waterway crossings and services crossing in accordance with relevant publications. • Refueling outside of waterfront land. • Environmental monitoring after construction.	Provided controls are implemented, maintained and monitored, the cumulative impacts of the project the Goulburn River, would be negligible.
Merriwa Solar Farm	This is a proposed project and details on proposed construction are not yet available. The proposed Merriwa Solar Farm is the closest major project to the study area. It is within the catchment of the Bow River, which confluences with the Goulburn River approximately 25 km downstream of the study area. Chapter 19 of the EIS	Details on potential construction mitigation measures are not available, however it is anticipated that the following would be undertaken as a minimum: • Erosion and sediment control measures in accordance with the Blue Book. • Stockpile	Details on potential operational impacts are not available.	Details on potential operation mitigation measures are not available, however it is anticipated that the following would be undertaken as a minimum: • Design waterway crossings and services crossings in accordance with relevant publications. • Refueling outside of waterfront land.	Provided controls are implemented, maintained and monitored, the cumulative impacts of the project the Goulburn River, would be negligible.

Major Project	Potential impacts on aquatic biodiversity during construction[2]	Construction mitigation measures	Potential impact during operation	Operation mitigation measures	Construction and operation residual impact
	indicated a possible overlap in construction and potential cumulative impacts on biodiversity due to the site proximity and similarities. Construction works have the potential to reduce water quality in Goulburn River through the mobilisation of sediments, litter and other contaminants via wind or stormwater runoff which could subsequently impact aquatic biodiversity. Increased turbidity results in shading and potential dieback of aquatic vegetation, fish kills through clogging gills or making prey hard to find and/or reduced recruitment by smothering fish eggs. Excess nutrients attached to sediments can result in algal blooms and oxygen depletion, leading to fish kills. Transport of contaminants resulting from spill such as petroleum, diesel, hydraulic fluids and oils that may become mobilised following rainfall and cause toxicity and mortality in freshwater organisms, which can move	management. • Compounds and stockpile sites located outside of riparian habitat and waterfront land. • Monitoring and maintenance of erosion and sediment control devices.		• Environmental monitoring after construction.	

Major Project	Potential impacts on aquatic biodiversity during construction[2]	Construction mitigation measures	Potential impact during operation	Operation mitigation measures	Construction and operation residual impact
	up the food chain.				
Ulan Solar Farm	This is a proposed project and details on proposed construction are not yet available. The proposed Ulan Solar Farm is within the catchment of the Sportsmans Hollow Creek, which confluences with the Goulburn River approximately 70 km upstream of the study area. Construction works have the potential to reduce water quality in Goulburn River through the mobilisation of sediments, litter and other contaminants via wind or stormwater runoff which could subsequently impact aquatic biodiversity. Increased turbidity results in shading and potential dieback of aquatic vegetation, fish kills through clogging gills or making prey hard to find and/or reduced recruitment by smothering fish eggs. Excess nutrients attached to sediments can result in algal blooms and oxygen depletion, leading to fish kills. Transport of	Details on potential construction mitigation measures are not available, however it is anticipated that the following would be undertaken as a minimum: • Erosion and sediment control measures in accordance with the Blue Book. • Stockpile management. • Compounds and stockpile sites located outside of riparian habitat and waterfront land. • Monitoring and maintenance of erosion and sediment control devices.	Details on potential operational impacts are not available.	Details on potential operation mitigation measures are not available, however it is anticipated that the following would be undertaken as a minimum: • Design waterway crossings and services crossing in accordance with relevant publications. • Refueling outside of waterfront land. • Environmental monitoring after construction.	Provided controls are implemented, maintained and monitored, the cumulative impacts of the project on the Goulburn River, would be negligible.

Major Project	Potential impacts on aquatic biodiversity during construction[2]	Construction mitigation measures	Potential impact during operation	Operation mitigation measures	Construction and operation residual impact
	contaminants resulting from spill such as petroleum, diesel, hydraulic fluids and oils that may become mobilised following rainfall and cause toxicity and mortality in freshwater organisms, which can move up the food chain.				

This assessment concludes that the cumulative impacts from the four major works projects occurring within the Goulburn River catchment are unlikely to be significant, provided the biodiversity management programs for each project are implemented, maintained and monitored.

6. Mitigation and management measures

The mitigation measures to minimise impacts to aquatic biodiversity from the project during detailed design / pre-construction, construction and operation are outlined in Table 6-1.

