Technical Report - Surface Water Quality and Groundwater

Virya Energy

Yanco Delta Wind Farm
3 June 2022

Executive Summary

Virya Energy is proposing to construct, operate and maintain the Yanco Delta Wind Farm (the Project). Approval is sought under Division 4.7 of Part 4 of the *Environmental Planning and Assessment Act 1979* (NSW) (EP&A Act) and Part 9, Division 1 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The Project would involve the construction, operation and maintenance of a wind farm with up to 208 wind turbine generators (WTGs), a battery energy storage system (BESS) and associated electrical infrastructure. The generating capacity of the wind farm is approximately 1,500 megawatts (MW).

This surface water quality and groundwater assessment has been prepared to address the Secretary's Environmental Assessment Requirements (SEARs) relating to surface water quality and groundwater impacts and will assist the Minister for Planning to make a determination on whether or not to approve the Project. This assessment provides an assessment of potential impacts of the Project on surface water quality and groundwater and outlines proposed management measures.

Existing environment

The topography of the Project area is relatively flat with gentle undulations, sloping gently down gradient. The Project area traverses Delta Creek in the northern portion of the Project area and Turn Back Jimmy Creek within the southern portion. Yanco Creek is located between the northern and southern portions of the Project area. There are also a number of drainage depressions within the Project area.

Yanco Creek is the only permanent waterway in the Project area, with Delta Creek, Turn Back Jimmy Creek and the drainage depressions classified as ephemeral. Limited water quality data suggests that nominated WQOs are only partially being achieved due to elevated total phosphorus and turbidity and low dissolved oxygen in waterways.

The regional water table is relatively deep (approximately 20 metres below ground level (mbgl) to 25 mbgl) and uniform however localised perched groundwater systems are considered likely to be present across relatively low lying parts of the study area. Based on salinity data for registered bores, groundwater quality in the Project area has a salinity ranging from 300 mg/L to 3,000 mg/L and is generally fresh to slightly brackish.

Overview of surface water quality impacts

Construction of the Project would involve a range of activities including vegetation clearing and subsequent mulching, earthworks, trenching, concrete works and the establishment of a construction compound. These construction activities present a potential risk to downstream water quality if appropriate management measures are not implemented, monitored and maintained throughout the construction phase.

Without the implementation of mitigation measures, construction activities may result in the following potential impact to surface water quality within the study area, which is identified as a 500 metre buffer around the Project area:

- Erosion and sedimentation of waterways
- Reduced water quality from elevated turbidity, increased nutrients and other contaminants
- Smothering of aquatic organisms from increased sediments and associated low dissolved oxygen levels
- Potential increased occurrence of algal blooms associated with reduced water quality
- Increased alkalinity and pH from concreting and its by-products
- Migration of litter off-site
- Contamination from accidental leaks or spills of chemicals and fuels.

Due to the largely ephemeral nature of the waterways, the relatively flat topography and the implementation of management measures these potential impacts are considered unlikely to occur and would be managed through implementation of erosion and sediment controls area in accordance with the principles and requirements of

Managing Urban Stormwater – Soils and Construction, Volume 1 (Landcom, 2004) and other identified management measures.

During Project operation, potential impacts to surface water quality would primarily be associated with the use of access tracks and the use of the operation and maintenance facility which could result in increased runoff, erosion and sedimentation and accidental leaks and spills. Without appropriate management measures, there is the potential for the water quality of downstream waterways to be impacted from leaks and spills and erosion and sedimentation. These identified operational impacts are considered unlikely as hydrological changes, which may result in increased runoff, would be managed to ensure there was no impact to downstream water quality. Additionally, the risk of leaks and spills and stormwater leaving hardstand areas would be managed by bunding and installing appropriate controls to ensure any contaminated runoff would be captured and cleaned up as required.

Overview of groundwater impacts

Project construction and operational activities are not anticipated to intersect the regional water table, meaning potential groundwater impacts are limited. Project induced changes to watercourse baseflow, regional groundwater system levels, flow directions and impacts to existing registered bores are not anticipated during the Project's construction or operation phases. Material groundwater take is also not anticipated to occur during construction or operation.

Although the Project is not anticipated to intersect the regional water table, it is possible that the Project's excavations could intercept localised perched groundwater systems. Changes to perched groundwater levels could occur if Project excavations intercept localised perched groundwater systems but these would be small, localised and likely limited to within the construction period.

Project construction and operation is not expected to impact groundwater salinity. Changes to groundwater quality could occur if groundwater systems become contaminated due to accidental spills or leaks of hazardous materials during operation. The contamination risk is low however given the implementation of management measures.

There are numerous potential and High Priority Groundwater Dependent Ecosystems (GDEs) within the study area and Project area. These are primarily wetland ecosystems that occur along the boundaries of Yanco Creek and within smaller pockets within the study area and Project area. Impacts to GDEs due to potential changes to groundwater levels and/or quality are not anticipated during the construction or operation phases. This is because construction and operational activities are not anticipated to intersect the regional water table, and perched water tables, if intersected, would only be intersected for short durations (i.e. short term timeframe for exposed footing excavations) and by relatively small interception depths. The Project's maximum excavation depth is anticipated to be between 2.5 mbgl to 3 mbgl for WTG footings.

The majority of potential and High Priority GDEs would not be intersected by proposed infrastructure work. Some isolated areas, however, overlap proposed infrastructure and therefore such GDEs, if present, may require clearing. Impacts associated with the clearing of GDEs are addressed as part of the biodiversity assessment for the Project.

Management measures

Management measures would be required to avoid, minimise and manage any short term impacts on downstream receivers (waterways and drainage lines) as a result of construction and operation of the Project. Prior to construction, erosion and sedimentation controls would be determined and implemented in accordance with *Managing urban stormwater soils and construction – Volume 1* (Landcom, 2004) to avoid any adverse impacts. A detailed Erosion and Sediment Control Plan (ESCP) and Construction Soil and Water Management Plan (CSWMP) would be prepared as part of the Construction Environmental Management Plan (CEMP) to manage erosion and sediment impacts associated with land disturbance and waterway crossings so that impacts to soil and water quality are minimised throughout the construction phase. The CEMP would also include

procedures for the appropriate storage of equipment and hazardous substances and emergency response procedures to manage leaks and spills.

Management measures implemented during operation to protect water quality would include procedures for the appropriate storage of equipment and hazardous substances and emergency response procedures to manage leaks and spills. Monitoring during construction and operation would be undertaken to assess and manage downstream receivers to identify any evidence of channel erosion and scour and water management measures to ensure the Project meets performance targets of no pollution of water.

No specific groundwater monitoring measures are proposed or deemed necessary for the Project.

Conclusion

Overall, with the implementation of the proposed controls and management measures, the Project would have minimal potential impacts to surface water quality and groundwater. As such, water quality objectives for downstream receivers are likely to be met and the functionality and long-term viability of their aquatic ecosystems would be maintained, and groundwater systems are not anticipated to be materially impacted.

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Glossary and Terms

Term	Definition
ADWG	Australian Drinking Water Guidelines
AHD	Australian Height Datum
AIP	Aquifer Interference Policy
ANZG	Australian and New Zealand Guidelines
ASC	Australian Soil Classification
ASS	Acid sulfate soils
BESS	Battery Energy Storage System
BOM	Bureau of Meteorology
CEMP	Construction Environmental Management Plan
CSWMP	Construction Soil and Water Management Plan
DGV	Default guideline value
DO	Dissolved oxygen
EC	Electrical conductivity
EEC	Endangered ecological community
EIS	Environmental Impact Statement
EP&A Act	*Environmental Planning and Assessment Act 1979*
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
EPL	Environment Protection Licence
ESCP	Erosion Sediment Control Plan
FM Act	*Fisheries Management Act 1994*
GDE	Groundwater Dependent Ecosystem
KFH	Key Fish Habitat
LEP	Local Environment Plan
mbgl	metres below ground level
mg/L	Milligrams per litre
MNES	Matters of National Environmental Significance
MW	Megawatt
NWQMS	National Water Quality Management Strategy
POEO Act	*Protection of the Environment Operations Act 1997*
SEARs	Secretary's Environmental Assessment Requirements
SRE	Sensitive Receiving Environment
SSD	State Significant Development
TN	Total nitrogen

Term	Definition
TP	Total phosphorus
WAL	Water Access Licence
WM Act	*Water Management Act 2000*
WQO	Water Quality Objective
WSP	Water Sharing Plan
WTG	Wind Turbine Generator

1. Introduction

1.1 Background

Virya Energy is proposing to construct, operate and maintain the Yanco Delta Wind Farm (the Project). Approval is sought under Division 4.7 of Part 4 of the *Environmental Planning and Assessment Act 1979* (NSW) (EP&A Act) and Part 9, Division 1 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

The Project would involve the construction, operation and maintenance of a wind farm with up to 208 wind turbine generators (WTGs), a battery energy storage system (BESS) and associated electrical infrastructure. The generating capacity of the wind farm is approximately 1,500 megawatts (MW). The Project would be located within the South-West Renewable Energy Zone (REZ), 10 kilometres north-west of the town of Jerilderie, within the Murrumbidgee Council and Edward River Council Local Government Areas (LGAs) (refer to **Figure 1-1**).

The Project area is defined as the property boundaries of Project landowners (i.e. landowners that have entered into agreements with Virya Energy to have WTGs or associated infrastructure on their properties).

1.2 Project description

The Project would include the following key features:

- Up to 208 WTGs to a maximum tip height of 270 metres
- Generating capacity of approximately 1500 MW
- BESS, approximately 800 MW/800 megawatt hours (MWh) (type yet to be determined)
- Permanent ancillary infrastructure, including operation and maintenance facility, internal roads, hardstands, underground and overhead cabling, wind monitoring masts, central primary substation and up to eight collector substations
- Temporary facilities, including site compounds, laydown areas, stockpiles, gravel borrow pit(s) and concrete batch plants.

An indicative Project layout is provided in **Figure 1-2**.

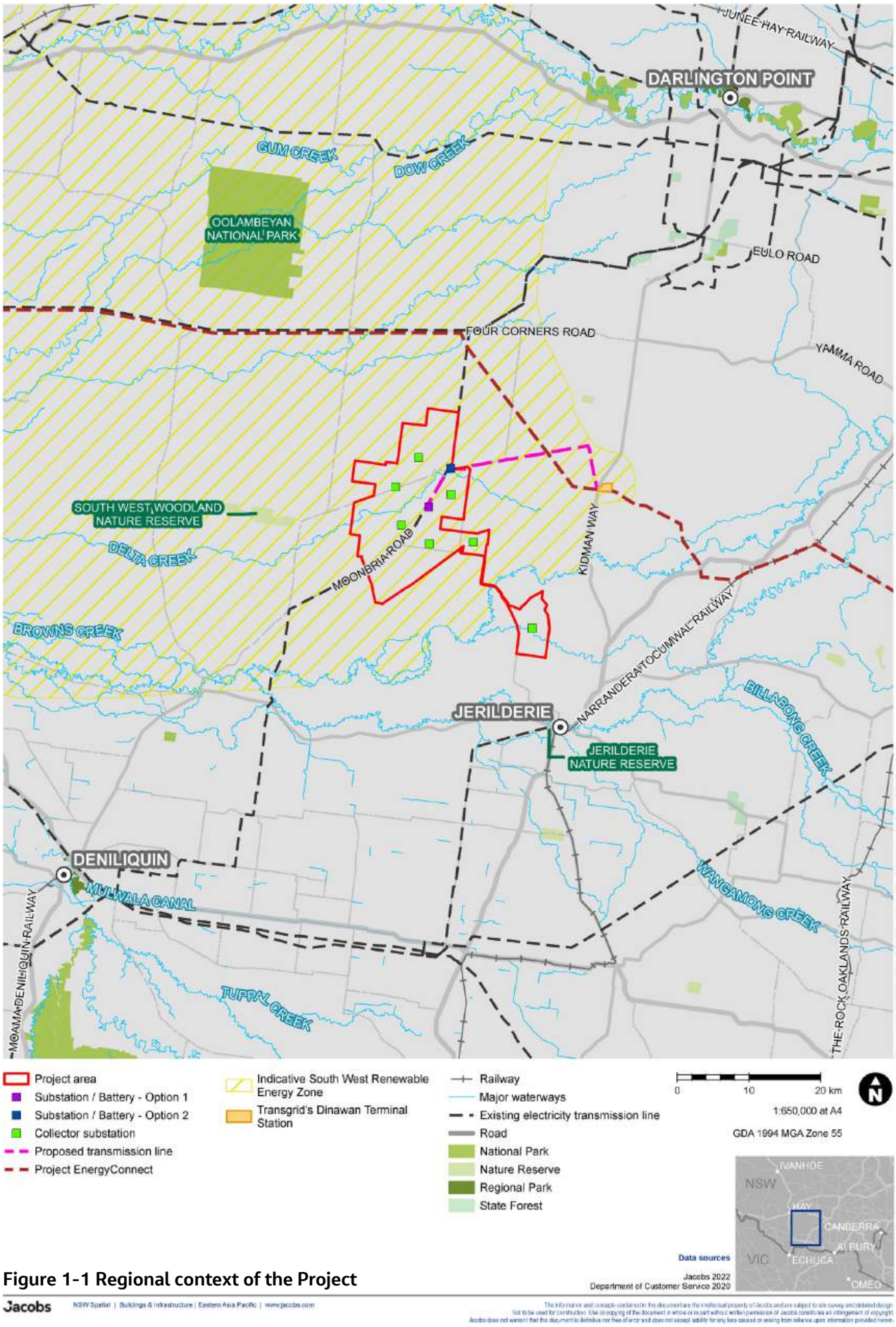


Figure 1-1 Regional context of the Project

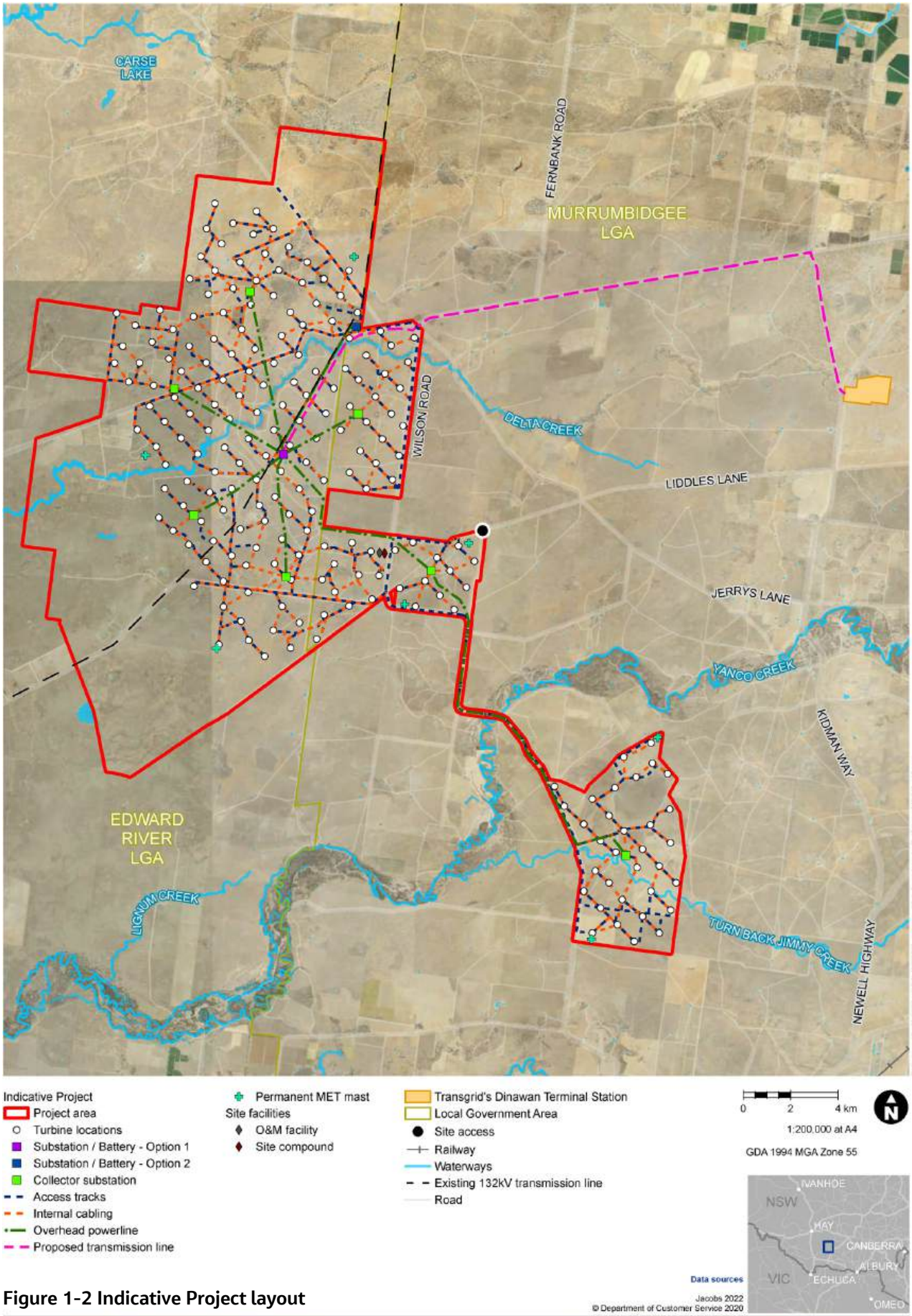


Figure 1-2 Indicative Project layout

1.3 Secretary's Environmental Assessment Requirements

This assessment forms part of the environmental impact statement (EIS) for the Project. The EIS has been prepared under Division 4.7 of the EP&A Act. This assessment has been prepared to address the Secretary's Environmental Assessment Requirements (SEARs) (SSD-41743746) relating to surface water quality and groundwater and will assist the Minister for Planning to make a determination on whether or not to approve the Project.

Table 1-1 outlines the SEARs relevant to this assessment along with a reference to where these are addressed.

Table 1-1 SEARs relevant to surface water quality and groundwater

Secretary's Requirement	Where addressed in this report
Water and Soils – the EIS must:	
• Quantify water demand, identify water sources (surface and groundwater), including any licensing requirements, and determine whether an adequate and secure water supply is available for the development;	Water demand and water sources for the Project is discussed in **Section 5.1** for construction and **Section 5.2** for operation.
• An assessment of the likely impacts of the development (including flooding) on surface water and groundwater resources traversing the site and surrounding watercourses (including their Strahler Stream Order), drainage channels, wetlands, riparian land, farm dams, groundwater dependent ecosystems and acid sulfate soils, related infrastructure, adjacent licensed water users and basic landholder rights, and measures proposed to monitor, reduce and mitigate these impacts;	Potential impact on surface water resources is discussed in **Section 6.1** for construction, and **Section 7.1** for operation. Cumulative surface water impacts are provided in **Section 9.1**. Potential impacts to groundwater resources are assessed in **Section 6.2** for construction, and **Section 7.2** for operation. Cumulative groundwater impacts are provided in **Section 9.2**. Specifically, potential impacts on: • Watercourses and drainage channels (refer to **Section 6.1** and **Section 7.1**) • Wetlands and riparian land (refer to **Section 6.1.2**, and the Biodiversity Development Assessment Report (Jacobs 2022a)) • Farm dams (**Section 5.3**) • Groundwater dependent ecosystems (refer to **Section 6.2.3** and **Section 7.2.3**) • Acid sulfate soils (refer to **Section 6.1.1**) • Related infrastructure (doesn't apply to the Project) • Adjacent licensed water users and basic landholder rights (refer to **Section 5.1**, **Section 6.2.4** and **Section 7.2.4**). Measures proposed to monitor, reduce and mitigate these impacts are discussed in **Chapter 10**. Potential flooding impacts are provided in the Flooding and hydrology technical report (Jacobs 2022d).

Secretary's Requirement	Where addressed in this report
• Where the Project involves works within 40 metres of the high bank of any river, lake or wetlands (collectively waterfront land), identify likely impacts to the waterfront land, and how the activities are to be designed and implemented in accordance with the DPI *Guidelines for Controlled Activities on Waterfront Land* (2018) and (if necessary) *Why Do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings* (DPI 2003); and *Policy & Guidelines for Fish Habitat Conservation & Management* (DPI, 2013);	**Section 2.2.3** and **Section 2.3.9** discuss the legislative requirements for works on waterfront land. Potential impacts to waterfront land is provided in **Section 5.1**.
• A description of the measures to minimise surface and groundwater impacts, including how works on erodible soil types would be managed and any contingency requirements to address residual impacts in accordance with the Managing Urban Stormwater: Soils and Construction series of guidelines	Measures to mitigate potential impacts to surface water and groundwater, including the management of erodible soils, are outlined in **Chapter 10**. Further information on erodible soils and soil erosion hazard is provided in the Soils and contamination technical report (Jacobs, 2022b).
• An assessment of risks of dust generation and propose mitigation measures designed in accordance with the Approved Methods and Guidelines for the Modelling and Assessment of Air Pollutants in New South Wales (DECC, 2005).	Assessment of impacts of dust generation is discussed in **Section 6.1** and **Section 7.1**. Mitigation measures are included in **Chapter 10**. Further information on air quality impacts in accordance with the Approved Methods and Guidelines for the Modelling and Assessment of Air Pollutants in New South Wales is provided in Chapter 14 (Air Quality) of the EIS.

1.4 Structure of this report

The structure and content of this report are outlined in **Table 1-2**.