Table 6-1. Summary of mitigation and management measures

Impact type	Mitigation management measure	Project phase
Riparian vegetation	Detailed design and construction planning avoided direct impacts on native riparian vegetation (section 5.1.2.1).	Detailed design/ Pre-construction
Key Fish habitat	Detailed design and construction planning would seek to identify refinements that further avoid or minimise impacts on key fish habitat (KFH) (section 5.6.1).	Detailed design/ pre-construction
Fish passage	Fish passage would be maintained at watercourses identified as KFH within the Development Footprint. Minimum requirements for fish passage are discussed in section 5.1.2.3. It is proposed that culverts would be installed to prevent blocking of fish passage where access roads cross watercourses.	Detailed design/ pre-construction / construction
Fauna	Pre-clearance surveys would be carried out prior to construction by a suitability qualified ecologist including native aquatic fauna salvage in accordance with a farm dam dewatering policy (refer section 5.1.2.7). All salvaged aquatic fauna would be relocated to similar habitat nearby.	Pre-construction/ Construction
Instream impacts	Appropriate erosion and sediment control would be installed in accordance with the Erosion and Sediment Control Plan, around ground disturbance works conducted on waterfront land or within watercourses mapped as KFH	Construction
Riparian vegetation	Exclusion areas would be established and maintained around riparian vegetation to be retained on waterfront land (40 metres from top of bank for watercourses with defined bed and banks (parts of Redlynch Creek and Rocky Creek) (refer 5.6.2).	Construction
Riparian vegetation	Activities within vegetated riparian zones would be managed to minimise impacts to aquatic environments as far as practicable. Riparian areas subject to disturbance would be progressively stabilised and rehabilitated in accordance with the Biodiversity Management Plan. The spread of exotic species would be minimized through implementation of the Weed and Pest Management Plan.	Construction
Instream impacts	Instream works in areas mapped as KFH (i.e. Redlynch Creek, unnamed tributary of Poggy Creek and unnamed tributary of Rocky Creek) would be undertaken in dry conditions as far as practicable and appropriate erosion and sediment control would be installed and maintained. Watercourses impacted by instream works would have the bed and bank morphology reinstated, and disturbed areas would be stabilized using vegetation to minimize erosion in accordance with the Biodiversity Management Plan.	Construction/ Decommissioning
Unexpected finds	A species unexpected finds protocol would be implemented if threatened species, not assessed in the aquatic assessment, are identified in the Development Footprint. This would include stop work orders in the immediate area and notifying DPIE.	Construction
Instream	Refueling would be conducted outside of waterfront land	Construction,

Impact type	Mitigation management measure	Project phase
impacts	(refer section 5.6.2), with appropriate measures in place to avoid impacts to waterways, aquatic habitats, and groundwater. This includes spill kits always kept with maintenance vehicles and or machinery within 100 metres of a watercourse.	operation and decommissioning
Instream impacts	If herbicide is used to control exotic species within the Project Area, its use would be kept to a minimum and it would be applied in accordance with relevant application guidelines.	Construction and Operation

7. Conclusion

The aquatic ecological assessment for the construction and operation of the Goulburn River Solar Farm and Battery Energy Storage System near Merriwa has been prepared based on a review of available aerial photography, topography, databases, literature, policies and guidelines, as well as results of field investigation. The key findings of report are as follows:

Existing aquatic environment

- The Project Area includes 90 mapped hydrolines, of which three are third order watercourses based on Strahler stream order (Strahler, 1952), and five are mapped as KFH by DPI (2007). Six watercourses within the Project Area were subject to field survey and habitat assessment.
- Aquatic habitat assessment in the field found that all watercourses within the Project Area were highly ephemeral, with only Redlynch Creek containing shallow remnant pools following rainfall.
- First and second order drainage lines were dry and most riparian zones were significantly modified by agricultural land practices.
- Targeted threatened fauna surveys were undertaken using bait traps in remnant pools on Redlynch Creek however no aquatic fauna was recorded.
- Watercourses within the Project Area were defined as Type 3 minimally sensitive KFH.

Impact assessment

Three watercourses (or sections of) mapped as KFH occur within the Development Footprint:

- Redlynch Creek
- an unnamed tributary of Poggy Creek
- an unnamed tributary of Rocky Creek.

In addition, seven farm dams occur within the Development Footprint.