Table 1-2 Structure and content of this report

Chapter	Description
Chapter 1 Introduction	Outlines key elements of the Project, SEARs and the structure of this report (this Chapter)
Chapter 2 Policy and planning setting	Provides an outline of the statutory context, including applicable legislation and planning policies
Chapter 3 Assessment methodology	Provides a description of the assessment methodology for this assessment
Chapter 4 Existing environment	Provides a preliminary description of the existing environment
Chapter 5 Potential construction impacts	Presents the outcomes of the construction impact assessment and construction water demand for the Project

Chapter	Description
Chapter 7 Potential operational impacts	Presents the outcomes of the operational impact assessment and operational water demand for the Project
Chapter 8 Potential decommissioning impacts	Provides a description of how the Project would be decommissioned once it reaches its end of operational life
Chapter 9 Potential cumulative impacts	Presents the qualitative assessment of potential cumulative construction and operational surface water quality and groundwater impacts with other projects near the Project
Chapter 10 Environmental management measures	Presents the surface water quality and groundwater management measures applicable for the Project
Chapter 11 Conclusion	Summarises the findings of this report
References	Provides details of external resources used
Appendix A Construction water balance	Provides details of the construction water balance

2. Policy and Planning

2.1 Commonwealth legislation

2.1.1 Environment Protection and Biodiversity Conservation Act 1999

The EPBC Act is primary federal environmental legislation that provides the legal framework to protect and manage Matters of National Environmental Significance (MNES) including nationally and internationally important flora, fauna, ecological communities, cultural heritage and water resources. MNES that are relevant to the Project that are related to surface water quality and are located within proximity of or are predicted to occur within the study area (defined in **Section 3.1**) include the following:

- Flathead Galaxias (*Galaxias rostratus)*, listed as critically endangered under the EPBC Act
- Silver Perch (*Bidyanus bidyanus*) listed as Critically endangered under the EPBC Act.
- Murray Cod (*Maccullochella peelii*) listed as Vulnerable under the EPBC Act
- Trout Cod (*Maccullochella* macquariensis) listed as Endangered under the EPBC Act and
- Macquarie Perch (*Macquaria* australasica) listed as Endangered under the EPBC Act.

Consideration has been given to the relevant MNES in the determination of Sensitive Receiving Environments (SREs) (refer to **Section 4.3.4**). Impacts to aquatic species and ecological communities have also been broadly assessed in **Section 6.1** and **Section 7.1**, and are further addressed in the Biodiversity Development Assessment Report for the Project (Jacobs, 2022a).

With respect to groundwater, the Biodiversity Development Assessment Report for the Project (Jacobs, 2022a) indicates MNES flora known within the Project area, or likely to occur within the Project area, have a low GDE potential.

2.2 State legislation

2.2.1 Environmental Planning and Assessment Act 1979

The EP&A Act and Environmental Planning and Assessment Regulation 2021 establish the framework for development assessments in NSW. The EP&A Act and the Regulation include provisions to ensure that the potential environmental impacts of a development are considered in the decision-making process prior to proceeding to construction.

Part 4 of the EP&A Act establishes the framework for assessing development that is permissible with consent. The Project is State Significant Development (SSD) under Section 2.6(1) in conjunction with Section 20 of Schedule 1 of the State Environmental Planning Policy (Planning Systems) 2021.

The Project is defined as electricity generating work and has a capital investment value (CIV) estimated to exceed one billion Australian dollars. Therefore, the Project is proceeding with an application for planning approval as an SSD. Under Section 4.12(8) of the EP&A Act, the application is to be accompanied by an EIS prepared by or on behalf of the applicant in the form prescribed by the Regulations.

2.2.2 Protection of the Environment Operations Act 1997

The NSW *Protection of the Environment Operations Act 1997* (POEO Act) is administered by the NSW Environment Protection Authority. The POEO Act regulates air and water pollution, noise control and waste management within the state. In addition, the Act contains pollution controls and requirements for granting Environment Protection Licences. Schedule 1 of the Act lists activities that require an EPL.

An EPL under the POEO Act is required for wind energy projects which are SSD or designated development. In accordance with section 43(d) of the POEO Act, an EPL may also be issued to control the carrying out of a non-scheduled activity for the purpose of regulating water pollution.

2.2.3 Water Management Act 2000

The *Water Management Act 2000* (WM Act) is the primary legislation for the management of water in the study area (defined in **Section 3.1**). The WM Act contains provisions for the licensing of water access and use. Groundwater quality protection is also achieved through consideration of both the objects and principles of the WM Act.

In general, the WM Act governs the issue of water access licences (WALs) and approvals for those water sources (rivers, lakes, estuaries and groundwater) in NSW where Water Sharing Plans (WSPs) have commenced. WSPs have commenced within the study area and are shown in **Table 2-1**. With respect to groundwater, the upper most groundwater source and WSP is shown in **Table 2-1**. This groundwater source consists of unconsolidated alluvial sediments to a depth of 40 metres or to the bottom of the Shepparton Formation, whichever is deeper. Additional groundwater sources and WSPs underly the upper most groundwater source and WSP. However, these deeper groundwater sources and WSPs are not applicable as Project works are not proposed at depths of greater than a few metres below ground level and are unlikely to influence these deeper groundwater systems.

Table 2-1 WSPs and water sources in study area

Water Type	Water Sharing Plan	Water Source
Surface water	Water Sharing Plan for the Murrumbidgee Unregulated and Alluvial Water Sources 2012	Lower Billabong Anabranch Water Source
		Murrumbidgee Western Water Source
Groundwater	Water Sharing Plan for the Murrumbidgee Alluvial Groundwater Sources 2020 (NSW Government, 2020)	Lower Murrumbidgee Shallow Groundwater Source

Section 91 of the WM Act requires an 'activity approval' to carry out a 'controlled activity' in, on or under waterfront land or to carry out an aquifer interference activity. The definition of a controlled activity includes the carrying out of work, the removal of material or vegetation from land, the deposition of material on land and the carrying out of any other activity that affects the quality or flow of water in a water source.

'Waterfront land' is defined as including the bed and banks of rivers as well as land that is 40 metres inland of the highest bank of the river. While Project area only includes creeks and tributaries, this is considered to be covered by the definition as the Act protects all riparian zones. As the Project would involve construction of an ancillary road/facility within 40 metres of a waterway as well as trenching through waterways, the Project would meet the definition of a controlled activity under the WM Act and therefore require an 'activity approval'.

Ordinarily, if an activity leads to a take from a groundwater or surface water source covered by a WSP, then an approval and/or licence is required. In general, the WM Act requires:

- A WAL to take water
- A water supply works approval to construct a work
- A water use approval to use the water.

However, as the Project is considered to be State Significant Development, under section 4.41 (1g) of the EP&A Act, the authorisation provided by a water use approval under Section 89 of the WM Act, a water management work approval under Section 90 of the WM Act or an activity approval under Section 91 WM Act would not be required. Rather, this authorisation is provided by a development consent.

Also, if groundwater take occurs due to temporary construction dewatering, if the take is less than 3 ML per year, the Project is exempt from a WAL.

Surface water and groundwater extraction is not proposed or anticipated. However, if it were to occur, if the Project's groundwater / surface water extraction is assessed and approved as part of the SSD, only a WAL would be required, unless the take was for temporary construction dewatering and less than 3 ML per year. A WAL authorises the taking of a share of water from a specified water source in accordance with the volumetric entitlement in the WAL. That entitlement is measured by the number of units assigned to the WAL and the annual volumetric value of a unit for that water source as determined by the Minister administering the WM Act. Units can be transferred from one WAL to another. A WAL is held personally and may be transferred and otherwise dealt with in accordance with the WM Act.

Although surface water and groundwater extraction is not proposed or anticipated, water supply options would continue to be explored during detailed design. If required, the Proponent would enter into agreements with landholders to source water from dams and / or bores for construction and / or operation. If groundwater was extracted to provide a Project water source, where possible, it would be extracted at already approved rates from already approved bores.

2.2.4 Fisheries Management Act 1994

The following threatened aquatic species, populations and ecological communities have been mapped as having potential to occur within the Project area:

- Flathead Galaxias (*Galaxias rostratus*) - critically endangered under the FM Act
- Silver Perch (*Bidyanus bidyanus*) - Vulnerable under the FM Act
- Macquarie Perch (.(*Macquaria australasica)* – Endangered under the FM Act
- Trout Cod (*Maccullochella macquariensis*) – Endangered under the FM Act
- Aquatic ecological community in the natural drainage system of the lower Murray River catchment (Murray River EEC) – Endangered ecological community.

With regard to this Project, works associated with construction of the access roads and cable trenches would require 'dredging' (excavation of water land or removal of material from water land) or 'reclamation' (using material to fill/reclaim or depositing material to construct anything other than water land) as defined under section 198A of the FM Act. In addition, construction and operation of the Project would result in the 'temporary or permanent blockage of fish passage within watercourses' as defined under section 219 of the FM Act.

Part 7 of the FM Act relates to the protection of aquatic habitats, including providing management of dredging and reclamation works within permanently or intermittently flowing watercourses, as well as the temporary or permanent blockage of fish passage within a waterway. However, by force of section 4.41 of the EP&A Act, the requirement to receive permits for these activities (listed under sections 201, 205 or 219 of the FM Act) do not apply.

Despite the exemption, the Project aims to maintain and improve fish passage throughout construction and operation through design of an appropriate instream construction methodology and use of fishways for regulator structures.

2.3 Regulatory policies/relevant guidelines

2.3.1 National Water Quality Management Strategy

The National Water Quality Management Strategy (NWQMS) (Australian Government, 2018) is the overarching strategy for managing water quality in Australia and was developed with the objective of achieving sustainable use of the nation's water resources by protecting and enhancing their quality while maintaining economic and social development.

The NWQMS contains all subsequent guidelines and policies related to water quality including:

- The NSW Water Quality and River Flow Objectives (DECCW, 2006) which sets out water quality objectives to sustain current or likely future environmental values for water resources (refer to **Section 2.3.3**)
- The Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG, 2018) which outlines relevant guidelines related to the water quality objectives (refer to **Section** 2.3.2)
- The Guidelines for Groundwater Quality Protection in Australia (Australian Government, 2013) (refer to **Section 2.3.12**)

2.3.2 Australian and New Zealand Guidelines for Fresh and Marine Water Quality

The current *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZG (2018) Water Quality Guidelines), also referred to as the 'revised Water Quality Guidelines', were released in 2018 as an online resource. They provide high-level guidance on the management context, ecological descriptions, biological indicator selection, regional default guideline values for physical and chemical stressors and other advice for three of Australia's 12 inland water drainage divisions. For ecoregions where regional physical and chemical stressor default guideline values are not yet provided and local jurisdictions have not yet derived finer scale (e.g. catchment, basin or physiographic level) guideline values, the regional default guideline values provided in the superseded *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (Australia and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ), 2000) (ANZG (2000) Water Quality Guidelines) apply.

The ANZG (2018) Water Quality Guidelines do not contain default guideline values relevant to the region. The water quality targets relevant to the Project are set out in the Murray-Darling Basin Plan (refer to **Section 2.3.4**), the Murray-Darling Basin Agreement and the ANZG (2000) Water Quality Guidelines.

2.3.3 NSW Water Quality and River Flow Objectives

The *NSW Water Quality and River Flow Objectives* (Department of Environment, Climate Change and Water (DECCW), 2006) are the agreed environmental values and long-term goals for NSW's surface waters. The *NSW Water Quality and River Flow Objectives* are separated into, the NSW Water Quality Objectives (WQOs) and the NSW River Flow Objectives (RFOs), which are distinct because they relate to different environmental attributes of a waterway that are important for long-term functionality.

Project impacts to NSW WQOs nominated for waterways within the study area (defined in **Section 3.1**) have been described and addressed in **Section 2.2.4** and **Section 4.3.4**. The NSW RFOs have been described and addressed in the Flooding and hydrology technical report (Jacobs, 2022).

The NSW WQOs identify environmental values for NSW waterways and the associated water quality indicators which relate to these environmental values. The NSW WQOs then refer to ANZG (2018) Water Quality Guidelines and other guidelines to provide DGVs and technical guidance to assess the water quality needed to protect these values.

The Project falls withing the Murray River Catchment. Different WQOs have been set for areas within this catchment based on land use and the nature of its watercourses and their flows. Yanco Creek, located between the northern and southern portion of the Project area, receives controlled flows from the Murrumbidgee River

and has been categorised as a "controlled river with altered flow pattern (regulated creeks)". Delta Creek and Turn Back Jimmy Creek (both within the Project area) have been categorised as "uncontrolled streams". Each of these categories have numerous water quality objectives for protection.

WQOs applying to waterway categories within the study area are outlined in **Section 3.2.4.**

2.3.4 Murray-Darling Basin Plan

The Murray-Darling Basin Plan (MDBA, 2012) provides a coordinated approach to managing basin water resources across Queensland, NSW, ACT, Victoria and South Australia. In NSW, the plan came into effect following the signing of Inter-governmental and National Partnership Agreements in 2014. As the lead agency, DPE (Water) is working across the NSW government with the NSW Biodiversity, Conservation and Science and the Department of Primary Industries (Fisheries) and other agencies to implement the plan. The plan has been considered in this assessment of water quality.

2.3.5 Murrumbidgee Long Term Water Plan

The Murrumbidgee Long-Term Water Plan Part A (Department of Planning, Industry and Environment, 2020a) identifies strategies for maintaining and improving the long-term health of the Murrumbidgee riverine and floodplain environmental assets and the ecological functions they perform. This includes detailed descriptions of ecologically important river flows and risks to water for the environment.

The Long-Term Water Plan does not prescribe how environmental water should be managed in the future, rather it aims to help water managers make decisions about where, when and how available water can be used to achieve the agreed long-term ecological objectives. The Long-Term Water Plan considers all sources of water and how these can be managed to help support environmental outcomes in the catchment. This recognises that the Murray–Darling Basin Plan specifically requires environmental water managers to act adaptively by making timely decisions based on the best-available knowledge, and from monitoring and evaluating the outcomes from water use.

The Long-Term Water Plan comprises two parts:

- Part A provides a catchment-scale description of the flow regimes required to maintain or improve environmental outcomes in the Murrumbidgee Catchment
- Part B describes the flow regimes required to maintain or improve environmental outcomes in the Murrumbidgee at a planning unit scale.

To address variation along the Murrumbidgee River, the Murrumbidgee Long-Term Water Plan divides the river into 14 planning units, which correspond to the 14 management zones in the WSP. The Project spans across two planning units: the Upper Yanco Creek (PU10) and the Lower Yanco Creek to Lower Billabong Creek (PU12). Potential impacts from the Project within these planning units are provided in **Chapter 5** and **Chapter 7**.

2.3.6 Murrumbidgee Surface Water Resource Plan

Water Quality Management Plan

Under the Murray-Darling Basin Plan, there is a requirement to develop water quality management plans for each water resource plan area within the Murray-Darling Basin with the purpose of providing a framework to protect, enhance and restore water quality that is suitable for a range of outcomes. The *Water Quality Management Plan for the Murrumbidgee Water Resource Plan Area* (DPIE, 2019b) identifies relevant water quality objectives for the Murrumbidgee watercourse and the water quality targets required to achieve these objectives.

The Plan notes that water quality attributes in the Murrumbidgee are strongly related to flow. High flow from rainfall and runoff results in higher turbidity, nutrients and possibly pesticides and pathogens but lower electrical

conductivity. There is also a general trend towards increasing turbidity with distance down the catchment due to the cumulative impacts of land use, soil disturbance and human activity on water quality upstream.

2.3.7 Australian Drinking Water Guidelines

The *Australian Drinking Water Guidelines* (ADWG) are prepared by the National Health and Medical Research Council and Natural Resource Management Ministerial Council (2011) for the Australian Government and are:

"…intended to provide a framework for good management of drinking water supplies that, if implemented, will assure safety at point of use. The ADWG have been developed after consideration of the best available scientific evidence. They are designed to provide an authoritative reference on what defines safe, good quality water, how it can be achieved and how it can be assured. They are concerned both with safety from a health point of view and with aesthetic quality."

The ADWG are not mandatory standards; however, they provide a basis for determining the quality of water to be supplied to consumers in all parts of Australia. They are intended for use by the Australian community and all agencies with responsibilities associated with the supply of drinking water, including catchment and water resource managers, drinking water suppliers, water regulators and health authorities.

Given one of the nominated environmental values within the WQOs is "drinking water at point of supply – groundwater", the Australian drinking water guidelines are relevant to this Project in terms of assessing potential impacts on the quality of the water resource. Groundwater quality impacts of the Project are discussed in **Section 6.2** and **Section 7.2.**

2.3.8 Guidelines for Managing Risks in Recreational Water

The *Guidelines for Managing Risks in Recreational Water* (National Health and Medical Research Council, 2008) aim to protect the health of humans from threats posed by the recreational use of coastal, estuarine and fresh waters.

The guidelines provide recommended values for indicators that may pose a risk to human health. These indicators are relevant for the Murrumbidgee Catchment which has "maintaining the quality of surface water for recreational use" as a water quality objective in the Basin Plan (DPIE, 2019). Potential threats to the recreational use of the waterway may arise as a result of the construction and operation of the Project, refer to **Section 6.1.1** and **Section 7.1**.

2.3.9 Guideline for controlled activities on waterfront land

Controlled activities carried out in, on or under waterfront land are regulated by the *Water Management Act 2000* (WM Act) (refer to **Section 2.2.3**). The Act defines waterfront land to include the bed and bank of any river, lake or estuary and all land within 40 metres of the highest bank of the river lake or estuary. While Project area only includes creeks and tributaries, this is considered to be covered by the definition as the Act protects all riparian zones.

Section 91(2) of the water management act sates that approval is required for the carrying out of a controlled activity in, on or under waterfront land.

The Project would involve trenching through waterways and other construction works within 40 metres of waterways, however a controlled activity approval is not required for the Project which falls under the exemptions listed in Section 4.41 of the EP&A Act.

2.3.10 Policy and Guidelines for Fish Habitat Conservation and Management

The *Policy and Guidelines for Fish Habitat Conservation and Management* (DPI, 2013) is the guideline applicable to all planning and development proposals and various activities that affect freshwater ecosystems in NSW. The aims of this guideline are to maintain and enhance fish habitat for the benefit of native fish species, including

threatened species in freshwater environments. First published in 1999, the 2013 updated document assists developers, their consultants and government and non-government organisations to ensure their actions comply with legislation, as well as policies and guidelines that relate to fish habitat conservation and management. It is also intended to inform land use and natural resource management planning, development planning and assessment processes, and to improve awareness and understanding of the importance of fish habitats and how impacts can be mitigated, managed and offset.

The guidelines outlined in this document are taken into account when NSW Fisheries assesses proposals for developments and other activities that affect fish habitats. The document contains:

- Background information on aquatic habitats and fisheries resources in NSW
- An outline of the legislative requirements relevant to planning and development which may affect fisheries or aquatic habitat in NSW
- General policies and classification schemes for the protection and management of fish habitats and an outline of the information that NSW Fisheries requires to be included in development proposals that affect habitat
- Specific policies and guidelines aimed at maintaining and enhancing the free passage of fish through instream structures and barriers
- Specific policies and guidelines for foreshore works and waterfront developments
- Specific policies and guidelines for the management of other activities that affect watercourses.

The above policies and guidelines have been considered as part of this assessment.

2.3.11 NSW Aquifer Interference Policy

The NSW Aquifer Interference Policy (AIP) (DPI, 2012) outlines 'Minimal Impact Considerations' for water table and groundwater pressure drawdown for High Priority GDEs (as identified in the WSP), high priority culturally significant sites (as identified in the WSP) and existing groundwater supply bores. Water quality impact considerations are also outlined.

Different 'Minimal Impact Considerations' from DPI (2012) are applicable to different groundwater system types. In the context of the AIP, the Project is characterised to reside in the 'alluvial water source' sub-category of the 'highly productive groundwater sources' category. The productivity characterisation is made on the basis that groundwater systems in the Project's upper groundwater source and WSP could simultaneously produce yields greater than 5 L/s and have a total dissolved solids concentration of <1,500 mg/L, which is the NSW DPI (2012) criterion used distinguish a 'highly productive' groundwater source from a 'less productive groundwater source'.

In accordance with the AIP (DPI, 2012), the Minimal Impact Considerations outlined in **Table 2-2** apply to the Project.

Table 2-2 AIP (DPI, 2012) Minimal Impact Considerations - Highly Productive Alluvial Groundwater Sources

Water table	Water pressure	Groundwater quality
1. *Less than or equal to 10% cumulative variation in the water table, allowing for typical climatic "post-water sharing plan" variations, 40m from any:* *(a) high priority GDE; or* *(b) high priority culturally significant site;* *listed in the schedule of the relevant water sharing plan.*	1. *A cumulative pressure head decline of not more than 40% of the "post-water sharing plan"(2) pressure head above the base of the water source to a maximum of a 2m decline, at any water supply work.* *If the predicted pressure head decline is greater than requirement 1. above, then*	1. *Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40m from the activity.* 2. *No increase of more than 1% per activity in long-term average salinity in a highly connected surface water*

Water table	Water pressure	Groundwater quality
A maximum of a 2m decline cumulatively at any water supply work. *2. If more than 10% cumulative variation in the water table, allowing for typical climatic "post-water sharing plan" variations, 40m from any:* *(a) high priority GDE; or* *(b) high priority culturally significant site;* *listed in the schedule of the relevant water sharing plan then appropriate studies would be required to demonstrate to the Minister's satisfaction that the variation would not prevent the long-term viability of the dependent ecosystem or significant site.* *If more than 2m decline cumulatively at any water supply work, then make good provisions should apply.*	*appropriate studies are required to demonstrate to the Minister's satisfaction that the decline will not prevent the long-term viability of the affected water supply works unless make good provisions apply.*	*source at the nearest point to the activity.* *If condition 1 is not met then appropriate studies would be required to demonstrate to the Minister's satisfaction that the change in groundwater quality would not prevent the long-term viability of the dependent ecosystem, significant site or affected water supply works.* *If condition 2 is not met then appropriate studies are required to demonstrate to the Minister's satisfaction that the River Condition Index category of the highly connected surface water source will not be reduced at the nearest point to the activity.*

2.3.12 Guidelines for Groundwater Quality Protection

The Guidelines for Groundwater Quality Protection in Australia (Australian Government, 2013) set out a high-level risk-based approach to protecting or improving groundwater quality for a range of groundwater beneficial uses (called 'environmental values'), including aquatic ecosystems, primary industries (including irrigation and general water users, stock drinking water, aquaculture and human consumption of aquatic foods), recreational and aesthetic values (e.g. swimming, boating and aesthetic appeal of water bodies), drinking water, industrial water and cultural values.

For the purpose of this assessment, the drinking water, primary industry and aquatic ecosystem 'environmental values are considered applicable. Groundwater is not extracted for industrial purposes in the study area (defined in **Section 3.1**) and recreational, aesthetic and cultural values are not considered applicable as the watercourses in the study area are not used for these purposes.

3. Assessment methodology

3.1 Study area

For the purposes of the surface and groundwater assessments, the study area (**Figure 3-1**) is defined as the Project area and transmission line with a 500 metre buffer. This was adopted to encapsulate a conservative estimate for the maximum distance that sediments and pollutants may mobilise from a point source.

For the purpose of contouring, water level data was collected from a larger data review area, about 40 kilometres by 40 kilometres, centred around the Project area. A larger study area was required for contouring to provide sufficient data points to increase reliability and confidence in the groundwater level and flow information.

3.2 Surface water quality

3.2.1 Desktop assessment

The desktop assessment involved a review of the existing surface water conditions across the study area to assess the likely and potential impacts of the Project on surface water quality during construction and operation. The review of information has included review of available scientific literature, existing water data, and land use information to aid in determining the existing baseline conditions within the Project area. Literature sources included:

- Key Fish Habitat Maps (DPI, 2007)
- State of the Catchments 2010 Riverine ecosystems: Murrumbidgee region
- Water quality technical report for the Murrumbidgee surface water resource plan area (SW9)
- Water quality management plan for the Murrumbidgee water resource plan area (SW9)
- Murrumbidgee Long Term Water Plan. Part A: Murrumbidgee catchment
- Murrumbidgee Long Term Water Plan. Part B: Murrumbidgee planning units
- Murrumbidgee Surface Water Monitoring, Evaluation and Reporting Plan
- NSW Water Quality and River Flow Objectives.

3.2.2 Data analysis

3.2.3 Identification of sensitive receiving environments

Sensitive receiving environments (SREs) are environments that have a high conservation or community value or support ecosystem/human uses of water that are particularly sensitive to pollution or degradation. SREs were identified within the study area based on the following conditions:

- Water course classification (Fairfull and Witheridge, 2003)
- Key Fish Habitat Mapping (DPI, 2007)
- Presence of threatened aquatic species listed under the *Fisheries Management Act 1994* (FM Act) and the *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act). Likelihood of presence is based on threatened species distribution mapping (DPI, 2016) and database searches including the Protected Matters Search Tool (DAWE, 2022), Bionet Atlas records (EESG, 2022) and ALA records (ALA, 2022)
- Groundwater and surface water dependent vegetation and fauna communities listed under the *Biodiversity Conservation Act* 2016 (BC Act) and EPBC Act
- Proximity to a drinking water catchment
- Proximity to protected areas including Ramsar listed wetlands and National Parks.

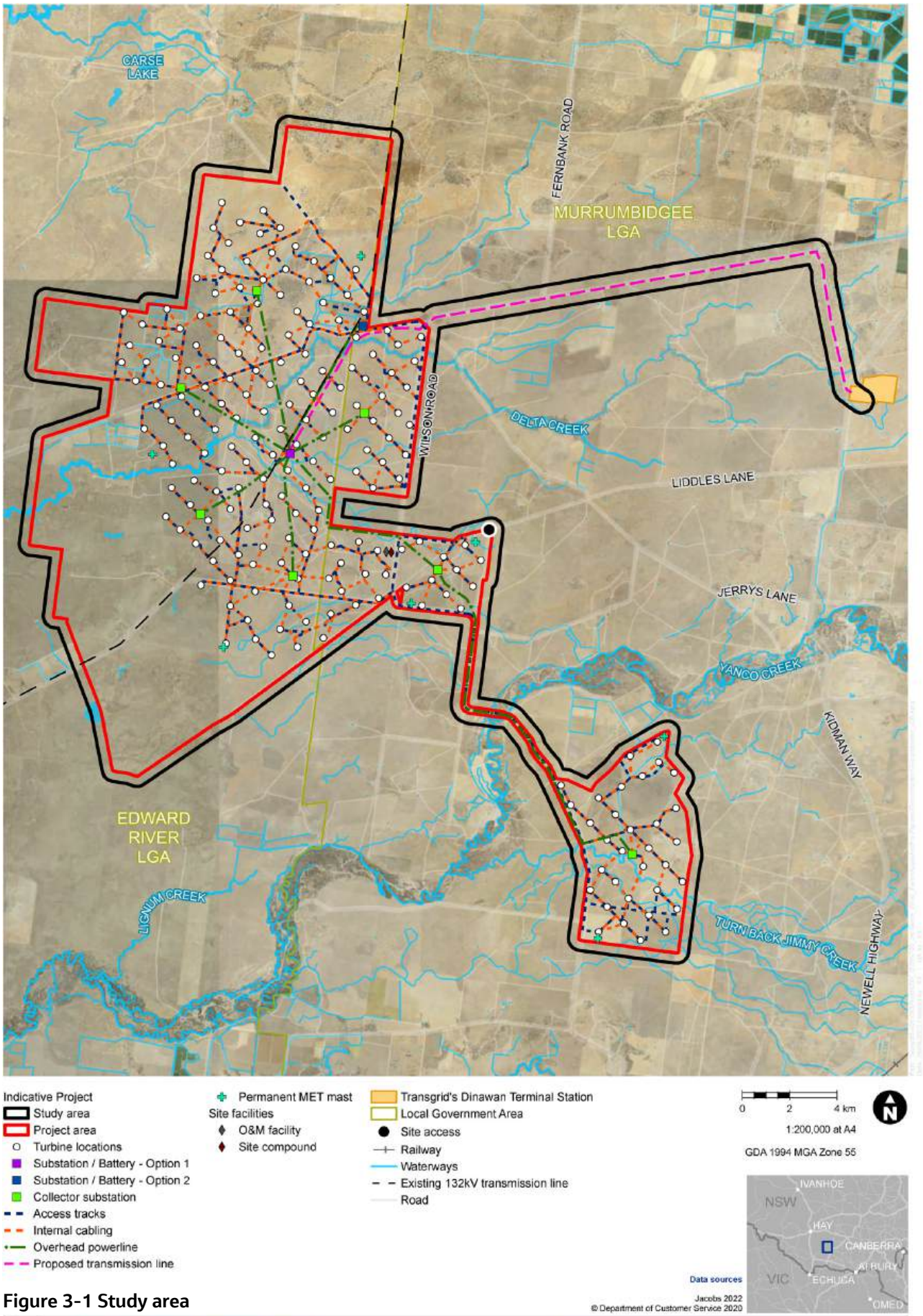


Figure 3-1 Study area

3.2.4 Identification of water quality criteria

As outlined in **Section 2.3.3**, WQOs were identified for waterways within the study area using the NSW Water Quality Objectives (DECCW, 2006). The relevant water quality objectives relevant to the study area are the protection of:

- Aquatic ecosystems
- Visual amenity
- Secondary contact recreation
- Primary contact recreation
- Livestock water supply
- Irrigation water supply
- Homestead water supply
- Drinking water at point of supply - Disinfection only; (clarification and disinfection)
- Drinking water at point of supply – groundwater
- Aquatic foods (cooked).

These WQOs, the indicators, and the recommended guidelines for protection of these objectives are provided in **Table 3-1**.

Table 3-1 Water quality objectives for waterways in the Project

Water quality objective	Indicator	Guideline
Aquatic ecosystems - maintaining or improving the ecological condition of waterbodies and their riparian zones over the long term	Total phosphorus	0.05 mg/L[1]
	Total nitrogen	0.6 mg/L[1]
	Chlorophyll-*a*	5 µg/L
	Turbidity	35 NTU
	Salinity (Electrical conductivity)	Median 162[1] µS/cm
	Dissolved oxygen	80-110[1] percent saturation
	pH	6.5-8[1]
	Toxicants	As per ANZG (2018) toxicant default guideline values for water quality in aquatic ecosystems
Visual amenity - aesthetic qualities of waters	Visual clarity and colour	Natural visual clarity should not be reduced by more than 20%. Natural hue of water should not be changed by more than 10 points on the Munsell Scale. The natural reflectance of the water should not be changed by more than 50%.
	Surface films and debris	Oils and petrochemicals should not be noticeable as a visible film on the water, nor should they be detectable by odour. Waters should be free from floating debris and matter.
	Nuisance organisms	Macrophytes, phytoplankton scums, filamentous algal mats, blue-green algae, sewage fungus and leeches should not be present in unsightly amounts n/a

Water quality objective	Indicator	Guideline
Secondary contact recreation – maintaining or improving water quality for activities such as boating and wading, where there is a low probability of water being swallowed	Faecal coliforms, enterococci, algae and blue-green algae	As per the NHMRC (2008) Guidelines for managing risks in recreational water. Secondary contact recreation – maintaining or improving water quality for activities such as boating and wading, where there is a low probability of water being swallowed
	Nuisance organisms	As per the visual amenity guidelines. Large numbers of midges and aquatic worms are undesirable.
	Chemical contaminants	Waters containing chemicals that are either toxic or irritating to the skin or mucous membranes are unsuitable for recreation Toxic substances should not exceed values in Table 9.3 of NHMRC (2008) guidelines
	Visual clarity and colour	As per the visual amenity guidelines.
	Surface films	As per the visual amenity guidelines.
Primary contact recreation – maintaining or improving water quality for activities such as swimming where there is a high probability of water being swallowed	Faecal coliforms, enterococci, algae and blue-green algae	As per the NHMRC 2008 Guidelines for managing risks in recreational water.
	Protozoans	Pathogenic free-living protozoans should be absent from bodies of fresh water.
	Chemical contaminants	Waters containing chemicals that are either toxic or irritating to the skin or mucus membranes are unsuitable for recreation. Toxic substances should not exceed values in Table 9.2 of NHMRC (2008) guidelines.
	Visual clarity and colour	As per the visual amenity guidelines.
	Temperature	15°-35°C for prolonged exposure.
Livestock water Supply – protecting water quality to maximise the production of healthy livestock	Algae and blue-green algae	An increasing risk to livestock health is likely when cell counts of microcystins exceed 11 500 cells/mL and/or concentrations of microcystins exceed 2.3 µg/L expressed as microcystin-LR toxicity equivalents.
	Salinity (electrical conductivity)	Recommended concentrations of total dissolved solids in drinking water for livestock are given in Table 4.3.1 of ANZECC Guidelines (ANZECC/ARMCANZ, 2000).
	Thermotolerant coliforms (faecal coliforms)	Drinking water for livestock should contain less than 100 thermotolerant coliforms per 100 mL (median value)
	Chemical contaminants	Refer to Table 4.3.2 of ANZECC Guidelines (ANZECC/ARMCANZ, 2000) for heavy metals and metalloids in livestock drinking water. Refer to Australian Drinking Water Guidelines (NHMRC and NRMMC, 2018) for information regarding pesticides and other organic contaminants, using criteria for raw drinking water.

Water quality objective	Indicator	Guideline
Irrigation water supply – protecting the quality of waters applied to crops and pasture	Algae and blue-green algae	An increasing risk to livestock health is likely when cell counts of microcystins exceed 11 500 cells/mL and/or concentrations of microcystins exceed 2.3 µg/L expressed as microcystin-LR toxicity equivalents.
	Salinity (electrical conductivity)	Recommended concentrations of total dissolved solids in drinking water for livestock are given in Table 4.3.1 of ANZECC Guidelines (ANZECC/ARMCANZ, 2000).
	Thermotolerant coliforms (faecal coliforms)	Drinking water for livestock should contain less than 100 thermotolerant coliforms per 100 mL (median value)
	Chemical contaminants	Refer to Table 4.3.2 of ANZECC Guidelines (ANZECC/ARMCANZ, 2000) for heavy metals and metalloids in livestock drinking water. Refer to Australian Drinking Water Guidelines (NHMRC and NRMMC, 2018) for information regarding pesticides and other organic contaminants, using criteria for raw drinking water.
Homestead water supply – protecting water quality for domestic use in homesteads, including drinking, cooking and bathing	Blue-green algae	Recommend twice weekly inspections during danger period for storages with history of algal blooms. No guideline values are set for cyanobacteria in drinking water. In water storages, counts of < 1000 algal cells/mL are of no concern. >500 algal cells/mL - increase monitoring. >2000 algal cells/mL - immediate action indicated; seek expert advice. >6500 algal cells/mL - seek advice from health authority
	Turbidity	5 NTU; <1 NTU desirable for effective disinfection; >1 NTU may shield some micro-organisms from disinfection
	Total dissolved solids	<500 mg/L is regarded as good quality drinking water based on taste. 500-1000 mg/L is acceptable based on taste. >1000 mg/L may be associated with excessive scaling, corrosion and unsatisfactory taste.
	Faecal coliforms	0 faecal coliforms per 100 mL (0/100 mL). If micro-organisms are detected in water, advice should be sought from the relevant health authority. See also the Guidelines for Microbiological Quality in relation to Monitoring, Monitoring Frequency and Assessing Performance in the *Australian Drinking Water Guidelines* (NHMRC and NRMMC, 2018).
	pH	6.5-8.5
	Chemical contaminants	See Guidelines for Inorganic Chemicals in the *Australian Drinking Water Guidelines* (NHMRC & NRMMC, 2004).

Water quality objective	Indicator	Guideline
Drinking water at point of supply - Disinfection only; (clarification and disinfection), groundwater - refers to the quality of drinking water drawn from the raw surface and groundwater sources before any treatment	Blue-green algae	Recommend twice weekly inspections during danger period for storages with history of algal blooms. >500 algal cells/mL - increase monitoring. < 2000 algal cells/mL - water may be used for potable supply. >2000 algal cells/mL - immediate action indicated; seek expert advice. >6500 algal cells/mL - seek advice from health authority. >15 000 algal cells/mL - may not be used for potable supply except with full water treatment, which incorporates filtration and activated carbon.
	Turbidity	Site specific determinant
	Salinity (electrical conductivity)	<1500 µS/cm > 800 µS/cm causes a deterioration in taste
	Faecal Coliforms	0 faecal coliforms per 100 mL (0/100 mL)
	Total coliforms	95% of samples should be 0 coliforms/ 100 mL throughout the year. Up to 10 coliform organisms may be accepted occasionally in 100 mL. Coliform organisms should not be detected in 100 mL in any two consecutive samples.
	Dissolved oxygen	>80% saturation
	pH	6.5-8.5
	Chemical contaminants	See ANZG (2018) guidelines, section 6.2.2.
Aquatic foods (cooked) refers to protecting water quality so that it is suitable for production of aquatic foods for human consumption and aquaculture activities	Algae and blue-green algae	No guideline is directly applicable, but toxins present in blue-green algae may accumulate in other aquatic organisms.
	Faecal coliforms	*Guideline in water for shellfish:* The median faecal coliform concentration should not exceed 14 MPN/100mL; with no more than 10% of the samples exceeding 43 MPN/100 mL. *Standard in edible tissue:* Fish destined for human consumption should not exceed a limit of 2.3 MPN *E Coli* /g of flesh with a standard plate count of 100,000 organisms /g.
	Toxicants (as applied to aquaculture activities)	Metals: • Copper: less than 5 µgm/L. • Mercury: less than 1 µgm/L. • Zinc: less than 5 µgm/L. Organochlorines: • Chlordane: less than 0.004 µgm/L (saltwater production) PCB's: less than 2 µgm/L.

Water quality objective	Indicator	Guideline
	Physico-chemical indicators (as applied to aquaculture activities)	• Suspended solids: less than 40 micrograms per litre (freshwater) • Temperature: less than 2 degrees Celsius change over one hour.

[1] Basin plan water quality target

3.2.5 Impact assessment methodology

Water quality data for waterways in the Yanco Creek system was collated from Institute for Land, Water and Society (Charles Sturt University) who undertake monitoring between October 2021 and April 2022 to assess the ecological responses to Commonwealth environmental water. Data was reviewed to characterise existing water quality and whether the nominated WQOs, are currently being achieved based on associated DGVs for relevant indicators. The data was used to provide a qualitative assessment of impacts from the construction and operational phase of the Project.

3.2.5.1 Assessment of construction impacts

The construction impact assessment involved:

- Identifying unmitigated risks to surface water quality from the various proposed construction activities
- Identifying potential impacts to downstream waterways and SREs
- Assessing potential impacts to the nominated WQOs with consideration of the relevant guidelines
- Identifying appropriate measures to mitigate and manage the potential impacts to surface water quality resulting from construction of the Project.

3.2.5.2 Assessment of operational impacts

The assessment of potential impacts during operation involved:

- Identifying potential unmitigated risks to surface water quality from the operation of the Project
- Identifying potential impacts to downstream waterways and SREs
- Assessing potential impacts to the nominated WQOs from operation of the Project
- Identification of appropriate measures to mitigate the residual impact of the operational phase.

3.2.5.3 Assessment of impacts from decommissioning

The assessment of potential impacts during decommissioning of the Project involved:

- Identifying potential unmitigated risks to surface water quality from the decommissioning of the Project
- Identifying potential impacts to downstream waterways and SREs
- Assessing potential impacts to the nominated WQOs from decommissioning of the Project.

3.3 Groundwater quality and quantity assessment methodology

Potential groundwater related impacts which may occur due to the Project have been assessed by:

- Characterising the existing environmental setting including climate, topography, geology, and groundwater occurrence, quality and use, including GDEs
- Developing a conceptual groundwater model
- Assessing the potential for the Project to interact with the water table and underlying groundwater systems. This was undertaken by assessing the Project's activities which could potentially intersect the water table and

comparing the likely level of these activities to inferred groundwater elevations. The inferred groundwater elevations were assessed using a three-dimensional phreatic surface derived from groundwater level data from public domain online databases
- Qualitative assessment of the potential for the Project to impact on other groundwater users, baseflow to surface water drainage systems, and GDEs
- Assessment of potential groundwater related impacts against the minimal impact considerations of the AIP (DPI, 2012)
- Providing recommendations for monitoring and management of identified potential impacts and risks, including management measures as appropriate.

3.4 Assessment of cumulative impacts

Cumulative impacts have the potential to occur when impacts from a Project interact or overlap with impacts from other projects and can potentially result in a larger overall effect (positive or negative) on the environment, businesses or local communities. Cumulative surface water quality and groundwater impacts have been assessed through a qualitative analysis, taking into account relevant projects.

4. Existing environment

4.1 Catchment overview

The Project is situated within the Murrumbidgee River Catchment.

4.1.1 Land use

The Project area is zoned as RU1 – Primary Production under the Conargo Local Environment Plan (LEP) and Jerilderie LEP, for agricultural activity. Over time agricultural uses have included pastoral purposes, cattle and sheep production. Native vegetation also exists within parts of the Project area.

4.1.2 Climate

4.1.2.1 Rainfall and temperature

Review of data available through the Bureau of Meteorology BOM) – Monthly Statistics: Climate Data Online BOM, 2022a) indicates that the nearest BOM weather station for rainfall and temperature data is the Yanco Agricultural Institute Weather Station (#74037) located approximately 80 kilometres northeast of the Project area at its nearest point.

Utilising the BOM climate database, the average total rainfall for each calendar month from 1996 to 2021 (25 years) was calculated and is summarised in **Table 4-1** and presented in **Figure 4-1**.

Table 4-1 Average total monthly rainfall recorded at Yanco Agricultural Institute Weather Station (#74037)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Monthly Average Total Rainfall (mm)	27.2	37.7	44.6	23.7	27.4	40.7	34.5	35.7	34.0	31.2	40.5	29.9	407.1

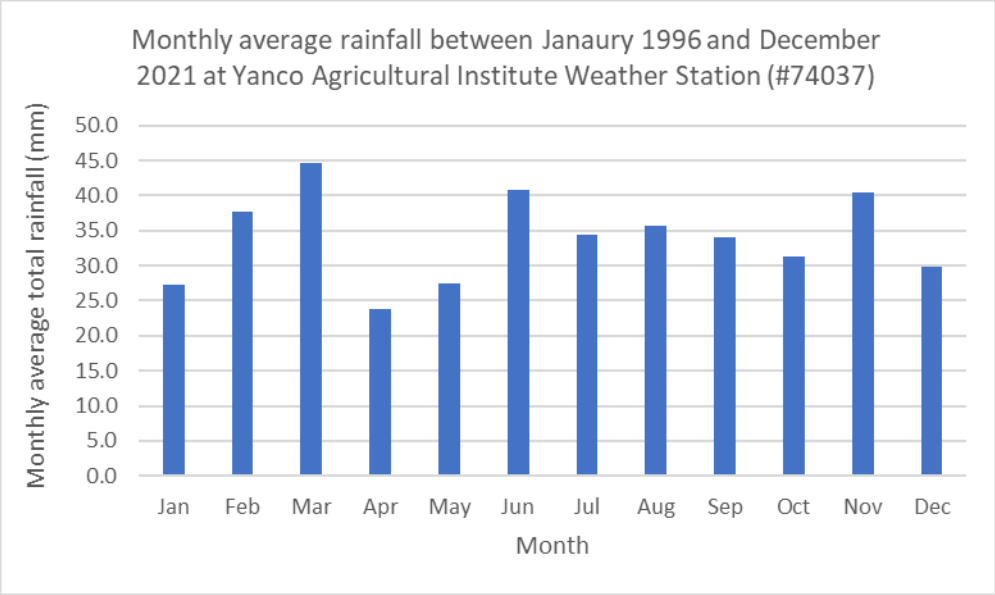


Figure 4-1 Average total monthly rainfall between 1996 and 2021, as recorded by Yanco Agricultural Institute Weather Station (#74037)

Analysis of the available rainfall data presented in **Figure 4-1** shows there is only a moderate level of seasonality within the study area, and that rainfall is typically low in most months. Lowest average rainfall was recorded in April (23.7 millimetres) and May (27.4 millimetres), followed by January (27.2 millimetres). Highest monthly rainfall was recorded in March (44.6 millimetres) followed by June (40.7 millimetres) and November (40.5 millimetres). Between July and October there is very little variation between monthly rainfalls

Long-term temperature data from Yanco Agricultural Institute Weather Station (BOM, 2022) was reviewed and is presented in **Figure 4-2**. This data demonstrates the average monthly maximum and minimum temperature ranges between 2000 to 2021.

The analysis of available temperature data indicates that the Project is positioned within a temperate climatic region characterised by warm summers and cool winters. Average minimum and maximum temperature range from approximately 5 to16 degrees Celsius (June to August) and 15 to 34 degrees Celsius (December to March) seasonally, with predominately mild to moderate autumn and spring months.