Direct impacts from the project on aquatic biodiversity could include potential blockage of fish passage (during floods) where filling is required for access roads across KFH watercourses, potential modification to riparian habitat through the spread of exotic flora, potential mortality to protected aquatic fauna during farm dam dewatering and filling and potential impacts on water quality through disturbance of soil on waterfront land. Potential indirect impacts to aquatic biodiversity relate to the mobilisation of poor-quality stormwater runoff from construction activities including vegetation removal, earthworks, establishment and use of construction compounds and access roads and pollution downstream and potential mortality to aquatic flora and fauna.

Following assessment, all watercourses within the study area were considered to have a low or negligible risk of potential impact from the project during construction, operation and decommissioning due to the highly ephemeral nature of the watercourses, the lack of KFH features and or the minor nature of works proposed within the catchment of these watercourses.

Potential risks can be managed in ephemeral watercourses by:

- undertaking construction when watercourses are dry (where practicable) as aquatic fauna species would not be present
- implementing appropriate erosion and sediment control measures
- installing fish friendly crossings (in accordance with relevant guidelines) where access roads are proposed across watercourses mapped as KFH
- avoiding all construction activities, including tree removal and re-fuelling of vehicles and other machinery, on waterfront land (i.e., land 40 metres from the top of bank, where watercourses have a defined bed and banks)

- re-instating watercourse bed, banks and riparian vegetation where these are disturbed in areas mapped as KFH.

Potential indirect risks to the perennial watercourse (Goulburn River) can be managed through the implementation of appropriate erosion and sediment control measures on upstream watercourses during construction.

Threatened species, populations and EECs

Desktop studies identified one endangered population (Darling River Hardyhead) and one threatened species (Southern Purple Spotted Gudgeon) had a moderate likelihood of occurrence in watercourses within the study area (Goulburn River), however watercourses within the Project Area are considered unlikely to provide habitat for these species. Potential indirect impacts on these species through impacts on water quality in the Goulburn River were considered.

Assessment under the FM Act concluded that the project was unlikely to have an adverse effect on the life cycle of these species such that a viable local population is likely to be placed at risk of extinction. This was based on the absence of direct impacts to habitat for these species. Potential indirect impacts on water quality associated with the mobilization of sediments can be managed using standard practices during the operation, construction and decommissioning phases of the project and the level of impact to the aquatic environment is therefore considered minor.

One KTP is triggered by the project:

- installation and operation of instream structures and other mechanisms that alter natural flow regimes of rivers and streams.

Where the filling of watercourses mapped as KFH is required for access roads, culverts would be designed in accordance with relevant guidelines (Fairfull and Witheridge, 2003) and would not significantly impact natural flow regimes.

Impacts to key fish habitat

KFH within the study area was determined based on existing KFH mapping by DPI (2007), watercourses sensitivity type (DPI, 2013) and watercourse class (Fairfull and Witheridge, 2003) which were defined following site inspection.

All watercourses within the Project Area were defined as having minimally sensitive KFH due to their highly ephemeral nature and the absence of fish habitat features. Regardless, the Development Footprint covers mapped KFH along the following watercourses:

- approximately 250 metres along Redlynch Creek
- approximately 150 metres along an unnamed tributary of Poggys Creek
- approximately 530 metres along an unnamed tributary of Rocky Creek

While Redlynch Creek is defined as an exclusion area, proposed access roads cross this watercourse in four locations. Where access roads cross a watercourse defined as KFH, appropriate fish passage would be maintained through the installation of a high flow design culvert. As such, fish passage would be maintained and KFH would not be permanently lost or disrupted so no aquatic biodiversity offset would be required.

Waterfront land includes the bed and bank of watercourses and all land within 40 metres of the highest bank (DPI, 2012). However, watercourses lacking defined bed and banks are not typically associated with waterfront land. Within the Development Footprint, Redlynch Creek and an unnamed tributary of Rocky Creek have defined bed and banks and as such, these watercourses have associated waterfront land. Where possible, construction works would not be undertaken on waterfront land. Any disturbance to waterfront land would be remediated as detailed in the Biodiversity Management Plan.

No aquatic groundwater dependent ecosystems (GDEs) were identified in the study area.

Mitigation and management measures

The project has been designed to avoid and minimise potential impacts to watercourses and aquatic biodiversity as far as practicable. Any impacts to aquatic biodiversity would be managed through the implementation of appropriate mitigation and management detailed in this assessment.