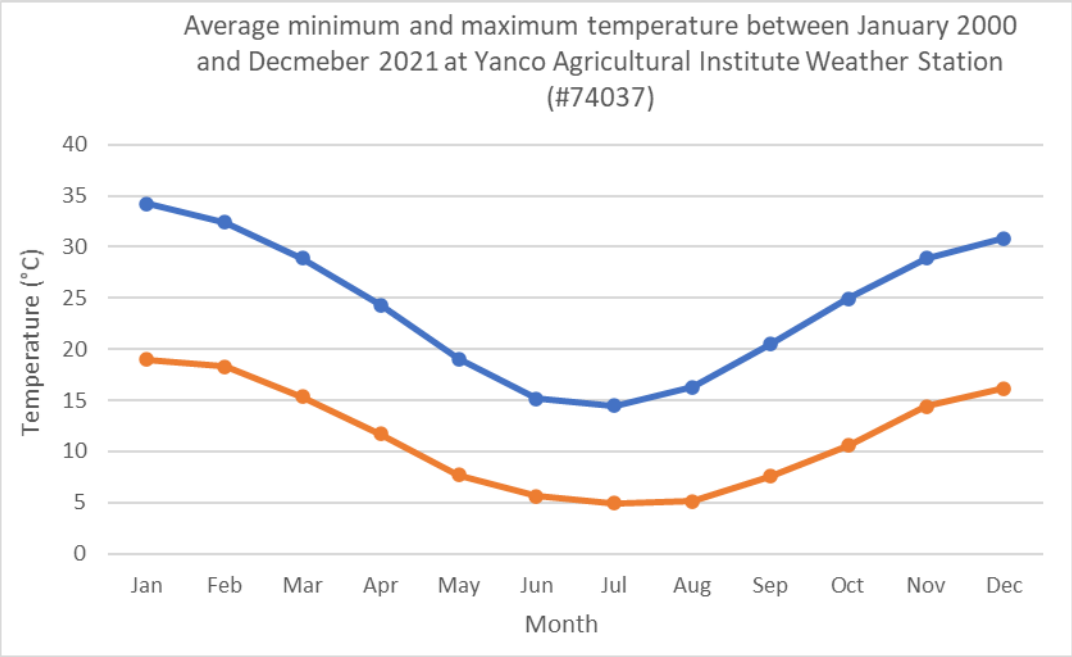


Figure 4-2 Average monthly minimum and maximum temperature between 2000 and 2021, as recorded at Yanco Agricultural Institute Weather Station (#74037)

Climate change predictions in the Murrumbidgee catchment is expected to occur and result in a decrease in spring rainfall but an increase in autumn rainfall. Summer rainfall is also expected to increase (DPIE, 2020). Mean temperature are also expected to increase across the region with the greatest increase during summer.

4.2 Waterways

The Project area traverses Delta Creek in the northern portion of the Project area and Turn Back Jimmy Creek within the southern portion. Yanco Creek is located between the northern and southern portions of the Project area. In addition to the mapped waterways, the Project area exhibits some minor drainage depressions that hold water during rainfall and flooding, and flow in a south-westerly direction. A slope dips toward Delta Creek in the northern portion of the Project area. These minor topographic depressions on the floodplain hold water for longer, creating scattered swamp environments within the Project area, shown in **Figure 4-3**.

Key waterways within the study area have been described according to:

- The Strahler stream classification system where waterways are given an order according to the number of additional tributaries associated with each waterway (Strahler, 1952)
- Key hydrological characteristics including stream type, general direction of stream flow and discharge conditions
- Whether the waterway is classified as key fish habitat (KFH), based on published KFH mapping of NSW by NSW Fisheries (DPI, 2022)
- Other relevant features within, or in proximity to the waterway or waterbody
- Whether the watercourse or waterbody is predicted to support any threatened aquatic species under Commonwealth (EPBC Act) or state legislation (FM Act and/or BC Act).

A summary of the important features of waterways within the study area have been described in **Table 4-2** and shown in **Figure 4-4** and **Figure 4-6**.

Table 4-2 Summary of key features of waterways and waterbodies identified as having potential to be impacted in the study area

Waterway / waterbody	Stream order	KFH (DPI, 2022)	Stream type	Threatened species predicted habitat (DPI, 2022)	Relevant features
Delta Creek	2	No – however is mapped as predicted threatened species habitat	Ephemeral	Yes – Flathead Galaxias (critically endangered) Yes – Silver Perch (vulnerable)	• Drains south-west during significant rainfall, although does not connect to any downstream major channel unless the area is flooded • Wetland/swamp environment
Yanco Creek	9	Yes	Perennial	Yes – Flathead Galaxias (critically endangered) Yes – Silver Perch (vulnerable)	• Drains south-west toward Murray River • Well-defined channel • Large woody debris present • Riparian and in-stream vegetation present
Turn Back Jimmy Creek	3	Yes	Ephemeral	Yes – Flathead Galaxias (critically endangered) Yes – Silver Perch (vulnerable)	• Flood-runner between Colombo Creek and Yanco Creek • Minimal/no channel definition • Minimal/no riparian or instream vegetation • No other aquatic habitat features

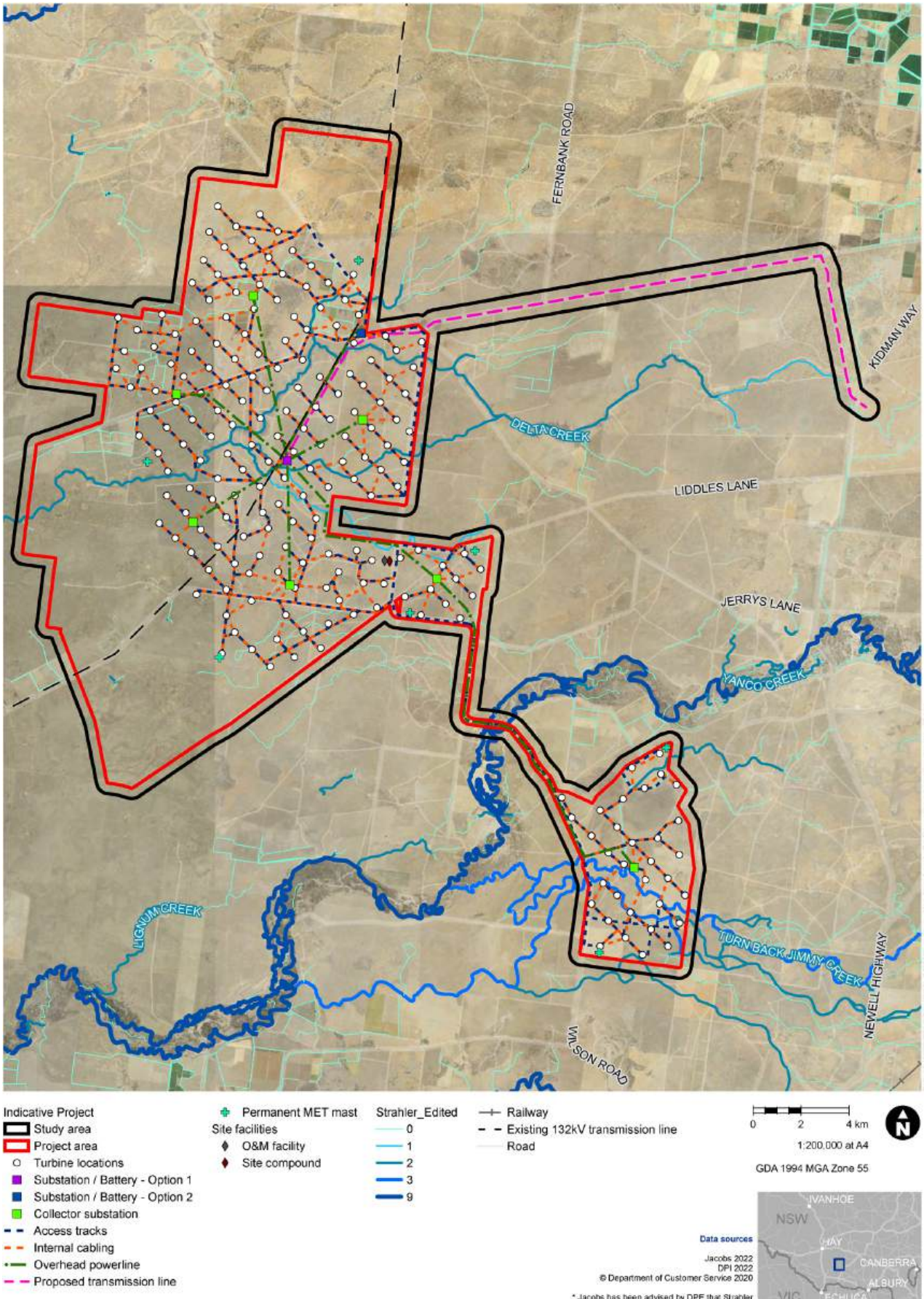


Figure 4-3 Waterways within and surrounding the Project area

Figure 4-4 Delta Creek

Figure 4-5 Yanco Creek

Figure 4-6 Turn Back Jimmy

4.3 Existing surface water quality

A summary of the desktop review of surface water quality monitoring data is provided in the sections below.

4.3.1 State of the Catchments 2010 Riverine ecosystems: Murrumbidgee region (DECCW, 2010)

The 2010 State of the Catchments (SOC) for the Murrumbidgee region (DECCW, 2010) reported water quality for Yanco Creek at Morundah and the Yanco Creek offtake location. The key indicators presented in the SOC were Total Phosphorus (TP) and turbidity which were compared against the ANZG (2018) guidelines. Based on the guidelines, TP should be less than 0.025mg/L for lowland sites, however this was exceeded 59 percent of the time at Morundah and 23 percent of the time at the offtake location. For turbidity, the guidelines indicate that turbidity levels should remain less than 50 NTU, however this was only achieved 38% and 11% of the time at Morundah and the offtake location respectively.

Further, long term data indicates that there is currently an increasing trend in turbidity values in Yanco Creek (DECCW, 2010). The health of the water waterway was characterised using aquatic biota data which comprises of macroinvertebrate and fish data. Macroinvertebrate data indicates that Yanco Creek is in moderate condition, however fish data indicates poor to very poor condition due to the lack of native species compared to introduced species (DECCW, 2010).

4.3.2 Water quality technical report for the Murrumbidgee surface water resource plan area (SW9) (DPI, 2019)

The NSW Department of Planning, Industry and Environment (DPIE) have also reported water quality for Yanco Creek at Morundah and Yanco Creek at Yanco Bridge in the *Water Quality Technical report for the Murrumbidgee surface water resource plan area (SW9)* (DPIE, 2020). Median water quality results are presented in **Table 4-3**.

Table 4-3 Median water quality for Yanco Creek between 2007 and 2015 (DPIE, 2020)

Indicator	Yanco Creek at Morundah (median)	Yanco Creek at Yanco Bridge (median)	Guideline
Total nitrogen (TN) (mg/L)	0.4	0.56	0.6[1]
Total phosphorus (TP) (mg/L)	0.059	0.074	0.05[1]
Turbidity (NTU)	58	78	35[1]
Total suspended solids (mg/L)	51	44	No guideline
Dissolved oxygen (DO) (% saturation)	95	79	80-110[1]
pH	7.3	7.0	6.5-8[1]
Electrical conductivity (EC) (µs/cm)	132	150	Median 162[1]

[1] Basin plan water quality target

Based on data provided in *Water Quality Technical report for the Murrumbidgee surface water resource plan area (SW9)* water quality of Yanco Creek could be described as:

- Exhibiting elevated turbidity that presents a risk to aquatic ecosystems
- Total nitrogen and total phosphorus concentration are elevated and higher than most other waterways in the area (SW9). Exceedance of this basin plan targets usually occurs following rainfall
- Turbidity, TN and TP tend to be higher at Yanco Bridge than Morundah with these indicators increasing with distance downstream
- pH is generally compliant and meets the requirements for the protection of aquatic ecosystems and agricultural uses
- Bank erosion and sedimentation is a known water quality issue for Yanco Creek
- Poorer water quality (i.e., higher nutrients and turbidity) is generally experienced in high flow/wetter conditions than during dry weather due to run-off inputs
- Elevated suspended solids present a high risk to aquatic ecosystems and are largely the result of the widespread conversion of land from cropping and irrigation from native vegetation. Elevated nutrients from both point and non-point sources also present a high risk to aquatic ecosystems as do elevated nutrients (DPIE, 2020).

4.3.3 Murrumbidgee Monitoring Evaluation and Research Program: ecological responses to Commonwealth environmental water

Most recently, Charles Sturt University has undertaken monitoring at number of sites in the Yanco Creek System to assess the ecological outcomes from environmental watering in the Murrumbidgee system. Whilst not in the Project area, the closest sites include Broome Creek (and wetland) and Bundure Creek (and wetland). Both sites are located downstream of the Project approximately 25 kilometres from the Project crossing of Yanco Creek at Wilson Road. In-situ monitoring was undertaken over four separate events, October and December 2021 and February and April 2022. A summary of these results is provided in **Table 4-4**. Turbidity reported is very high due to equipment deployment impacting turbidity at the time of sampling. Dissolved oxygen levels often fell below the recommended limit for protection of aquatic ecosystems as did median conductivity, although only slightly. pH levels complied with the basin plan water quality target of 6.58.

Table 4-4 Median Water Quality Yanco Creek System October 2021-April 2022 (source: Charles Sturt University)

Indicator	Broome Wetland	Broome Creek	Bundure Wetland	Bundure Creek	Guideline
Temperature	23.7	21.8	21.3	20.4	No guideline
EC (µs/cm)	160.5	151.5	141	144	Median 162[1]
DO (% sat)	80	72.05	68.9	59.8	80-110[1]
pH	7.41	7.23	7.05	7.15	6.5-8[1]
Turbidity (NTU)	81.2	102.55	80.5	123	35[1]

[1] Basin plan water quality target

4.3.4 Summary

Available water quality data suggests that nominated WQOs are only partially being achieved. Elevated total phosphorus and turbidity and low dissolved oxygen in waterways in the Murrumbidgee Catchment are currently not meeting recommended DGVs for the protection of aquatic ecosystems and therefore this WQO is currently not protected. Turbidity which was reported as above nominated DGVs may impact on achieving the WQO of visual amenity and recreation (primary and secondary) due to a reduction in the clarity of the water. Due the absence of data for chemical contaminants, bacteriological indicators and algae protection of the remaining nominated WQO cannot be confirmed.

4.4 Sensitive Receiving Environments

As described in **Section 4.2**, the Project intersects with Delta Creek in the northern portion of the Project area. The southern portion of the Project area also intersects Turn Back Jimmy Creek. Yanco Creek is located between the northern and southern portions of the Project area. All three waterways have been deemed sensitive receiving environments. Determination of SREs has considered the following:

- Key Fish Habitat
- Threatened aquatic species
- Threatened aquatic ecological communities.

4.4.1 Key Fish Habitat

According to DPI (Fisheries) Key Fish Habitat (KFH) mapping (DPI, 2022), Yanco Creek and Turn Back Jimmy Creek are considered KFH. Delta Creek is not mapped as KFH; however, mapping predicts it to host threatened species habitat, however given the ephemeral nature of Delta Creek and a lack of connection to larger, more permanent waterways, presence of threatened species habitat is unlikely.

Yanco Creek is a ninth order, permanently flowing waterway with a well-defined channel. There is significant aquatic habitat available, including lots of large woody debris, exposed roots and some instream and riparian vegetation. According to the Protected Matters Search Tool (DAWE, 2022) and NSW threatened species habitat mapping (DPI, 2022), Yanco Creek is predicted habitat for the Flathead Galaxias (*Galaxias rostratus*), Silver Perch (*Bidyanus bidyanus*) and Murray Cod (*Maccullochella peelii*). According to the DPI (Fisheries) policy and guidelines (2013), Yanco Creek therefore falls into Type 1 – Highly Sensitive Key Fish Habitat.

Turn Back Jimmy Creek is a third order, ephemeral drainage depression with minimal/no channel definition. The channel acts as a flood runner between Colombo Creek in the east and Yanco Creek in the west. The channel does not exhibit any significant aquatic habitat features, however it is predicted habitat for the Flathead Galaxias (*Galaxias rostratus*) and Silver Perch (*Bidyanus bidyanus*) (DPI, 2022). According to the DPI (Fisheries) policy and guidelines (2013), Turn Back Jimmy Creek therefore falls into Type 1 – Highly Sensitive Key Fish Habitat.

At the Project crossing site, Delta Creek is a second order, ephemeral creek with minor channel definition. Delta Creek is not mapped as Key Fish Habitat, however exhibits some wetland habitat features including wetland vegetation, for instance Lignum (*Muehlenbeckia cunninghamii*), and is mapped as predicted habitat for the Flathead Galaxias (*Galaxias rostratus*) and Silver Perch (*Bidyanus bidyanus*). According to the DPI (Fisheries) policy and guidelines (2013), Delta Creek therefore falls into Type 1 – Highly Sensitive Key Fish Habitat.

4.4.2 Threatened aquatic species

Based on the current indicative distribution of threatened species in NSW provided by DPI (Fisheries) (DPI, 2022), the Flathead Galaxias (*Galaxias rostratus*) and Silver Perch (*Bidyanus bidyanus*) have predicted distribution in Delta Creek, Yanco Creek and Turn Back Jimmy Creek. According to the Protected Matters Search Tool (PMST), Murray Cod (*Maccullochella peelii*), Trout Cod *(Maccullochella macquariensis*) and Macquarie Perch (*Maccullochella macquariensis*) species or species habitat may also occur within the area, although the likelihood of these species occurring is considered low.

4.4.3 Threatened aquatic ecological communities

The Project area lies wholly within the endangered ecological community (EEC) known as 'the Lower Murray River Drainage System' (Lower Murray River EEC). The Lower Murray River EEC encompasses all natural creeks, rivers and associated lagoons, billabongs and lakes of the regulated portions of the Murray, Murrumbidgee and Tumut Rivers, as well as their tributaries and branches. This includes Delta Creek, Yanco Creek and Turn Back Jimmy Creek (refer to **Figure 4-7**).

The Lower Murray River EEC occurs in a lowland riverine environment, characterised by meandering channels and wide floodplains. The land is generally flat to gently sloping. In their natural state, these lowland rivers experience extremely variable flows, ranging from floods to droughts. Lowland rivers provide a wide range of habitats for fish and invertebrate, including pools, runs or riffles, backwaters and billabongs, large woody habitats and aquatic plants. Floodplains also provide a mosaic of habitat types, including permanent and temporary wetland, as well as terrestrial habitats (DPI, 2007).

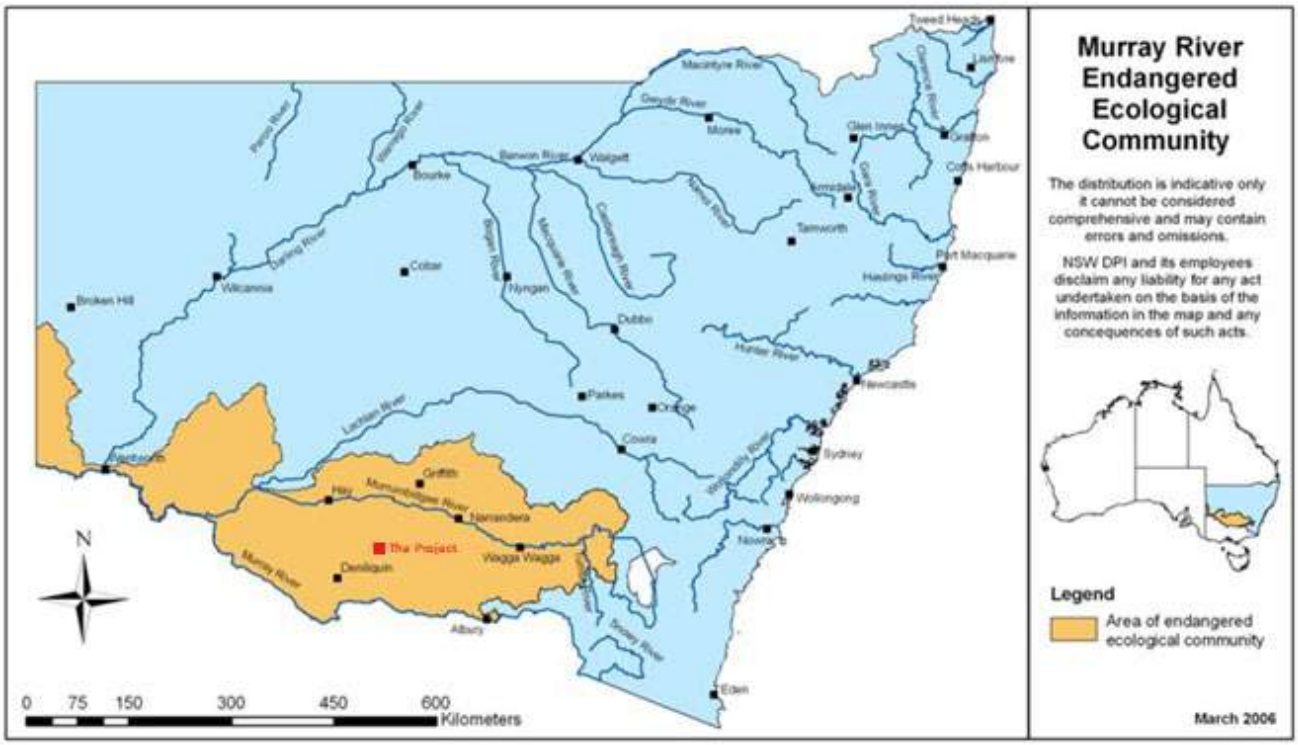


Figure 4-7 Map of Lower Murray River EEC (Source: DPI, 2007), the Project in red

4.5 Soils

4.5.1 Soil landscapes

The Soils and contamination technical report (Jacobs, 2022b) for the Project indicates that Soil Landscape Maps are available for the southern half of the Project area only (south of Moonbria). Jacobs (2022b) indicates that the southern half of the Project area includes predominantly three soil landscapes as follows:

- Jerilderie (jex) – Broad level plains on alluvium deposits from the Riverine Plains
- Coleambally (clo) – Undulating sand plains deposited from re-worked alluvium, sand ridges and swales present
- Yancobong (ybz) – Confined alluvial floodplains and channels from Billabong Creek and Yanco Creek, and their palaeochannels.

Small pockets of the following soil landscapes are also present within the Project area:

- Currawarna (cww) – Slight undulation and gently inclined dunes of thick (>2 metres) windblown sand layers, underlain by thick alluvium
- Lake Gunbar (lgt) – Low-lying areas and depressions within the Riverine Plains, comprised of cracking clays, self-mulching and surface crusting surfaces
- Lake Urana (lky) – Ephemeral clay lake beds of varying size, with lunettes (ylw) to the east and north
- Yanga Lunettes (ylw) – Crescent-shaped dunes formed on the eastern margins of lake beds and water body relicts. Calcareous soils dominate, with duplex and solodic soils present on lower slopes
- Niemur River (nmu) – Active inset floodplains and meander plains of the Niemur, Edward and Wakool Rivers and their tributaries and distributaries, extending from Lockhart in the east into the far west of the catchment
- Coleambally Variant A (cloa) – Level sandplains, with relicts of prior waterways now infilled with shallow aeolian deposits.