Conclusion

The aquatic biodiversity impact assessment concludes that the impacts of the project would not significantly compromise the functionality, long-term connectivity or viability of habitats, or ecological processes within watercourses in the study area nor would it directly impact threatened species/populations with potential to occur in the study area. Most of the potential impacts are associated with indirect impacts on water quality and would therefore be temporary and managed through the adoption of appropriate erosion and sediment control measures.

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Appendix A. Assessment of significance (FM Act)

Section 5.5 of the EP&A Act requires that a determining authority examine and take into account to the fullest extent possible all matters affecting or likely to affect the environment by reason of the project and that assessment of significance is undertaken to assess the likelihood of significant impact upon threatened species, populations or ecological communities listed under the FM Act. The test for determining whether the project is likely to affect threatened species, populations or ecological communities or their habitats is in section 221ZV of the FM Act.

Two aquatic species were identified as likely or possible to occur within the study area (Appendix A) and are assessed against an assessment of significance:

1. Darling River Hardyhead *C. amniculus* Endangered population
2. Southern Purple-Spotted Gudgeon *M. adspersa* Endangered species.

The following is to be taken into account for the purposes of determining whether a proposed development or activity is likely to significantly affect threatened species, populations or ecological communities:

Impact on local population of a species

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

Southern Purple Spotted Gudgeon
Southern Purple Spotted Gudgeon is listed as an endangered species in NSW. Southern Purple Spotted Gudgeon have a rounded head with a small mouth and a rounded tail. They have two dorsal fins; the first being shorter and lower than the second. They are generally dark brown in colour along the back, fading to pale brown or cream on the belly. A number of distinguishing markings occur along the body, such as white and red spots and a blue wash along the flanks, all of which brighten during breeding, and yellow bars on the margins of the dorsal and anal fins. The three red-maroon bars on the cheek differentiate the species from other similarly shaped freshwater gudgeon species within NSW even at very small sizes (such as Coxs, Striped and Flathead Gudgeons). Southern Purple Spotted Gudgeon grow to around 15 cm in length.

Two populations of Southern Purple Spotted Gudgeon occur in NSW; an eastern population found in coastal catchments north of the Clarence River, and a western population found throughout Murray-Darling Basin. During the early 1980s, the Murray-Darling Basin population experienced rapid and dramatic reductions in distribution and abundance. The population is now confined to small remnant populations in the Macquarie, Gwydir and Border Rivers catchments and a self-sustaining population created from captive-bred fish in the Castlereagh Catchment. Since all remaining populations in the western region are small, isolated and disconnected from each other, there is limited gene flow between populations. There have been few recent records of the eastern population despite targeted sampling at those locations where the species has previously been found. Only two extant populations are known, one in the Richmond catchment and the other in the Hunter Valley. However, the population in Goorangoola Creek (Hunter River catchment) is outside what was previously considered the natural range of the species and it remains unknown whether the population is endemic or recently introduced.

Southern Purple Spotted Gudgeon are a benthic species that can be found in a variety of habitat types such as rivers, creeks and billabongs with slow-moving or still waters or in streams with low turbidity. Cover in the form of aquatic vegetation, overhanging vegetation from riverbanks, leaf litter, rocks or snags are important for the species. Most remnant populations in NSW occur in small to medium sized streams. They feed mainly on terrestrial insects and their larvae, worms, small fish, tadpoles, and some plant matter. Eggs are

deposited in clusters on solid objects such as rocks, wood or broad-leafed plants. The male guards and fans the eggs until they hatch (3 - 8 days).

The species is threatened by:

- Predation by introduced fish such as Eastern Gambusia (*Gambusia holbrooki*) and Redfin Perch (*Perca fluviatilis*).
- Habitat disturbance by common carp (*Cyprinus carpio*).
- Loss of favourable habitat, particularly aquatic plants.
- Fluctuations in water levels and flow as a result of river regulation have a significant impact on the inundation frequency for wetland habitats including habitats important for Southern Purple Spotted Gudgeon reproduction and recruitment.
- Thermal pollution.
- Increased turbidity and damage of stream banks by livestock access.
- Decreased water quality due to agricultural runoff and siltation.
- Local extinctions may not be naturally recolonised because of the species' inability to disperse the long distances required.
- Populations are generally small and isolated from each other, and therefore vulnerable to localised extinctions from severe events.

The study area is outside of the indicative distribution mapping for Southern Purple Spotted Gudgeon (DPI, 2016), however indicative distributions do include some downstream tributaries of the Goulburn River (Figure 4-3) and as such, this species was included in further assessment as a conservative approach.