The location and extent of each soil landscape is closely related to surface landform and topography. Soil landscapes across the Project area are presented in **Figure 4-8**.

4.5.2 Salinity

Soil salinity is a complex issue relating to salt and water cycles both above and below the ground. Surface water and groundwater can dissolve and mobilise salts and cause their accumulation in other areas. Development can cause changes to these water flows and cause salt to accumulate in different areas.

The Soils and contamination technical report (Jacobs, 2022b) for the Project indicates the following with respect to salinity:

- There are no current records of dryland salinity within the Project area
- The Overall Salinity Hazard in the Hydrogeological Landscapes of New South Wales and the Australian Capital Territory Map (DPIE, 2022) characterises the soils within the construction area and along the transmission line as a moderate overall salinity hazard. Soils within the Project area and along the transmission line showed a high potential for land salinity
- Salinity can be associated with sodic soils such as Sodosols, as well as Vertosols, Kurosols and Kandosols, which are present on site. Areas of current or potential soil salinity may be encountered along the Project area where there is alluvium, waterlogged ground or shallow groundwater.

4.5.3 Acid sulfate Soils and Rock

The Soils and contamination technical report (Jacobs, 2022b) for the Project indicates the following:

- There is generally an extremely low to low probability of ASS occurrence in the study area. However, there are small sections of high probability ASS occurrence around water bodies and water courses.
- To date, no occurrences of acid rock have been documented within the soil landscapes / geology present within the Project area.

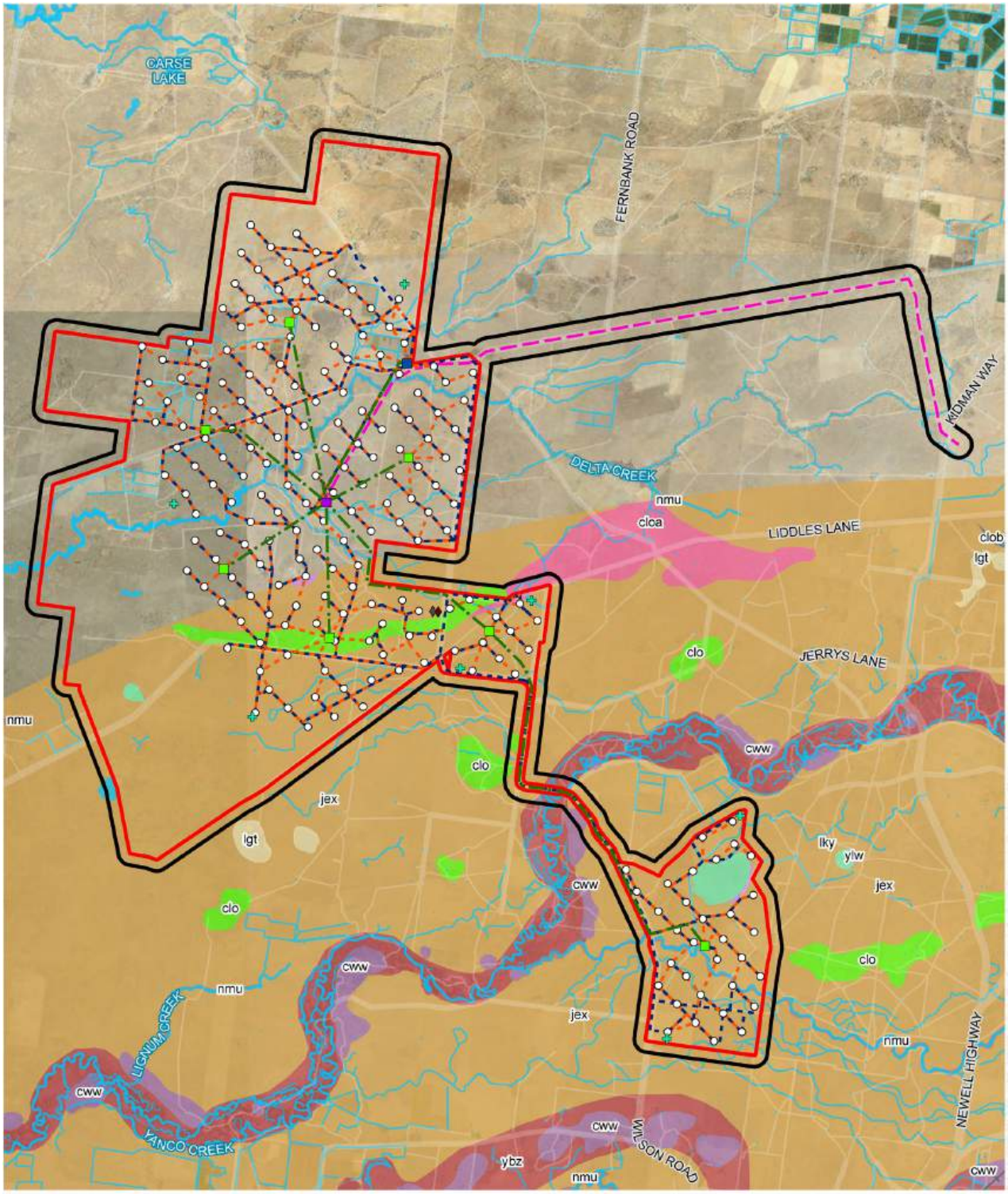


Figure 4-8 Soil landscapes

4.6 Topography

The Project area is largely flat with altitudes varying between 100 metres and 114 metres AHD.

4.7 Geology

Seamless geology NSW mapping (Colquhoun et al., 2021) (**Figure 4-9**) shows that the site is predominantly underlain by Cenozoic aged alluvial floodplain deposits. The Project area is also underlain by smaller pockets of Quaternary aged aeolian deposits. Minor pockets of Upper Pleistocene aged aeolian sand deposits and Quaternary aged playa lake deposits also exist in the south-eastern portion of the Project Area. Quaternary aged alluvial channel deposits underly the region within close proximity to Yanco Creek.

Geotechnical investigations within the Project area (Jacobs, 2022c) indicate that the Cenozoic alluvial floodplain sediments in the Project area are generally characterised by silt, very fine to medium grained, lithic to quartz-rich sand, and clay. Quaternary aged aeolian deposits are dominated by sands. Quaternary aged playa lake deposits are typically friable to plastic, finely laminated grey clay and silty clay. Quaternary aged alluvial channel deposits are generally unconsolidated grey humic, clayey, very fine-grained sand, typically overlying light brown clayey silt.

There are no mapped bedrock outcrops within the study area. The Jerilderie 1:250,000 Geological Map's (Geological Survey of NSW, 1976) cross section passes through the south of the study area. This geological map and cross section indicates the Quaternary alluvium deposits are unconsolidated and extend from ground level to 100 mbgl to 150 mbgl, and are underlain by Tertiary deposits to 170 mbgl to 190 mbgl. The Tertiary deposits are typically poorly consolidated, although consolidated layers may be present, including coal bands. Permian deposits consisting of boulder and pebble clays, sandstone, claystones, shales and minor coal bands underly the Tertiary deposits.

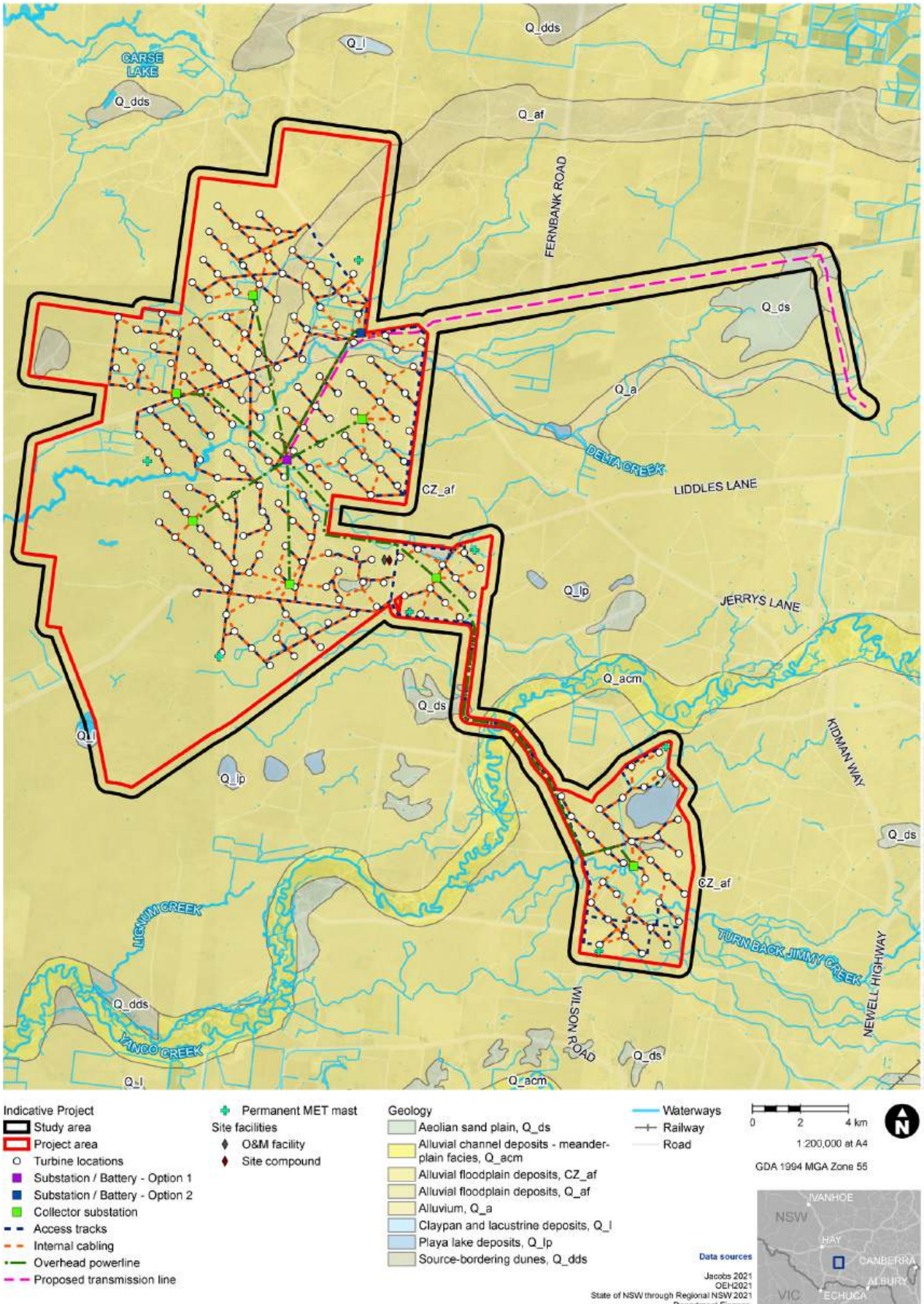


Figure 4-9 Seamless geology NSW mapping (Colquhoun et al., 2021)

4.8 Hydrogeology

4.8.1 Groundwater systems

Drillers logs contained within Groundwater Work Summary Reports (Water NSW, 2022) for bores completed within the study area indicate alluvial groundwater systems are present in the study area. The alluvium generally consists of clay and sand layers, with clay being more dominant. The thickness of sand layers is variable and ranges from less than 5 metres to approximately 50 metres.

Thin coal layers are noted in the driller logs at depths greater than 100 mbgl that are inferred to be associated with the Tertiary aged sediments, which are typically poorly consolidated, although consolidated layers may be present within the Tertiary material.

As noted in **Section 4.8.3**, the regional water table is relatively deep (approximately 20 mbgl to 25 mbgl) and uniform. However, a shallow borehole documented in the Project's geotechnical report (Jacobs, 2022c), located near the intersection of Moonbria Road and Wilson Road, encountered groundwater seepage at a depth of 4.8 mbgl. The ground surface in the study area is very flat and situated on a floodplain with GDEs mapped within the study area. Therefore, localised perched groundwater systems are considered likely to be present across relatively low lying parts of the study area. Although the distribution and characteristics of these potential perched systems are not known.

4.8.2 Registered groundwater bores

There are 108 registered groundwater bores within the study area according to the BoM's Australian Groundwater Explorer (BoM, 2022b). Use types include:

- Stock – 55 bores
- Monitoring – 16 bores
- Unknown –12 bores
- Household use – 10 bores
- Irrigation – 13 bores
- Exploration – 2 bores.

The predominant use type is stock and all registered bores in the southern portion of the study area have a use type of stock.

Excluding bores with a depth noted as 0 mbgl, the bore depths are recorded as ranging from 11 mbgl to 234 mbgl in depth, with an average depth of 81 mbgl.

Recorded bore yields were investigated for bores within the broader study area, which has since been superseded. Although somewhat larger than the study area documented in this report, this area is suitable for yield characterisation. Out of 110 registered groundwater bores within the broader study area, 19 bores had yield data. Excluding outlier values at GW505660 (200 L/s) and GW500964 (220 L/s), bore yields ranged from 0.03 L/s to 5 L/s, with and median yield of 2.5 L/s.

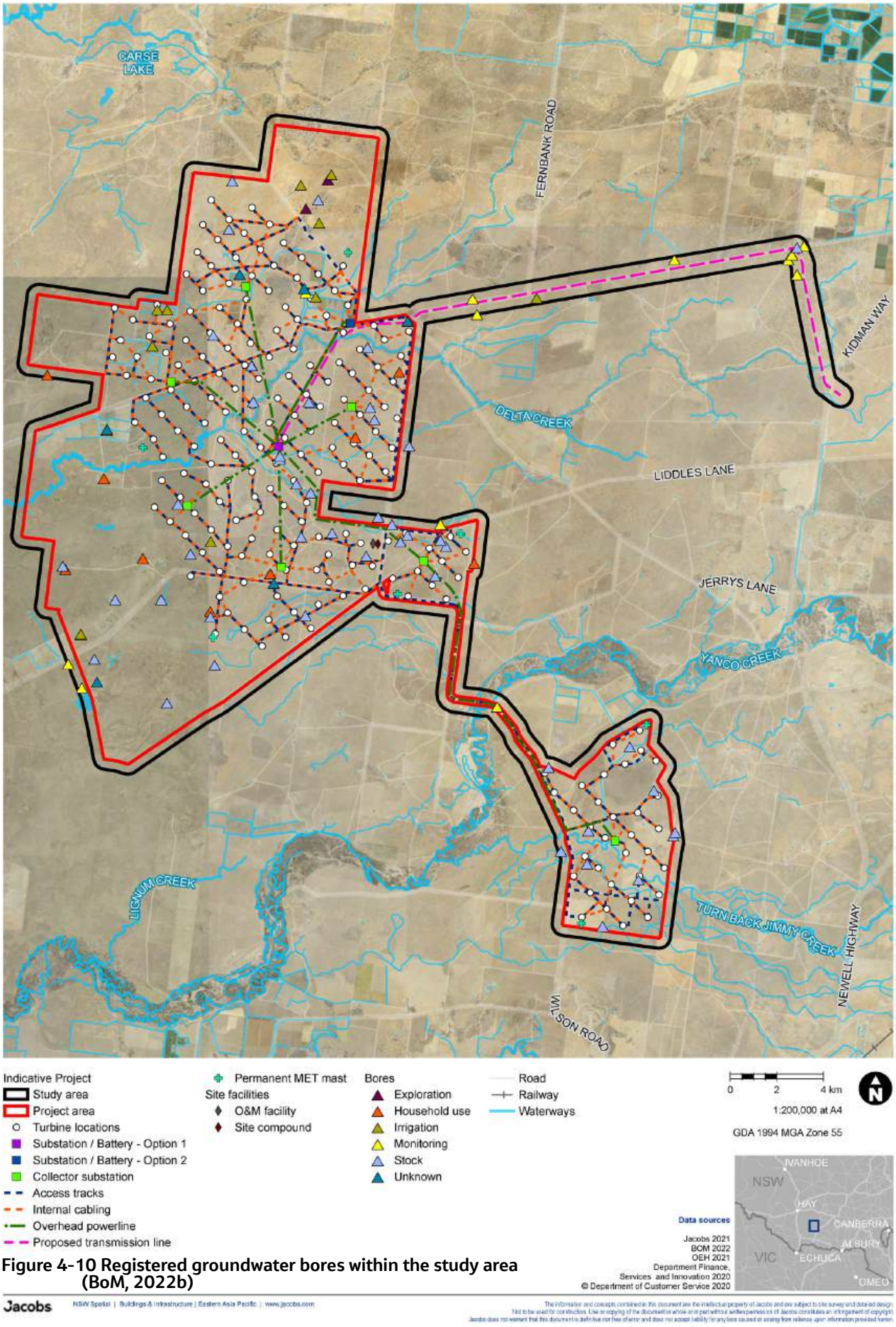


Figure 4-10 Registered groundwater bores within the study area (BoM, 2022b)

4.8.3 Groundwater levels

Groundwater levels from registered bores (BoM, 2022b and Water NSW, 2022) located within the study area are generally between 20 mbgl and 25 mbgl. It is noted that water levels from registered bores are typically recorded at bore construction and so represent a broad temporal spread.

Groundwater levels from registered bores are contoured in **Figure 4-11** and range from 75 mAHD to 95 mAHD within the study area. The water level data comprises a mixture of water levels from different depths and potentially different groundwater systems. A total of 119 bore water levels were used to develop the contours.

No attempt has been made to isolate the water level data into separate groundwater system types or depth zones. Hence, the contouring is influenced by groundwater levels associated with a range of groundwater systems. In spite of these limitations, the contouring is considered suitable for assessment of regional groundwater flow directions, groundwater level/depth trends, and to inform assessment of whether groundwater is likely to be providing significant baseflow to watercourses in the study area. Although the contours are derived from groundwater levels from variable depth bores, the groundwater levels, depths and gradients are relatively uniform and consistent throughout the entire study area, indicating there are no outliers in the groundwater level data used for contouring.

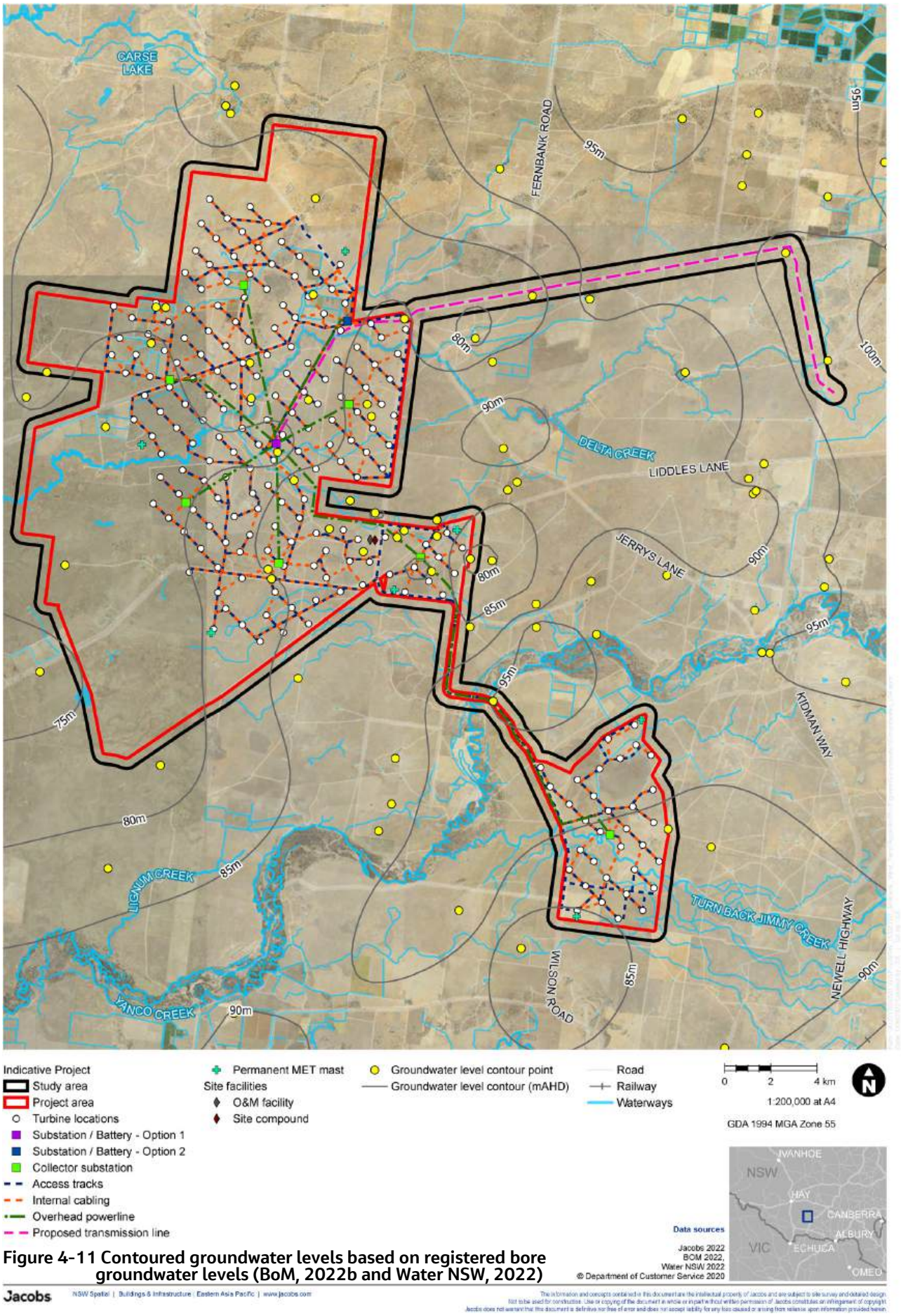


Figure 4-11 Contoured groundwater levels based on registered bore groundwater levels (BoM, 2022b and Water NSW, 2022)

4.8.4 Groundwater flow direction and hydraulic gradient

Based on the contoured groundwater levels (**Figure 4-11**, **Section 4.8.3**), the predominant groundwater flow direction is to the west, consistent with the general direction of surface water drainage.

The horizontal hydraulic gradient is approximately 0.001 metres per metre (m/m).

4.8.5 Hydraulic conductivity

Hydraulic conductivity testing has not been undertaken for the Project. Qualitatively, based on the groundwater system material types (**Section 4.8.1**) and yields (**Section 4.8.2**), hydraulic conductivity is anticipated to be low for clayey material and moderate to high for sandy material.