Watercourses within the Project Area do not contain suitable habitat for Southern Purple Spotted Gudgeon, hence no direct impacts on suitable habitat for this species are likely. The Goulburn River and its tributaries, including downstream sections of Redlynch Creek, provide suitable habitat for Southern Purple Spotted Gudgeon through the presence of aquatic vegetation, overhanging vegetation from riverbanks, leaf litter, rocks or snags. These watercourses are outside of the Project Area and therefore would not be directly impacted by the project however indirect impacts include alterations to water quality because of the project. These indirect impacts can however be managed through appropriate erosion and sediment control measures and spill kits kept in vehicles/machinery used during construction, and the ongoing maintenance of vehicles used during the operation of the project. As such, the project is unlikely to have an adverse effect on the life cycle of the Southern Purple Spotted Gudgeon such that a viable local population of the species is likely to be placed at risk of extinction.

Impacts on an endangered population

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

Darling River Hardyhead
The Darling River Hardyhead population in the Hunter River catchment is listed as an endangered population in NSW.

The Darling River Hardyhead is a small species of fish growing to a maximum of 80mm fork length, but is generally around 42mm. It has compressed sides and a small protrusible mouth and thin lips to help capture and grip food. It has a forked tail, two small, short-based dorsal fins, and pectoral fins that are positioned high on the body. The second dorsal fin is situated directly above the anal fin. The Darling River Hardyhead has large, silvery eyes. The scales are small and rarely overlap, and there are usually no scales on top of the head. The species is normally dusky gold coloured on its back with a dark silvery

stripe which runs along the length of the body. The underside of the Darling River Hardyhead is lighter in colour, often with a silvery sheen.

The Darling River Hardyhead occurs in the upper tributaries of the Darling River near the Queensland-New South Wales border. A small population also occurs in the Hunter River catchment. The Hunter River population is the only known occurrence of the species in an eastward flowing river and this population has always been relatively small.

They are usually found in slow flowing, clear, shallow waters or in aquatic vegetation at the edge of such waters. The species has also been recorded from the edge of fast flowing habitats such as the runs at the head of pools.

They are usually found singly or in small or large schools of up to about 50 fish. Little data has been recorded on the reproductive biology of the species, however it is closely related to the Murray hardyhead (*Craterocephalus fluviatilis*), which is considered a short lived (annual) species with an extended breeding season from spring through to autumn. The eggs will usually be deposited amongst aquatic vegetation.

Darling River Hardyheads primarily eat algae and fly larvae, but have also been seen to feed on small insects.

The species is threatened by:

- The habitat of the Darling River Hardyhead has been degraded through soil erosion, land clearing and livestock damage to riverbanks.
- Thermal pollution (changes in water temperature) from large impoundments such as Glenbawn Dam, Lake Lidell and Lake St Clair is likely to harm populations downstream.
- The presence of competing species, including alien Goldfish (Carassius auratus), eastern gambusia (*Gambusa holbrooki*) and common carp (*Cyprinus carpio*) may be causing significant declines of the Darling River Hardyhead in the Hunter River catchment. It is also likely that gambusia feed on the eggs and larvae of the Darling River Hardyhead.
- Water extraction from smaller tributary streams during droughts may put additional pressure on remnant populations.

Within the study area, the Goulburn River is within the indicative distribution mapping for the Darling River Hardyhead (DPI, 2016), however watercourses within the Project Area are not (Figure 4-3).

Watercourses within the Project Area do not contain suitable habitat for Darling River Hardyhead, hence no direct impacts on suitable habitat for this species are likely. The Goulburn River and its tributaries, including downstream sections of Redlynch Creek, provide suitable habitat for Darling River Hardyhead through the presence of slow flowing, clear, shallow waters, aquatic vegetation, along with runs and pools in faster flowing habitats. These watercourses are outside of the Project Area and therefore would not be directly impacted by the project however indirect impacts include alterations to water quality because of the project. These indirect impacts can however be managed through appropriate erosion and sediment control measures and spill kits kept in vehicles/machinery used during construction, and the ongoing maintenance of vehicles used during the operation of the project. As such, the project is unlikely to have an adverse effect on the life cycle of the Darling River Hardyhead such that a viable local population of the species is likely to be placed at risk of extinction.

Impact on Endangered Ecological Community

> *(c) in the case of an endangered ecological community or critically endangered ecological community, whether the proposed development or activity—*

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,

N/A

Habitat of a threatened species, population, ecological community

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

(i) the extent to which habitat is likely to be removed or modified as a result of the proposed development or activity, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed development or activity, and

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the threatened species, population or ecological community in the locality,

Two watercourses within the study area were identified as having potential habitat for threatened species/populations:

1. downstream areas of Redlynch Creek
2. Goulburn River

the project does not require any direct impacts to the downstream areas of Redlynch Creek or the Goulburn River and potential indirect impacts can be mitigated through appropriate erosion and sediment control. Thus, the habitat will not be removed or significantly modified, nor will the habitat become fragmented or isolated from other areas of habitat because of the project.

In terms of the importance of the habitat to be potentially modified, Redlynch Creek has not been identified within the indicative distribution for either Darling River Hardyhead or Southern Purple Spotted Gudgeon and is therefore considered to be of low importance to the long-term survival of these threatened species/populations, as they have not been recorded in these areas previously.

The Goulburn River was mapped as within the indicative distribution for the Darling River Hardyhead (but not the Southern Purple Spotted Gudgeon), however it is noted that the Goulburn River (within the study area) has been highly modified through land use practices in the catchment, with intensive farming practices, including extensive clearing of riparian vegetation to the bank, reducing the presence of aquatic vegetation, detritus, trailing bank vegetation and snags, which are important habitat features for this species. Thus, the existing habitat in the Goulburn River is likely to be of low importance to the long-term survival of these threatened species/populations.

Critical Habitat

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

N/A

Priorities Action Statement

(f) whether the proposed development or activity is consistent with a Priorities Action Statements.

All of the threatened species considered above have priority actions statements associated with their listing. The species action statements generally include:

- Advice to consent and determining authorities
- Collate and review existing information
- Community and stakeholder liaison, awareness and education
- Compliance / enforcement
- Enhance, modify or implement NRM planning processes to minimize adverse impacts on threatened species
- Habitat rehabilitation
- Pest eradication and control
- Research / monitoring
- Stocking / translocation
- Survey / mapping

the project is not inconsistent with any priorities action statement for the assessed threatened species/populations. Most recovery actions listed are not directly relevant to the project and relate to actions required by DPI to ensure the protection of these species. Habitat rehabilitation would be detailed in the Biodiversity Management Plan.

Priority actions statements for each species are detailed below:

Darling River Hardyhead

- Advice to consent and determining authorities
    - Provide information on the distribution of the Darling River Hardyhead to local councils and determining authorities to ensure appropriate consideration during development assessment processes (High priority).
- Collate and review existing information
    - Compile existing information on Darling River Hardyhead and identify knowledge gaps for the purpose of targeting future research activities (High priority).
    - Collate data on the historical distribution of Darling River Hardyhead including anecdotal and indigenous knowledge (Low priority).
- Community and stakeholder liaison, awareness and education
    - Encourage community reporting of Darling River Hardyhead sightings via the NSW DPI Threatened and Pest Species Sightings Program online form (Medium priority).
    - Implement education initiatives to improve awareness of the status of the Darling River Hardyhead and ways to minimise impacts on the species by preparing and distributing appropriate advisory material (Medium priority).
    - Install signs and/or interpretive displays at appropriate locations to assist with identification and awareness of Darling River Hardyhead (Low priority).
    - Foster long-term, two-way knowledge transfer and capacity building to enhance the role of indigenous ecological knowledge in the recovery of Darling River Hardyhead (Low priority).
- Compliance / enforcement
    - Maximise compliance activities at identified important sites (Low priority).
- Enhance, modify or implement NRM planning processes to minimize adverse impacts on threatened species