4.8.6 Surface water – groundwater interaction

The degree and type of interaction between groundwater and surface water is largely dependent on topography, watercourse geomorphology and the underlying groundwater systems, particularly the depth of groundwater levels relative to watercourse levels.

Contoured groundwater depths are 22 mbgl to 26 mbgl in the vicinity of Delta Creek, 10 mbgl to 16 mbgl in the vicinity of Yanco Creek and 15 mbgl to 20 mbgl in the vicinity of Turn Back Jimmy Creek. Therefore, regional scale surface water – groundwater interaction in the study area is conceptualised to be generally limited and characterised by 'disconnected losing watercourses'. 'Disconnected losing watercourses' are defined as having watercourse water levels that are above and disconnected from underlying groundwater systems. Indirectly, losing watercourses can interact with the underlying groundwater systems by providing recharge via leakage from the watercourse to the groundwater system.

There may be some localised surface water – groundwater interaction associated with shallow perched groundwater systems, which may be present in relatively low lying areas.

4.8.7 Groundwater Dependent Ecosystems

The occurrence of potential GDEs was assessed through review of the BoM's GDE Atlas (BoM, 2022c) and high priority GDE mapping in the WSP (NSW Government, 2020). A summary is provided in the sections below.

4.8.7.1 BoM (2022c) Terrestrial GDEs

Isolated tracts of land in the vicinity of Delta Creek and large tracts of land in the vicinity of Yanco Creek are mapped as high potential GDE (**Figure 4-12**). Additionally, there are small tracts of land mapped as high potential GDE within the Project area. There are also large tracts of land within the Project area mapped as low potential GDE.

The mapped potential GDEs have ecosystem types generally consisting of swamps, woodland and grass wetlands. The presence of terrestrial GDEs are discussed in the Biodiversity Development Assessment Report for the Project (Jacobs, 2022a).

4.8.7.2 BoM (2022c) Aquatic GDEs

Delta Creek, Yanco Creek and Turn Back Jimmy Creek are mapped as low potential aquatic GDEs (**Figure 4-12**). Additionally, there is a large tract of land about 2.5 kilometres long and 1.7 kilometres wide within the southern portion of the Project area and smaller isolated tracts of land in the northern portion of the Project area that are mapped as low potential aquatic GDEs, which have an ecosystem type of 'wetland'.

4.8.7.3 WSP (NSW Government, 2020) High Priority GDEs

The WSP (NSW Government, 2020) applicable to the Project area has mapped land in the vicinity of Yanco Creek as a High Priority GDE (**Figure 4-12**). Additionally, the WSP maps small, isolated tracts of land within the northern and southern portions of the Project area as High Priority GDE.

In the northern portion of the Project area there are 25 separate small clusters of High Priority GDE in addition to the High Priority GDEs located along Yanco Creek. Of these 25 separate small clusters of High Priority GDE, three separate small clusters of High Priority GDE are intersected by proposed Projects elements, being access tracks and / or internal cables.

In the southern portion of the Project area there are three distinct small areas of High Priority GDE located greater than approximately 350 metres from the nearest WTG. One of these areas of High Priority GDE is intersected by internal cabling and access track.

4.8.7.4 Groundwater system dependency

Based on the relatively deep and uniform regional water table depths (**Section 4.8.3**), the potential GDEs and High Priority GDEs discussed above are considered unlikely to be relying on the regional water table and instead, if reliant on groundwater, are interpreted to be associated with perched groundwater systems situated in marshy areas which are recharged by rainfall and floodwaters.

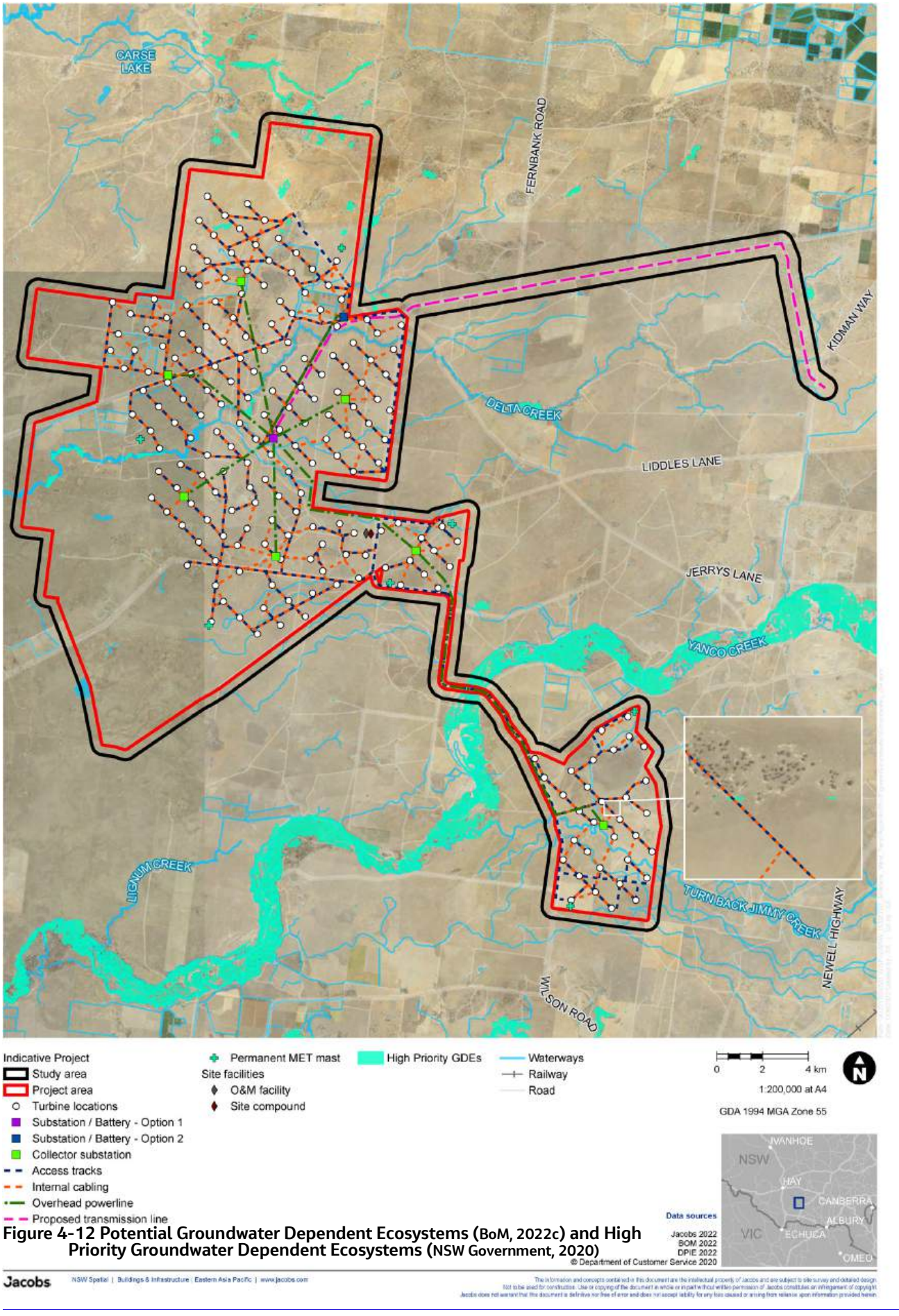


Figure 4-12 Potential Groundwater Dependent Ecosystems (BoM, 2022c) and High Priority Groundwater Dependent Ecosystems (NSW Government, 2020)

4.9 Existing groundwater quality

Water NSW (2022) and BoM (2022b) salinity data for registered bores indicates that groundwater in the study area has a salinity ranging from 300 mg/L to 3,000 mg/L and is generally fresh to slightly brackish (Freeze and Cherry, 1979).

4.10 Conceptual groundwater model

The conceptual groundwater model for the Project is summarised below and depicted in a conceptual hydrogeological fence section in **Figure 4-13** and **Figure 4-14**. Features of the conceptual groundwater model include:

- Alluvial groundwater systems are present in the study area. The alluvial material at surface is mostly Cenozoic aged. The alluvium consists of clay and sand layers, with clay being more dominant. The thickness of sand layers is variable and ranges from less than 5 metres to approximately 50 metres
- Consolidated material is conceptualised to be relatively deep across the study area, at a depth of greater than 100 mbgl
- The regional water table is relatively deep and uniform, generally lying between 20 mbgl and 25 mbgl, approximately 75 mAHD to 95 mAHD. However, localised perched groundwater systems are likely to be present over relatively low lying parts of the study area and are likely to have much shallower groundwater levels, potentially close to ground level
- The predominant groundwater flow direction is to the west, with a low horizontal hydraulic gradient of around 0.001 m/m, consistent with the flat topography
- Hydraulic conductivity testing has not been undertaken for the Project. However, hydraulic conductivity is anticipated to be low for clay dominant alluvium and moderate to high for sandy alluvial material
- Recharge occurs via rainfall infiltration, and via floodwater, during periods of flooding
- Groundwater discharge in the study area occurs via throughflow (i.e. out of the study area), abstraction by existing bores (bores are predominantly stock bores) and via evapotranspiration from shallow perched groundwater systems
- GDEs associated with perched groundwater systems are present within the study area
- Given the large depth to the regional water table, significant groundwater - surface water interaction is not anticipated within the study area. However, some surface water – groundwater interaction may be occurring which is associated with shallow perched groundwater systems
- Groundwater in the study area is generally fresh to slightly brackish
- Project construction and operational activities are unlikely to intercept the regional water table. However, may have potential to intercept localised perched groundwater systems.

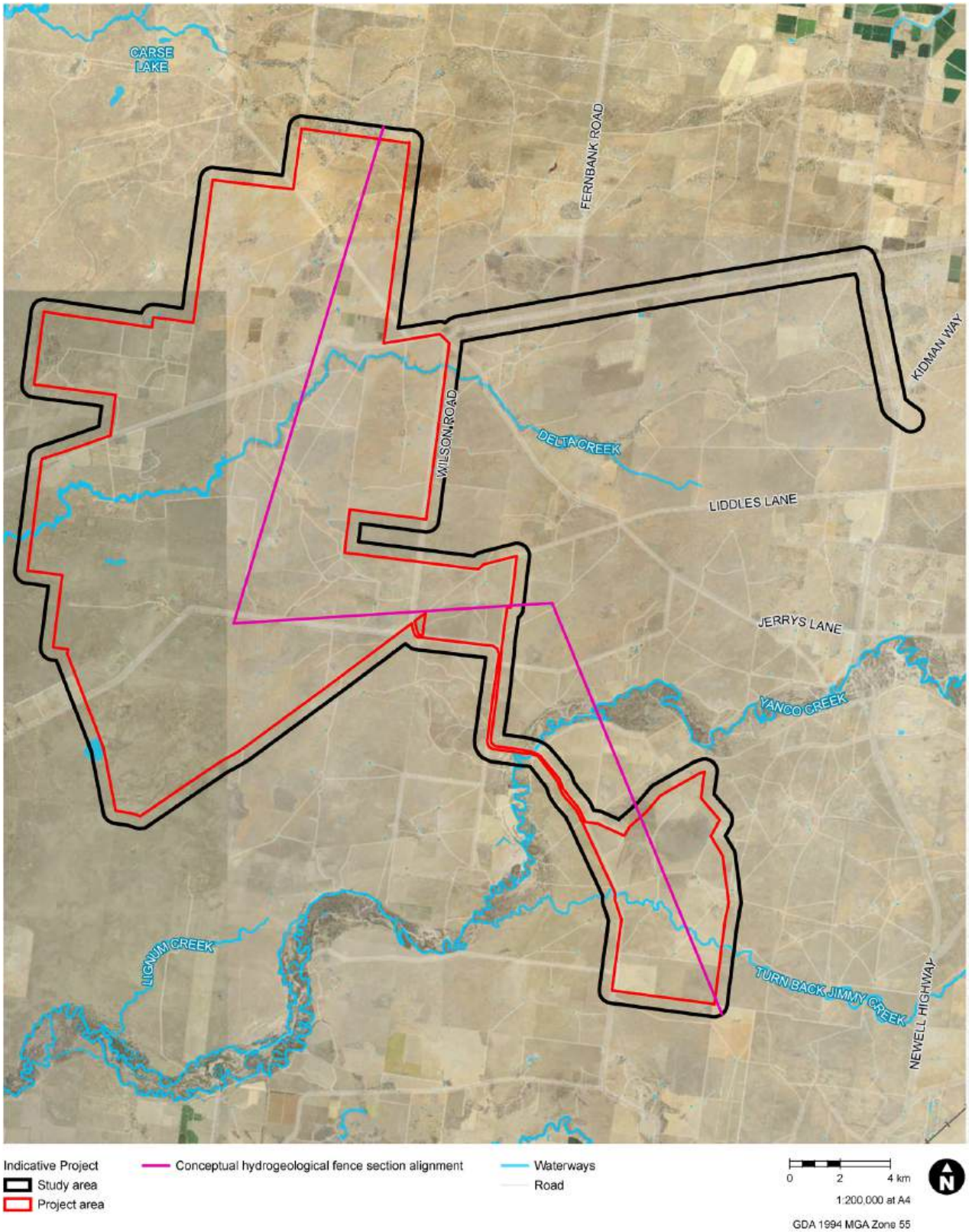
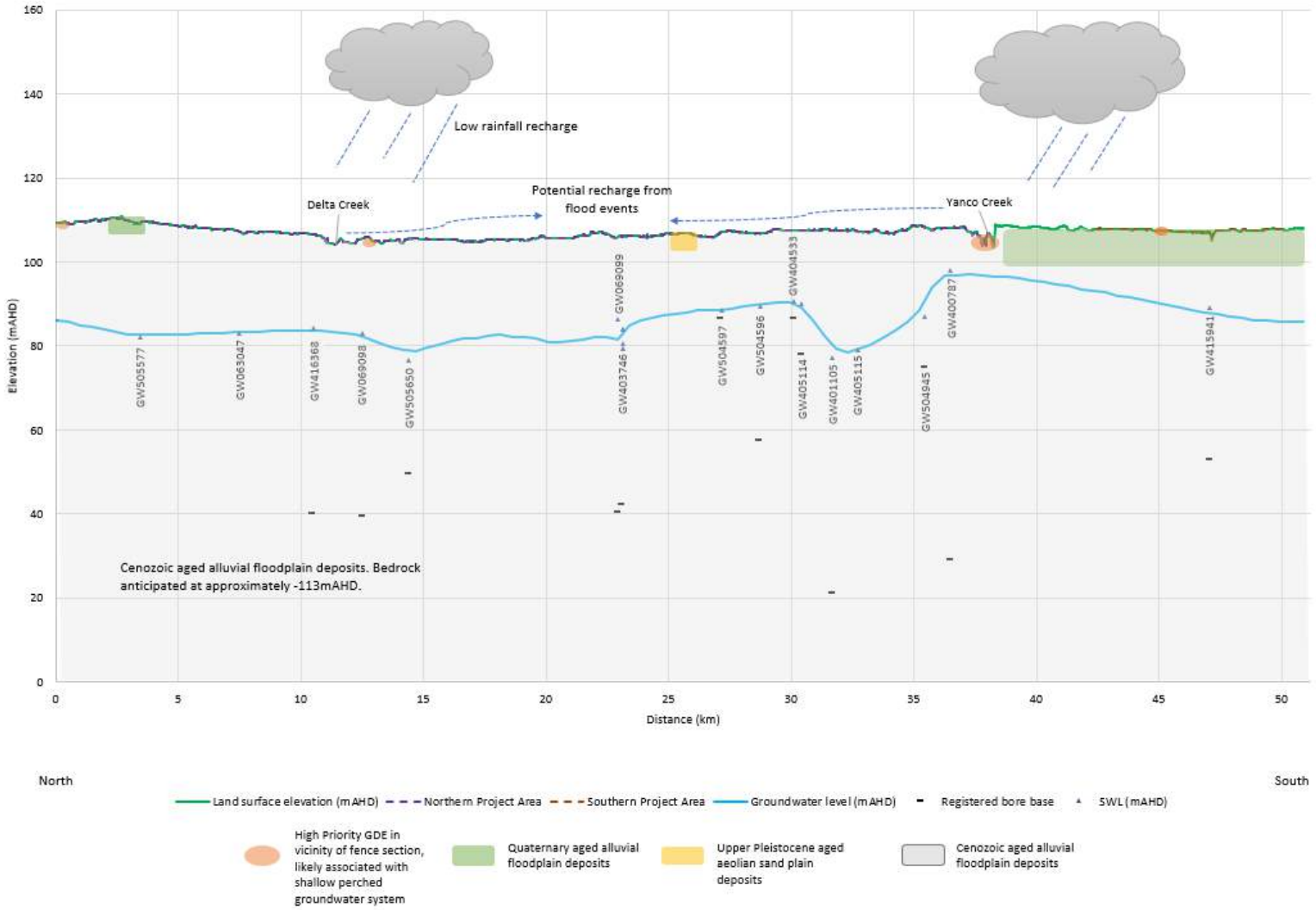


Figure 4-13 Conceptual hydrogeological fence section, mapped overview



Notes: 1. Where bore depth unknown, borehole depth was used as a surrogate for bore depth. 2. Quaternary aged alluvial floodplain deposits and Upper Pleistocene aged aeolian sand plain deposits are pictured to demonstrate lateral extent at surface. The depth of these deposits is unknown.

Figure 4-14 Conceptual hydrogeological fence section

5. Water demand

5.1 Construction Water demand

Water supply would be required during the 36 month construction phase of the Project. Key Project water demands include:

- Soil and fill conditioning
- Dust suppression
- Concrete production
- Concrete washout
- Vehicle and equipment wash down
- Amenities.

Water demands at this stage have been assessed based on the current design and a number of necessary assumptions.

The Yanco Delta Wind Farm Project – Geotechnical Investigations Report (Jacobs, 2022c) notes that Project soils are potentially problematic, particularly within wetter periods where trafficking across the site may prove very difficult. The water demand makes some basic assumptions about water requirements for soil conditioning, but final soil treatment would be dependent on more detailed site investigations. Key assumptions regarding all water demand calculations are provided in **Appendix A**.

Total Project water demands are presented on **Table 5-1**. The most substantial water demand is for dust suppression, followed by concrete batching and soil conditioning for road construction. Total water demand is estimated at 417.9 ML.

Water demand will vary over the Project construction phase, with most demand occurring during the first year of construction. The estimated monthly water demand is presented on **Figure 5-1**, with a more detailed breakdown provided in **Appendix A**.

Table 5-1 Project Water Demand

Water Use	Water Demand (ML)
Dust Suppression	154.366
WTG Foundations - concrete batching	105.840
Road Construction	102.600
WTG Hard Stand Construction	31.920
Concrete Washout	15.470
WTG Foundations - concrete curing	5.250
BESS Foundations - earthworks	1.800
Potable	0.360
Vehicle washdown	0.270
Total	**417.880**

Maximum water demand is expected to occur during Year 1 of construction with demand peaking at 26.3 ML/month. This coincides with the main period of construction of access tracks, WTG foundations and hardstand areas.

Over the first 18 months of construction the average monthly demand is approximately 18.8 ML, or 0.62 ML/day, while over the final 18 months, the average monthly demand drops to 4.4 ML, or 0.14 ML/day.

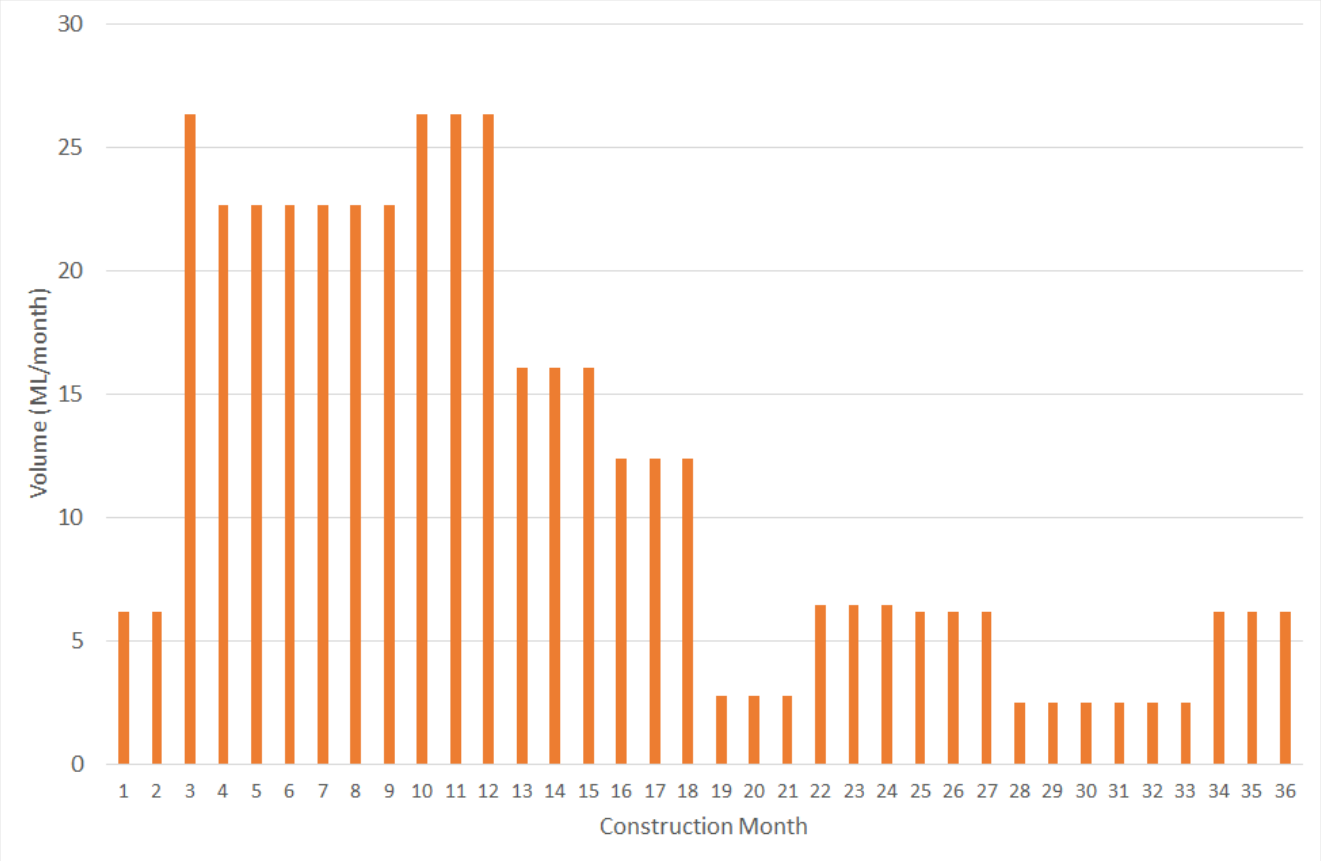


Figure 5-1 Project Construction Water Demand

5.2 Operational Water demand

Operational water demands would be substantially reduced from even the lowest periods of construction demand.