  - Negotiate with relevant authorities to encourage the identification, assessment, and modification of natural resource management plans and policies to minimise impacts on Darling River Hardyhead habitats and water quality (High priority).
  - Implement relevant State policies and programs (e.g. the NSW Diffuse Source Water Pollution Strategy) in an effort to reduce water pollution (particularly chemical pollution from agricultural pesticides) impacts on Darling River Hardyhead habitats in NSW (High priority).
- Habitat rehabilitation
  - Undertake work to identify, restore and protect known and potential Darling River Hardyhead habitats and address key threats such as habitat degradation and water quality decline from expanding development (High priority).
  - Undertake priority rehabilitation, restoration and enhancement work (e.g. rehabilitating riparian vegetation, cold water pollution reduction measures, reinstating large woody debris, removal of barriers to fish passage, removal of willows from riverbanks, sediment and erosion control measures) at key sites known to support Darling River Hardyhead populations (High priority).
  - Actively seek funds through grant schemes or other sources to implement riparian vegetation and water quality improvement projects in priority areas (Medium priority).
- Pest eradication and control
  - Investigate and implement integrated management of introduced species in and adjacent to identified Darling River Hardyhead habitats and take action to prevent the spread of introduced species into these habitats (Medium priority).
- Research / monitoring
  - Conduct research on the biology and ecology of Darling River Hardyhead, particularly the species' ecological role, environmental tolerances, factors influencing population dynamics, age and growth, life cycle and diet (High priority).
  - Undertake research to identify, prioritise and improve understanding of the threatening processes and causes of decline of Darling River Hardyhead (High priority).
  - Monitor populations of Darling River Hardyhead over time to assess trends in abundance and distribution and to identify emerging threatening processes (Medium priority).
  - Actively encourage community involvement in aspects of Darling River Hardyhead recovery including for example, research and monitoring programs (Medium priority).
  - Actively seek grants or investor partnerships to fund research and monitoring programs for Darling River Hardyhead (Medium priority).
  - Obtain and analyse genetic material from remnant populations of Darling River Hardyhead to identify genetic units to inform conservation breeding or translocation (Medium priority).
- Stocking / translocation
  - Develop an emergency response policy to guide the collection and captive husbandry of Darling River Hardyhead. The policy should address the circumstances in which wild individuals may be collected, held and re-released,

and identify holding facilities, potential funding sources and legal requirements (Medium priority).

- Identify potential candidate sites for possible future translocation of Darling River Hardyhead (Medium priority).
- Undertake emergency rescues of Darling River Hardyhead in response to droughts, oil spills/ pollution, detection of biosecurity threats (e.g. disease or pests), or to avoid imminent impacts in accordance with the emergency response policy (Medium priority).
- Maintain and monitor translocated populations (Medium priority).
- Implement the NSW Freshwater Fish Stocking Fishery Management Strategy to prevent significant impacts from stocking on Darling River Hardyhead populations (Medium priority).
- Review and assess the potential of artificial refuge areas for the protection of Darling River Hardyhead (Low priority).

- Survey / mapping
  - Conduct targeted surveys to determine the current distribution and abundance of Darling River Hardyhead (High priority).
  - Collect data on the presence/absence of Darling River Hardyhead during incidental surveys (High priority).

Southern Purple Spotted Gudgeon

- Advice to consent and determining authorities
  - Provide information on the distribution of Southern Purple Spotted Gudgeon to local councils and determining authorities to ensure appropriate consideration during development assessment processes (High priority).
- Collate and review existing information
  - Compile existing information on Southern Purple Spotted Gudgeon and identify knowledge gaps for the purpose of targeting future research activities (Medium priority).
  - Collate data on the historical distribution of Southern Purple Spotted Gudgeon including anecdotal and indigenous knowledge (Low priority).
- Community and stakeholder liaison, awareness and education
  - Encourage community reporting of Southern Purple Spotted Gudgeon via the NSW DPI Threatened and Pest Species Sightings Program online form (Medium priority).
  - Implement education initiatives to improve awareness of the status of Southern Purple Spotted Gudgeon and ways to minimise impacts on the species by preparing and distributing appropriate advisory material (Medium priority).
  - Install signs and/or interpretive displays at appropriate locations to assist with identification and awareness of Southern Purple Spotted Gudgeon (Low priority).
  - Foster long-term, two-way knowledge transfer and capacity building to enhance the role of indigenous ecological knowledge in the recovery of Southern Purple Spotted Gudgeon (Low priority).
- Compliance / enforcement
  - Maximise compliance with the ban on collecting Southern Purple Spotted Gudgeon by communicating with aquarium enthusiasts using a number of

communication mediums (e.g. aquarium industry journals, newsletters, conferences) (High priority).

- Maximise compliance activities at identified important sites (Medium priority).