Ongoing potable supply would be required, however, this would be for a much reduced workforce. Ad-hoc water use may also be required for road maintenance. Water supply for operation would correspond with the information presented in **Section 5.3**.

5.3 Water Supply

The majority of water required to meet Project water demands would be imported, and would most likely be sourced through a commercial arrangement with Murrumbidgee Council, with raw water utilised for construction and potable supplies sourced for site offices and amenities.

Potable water demands for the Project would be supplied via water tanker and stored in on-site water tanks. Potable water storages would be routinely tested to ensure water quality meets the requirements of the Australian Drinking Water Guidelines (ADWG) (National Health and Medical Research Council, 2011) and an appropriate maintenance regime would be implemented to ensure water quality ADWG water quality standards are maintained.

Sources for non-potable water demands may include:

- Harvested runoff from disturbed areas captured in excavations or sediment basins/traps constructed to prevent sediment transport off-site

- Harvested runoff from farm dams under agreement with host or local landholders
- Groundwater from licenced bores under agreement with host or local landholders
- Recycling and reusing water
- Purchasing and transporting water to site by tanker.

The largest water demands, such as for dust suppression, soil conditioning, and concrete batching, are all non-recoverable water uses. Where possible, water uses. such as for concrete facility and vehicle washdown, would be recycled and reused as far as practical.

During construction there may also be opportunities to utilise water collected in sediment retention ponds, or locally sourced from farm dams or private bores. Local water supply from private dams and bores would need to be with harvestable water rights and water access licencing conditions.

Where further licenses are needed to access water from these sources or license amendments are required, these would be sourced by Virya Energy prior to the water being used.

6. Potential construction impacts

Construction of the Project would involve the following elements as outlined in **Table 6-1**. The construction elements would involve a range of activities including vegetation clearing and subsequent mulching, earthworks, trenching, concrete works and the establishment of a construction compound. These construction activities present a potential risk to surface water quality and groundwater if appropriate management measures are not implemented, monitored and maintained throughout the construction phase. These potential impacts are discussed in the sections that follow.

Table 6-1 Construction activities associated with Project elements

Project Element	Summary of Component	Construction activities
Wind turbine generators - installation of up to 208 WTGs throughout the Project area	• Hardstand areas – each WTG is mounted on a reinforced concrete footing and would have a hardstand area of 40x50m • Micrositing – may result in relocation of WTG due to potential technical, geotechnical or environmental issues	• Vegetation clearance • Earthworks and excavation • Stockpiling • Concreting • Transport of excess spoil off site • Vehicle movements to and from sites
Battery Energy Storage System (BESS)	• Installation of BESS that would cover a footprint of up to 5 hectares. • BESS would consist of battery modules and components and ancillary infrastructure	• Vegetation clearance • Earthworks and excavation • Stockpiling • Concreting • Transport of excess spoil off site • Vehicle movements to and from sites
Electrical connections	• Internal cabling – about 287 km of cables most of which are underground and along proposed access tracks and installation of about 60 km of overhead powerlines • Substations – 8 collector substations (~ 1 ha) proposed which would then connect to the central primary substation (~10 ha) • Transmission line – approximately 32 km of overhead transmission line to be construction within an existing easement • Transmission line construction to connect to the Dinawan Terminal Station	• Vegetation clearance/trimming • Earthworks • Use of heavy machinery • Trenching of cable route • Instream works • Stockpiling • Backfilling • Transport of excess spoil off site • Establishment of erosion and sediment controls • Concrete/grouting • Use of heavy machinery
Temporary facilities	• Construction compound – main compound would be up to 1 hectare in size and would include site office, car-park area, storage and equipment laydown areas • Gravel borrow pits and concrete batch plants – up to 2 concrete batching plants to produce concrete for construction of hardstand areas and other ancillary infrastructure. Gravel for concrete production may be sourced from nearby gravel pits.	• Vegetation clearance • Earthworks and excavation • stockpiling • Establishment of Construction compounds and ancillary facilities. • Vehicle movements to and from sites • Concreting

Project Element	Summary of Component	Construction activities
	• Construction access tracks – internal access tracks to provide access to and from WTGs, temporary facilities and other construction areas. tracks would be stabilised where required but not paved or asphalted	

6.1 Surface water quality

The key pollutants of concern during construction would be sediment, oil and grease and pH. Other pollutants (such as nutrients), however, may also be bound to the sediment or present in dissolved form. Based on available data, the water quality objectives, as defined in **Table 3-1**, (namely protection of aquatic ecosystems) are not currently being met. The Project would aim to contribute to achieving these WQOs, to the extent possible, through the implementation of management measures provided in **Table 10-1**.

As described in **Section 4.3.4**, it is not confirmed if the remaining nominated WQO are being achieved. The key indicators of concern for protection of recreational suitability is enterococci and algae. The construction of the Project is not expected to generate an increase in these indicators and, therefore, would not impact on achieving protection of primary and secondary contact recreation.

While much of the proposed Project infrastructure has been designed to avoid waterways, some components such as access tracks and underground cables cannot completely avoid waterways. **Table 6-2** indicatively lists the waterways that may be impacted by the Project most of which are unnamed ephemeral drainage lines.

Table 6-2 Waterways and crossings by the Project infrastructure

Waterways	Intersected by
Delta Creek	Existing access tracks that would be widened Overhead transmission line crossing Delta Creek and unnamed ephemeral drainage lines at Cadell Road
Unnamed drainage line to Delta Creek (south-east)	Underground cabling and access tracks in 8 locations
Unnamed drainage line to Delta Creek (north)	Underground cabling and access tracks in 12 locations
Yanco Creek	Wilson Road (existing road) that would be utilised as access track
Turn Back Jimmy Creek	Overhead wiring in 3 locations
Unnamed drainage line to Turn Back Jimmy Creek (south)	Underground cabling in 5 locations and access track in 2 locations
Unnamed drainage line to Turn Back Jimmy Creek (north)	Underground cabling and access tracks in 6 locations
Other unnamed drainage lines	A number of other unnamed drainage lines within the Project area would be intersected by proposed Project access roads and underground cabling

At Delta Creek and surrounding tributaries, access tracks, transmission line to Dinawan Terminal Station and underground cabling would utilise existing tracks where possible. Where this is not possible, the Project would trench for underground cabling. At other waterways, such as Yanco Creek and Turn Back Jimmy Creek, and their associated tributaries, the installation of overhead wiring would occur as preference to trenching through waterways.

Instream work presents a risk to downstream water quality from the disturbance of the streambed and the mobilisation of sediments and other pollutants, resulting in poor water quality immediately downstream. Work occurring outside of these waterways can also indirectly impact downstream receivers from mobilisation of sediment and pollutants via wind and rain, if not appropriately managed during construction. Construction of the Project would not result in controlled discharges to waterways nor would there be any water take from surface water during construction (refer to **Section 5.3**).

Potential impacts to surface water quality during construction and the risk of their occurrence are described in the sections below.

6.1.1 Erosion and sedimentation

Construction of the Project would require disturbance of approximately 238 hectares of the Project area. This could result in erosion and sedimentation of downstream environments. Key activities during construction that can directly or indirectly increase erosion and sedimentation include:

- Stockpiling – excavated material would require stockpiling before being reused on the Project. If stockpiles are not adequately stabilised, material could erode away during high rainfall or windy events
- Construction of hardstand areas and access roads – there is the risk of soil compaction during the construction of access roads and hardstand areas from the operation and movement of heavy machinery. This heavy machinery can disturb soil surface, increasing the potential for erosion
- Cabling – the installation of cables underground would involve soil disturbance from trenching. The disturbance of soil by machinery could increase the potential for soil erosion.

Soils exposed during earthworks would be at risk of being transferred via wind or stormwater runoff to downstream aquatic environments. Additionally, there is a high probability of Acid sulfate soils (ASS) around watercourses. Excavated soils may also contain contaminants (i.e. heavy metals and hydrocarbons) from previous land uses which could become exposed as a result of earthworks.

Previous land uses, as identified in the Soils and contamination technical report (Jacobs, 2022b), include the:

- Historical and current application of herbicides and pesticides associated with general cropping and farming activities
- Heavy metals from sheep and cattle dips
- Heavy metals, cyanide compounds, hydrocarbons (TRH, BTEX, PAH), volatile organic compounds (VOC and SVOC), and explosive compounds associated with the historical quarry.

Waterways at most risk are those where construction work would occur near or traverse the waterway. This includes Delta Creek, Turn Back Jimmy Creek and several drainage depressions that would flow to these waterways under high flow conditions.

Once sediments enter the waterway, they can directly and indirectly impact on water quality and the aquatic environment as detailed below:

- Increased sedimentation and deposition can alter the geomorphology of waterways, increase turbidity and reduce water clarity, impacting visual amenity and lead to smothering of aquatic ecosystems due to clogging fish gills or decreasing trophic interactions due to reduced visibility
- Sediments may also contain high concentrations of nutrients which can lead to algal blooms and subsequently result in reduced light penetration and limits the growth of aquatic vegetation. Algal blooms may also result in a reduction in dissolved oxygen within the waterway leading to anoxic conditions resulting in fish-kills
- Mobilised sediments may contain elevated concentrations of metals and other contaminants, which can negatively impact aquatic life, as well as reduce the suitability of the water for other beneficial uses (i.e. drinking, irrigation and recreation).

Sediment-laden runoff and pollutants from soil disturbance have the potential to temporarily reduce downstream water quality. If mobilised downstream, however, impacts to surrounding waterways are considered unlikely to occur as construction runoff would be managed with the implementation of management measures outlined in **Chapter 10**. Site erosion and sediment controls and other management measures would be established as the first step in commencement of construction activities to avoid and/or manage erosion and sedimentation impacts.

In the event that acid sulfate soils are encountered and disturbed during excavation, an ASS management plan would be prepared and implemented as part of the Construction Environmental Management Plan (CEMP) Contaminated soils, where encountered, would be managed to minimise risks that contaminants are not mobilised downstream. Further information of the potential risks associated with contaminated soils is provided in the Soils and contamination technical report (Jacobs, 2022b).

6.1.2 Removal of vegetation

Construction of the Project would require removal of up to 173 hectares of native vegetation. Vegetation removal exposes soils to weathering processes, thereby increasing the risk of erosion and sedimentation. Clearing and mulching of vegetation can also result in tannin leachate entering downstream waterways. Tannins can result in dark coloured water being discharged from construction sites into downstream waterways. This reduces the visual amenity of the water, alters the pH, and reduces visibility and light penetration through the water column. Tannin can also increase biochemical oxygen demand (BOD), thereby decreasing dissolved oxygen. This can impact on aquatic ecosystems and lead to fish kills.

Vegetation clearing, particularly riparian vegetation, can result in poor water quality due to increased sediment laden runoff and bank erosion. Approximately 3.96 hectares of riparian vegetation removed is required throughout the Project area. Waterways are greatest risk of impacts from tannin leachates are Yanco Creek due to their proximity to the vegetation clearing. The risk of tannin leachate mobilising to downstream receivers during Project construction is considered low given the minimal amount of riparian removal.

Water quality as a result of Project vegetation clearing would be managed through erosion and sediment controls, as well as additional management measures (detailed in **Table 10-1**). These would be established on-site prior to any vegetation clearance work being carried out.

6.1.3 Stockpiling of topsoil and vegetation

Excavation material would need to be stockpiled prior to being reused on the Project or transferred. Stockpiles of raw materials or spoil would be located as close as practical to the work area and appropriate environmental management measures would be implemented to minimise impacts on receiving waters from erosion and sedimentation. The main construction compound which would have stockpiling is located approximately 400 to 500 metres from an unnamed tributary of Delta Creek. Stockpiles would also be located throughout the Project area and therefore can present a risk to nearby waterways.

Stockpiles that are not adequately stabilised can result in material eroding away during windy conditions or high rainfall events. This can introduce sediments, nutrients, hydrocarbons, metals, contaminants and gross pollutants into downstream waterways, Sedimentation can result in increased turbidity of waterways. Elevated turbidity could lead to fish kills due to clogging of fish gills. Increased turbidity can also reduce light penetration which can limit the growth of aquatic vegetation.

Stockpile management during Project construction would be detailed in the Construction Soil and Water Management Plan (CSWMP) and include locating stockpiles away from overland flow paths and providing stabilisation, watering and covering of stockpiles where necessary.

6.1.4 Transportation of excavated material and the movement of heavy vehicles across exposed earth

The movement and operation of heavy machinery within the Project area can disturb soils, particularly in areas where vegetation has been removed or topsoil has been stripped, thereby increasing the potential for erosion and sedimentation in downstream receiving environments. Waterways near access tracks, ancillary facilities and areas when construction vehicles, plant and equipment would be used are at greatest risk.

The transport of excavated material or fill to and from the Project area also presents a risk to water quality. Construction access roads are required between WTGs, substations and to the construction compounds. Waterways at greatest risk are those that are either crossed or are near unsealed access tracks and the construction compound, including Delta Creek and Turn Back Jimmy Creek and several of their unnamed tributaries.

6.1.5 Accidental spills and litter

The release of potentially harmful chemicals and other substances in the environment may occur accidently during construction due to leakage or spills of petroleum, oils and other toxicants from construction machinery, plant equipment, refuelling and vehicles travelling to and from site. Spills and leakages could be transported to downstream waterways.

Potential pollutants of concern include hydrocarbons, oil and grease, hydraulic fluids, high pH, zinc and other hazardous chemicals. These can result in oily films on surface waters reducing the visual amenity and biodiversity, loss of habitat, and fish kills from increased concentrations of toxicants. Accidental spills can occur throughout the Project area, particularly at the construction compound. The proposed Project construction compound would be up to one hectare and would include a site office, car park area, storage and equipment laydown area. This would be located approximately 300 metres away from an unnamed drainage channel of Delta Creek and, therefore, presents a very low risk to water quality.

Spills can also occur on any access roads where transport of materials would occur. As such, all waterways previously identified (**Section 4.2**) as being at risk during construction, with the addition of Yanco Creek which would be crossed via an existing road, are at risk from accidental spills.

Construction may involve the creation of litter at construction compounds and at work sites. If not properly disposed of, mobilisation of litter by construction personnel to waterways may lead to the introduction of gross pollutants, hydrocarbons and heavy metals into the waterways which may be harmful to aquatic life and reduce visual amenity.

Any accidental spills from Project construction or littering is unlikely to result in any significant long-term impact to downstream water quality and aquatic ecosystems as any impacts would be temporary and manageable through erosion and sediment controls and additional management measures (as outlined in **Table 10-1**). These would be further developed and implemented as part of the CEMP.

6.1.6 Trenching

Approximately 287 kilometres of cables would be required for the Project, the majority of which would be underground. Installation of these cables would require excavations of trenches 0.5 metres wide and 1.2 metres deep. Trenching would occur over a relatively flat topography (refer to **Section 4.6**). The cables are laid in a trench and then backfilled. The surface is then restored and stabilised. Excavated material is generally stockpiled adjacent to the trench for later use when backfilling.

There is potential for erosion to occur as a result of trenching and earthworks for cabling. This risk of erosion is influenced by the extent of vegetation clearance and soil disturbance and topography. The impact to water quality would be as per those related to erosion and sedimentation (refer **Section 6.1.1**) such as increased turbidity and smothering for downstream habitats due to increased mobilisation of sediments. Delta Creek, Turn

Back Jimmy Creek and unnamed drainage lines as documented in **Table 6-2** are all at risk as cabling would be laid across these waterways or in proximity.

As described in **Section 6.1.1, c**onstruction of access tracks and installation of cables would require works within waterways. These works are proposed in 1 – 3 order streams that are essentially ephemeral drainage depressions and would not impact on the bankful level (i.e. the water level, or stage, at which a waterway is at the top of its banks and any further rise would result in water moving into the flood plain). As such, detailed design of waterway crossings are not required to consider the DPI guidelines *Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings (2003)* , DPI *Guidelines for watercourse crossings on waterfront land (2012) ,Guidelines for riparian corridors on waterfront land* (2012*)* and DPI *Guidelines for controlled activities on waterfront land – riparian corridors* (2018) Despite this, works within or near watercourses would be undertaken with consideration given to the *Guidelines for Controlled Activities on Waterfront Land*.

6.1.7 Concrete work

Concrete work would be required for the foundation to which each WTG would be mounted. Up to two concrete batching plants would be used during construction to produce the concrete required for this. The batching plants would be adjacent to the construction compound.

Concrete work may result in concrete dust, concrete slurries or washout water being discharged to downstream waterways. Concreting and its by-products can result in increased alkalinity and pH which can be harmful to aquatic life. Water from concrete curing can be high in chromium and can accumulate in the gills of fish affecting the health of aquatic organisms.

The risk of transportation of concrete waste is considered low as no concreting would occur within the riparian zone, which is defined as 40 metres from the waterway bank in accordance with the *Guidelines for Controlled Activities on Waterfront Land* (DPI, 2018). Additionally, water quality controls and management measures (detailed in **Chapter 10**) would be implemented to ensure no runoff is mobilised downstream.

6.1.8 Installation of transmission infrastructure

Power transmission infrastructure would be required to transmit the electricity generated by the WTGs. In addition to the underground cable mentioned in **Section 6.1.6**, approximately 60 kilometres of overhead powerlines and substations would also be required. Laydown of material and equipment and stockpiling of construction materials would occur within the cleared areas of the transmission corridor adjacent to each transmission structure. Installation of the substation/s and powerlines would involve soil disturbance. The disturbance of soil by construction machinery could increase soil erosion which has the potential to impact downstream water quality.

No waterways would be directly impacted by installation of structures which would not occur instream. There is, however, a very low risk that waterways or drainage lines located near the transmission line corridor could be impacted by earthworks and stockpiles.

6.2 Groundwater

6.2.1 Potential changes to groundwater levels and flow directions

Construction activities are not anticipated to intersect the regional water table. Therefore, changes to regional groundwater system levels and flow directions are not anticipated to occur during the Project's construction phase. This assessment is made as the regional water table is at a depth of approximately 20 mbgl to 25 mbgl in the study area and Project excavations are anticipated to be limited to between 2.5 mbgl to 3.0 mbgl for the WTG foundations. Additional Project excavations for minor structures, access tracks, underground cabling, ancillary infrastructure and temporary facilities are not anticipated to exceed the depth of WTG footing excavations.

It is possible that proposed Project's excavations could intercept localised perched groundwater systems. If shallow perched groundwater systems are intercepted by Project excavations, material groundwater impacts are not anticipated. This is due to the limited vertical extent of the Project and short term timeframe for exposed footing excavations. Once footings are poured and concrete cured, or trenches backfilled, if groundwater is encountered, groundwater levels would recover.

6.2.2 Potential changes to baseflow volumes

Project construction activities are not anticipated to intersect the regional water table. Therefore, material changes to watercourse baseflow during the construction phase would not occur.

6.2.3 Potential impacts to GDEs

Impacts to GDEs due to Project induced groundwater level reductions are not anticipated. As outlined in **Section 6.2.1**, Project work is not anticipated to intersect the regional water table, but could intercept shallow perched groundwater systems. Any potential impacts to perched groundwater systems would be localised and short-lived and, as such, would not result in material impacts to GDEs.

Separate to the above, some areas of potential GDE and High Priority GDE are mapped in locations where Project infrastructure is proposed. Therefore, such GDEs, if present, may require clearing. Potential impacts associated with clearing of GDEs is assessed in the Project's Biodiversity Development Assessment Report (Jacobs, 2022a).

6.2.4 Potential impacts to registered bores

Project construction activities are not anticipated to intersect the regional water table. Therefore, existing registered bores in the vicinity of the Project would not be impacted.

6.2.5 Potential changes to groundwater quality

Changes to groundwater quality could occur if groundwater systems become contaminated due to accidental spills or leaks of hazardous materials (such as fuels, lubricants and hydraulic oils) that occur during construction. This risk of groundwater contamination occurring is considered low with the implementation of management measures, including standard controls which would be incorporated in the CEMP that would be prepared for the Project.

The Project is not expected to change groundwater salinity during the construction phase.

6.2.6 Groundwater take

Material groundwater take is not anticipated to occur during the Project construction. This is because Project work is not anticipated to intersect the regional water table. There is a potential for some minor groundwater take to occur if Project excavations intercept localised perched groundwater systems. However, such take would be regionally insignificant and likely below 3 ML/year, which is the threshold volume beneath which a WAL is not required for temporary construction dewatering.

Water demand and supply options are discussed in **Section 5.1**.

6.2.7 NSW AIP minimal impact consideration assessment summary

During construction, Project impacts are assessed as likely to be less than the NSW AIP's (DPIE, 2012) minimal impact considerations (**Section 2.3.11**). This is because:

- No Project induced drawdown is anticipated at existing surrounding registered bores
- Project induced drawdown is not anticipated at high priority GDEs
- The Project is unlikely to lower the groundwater's beneficial use category beyond 40 metres from the activity
- The Project is unlikely to change groundwater salinity.

7. Potential operational impacts

7.1 Surface water quality

During operation, risks to surface water quality are primarily associated with the establishment of new permanent impervious surfaces and the operation and maintenance facility, the use of internal access tracks to, from and between WTGs, and decommissioning activities. These are discussed in the sections below.

The key pollutants of concern during operation would be sediment and contaminants such as hydrocarbons. Other pollutants (such as nutrients), however, may also be bound to the sediment or present in dissolved form. Based on available data, the water quality objectives, as defined in **Table 3-1**, namely protection of aquatic ecosystems are not currently being met. The project however, through the implementation of management measures provided in **Table 10-1** is not expected to result in a deterioration in water quality such that the nominated WQOs would not be achieved in the future. Additionally, the key indicator of concern for protection of recreational suitability is enterococci and algae. The operation of the Project is not expected to generate an increase in these indicators and therefore would not impact on achieving protection of primary and secondary contact recreation.