- Enhance, modify or implement NRM planning processes to minimize adverse impacts on threatened species
  - Incorporate new research information into catchment management, river health and wetlands programs where appropriate (High priority).
  - Negotiate with relevant authorities to encourage the identification, assessment, and modification of natural resource management plans and policies to minimise impacts on Southern Purple Spotted Gudgeon habitats and water quality (High priority).
  - Implement relevant State policies and programs (e.g. the NSW Diffuse Source Water Pollution Strategy) in an effort to reduce water pollution (particularly chemical pollution from agricultural pesticides) impacts on Southern Purple Spotted Gudgeon habitats in NSW (Medium priority).
- Habitat rehabilitation
  - Undertake work to identify, restore and protect known and potential Southern Purple Spotted Gudgeon habitats and address key threats such as habitat degradation and water quality decline from expanding development (High priority).
  - Allocate and manage environmental water flows in regulated rivers to restore natural seasonal flow patterns, and to reduce the impact of cold water downstream of dams (High priority).
  - Actively seek funds through grant schemes or other sources to implement riparian vegetation and water quality improvement projects in priority areas (High priority).
  - Undertake priority rehabilitation, restoration and enhancement work (e.g. rehabilitating riparian vegetation, cold water pollution reduction measures, reinstating large woody debris, removal of barriers to fish passage, removal of willows from riverbanks, sediment and erosion control measures) at key sites known to support Southern Purple Spotted Gudgeon populations (High priority).
- Pest eradication and control
  - Investigate and implement integrated management of introduced species in and adjacent to identified Southern Purple Spotted Gudgeon habitats and take action to prevent the spread of introduced species into these habitats (Medium priority).
- Research / monitoring
  - Conduct research on the biology and ecology of Southern Purple Spotted Gudgeon, particularly the species' ecological role, environmental tolerances, factors influencing population dynamics, age and growth, life cycle and diet (High priority).
  - Undertake research to identify, prioritise and improve understanding of the threatening processes and causes of decline of Southern Purple Spotted Gudgeon (High priority).
  - Obtain and analyse genetic material from remnant populations of Southern Purple Spotted Gudgeon to identify genetic units to inform conservation breeding or translocation (High priority).

    - Actively encourage community involvement in aspects of Southern Purple Spotted Gudgeon research and monitoring programs (Medium priority).
    - Monitor populations of Southern Purple Spotted Gudgeon over time to assess trends in abundance and distribution and to identify emerging threatening processes (Medium priority).
    - Actively seek grants or investor partnerships to fund research and monitoring programs for Southern Purple Spotted Gudgeon (Medium priority).
- Survey / mapping
    - Conduct targeted surveys to determine the current distribution and abundance of Southern Purple Spotted Gudgeon (High priority).
    - Collect data on the presence/absence of Southern Purple Spotted Gudgeon during incidental surveys (High priority).
- Stocking / translocation
    - Conduct targeted sampling at stocked sites to assess the status of stocked populations including growth and recruitment rates (Medium priority).
    - Conduct research to evaluate the effectiveness of translocation of adult fish compared to stocking of juveniles to inform future conservation actions (Low priority).
    - Identify potential candidate sites for possible future translocation of Southern Purple Spotted Gudgeon (Low priority).
    - Maintain and monitor translocated populations (Low priority).

Key threatening Process

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

The following KTPs are listed under the FM Act:

- Degradation of native riparian vegetation along New South Wales water courses
- Hook and line fishing in areas important for the survival of threatened fish species
- Human-caused climate change
- Installation and operation of instream structures and other mechanisms that alter natural flow regimes of rivers and streams
- Introduction of fish to waters within a river catchment outside their natural range
- Introduction of non-indigenous fish and marine vegetation to the coastal waters of New South Wales
- Removal of large woody debris from New South Wales rivers and streams
- The current shark meshing program in New South Wales waters

Of these eight KTPs, only three are of relevance to the project:

1. Degradation of native riparian vegetation along New South Wales water courses
2. Installation and operation of instream structures and other mechanisms that alter natural flow regimes of rivers and streams
3. Removal of large woody debris from New South Wales rivers and streams

Under the proposal, ‘installation and operation of instream structures and other mechanisms that alter natural flow regimes of rivers and streams’ is triggered by the project though the installation of culvert to maintain fish passage across watercourses identified as KFH. Culverts would be designed in accordance with relevant guidelines, to

maintain fish passage and to minimise impacts to natural flow regimes. The installation of culverts however is not considered to significantly contribute to this KTP.

'Degradation of native riparian vegetation along New South Wales water courses' is not triggered by the project as removal of riparian vegetation has been avoided during the design phase.

'Removal of large woody debris from New South Wales rivers and streams' is not triggered by the project as no watercourses within the area of impact contain large woody debris.