7.1.1 Impervious surfaces

During operation, the Project would result in a minor increase of impervious surfaces within the Project area due to the presence of roads, WTG foundations and operational facilities. As the topography of the Project area is relatively flat, any increased runoff from impervious areas is expected to infiltrate into the adjacent catchment. Given the implementation of management measures detailed in **Table 10-1**, hardstand areas located near waterways such as Delta Creek and Turn Back Jimmy Creek and their unnamed tributaries would not result in an increased risk of erosion or subsequent downstream sedimentation. Further, given there is no significant increase to impervious areas within the Project area, changes to hydrological flows are expected to be negligible.

7.1.2 Operation and maintenance facility

The proposed Project operation and maintenance facility would include a main control room, offices and amenity for staff, storage and laydown areas for equipment and materials, water tanks and septic systems and car park. Other facilities that present a risk to water quality include substations and battery storage systems. The risk to water quality can result from inappropriate storage of materials, hydrocarbon spills or leaks from machinery entering the unnamed drainage of Delta Creek which is located approximately 300 metres away. The risk to waterways from accidental leaks and spills was discussed in **Section 6.1.5**. Due to the distance from the unnamed drainage line (approximately 300 metres away) and with the installation of bunds and/or sumps and other controls, the risk to surface water quality is greatly reduced.

7.1.3 Access tracks

Temporary tracks established during the construction of the Project would be retained and converted to permanent access tracks where required. Tracks would be cleared of vegetation and stabilised where required but are not proposed to be paved or asphalted. The risk to water quality from driving on unsealed tracks can include the creation and transport of dust due to vehicle movements and erosion of roads if not appropriately maintained. This could potentially lead to transport of sediment to downstream waterways, including Delta Creek and Turn Back Jimmy Creek and their unnamed tributaries.

7.2 Groundwater

7.2.1 Potential changes to groundwater levels and flow directions

The Project has limited potential to alter groundwater levels and flow directions during operation. This is because there are no mechanisms to cause significant changes in groundwater levels. Project operation and maintenance is not anticipated to intersect the regional water table.

Potential groundwater level drawdown associated with footing excavations (or other similar shallow excavations) intercepting localised perched groundwater systems during Project construction (refer to **Section 6.2.1**) is expected to recover and not be applicable during the operation of the Project.

7.2.2 Potential changes to baseflow volumes

Project operation and maintenance is not anticipated to intersect the regional water table. Therefore, material changes to watercourse baseflow during the operation phase are assessed as unlikely to occur.

7.2.3 Potential impacts to GDEs

Impacts to GDEs due to Project induced groundwater level reduction are not anticipated during operation. Potential groundwater level drawdown associated with footing excavations (or other similar shallow excavations) intercepting localised perched groundwater systems during Project construction (refer to **Section 6.2.1**) is expected to recover and not be applicable during the operation of the Project.

7.2.4 Potential impacts to registered bores

Project operation and maintenance is not anticipated to intersect the regional water table. Therefore, existing registered bores in the vicinity of the Project would not be impacted during the operation phase.

7.2.5 Potential changes to groundwater quality

Changes to groundwater quality could occur if groundwater systems become contaminated due to accidental spills or leaks of hazardous materials (such as fuels, lubricants and hydraulic oils) that occur during operation. This risk of groundwater contamination occurring is considered low, provided management measures are put in place.

The Project is not expected to change groundwater salinity during the operation phase.

7.2.6 Groundwater take

Groundwater take is not anticipated during Project operation.

7.2.7 NSW AIP minimal impact consideration assessment summary

During operation, Project impacts are assessed as likely to be less than the NSW AIP's (DPIE, 2012) minimal impact considerations (**Section 2.3.11**). This is because:

- No Project induced drawdown is anticipated at existing surrounding registered bores
- No Project induced drawdown is anticipated at high priority GDEs
- The Project is unlikely to lower the groundwater's beneficial use category beyond 40 metres from the activity
- The Project is unlikely to change groundwater salinity.

8. Potential decommissioning impacts

Once the Project reaches its end of operational life (30 years), the above-ground Project infrastructure would be removed, unless required for the future land use of the Project area., The Project area would then be returned to its pre-construction condition.

The equipment required for decommissioning and activities undertaken would be similar to that used during the construction phase. This would include delivery of construction equipment to site and use of construction equipment, transport of materials and disposal of waste. Therefore, decommissioning of the Project would present a similar risk to water quality and groundwater as described in **Section 6.1** and **Section 6.2** but at a reduced scale. It is considered reduced for the following reasons:

- Access tracks and laydown areas are already established and therefore no further disturbance would be required
- No concrete batching is required
- Buried infrastructure such as footings and cables would generally be retained in situ and therefore no need for significant earthworks and excavation
- The decommissioning phase would be shorter in duration to construction.

Water quality controls and management measures for decommissioning would be detailed in the CSWMP as described in **Chapter 10.**

9. Cumulative impacts

Cumulative impacts are a result of incremental, sustained and combined effects of human action and natural variations over time and can be both positive and negative. They can be compounded when the potential impacts of a project are combined with past, current, planned, or reasonably anticipated future impacts (DPIE, 2021a). Cumulative impacts can result in a greater extent, magnitude or duration of impacts and may also arise where multiple or consecutive construction for development impact the same receivers.

9.1 Surface water

Cumulative impacts to surface water may arise from the interaction and operation of activities of the Project and other approved projects in the area. When considered in isolation, specific project impacts may be considered minor, however, these impacts may be more substantial when the impact of multiple projects on the same receivers are considered. As such, the surface water quality impacts discussed in **Chapter 5** and **Chapter 7,** were assessed in consideration of recently completed and proposed projects within the broader regional area as described in **Table 9-1**.

The identified projects are in varying stages of delivery and planning. This section provides a qualitative assessment of cumulative surface water quality impacts based on the most current publicly available information on the nominated projects.

Table 9-1 Summary of potential cumulative impacts

Project name	Brief project description	Common receivers	Potential impacts on common receivers construction and operation
Bullawah Wind Farm (Announced)	Construction, operation and maintenance of a wind farm with up to 170 wind turbine generators (up to 300m tip height), BESS and associated infrastructure. The project will have a capacity of 1000MW.	No common receivers	Similarly to this project the True Blue Wind Farm will be located within the NSW Governments South West Renewable Energy Zone approximately 40 kilometres north-east of the project area. The main waterways within the True Blew study area are Coleambally Outfall Drain and Euroli Creek. Whist both projects lie within the Murrumbidgee Catchment, there are no common receivers and therefore cumulative impacts from construction and operation of both projects is not expected.
Baldon Wind Farm (Planning)	Construction, operation and maintenance of a wind farm with up to 162 wind turbine generators, BESS and associated infrastructure.	No common receivers	Baldon Wind Farm would be located within the South West Renewable Energy Zone, but is located more than 100 kilometres west of this project area. The major waterways within the Baldon Wind Farm study area are Abercrombie and The Forest Creek. Due to the distance between the two projects and no common receivers there would be no cumulative impacts from construction and operation of either project.
Keri Keri Solar Farm (Planning)	Solar farm with a maximum insalled capacity of 500MW_p (MW-peak) and an alternating current	No common receivers	The Keri Keri Solar Farm will be located within the South West Renewable Energy Zone more than 100 kilometres west of the project area The Solar Farm is located within the Keri Keri Wind Farm project area. Abercrombie Creek is the

Project name	Brief project description	Common receivers	Potential impacts on common receivers construction and operation
	capacity of up to 400 MW_n (MW- nominal). The project will also include ancillary infrastructure.		main waterway that traverses the Keri Keri Solar Farm project area. Due to the distance between the two projects and no common receivers there would be no cumulative impacts from construction and operation of either project.
Keri Keri Wind Farm (Planning)	Construction, operation and maintenance of a wind farm with up to 176 wind turbine generators, BESS (up to 200 MW/800 MWh) and associated infrastructure.	No common receivers	The Keri Keri Wind Farm will be located within the South West Renewable Energy Zone more than 100 kilometres west f the project area. Abercrombie Creek is the main waterway that traverses the Keri Keri Solar Farm project area. Due to the distance between the two projects and no common receivers there would be no cumulative impacts from construction and operation of either project.
Project EnergyConnect (Eastern) (Approved)	Construction and operation of a high voltage interconnector between NSW and SA.	Yanco Creek	Construction and operation of the Yanco Delta Wind Farm would occur more than 50 kilometres upstream of the Project EnergyConnect crossing of Yanco Creek. Construction of the Project EnergyConnect is due to commence in late 2022 and would take around 18 months to complete and therefore would be unlikely to overlap with the construction of this Project. Construction of both projects presents the same risk to water quality. With respect the Yanco Creek, the key risk from the project is accidental spills and litter due to the transport of material via the existing road network. Given the distance between project crossings of Yanco Creek and the implementation of appropriate management measures, cumulative impacts would be negligible.
Micro Solar Farm (Approved)	Construction and operation of a 5MW micro solar farm and associated infrastructure, located within the Coleambally Irrigation Area.	No common receivers	The Coleambally Micro Solar Farm is located in the Murrumbidgee Catchment and has the potential to impact on the Boona Channel and Tubbo Channel (and other unnamed drainage channels) which flow to the Murrumbidgee River. The Micro Solar farm is designed such that there will be no change in flow rates and therefore the impact from stormwater runoff to downstream waterways is considered low (ACEnergy, 2021). As there are no common receivers and impacts to surface water quality are not anticipated from the Micro Solar Farm there would be no cumulative impacts to surface water quality from both projects constructing and operating over a similar timeframe.

Project name	Brief project description	Common receivers	Potential impacts on common receivers construction and operation
Riverina and Darlington Point BESS (Approved)	Construction and operation of a combined 150MW / 300MWh three independent but co-located BESS projects.	No common receivers	The Riverina and Darlington Point Energy Storage System is located within the same catchment as the Project, the Murrumbidgee Catchment. The nearest waterway to the battery storage is the Murrumbidgee River, which is not a common receiver. As such, there would be no cumulative impact to surface water quality.
Coleambally BESS (Planning)	Construction and operation of a 100MW / 200-400 MWh BESS including ancillary infrastructure in Coleambally, NSW.	No common receivers	The footprint of the Colembally BESS is located adjacent to Tubbo Channel which is not located within the Project Area. As there are no common receivers, there would be no cumulative impacts to surface water quality.
Woodland BESS (Planning)	Construction and operation of a 200MW / 800MWh BESS located about 10 kilometres south of Darlington Point.	No common receivers	The Woodland BESS proposal area contains a number irrigation channels and no named waterways. There are no common receivers with the Project and therefore there would be no cumulative impacts to surface water quality.
Dinawan Energy Hub (Announced)	Construction and operation of a hybrid wind, solar and battery storage project.	Murrumbidgee catchment	The project footprint for the Dinawan Energy Hub has not yet been defined. Given that the Hub would be located about halfway between Coleambally and Jerilderie there is the potential that there may be some common receivers. Construction of the Dinawan Energy Hub is anticipated to comment in 2024 (once approved) and therefore could overlap with construction of the Project (Sparke Renewables, 2021). As the Dinawan Energy Hub footprint is currently unknown, the level of impact to surface water quality of downstream receiving environments generated by this project is currently unknown. Consequently, cumulative impacts associated with the construction or operation of the project is unknown.
Victoria to NSW Interconnector West (VNI West) (Announced)	A new interconnector between Victoria and NSW.	Murrumbidgee catchment	The transmission route for the Victoria to NSW Interconnector West is located in the vicinity of the Project. As such, there is the possibility of common downstream receivers. However, as the transmission route has not yet been finalised, the level of impact to surface water quality of downstream receiving environments generated by this project is currently unknown. Consequently, cumulative impacts associated with the construction or operation of the project is unknown.

The water quality impacts associated with the construction and operation of the Project are expected to be minor with the implementation of appropriate environmental management measures. The Project is therefore expected to have a minor contribution to cumulative surface water quality impacts.

9.2 Groundwater

Cumulative groundwater impacts associated with the construction and operation of the Project interacting with other major projects in the area are assessed as unlikely to occur. This is because no material impacts to groundwater due to the Project are likely provided appropriate management measures are adopted.

10. Environmental management measures

The following management measures detailed in **Table 10-1** have been developed to specifically manage potential surface water quality and groundwater impacts which have been predicted during construction and operation of the Project.

With regard to surface water, the key objective is to ensure downstream waterways are protected against potential impacts from construction and operation of the Project. For construction, these measures would be outlined in the Construction Environment Management Plan (CEMP), and would include (but not be limited to) preparation of a CSWMP, Erosion and Sediment Control Plan (ESCP) and emergency spill response procedures.

The proposed management measures, including erosion and sediment controls, are designed to minimise pollutant loading to downstream waterways during the construction of the Project.

Potential runoff from the construction phase of the Project is designed to meet standards outlined in the Blue Book and to meet the required limits for the protection of WQOs.

Table 10-1 Surface water quality and groundwater environmental management measures

Impact	Reference	Environmental Management Measure	Responsibility	Timing
Erosion and sedimentation	SW01	A Construction Soil and Water Management Plan (CSWMP) will be prepared as part of the CEMP. The CSWMP will include but not be limited to: • Measures to minimise/manage erosion and sediment transport both within the Project area and offsite (including work on erodible soil types), including the requirements for the preparation of Erosion and Sediment Control Plan (ESCP) for construction • Measures to manage accidental spills, including the requirement to maintain materials such as spill kits • Measures to manage any potential acid sulfate soils (ASS) if found in excavated fill material in accordance with the NSW Acid Sulfate Soil Guidelines (Acid Sulfate Soils Management Advisory Committee, 1998) • Measures to manage potential tannin leachate • Measures to manage stockpiles • Details of surface water quality monitoring to be undertaken prior to, throughout and following construction (refer to SW4 for further information). Measures to ensure that all waterway crossings will be constructed in accordance with the Guidelines for Controlled Activities on Waterfront Land – riparian corridors (Natural Resources Access Regulator, 2018), Guidelines for watercourse crossings on waterfront land (DPI, 2012), Guidelines for riparian corridors on waterfront land (DPI, 2012) and Why Do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings (DPI, 2003).	Contractor	Prior to construction, Construction, Decommissioning
Erosion and sedimentation	SW02	A construction ESCP will be prepared as part of the CSWMP and will detail the specific erosion and sediment control measures to be implemented within the Project area, in accordance with the principles and requirements of Managing Urban Stormwater – Soils and Construction, Volume 1 (Landcom, 2004). Scour protection and control measures will be identified in the CSWMP to reduce erosion and water quality impacts from increased sediment loads from ancillary sites and access tracks.	Contractor	Prior to construction, Construction
Disturbance	SW03	To avoid any impacts on water quality and threatened species, the following measures will be implemented: • Minimise the total area of bare earth exposed at any time	Contractor	Construction, decommissioning

Impact	Reference	Environmental Management Measure	Responsibility	Timing
		• Employ interim rehabilitation strategies to minimise dust generation, soil erosion and weed incursion on parts of the Project area that cannot yet be permanently rehabilitated • Where required, rehabilitate all areas of the Project area that are not proposed for future disturbance as soon as is practicable following construction and decommissioning.		
Water quality - monitoring	SW04	A surface water monitoring program will be implemented as part of the CSWMP prior to, during and following construction and decommissioning. The monitoring program will include but not be limited to: • Visual assessment and routine monitoring of physico-chemical parameters and contaminants of concern at downstream SREs to ensure compliance with applicable guidelines during construction and decommissioning • Visual assessment of surface water quality control structures at least once a week and also following any heavy rain during construction and decommissioning, to ensure controls are operating effectively for their designed purpose.	Contractor	Prior to construction, Construction, decommissioning
Construction – Spills and litter	SW05	Project specific controls and procedures will be developed and implemented as part of the CSWMP to reduce the risk of litter, spills and leaks entering downstream waterways and/or leaching into the soil and groundwater table. The CSWMP will include, but not be limited to, the following measures: • All fuels, chemicals and liquids will be stored on level ground away from waterways and will be stored in sealed bunded area within the construction compound • Refuelling and minor maintenance activities will be limited to designated areas with established spill capture and management controls • An emergency spill response procedure will be prepared as part of the CSWMP • Regular visual water quality checks (for hydrocarbon spills/slicks, turbid plumes and other water quality issues) will be carried out at waterways in proximity to work • Installing and maintaining control measures such as silt fencing and gross pollutant traps.	Contractor	Construction, decommissioning
Impacts of stockpiles	SW06	Stockpiles will be managed to minimise the potential for mobilisation and transport of dust, sediment and leachate in runoff. This will include: • Minimising the number of stockpiles, area used for stockpiles, and time that they are left exposed	Contractor	Construction

Impact	Reference	Environmental Management Measure	Responsibility	Timing
		• Locating stockpiles away from drainage lines, waterways and area where they may be susceptible to wind erosion • Stabilising stockpiles, establishing appropriate sediment controls and suppressing dust as required.		
Concrete works	SW07	Batch plants will be located on a concrete slab adjacent to the construction compound. To avoid ingress of concrete waste material into downstream waterways, the CEMP will outline procedures to capture, contain and appropriately dispose of any concrete waste from concrete work, including designated lined, bunded and controlled concrete washout areas.	Contractor	Prior to construction, Construction
Operation – stormwater runoff	SW08	Increased stormwater runoff during Project operation will be managed through: • The design of permanent drainage and water management, demonstrating the ability to meet Project performance outcomes of no pollution of water • Scour protection, control measures and maintenance of access tracks to reduce erosion and water quality impacts • Monitoring of receiving drainage channels and waterways downstream of discharge location to identify any evidence of channel erosion and scour.	Contractor	Operation
Operation – Spills and emergency management	SW09	Project specific controls and procedures will be developed to reduce the risk of the release of potentially harmful chemicals from spills entering downstream watercourses such as: • Appropriate storage of equipment and hazardous substances during operation • Operational procedures for emergency response to spills and leaks from equipment or maintenance activities.	Contractor	Operation
Water demand	SW10	Any water licences for the Project will be obtained in accordance with the *Water Management Act 2000*.	Proponent / Construction Contractor	Prior to construction, construction
Impacts to High Priority GDEs	GW01	If, during detailed design, Project excavation is designed to exceed the current proposed maximum depth of 3 mbgl, potential impacts to GDEs will be re-assessed by a suitably qualified hydrogeologist.	Contractor	During detailed design and construction

11. Conclusion

This surface water quality and groundwater assessment for the construction and operation of the Project has been prepared based on existing preliminary design information and a review and analysis of available data, aerial photography, topography, database searches, relevant literature, and applicable legislation, policies and guidelines.

Surface water

The desktop review identified waterways and sensitive receiving environments within the Project area. This included Delta Creek, Yanco Creek and Turn Back Jimmy Creek all of which have been identified as SREs. In addition to these waterways, there are numerous ephemeral unnamed tributaries within the Project area. Due to the ephemeral nature of most of the waterways, water quality data was only available for Yanco Creek and other waterways which, while outside of the Project area, are representative of the Yanco Creek system. Overall, water quality could be described as having elevated turbidity and nutrients and, at times, low dissolved oxygen. The existing water quality does not meet the recommended limits for protection of aquatic ecosystems. Existing literature suggests that water quality notably deteriorates following rainfall events.

The key risk to surface water quality would be related to earthwork, establishment of access roads and trenching (required to install cabling). Potential impacts during Project construction would therefore be associated with mobilisation of sediment and contamination to downstream waterways from wind and stormwater runoff.

During Project construction the following potential impacts were identified if no mitigation measures were implemented:

- Erosion and sedimentation of waterways
- Reduced water quality from elevated turbidity, increased nutrients and other contaminants
- Smothering of aquatic organisms from increased sediments and associated low dissolved oxygen levels
- Potential increased occurrence of algal blooms associated with reduced water quality
- Increased alkalinity and pH from concreting and its by-products
- Migration of litter off-site
- Contamination from accidental leaks or spills of chemicals and fuels.

These potential impacts are considered unlikely to occur and would be managed through implementation of erosion and sediment controls and other identified management measures.

During operation, potential impacts to surface water quality would primarily be associated with increased surface runoff, use of access tracks and the operation and maintenance facility. Without appropriate management measures, there is the potential for the water quality of downstream waterways to be impacted from leaks and spills and erosion and sedimentation. Identified operational impacts are also considered unlikely as management measures would be implemented during operation to protect water quality and would include procedures for the appropriate storage of equipment and hazardous substances and emergency response procedures to manage leaks and spills.

Groundwater

The Project is unlikely to cause material impacts to groundwater systems during construction or operation. This is because material changes to groundwater levels, flows and quality due to the Project are not anticipated. Potential groundwater impacts are predicted to be less than the NSW Aquifer Interference Policy's (DPI, 2012) 'minimal impact considerations', the primary groundwater criterion adopted for assessment.

The risk of groundwater systems being impacted by the Project is considered low provided the recommended management measures are adopted. Overall, with implementation of the proposed management measures, the Project is expected to have minimal impacts on groundwater systems.

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Appendix A. Construction Water Balance

Water balance – Key Assumptions

Water Use	Assumptions
Road Construction	• 5m wide by 270 km • Rip to 500mm and re-compact - add 8% water content to condition • 300mm road base - add 12% water content to condition • pro-rata over period of road construction
WTG Foundations	• 60 m radius (approx. 5,000 m^2) • 5040 t of 50MPa concrete (equivalent 2,291 m^3) – approx. 100 L water per tonne • 1 week curing - 5 L/m^2 (mixing curing compound) • 208 units spread evenly over excavation and foundation construction period
WTG Hardstand	• 40 m x 50 m (approx. 2,000 m^2) compacted fill • Rip to 500mm and re-compact - add 8% water content to condition • 300mm road base - add 12% water content to condition • pro-rata over period of road construction
Concrete Washdown	• Approx. 250 L per truck (18t) • spread evenly over excavation and foundation construction period
BESS Foundation	• up to 15 hectares (150,000 m^2) • assume 300mm fill on grade - add 12% water content to condition • assume timing coincides with electrical substations
Dust suppression	• Active work areas only - assume at 10% of total tracks at any one time • 0.3 mm per pass • Wet / dry season loading - dry 5 passes per day / wet 2 passes per day
Vehicle and equipment washdown	• Allowance 5,000 L/day - dry, 10,000 L/day wet
Potable	• Construction workforce - 150 pers. Years 1 and 3, 300 Pers. Year 2 • allowance 40 L/pers/day - 5.5 day week